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YIELD AND QUALITY COMPARETIVE OF DIFFERENT FODDER COWPEA TYPES MIXED WITH VARIOUS GRASSES

Ahmed M. Saad*

Agron. Dept., Fac. Agric., Benha Univ., Egypt

ABSTRACT

This study was conducted to evaluate the potentialities of three fodder cowpea types (*Vigna sinensis,* L.) which were: Creamy (CFC), Brown (BFC) and Dotted (DFC) of seed coat colors mixed with three fodder grasses which were: pearl millet (PM), sudan grass (SG) and sorghum sudan grass (SSG). Two field experiments were carried out at the Experimental Research Station, Faculty of Agriculture, Moshtohor, Benha University, Kalubia Governorate, Egypt, during two summer growing seasons (2011 and 2012). Experiments were designed and implemented to evaluate growth behavior, forage yield and quality. Results could be concluded as follows: Results indicated significant differences in total fresh and dry forage yields for each of the studied forage crops. Highest fresh and dry forage yields were obtained for pearl millet, while, the lowest values were obtained for Creamy F. cowpea with various significant differences values. The highest values of leaf : stem ratio and the lowest crude fiber (CF) content were obtained for Creamy F. cowpea type. Meanwhile, Brown F. cowpea had the highest crude protein (CP) content. Sorghum sudan grass gave the tallest plants as compared with the other tested forages with significant differences. Regarding the relevant mixtures, the highest values for mixtures of fresh and dry forage yields, plant height and crude protein, leaf : stem ratio and the lowest crude fiber content were recorded for SG + CFC, SG + DFC, SG + BFC, PM+CFC mixtures, respectively, with significant differences as compared with the other tested mixtures.

Key words: Fodder cowpea, forage mixtures, forage quality.

INTRODUCTION

Fresh fodder crops in pure stands and in their relevant mixtures have a great potential and will have a great role of ruminant's nutrition in Egypt. Evaluation of fodder crops is a function of both yield and quality as nutritive value. Fodder crops of high nutritive value are characterized by containing high protein content and high digestibility and low fiber content as well. Meanwhile, there are almost no certified commercial sources of leguminous forage seeds especially during summer season.

Among the available indigenous-native legumes are fodder cowpea (*Vigna sinensis* L.) of different types according to the color of their seed-coats and their relevant mixtures with different grasses (as pearl millet, sudan grass and sorghum sudan grass) which are expected to induce additive performance values in respect of nitrogen fixation and the extra other interacted beneficial well known advantages of mixtures are of great concern in this study.

In this respect, Mokoboki *et al.* (2000) clarified that there were significant varietal effects of cowpeas on its chemical composition. Crude protein content is an important parameter of forage quality. Along the same line, Quinn and Myers (2002) reported that the extreme variability of the cowpea species, which has led to number of commercial cultivars are grouped by the variation in bean shape, size and color. Ewansiha and Singh (2006) screened 72 accessions/ varieties of relevant herbaceous

*Corresponding author: Tel. : +201222559870
E-mail address: Ahmed.Saad@fagr.bu.edu.eg

legumes (lablab, horse gram, and cowpea) with grasses (3 cereals-millet, sorghum and maize). Meanwhile, Ajeigbe *et al.* (2008) studied several cowpea varieties which were of different seed coat colors (white, brown and black). Eight varieties had rough seed coat and one was smooth seeded.

Regarding forage mixtures of grasses and legumes, Foster *et al.* (2009) evaluated 3 forage legumes (soybean, cowpea and pigeonpea). They proved that leaf/stem ratio decreased with maturity and was greater for cowpea than the other studied legumes. Moreover, several researchers as (Abd El-Gawad *et al.,* 1990; Abo Deya *et al.,* 1990; Mohanpillai *et al.,* 1990; Abd El-Aal *et al.,* 1991; Abd El-Gawad *et al.,* 1992; Nor El-Din *et al.,* 1992; Sood and Sharma, 1992; Mohamed, 1992; Dubey *et al.,* 1995; Sudhakar *et al.,* 1996; Haggag, 1998; Abd El-Salam, 2002; Zeidan *et al.,* 2003; Singh *et al.,* 2003; Ibrahim *et al.,* 2006; Mohammed *et al.,* 2008; Geren *et al.,* 2008) reported that intercropping legumes with grasses increased fresh forage yield, dry yield, number of branches/ plant, leaf : stem ratio, plant height, CP and CF of their mixtures than their relevant pure stands.

The main target of this investigation was to evaluate the specific properties of growth behavior, forage yield and quality of some indigenous-native herbaceous legumes as fodder cowpea in their pure stands and when mixed with fodder grasses at a ratio of 50:50%.

MATERIALS AND METHODS

Two field experiments were carried out at the Experimental Research Station, Faculty of Agriculture, Moshtohor, Benha University, Kalubia Governorate, Egypt during two summer growing seasons (2011 and 2012) to evaluate their specific properties of growth behavior, forage yield and quality of some of the indigenous native herbaceous legumes as fodder cowpea of different seed-coat color (creamy, brown and dotted seed coat) in their pure stands and when mixed with some summer fodder grasses (pearl millet, sudan grass and sorghum sudan grass) at 50:50% mixtures.

Experimental design was layed out in a complete randomized block design (CRBD) with four replicates in both seasons. The pure stands and their forage mixtures were distributed randomly in blocks, each experimental unit was 10.5 m^2 area (3 x 3.5 m) of about 1/400 faddan area. Two individual cuts were obtained during each of the two summer growing seasons. The applied treatments were:

Fodder Cowpea Types

1- Fodder cowpea (*Vigna sinensis,* L.) of creamy seed-coat.

2- Fodder cowpea (*Vigna sinensis,* L.) of brown seed-coat.

3- Fodder cowpea (*Vigna sinensis,* L.) of dotted seed-coat.

The Common Summer Forage Grasses

1- Sorghum sudan grass (*Sorghum bicolor,* L.). var. Mabrouk.

2- Pearl millet (*Pennisetum americanum,* L.).var. Shandwil 1.

3- Sudan grass (*Sorghum sudanense,* L.). var. Giza 2.

Seeds of each of the three summer forage legumes were brought from indigenous-native region of Upper Egypt (Aswan). Meanwhile, Seeds of each of the three summer forage grasses were provided by Forage Department, Agriculture Research Center, Ministry of Agriculture, Giza, Egypt. The recommended seeding rates of each of the above forage crops were properly practiced. Seeds were sown on May, 19th in 2011 and 2012 seasons. Phosphorus fertilizer was applied in form of calcium super phosphate (15.5% P_2O_5) at a rate of 150 kg/ faddan during the appropriate soil preparation and before sowing. The recommended seeding rate for each of the above forage crops was followed in the assigned mixtures at a ratio of 50: 50% .

Studied Parameters

Two subsequent cuts were devoted for each of the two growing seasons (2011 and 2012). The first cut was obtained at 60 days from sowing and the second one was obtained 40 days later.

Appreviated symbol, seeding rate in pure stands and the proposed mixtures of fodder cowpea types and various forage grasses are presented in the following chart:

Pure stands	Appreviated symbol	Seeding rates (kg/fad.)
Legumes		
1 Creamy fodder cowpea	(CFC)	30
2 Brown fodder cowpea	(BRFC)	30
3 Dotted fodder cowpea	(DFC)	30
Fodder grasses		
4 Pearl millet	(PM)	20
5 Sorghum sudan grass	(SSG)	20
6 Sudan grass	(SG)	20
Relevant mixtures (50:50%)		
7 Pearl millet + Creamy fodder cowpea	(PM +CFC)	10+15
8 Pearl millet + Brown fodder cowpea	(PM + BRFC)	10+15
9 Pearl millet + Dotted fodder cowpea	(PM + DFC)	10+15
10 Sorghum sudan grass + Creamy fodder cowpea	(SSG +CFC)	10+15
11 Sorghum sudan grass + Brown fodder cowpea	(SSG + BRFC)	10+15
12 Sorghum sudan grass + Dotted fodder cowpea	(SSG + DFC)	10+15
13 Sudan grass + Creamy fodder cowpea	(SG +CFC)	10+15
14 Sudan grass + Brown fodder cowpea	(SG + BRFC)	10+15
15 Sudan grass + Dotted fodder cowpea	(SG + DFC)	10+15

Vegetative growth characteristics

Ten plants (5 legumes + 5 grasses) were randomly selected from each experimental unit during the two seasons. Meanwhile, vegetative behavior was studied on the basis of the average for each of the above two groups of grasses and legumes, the following growth parameters: plant height (cm); leaf / stem ratio were estimated on fresh weight basis.

Fresh and dry forage yields

Fresh forage yield in each experimental unit of the grown forage crop plants under study was determined for each of the subsequent cuts and for each of the two studied seasons then weighted using field scale of 0.5 kg sensitivity and forage yield was estimate and recorded in ton/fad.

Determining dry matter content and estimated total dry yield

Samples of about 200 g of fresh forage were selected randomly from each experimental unit just before cutting the whole experimental plot, accurately weighted using an electric balance of 0.01 g sensitivity. Such obtained fresh samples were dried in an air forced drying oven at 105°C for 3 hours till constant weight to determine the dry matter content. Then, dry yield per faddan was estimated.

Chemical analyses

Chemical analysis was conducted and presented on dry matter basis. Fresh forage samples were randomly taken (using quadrate of ¼ sq meters) from each experimental unit. Samples of the proposed treatments were properly prepared. Accurately weighed samples of the fresh forage of about 200 g were dried using an air forced drying oven at 75°C till a constant weight. Samples were dried in a labeled kraft paper bags which were laid in an air forced drying oven all over the drying period till constant weight. Dried samples were then cooled at room temperature, ground finely and screened using hummer mill of 40 michs. Prepared samples were kept in sealed labeled plastic bags and stored in the refrigerator at 5°C till needed for chemical analyses.

Samples of each two replicates for each treatment were mixed thoroughly to form two composite samples out of the 4 replicates. Out of each of the two composite samples, two analyses were conducted (for each treatment), then the average results of each analysis in the study were recorded.

Forage quality components included the following:

Table 1. The prevailing climatic factors at Kalubia Governorate during the two growing seasons

Climatic factors / Month	First season (2011)					Second season (2012)				
	Soil Temp. (C°)	Solar radiation (w/m²)	Wind speed (m/sec)	Air Temp. (C°)	Dew Point (C°)	Soil Temp. (C°)	Solar radiation (w/m²)	Wind speed (m/sec)	Air Temp. (C°)	Dew Point (C°)
1-15 June	27.1	252.7	1.42	24.9	16.1	29.9	255.3	1.60	25.5	16.7
16-30 June	28.0	245.1	1.51	24.9	16.8	30.2	241.6	1.00	27.5	20.3
1-15 July	32.56	243.9	1.26	26.4	19.1	30.6	238.8	1.00	27.9	20.8
16-31 July	31.8	245.7	1.12	27.4	21.2	30.3	228.2	0.75	27.7	22.9
1-15 August	30.1	229.4	1.00	26.6	20.7	27.7	207.0	0.60	28.8	22.7
16-31 August	28.8	181.3	0.63	25.3	20.3	28.6	193.8	0.50	28.5	19.3
1-15 September	27.1	132.8	0.89	23.8	18.8	28.7	164.6	0.80	23.9	20.1
16-30 September	26.7	196.6	0.84	24.1	18.2	28.2	154.4	0.60	24.6	17.9

Source: Faculty of Agriculture, Moshtohor., Benha Univ., Kalubia Governorate, Egypt.

Crude protein (CP) content

Total nitrogen percentage was determined according to the modified micro kjeldahl method. Crude protein content was estimated by multiplying nitrogen percentage by 6.25 (AOAC, 1995).

Crude fiber (CF) content

Crude fiber percentage was determined according to the AOAC (1995).

Statistical Analysis

The analysis of variance for each of the two growing seasons and their combined analysis was conducted after insuring the validity of partlet test according to the procedure described by Steel and Torrie (1981). The LSD test at the 5% level was used in means comparison.

RESULTS AND DISCUSSION

Fresh Forage Yield

Results in Table 2 represent total fresh forage yield of pure fodder cowpea types, it is clear from the combined analysis that there were appreciable differences among the grown pure F. cowpea types in their fresh forage yield during each of the two growing seasons with variable significant magnitudes. Brown F. cowpea type was the highest in fresh forage yield (18.07) followed by Dotted F. cowpea type (16.53), then Creamy F. cowpea type (13.26 ton/fad.) with significant differences. Also, the combined analysis showed that there were appreciable differences among the grown grasses in their fresh yield with variable significant magnitudes, where pearl millet was superior in fresh forage yield followed by sudan grass, then sorghum sudan grass with significant differences. The respective ranking order for fresh forage yield was 26.19, 23.00 and 22.73 ton/fad., as it is clear from Table 2.

Combined analysis revealed that mixtures production of the three previous grasses with the three fodder legumes could be ranked in descending order as follow: SG+CFC $_{(20.93)}$ > SSG+BFC$_{(20.80)}$>PM+BFC$_{(20.60)}$ > PM+DFC $_{(20.13)}$ >SG+BFC$_{(20.07)}$>SG+DFC$_{(19.67)}$> SSG+CFC $_{(19.06)}$ > SSG+DFC $_{(18.27)}$ > PM+CFC $_{(16.46\ ton/fad.)}$, with significant differences among the subsequent orders. It is more likely recommended that either of the two superior mixtures SG+CFC and SSG+BFC were the best combinations in total

Table 2. Fresh forage yield of legumes, grasses and their proposed mixtures (Ton/fad.)

Pure and mixtures forages*	First season (2011)			Second season (2012)			Combined analysis		
	1st cut	2nd cut	Total	1st cut	2nd cut	Total	1st cut	2nd cut	Total
Pure stands									
PM	18.00	7.20	25.20	18.13	9.06	27.19	18.06	8.13	26.19
SG	12.93	7.47	20.40	15.73	9.87	25.60	14.33	8.67	23.00
SSG	12.80	8.80	21.60	12.40	11.47	23.87	12.60	10.13	22.73
CFC	5.47	4.80	10.27	8.40	7.87	16.27	6.93	6.33	13.26
BFC	9.33	7.73	17.06	10.00	9.06	19.06	9.67	8.40	18.07
DFC	8.40	6.93	15.33	9.47	8.27	17.74	8.93	7.60	16.53
Relevant mixtures (50 + 50%)									
PM + CFC	6.80	6.80	13.60	10.27	9.06	19.33	8.53	7.93	16.46
PM + BFC	9.87	8.67	18.54	12.40	10.27	22.67	11.13	9.47	20.60
PM + DFC	8.93	8.27	17.20	12.13	10.93	23.06	10.53	9.60	20.13
SG + CFC	10.13	8.00	18.13	13.73	10.00	23.73	11.93	9.00	20.93
SG + BFC	10.00	7.60	17.60	12.00	10.53	22.53	11.00	9.07	20.07
SG + DFC	8.93	7.73	16.66	11.87	10.80	22.67	10.40	9.27	19.67
SSG + CFC	8.13	7.20	15.33	12.53	10.27	22.80	10.33	8.73	19.06
SSG + BFC	8.80	7.33	16.13	14.67	10.80	25.47	11.73	9.07	20.80
SSG + DFC	8.67	7.60	16.27	10.53	9.73	20.26	9.60	8.67	18.27
LSD at: 5% for:	F=1.33	F=1.02		F= 1.38	F= 1.10		F= 0.9 Y= 1.10 FY= 1.33	F= 0.73 Y= 0.52	

* PM= Pearl millet, SG=Sudan grass, SSG= Sorghum sudan grass, CFC= Creamy fodder cowpea, BFC = Brown fodder cowpea, DFC = Dotted fodder cowpea.

fresh forage biomass. Similar comparative studies were recorded by Abo Deya *et al.* (1990) for mixing sordan with cowpea, Abd El-Gawad *et al.* (1992) for mixing sudan grass with cowpea, Nor El-Din *et al.* (1992) for mixing pearl millet with guar, Dubey *et al.* (1995) for mixing sorghum with soybean and Geren *et al.* (2008) for mixing maize with cowpea. Presented results could be briefly summarized as follows:

Legumes

$BFC_{(18.07)} > DFC_{(16.53)} > CFC_{(13.26)}$

Grasses

$PM_{(26.19)} > SG_{(23.00)} > SSG_{(22.73)}$

Mixtures

$SG+CFC_{(20.93)} > SSG+BFC_{(20.80)} > PM+BFC_{(20.60)} > PM+DFC_{(20.13)} > SG+BFC_{(20.07)} > SG+DFC_{(19.67)} > SSG+CFC_{(19.06)} > SSG+DFC_{(18.27)} > PM+CFC_{(16.46\ ton/fed.)}$

Seasonal variations clarified significant difference in fresh yield among the studied fodder cowpea types (Table 2). Results indicate that Brown type of fodder cowpea was significantly the highest in total forage yield compared to each of other two types. These results were true in each of the two growing seasons. In this respect, all of the three tested F. cowpea types produced relatively higher total forage yield in the second season than the first one. Regarding fodder grasses, the productivity of fresh forage yield could be ranked in the following descending order: pearl millet (25.20), sorghum sudan grass (21.60) followed by sudan grass (20.40 ton/fad.) in the first season, being pearl millet (27.19) then sudan grass (25.60) followed by sorghum sudan grass (23.87 ton/fad.) in the second season. Regarding, fresh forage productivity of the proposed mixture were exerted much more increase magnitudes during the second season compared with the first one with significant differences.

Combined analysis revealed that total fresh forage yield was generally higher in the first cuts than the second ones for all of the tested F. cowpea types and summer fodder grasses with different significant magnitudes (Table 2). Similar significant differences in total fresh yield within the proceeded cuts with different behaviour among the grown forage mixtures. It is obviously clear that the obtained differences in fresh yield for each of the grown grasses and F.cowpea were indeed due to their individual specific genetical make up that interact differently with the prevailing environmental conditions of this study in various specific patterns (Table 1). In this respect other previous comparative studies for other forage legumes types and cultivars were reported previously by other researchers as Ewansiha and Singh (2006) and Ajeigbe *et al.* (2008) in cowpea.

Dry forage yield

Data in Table 3 presented the total dry forage yield of the proposed forage mixtures and their relevant pure stands in both seasons and the combined analysis.

It is clear from the combined analysis that there were appreciable differences among the grown F. cowpea types in their dry forage yield during each of the two growing seasons with variable significant magnitudes. Brown F. cowpea type was the highest regarding dry yield (2.48) followed by Dotted F. cowpea type (2.39), then Creamy F. cowpea type (1.67 ton/fad.) with significant differences. Also, there were appreciable differences among the grown grasses in their dry yield with significant magnitudes. Pearl millet produced the highest dry yield followed by sudan grass, then sorghum sudan grass with significant differences. The respective descending ranking order for dry yield was 4.43, 4.08 and 3.83 ton/ fad.

Combined analysis showed that mixtures productivity of the three previous grasses with the three indigenous-native legumes could be ranked in descending order as follow: SG + CFC $_{(3.31)}$ > PM+BFC $_{(3.19)}$ > PM+DFC $_{(3.16)}$ > SG+BFC $_{(3.05)}$ > SG+DFC $_{(2.96)}$ > SSG+DFC $_{(2.93)}$ >SSG+BFC $_{(2.92)}$ > SSG+CFC $_{(2.85)}$ > PM+CFC $_{(2.43\ \text{ton/fad.})}$, with significant differences among the subsequent order. It is more likely recommended that either of the two superior mixtures SG+CFC and PM + BFC were the best combinations in total dry forage production. The currently presented results of the behaviour of dry forage productivity of the grown fodder crops and their relevant mixtures were more or less similar to those reported by Haggag (1998) for sorghum with cowpea, Zeidan *et al.* (2003) for fodder maize with cowpea and Ibrahim *et al.* (2006) for maize with cowpea. Results could be briefly presented in the following chart:

Legumes

BFC $_{(2.48)}$ > DFC $_{(2.39)}$ > CFC $_{(1.67)}$

Grasses

PM $_{(4.43)}$ > SG $_{(4.08)}$ > SSG $_{(3.83)}$

Mixtures

SG+CFC $_{(3.31)}$> PM+BFC $_{(3.19)}$>PM+DFC $_{(3.16)}$> SG+BFC $_{(3.05)}$> SG+DFC $_{(2.96)}$>SSG+DFC $_{(2.93)}$ > SSG+BFC $_{(2.92)}$>SSG+CFC $_{(2.85)}$>PM+CFC $_{(2.43\ \text{ton/fed.})}$

Seasonal variation clarified significant difference in dry yield among the tested F. cowpea type (Table 3). It is also noticed that all of the three tested F. cowpea types produced relatively higher total dry yield in the second season than the first one. Meanwhile, fodder grasses could be ranked in the following descending order: pearl millet (4.17), then sorghum sudan grass (3.49) followed by sudan grass (3.47 ton/fad.) in the first season, being sudan grass (4.69) then pearl millet (4.68) followed by sorghum sudan grass (4.18 ton/ fad.), in the second season. This result indicate significant superiority of the total dry forage yield for the grown grasses varieties than F. cowpea types for both seasons (Table 3). Regarding, the dry matter production of the proposed mixture exerted much more magnitudes during the second season compared with the first one with significant differences.

Table 3. Dry yield of legumes, grasses and their proposed mixtures

Pure and mixtures forages*	First season (2011)			Second season (2012)			Combined analysis		
	1st cut	2nd cut	Total	1st cut	2nd cut	Total	1st cut	2nd cut	Total
				Pure stands					
PM	2.63	1.54	4.17	2.73	1.95	4.68	2.68	1.75	4.43
SG	2.18	1.29	3.47	2.29	2.40	4.69	2.24	1.84	4.08
SSG	1.95	1.54	3.19	1.71	2.47	4.18	1.83	2.00	3.83
CFC	0.61	0.63	1.24	0.77	1.32	2.09	0.69	0.98	1.67
BFC	1.08	1.05	2.13	1.18	1.64	2.82	1.13	1.35	2.48
DFC	0.96	1.27	2.23	1.05	1.48	2.53	1.01	1.38	2.39
				Relevant mixtures (50 + 50%)					
PM + CFC	0.81	1.06	1.87	1.16	1.82	2.98	0.99	1.44	2.43
PM + BFC	1.21	1.53	2.74	1.68	1.97	3.65	1.44	1.75	3.19
PM + DFC	1.06	1.41	2.47	1.24	2.61	3.85	1.15	2.01	3.16
SG + CFC	1.23	1.35	2.58	1.68	2.35	4.03	1.46	1.85	3.31
SG + BFC	1.26	1.28	2.54	1.52	2.03	3.55	1.39	1.66	3.05
SG + DFC	1.16	1.34	2.50	1.32	2.10	3.42	1.24	1.72	2.96
SSG + CFC	0.91	1.27	2.18	1.50	2.03	3.53	1.20	1.65	2.85
SSG + BFC	1.03	1.18	2.21	1.37	2.06	3.43	1.20	1.72	2.92
SSG + DFC	1.10	1.42	2.52	1.45	2.20	3.65	1.28	1.65	2.93
LSD at: 5% for:	F= 0.24	F= 0.20		F= 0.22	F= 0.28		F= 0.16 Y= 0.10	F= 0.17 Y=0.14 FY=0.24	

* PM = Pearl millet, SG = Sudan grass, SSG = Sorghum sudan grass, CFC = Creamy fodder cowpea, BFC = Brown fodder cowpea, DFC = Dotted fodder cowpea.

Combined analysis showed that the dry yield was generally higher in the second cuts than the first ones for all of the tested F. cowpea types with different significant magnitudes. Whereas, the Brown F. cowpea was the highest in total dry yield as compared with the other two F.cowpea types during the first cut. Moreover, Creamy F. cowpea was the lowest one during the second cut (Table 3). Concerning the grown fodder grasses, an opposite trend was noticed where the total dry yield was higher in the first cuts than the second ones for all of the three tested grasses (Table 3). Pearl millet was the highest in total dry production for the first cut and the lowest in the second cut for the grasses. Similar significant differences in total fresh yield within the proceeded cuts with different behaviour among the grown forage mixtures. It look to be true that the obtained significant differences in dry yield for each of the grown grasses was indeed due to their individual specific genetical make up that interact differently with the prevailing environmental conditions (Table 1). Similar results were reported by Mokoboki *et al.* (2000) with cowpea, Jilani *et al.* (2001) with lablab and Ajeigbe *et al.* (2008) with cowpea.

Leaf : Stem ratio

Data in Table 4 clarify leaf : stem ratio on fresh weight basis of the studied forage mixtures and their relevant pure in both seasons and the combined analysis.

Table 4. Leaf : Stem ratio of legumes, grasses and their proposed mixtures on fresh weight basis

Pure and mixtures forages*	First season (2011)			Second season (2012)			Combined analysis		
	1st cut	2nd cut	Mean	1st cut	2nd cut	Mean	1st cut	2nd cut	Mean
Pure stands									
PM	0.53	0.91	0.72	0.94	0.98	0.96	0.74	0.95	0.84
SG	0.33	0.25	0.29	0.64	0.45	0.54	0.48	0.35	0.41
SSG	0.81	0.75	0.78	0.66	0.52	0.59	0.73	0.64	0.68
CFC	1.25	0.99	0.12	0.92	0.80	0.86	1.08	0.90	0.99
BFC	0.96	1.01	0.98	1.68	0.30	0.99	1.32	0.65	0.98
DFC	1.06	1.12	1.09	0.83	0.39	0.61	0.94	0.76	0.85
Relevant mixtures (50 + 50%)									
PM + CFC	1.11	0.93	1.02	1.27	0.41	0.84	1.19	0.67	0.93
PM + BFC	0.83	0.65	0.74	1.04	0.26	0.65	0.94	0.45	0.69
PM + DFC	0.61	0.63	0.62	0.76	0.22	0.49	0.69	0.43	0.56
SG + CFC	0.29	0.24	0.26	0.23	0.54	0.38	0.26	0.39	0.32
SG + BFC	0.56	0.35	0.45	0.51	0.40	0.45	0.53	0.37	0.45
SG + DFC	0.37	0.55	0.46	0.51	0.82	0.66	0.44	0.68	0.56
SSG + CFC	0.95	1.14	1.04	0.45	0.35	0.40	0.70	0.75	0.72
SSG + BFC	0.73	0.58	0.65	0.81	0.45	0.63	0.77	0.51	0.64
SSG + DFC	0.43	1.29	0.86	0.48	0.23	0.35	0.46	0.76	0.61
LSD at: 5% for:	F= 0.12	F= 0.12		F= 0.22	F=0.11		F= 0.12 Y= 0.04 FY= 0.17	F= 0.08 Y= 0.06 FY=0.12	

* PM = Pearl millet, SG = Sudan grass, SSG = Sorghum sudan grass, CFC = Creamy fodder cowpea, BFC = Brown fodder cowpea, DFC = Dotted fodder cowpea.

Combined analysis exerted slight significant differences among the tested fodder cowpea types. Whereas, the Creamy type was of the highest leaf : stem ratio (0.99), then Brown F. cowpea (0.98) followed by Dotted F. cowpea (0.85). This ranking order evedentiate that Creamy and Brown F. cowpea types produced similar leaf : stem ratio without significant differences in between. Meanwhile, Dotted type produced the lowest leaf : stem ratio as compared with any of the tested forage legumes (Table 4). So, the Creamy type was of about 16% higher in leaf : stem ratio as compared with the other two types (Brown and Dotted). Concerning, summer fodder grasses varieties they were of appreciable differences in their leaf : stem ratio. Whereas, the respective leaf : stem ratio could be presented in the following descending order, pearl millet (0.84) sorghum sudan grass (0.68) followed by sudan grass (0.41) with slight significant differences (Table 4). It is also clear that leaf : stem ratio of the proposed mixture was much more during the first season compared with the second one.

Combined analysis proved that mixtures leaf: stem ratio for any of the six tested forages could be ranked in the following descending order: $PM+CFC_{(0.93)}$ > $SSG + CFC_{(0.72)}$ > $PM + BFC_{(0.69)}$ > $SSG+BFC_{(0.64)}$ > $SSG+DFC_{(0.61)}$ > $PM + DFC_{(0.56)}$ = $SG+DFC_{(0.56)}$ > $SG+BFC_{(0.45)}$ > $SG + CFC_{(0.32)}$ on fresh weight basis., within each of the subsequent order as shown in Table 4. It is more likely recommended that either of the two highest mixtures PM+CFC and SSG + CFC were of the best selected combinations. In this respect, increasing leaf : stem ratio in mixtures increased the nutrition value (TDN and DP) which improved forage quality. This is in addition to the well-known beneficial impact grasses especially for free nitrogen fixation from the ambient air through the symbiotic on rhizobium bacteria of legumes in the mixtures. The currently presented results of the behaviour of leaf : stem ratio of fodder crops and their proposed mixtures were more or less similar to those reported by Foster *et al.* (2009) in fodder cowpea.

Seasonal variations showed significant difference in leaf : stem ratio among the studied F. cowpea types (Table 4). It should be pointed out that, all of the three tested F. cowpea types produced relatively slightly higher leaf : stem ratio in the first season than the second one. Moreover, Creamy type of F. cowpea was the highest in leaf : stem ratio compared to each of other two types (Brown and Dotted) in the first season. Meanwhile, the Brown type was the highest in leaf-stem ratio in the second season. Other trend was noticed for grasses varieties in their leaf : stem ratio where the higher leaf : stem ratio was noticed during the second season rather than the first one. It should be pointed out that leaf : stem ratio of the proposed mixture was much more during the second season compared with the first one.

Results of the combined analysis clarified that leaf : stem ratio was generally higher in the first cuts than the second one for all of the tested F. cowpea types with different magnitudes. Also, all of the three tested varieties of grasses exerted significant slight reduction in leaf : stem ratio during the second cuts as compared with the first ones with almost similar magnitudes. In this respect, it is obviously that creamy F. cowpea type was the highest in leaf : stem ratio during the first cut and sudan grass was the lowest leaf : stem ratio during the second cut. Other fluctuations evedentiated among the applied mixture combinations (Table 4).

Plant height

Data in Table 5 clarify plant height in their pure stands which were varied according their nature (legumes/ grasses), types and or varieties, seasons and the subsequent duration of cuts. Such data represent the plant height for each of the two cuts in both seasons and their combined analysis.

Combined analysis showed that there were appreciable differences among the grown F. cowpea types in their plant heights with variable significant magnitudes. Creamy F. cowpea type plants were the tallest (104.20) followed by Dotted F. cowpea type (80.00), then Brown F. cowpea type (78.55 cm) with significant differences. Regarding summer fodder grasses, the combined analysis cleared that there were appreciable significant differences among the grown grasses in their plant heights. Sorghum sudan grass was of the tallest plants (151.00), then sudan grass (148.75), followed by pearl millet (135.50 cm) with significant differences (Table 5).

Combined analysis showed that mixture plant heights of the three summer grasses with the three indigenous-native legumes could be ranked in descending order as follow: SG+BFC $_{(145.75)}$ > SG + DFC $_{(128.40)}$ > SG + CFC $_{(128.30)}$ > SSG + CFC$_{(120.60)}$ > PM +BFC$_{(118.95)}$ > SSG + DFC$_{(118.90)}$ > PM+DFC$_{(114.60)}$ > PM+CFC $_{(114.10)}$ > SSG+BFC $_{(100.75\ cm)}$, with significant differences among the subsequent order. It is more likely recommended that either of the two superior mixtures SG+BFC and SG+DFC were the best combinations in plant height. The currently presented results of the behaviour of plant height of fodder crops and their mixtures were more or less similar to those reported by Mohamed (1992) for mixing sorghum with cowpea, Geren *et al.* (2008) for mixing maize with cowpea and Mohamed *et al.* (2008) for mixing sorghum with cowpea.

Seasonal variation evedentiated significant difference in plant height among the indigenous-native legumes (F. cowpea type). Results show that Creamy type of F.cowpea was significantly the tallest in the heights compared to each of the other two types. These results were true in each of the two growing seasons. In this respect, all of the three tested F.cowpea types produced relatively taller plants in the second season than the first one.

Results in Table 5 showed that plant height of fodder grasses could be ranked in the following descending order: sorghum sudan grass (169.70), pearl millet (164.50) followed by sudan grass (150.15 cm) in the first season, being Sudan grass (147.35), sorghum sudan grass (132.35) followed by pearl millet (106.50 cm) in the second season.

Table 5. Plant height (cm) of legumes, grasses and their proposed mixtures

Pure and mixtures forages*	First season (2011)			Second season (2012)			Combined analysis		
	1st cut	2nd cut	Mean	1st cut	2nd cut	Mean	1st cut	2nd cut	Mean
Pure stands									
PM	218.0	111.0	164.50	91.7	121.3	106.50	154.8	116.2	135.50
SG	186.0	114.3	150.15	129.7	165.0	147.35	157.8	139.7	148.75
SSG	221.7	117.7	169.70	132.7	132.0	132.35	177.2	124.8	151.00
CFC	97.0	64.3	80.65	110.0	146.0	128.00	103.2	105.2	104.20
BFC	67.0	58.0	62.50	97.7	91.7	94.70	82.3	74.8	78.55
DFC	88.3	68.0	78.15	68.0	95.7	81.85	78.2	81.8	80.00
Relevant mixtures (50 + 50%)									
PM + CFC	109.3	111.7	110.50	93.0	142.3	117.65	101.2	127.0	114.10
PM + BFC	108.3	125.0	116.65	99.0	143.3	121.15	103.7	134.2	118.95
PM + DFC	117.7	112.7	115.20	92.3	135.7	114.00	105.0	124.2	114.60
SG + CFC	160.7	112.3	136.50	89.0	151.3	120.15	124.8	131.8	128.30
SG + BFC	141.0	216.0	178.50	118.0	108.0	113.00	129.5	162.0	145.75
SG + DFC	151.7	137.7	144.70	120.0	104.3	112.15	135.8	121.0	128.40
SSG + CFC	92.7	112.3	102.50	132.3	145.0	138.65	112.5	128.7	120.60
SSG + BFC	112.3	80.0	96.15	89.0	121.7	105.35	100.7	100.8	100.75
SSG + DFC	110.0	993.0	101.50	113.0	159.7	136.35	111.5	126.3	118.90
LSD at: 5% for:	F=15.73	F=12.01		F=14.16	F=17.55		F=10.35 Y=5.98 FY=14.64	F=10.40 Y=8.94 FY=14.71	

* PM = Pearl millet, SG = Sudan grass, SSG = Sorghum sudan grass, CFC = Creamy fodder cowpea, BFC = Brown fodder cowpea, DFC = Dotted fodder cowpea.

It looks to be true that there was significant superiority of plant height for the grown grasses varieties than the leguminous F. cowpea types for the first than the second season. It should be pointed out that plant height of the proposed mixtures was much more taller during the second season compared with the first one.

The combined analysis clarified that plants were generally taller in the second cuts than the first ones for all of the tested F. cowpea types with different significant magnitudes (Table 5). It was also clear that, plants were taller in the first cuts than the second ones for all of the three tested fodder grasses with various significant magnitudes. The obtained significant differences in plant height for each of the grown grasses was indeed due to their individual specific genetical make up that interact differently with the prevailing environmental conditions of this study in various specific patterns (Table 1). These results were similar with the results reported by Ewansiha and Singh (2006) in cowpea and Ajeigbe *et al.* (2008) in cowpea.

It is obviously clear from the combined analysis that, sorghum sudan grass was the tallest plants in the first cut (177.2cm) and the pearl millet was the shortest one in the second cut (116.2cm) for the grasses. Meanwhile, the Creamy type produced the tallest plants as compared with the other two F. cowpea types during each of the two cuts (Table 5). In this respect, plant height of the proposed mixtures much more increased during the second cut as compared with the first one.

Crude protein (CP) content

Data in Table 6 show significant differences in CP content within each of the three F. cowpea types or between any of the three summer grasses in their pure stands. These results are very well accepted since the variation between varieties were not those more wide under similar circumstances, since these varieties have its own unique specific characteristics for the parameter under study. However, some of the specific future of varieties could show up under the ideal situation of specific well identified environmental factors.

Combined analysis evedentiate that, the grown F. cowpea types exerted relatively higher CP content than the grown summer fodder grasses varieties in their pure stands. It should be pointed out that, there were significant differences among the grown F. cowpea types in their CP contents with narrow differences. Brown F. cowpea type had the highest CP content (26.60), followed by Creamy F. cowpea type (24.68), then Dotted F. cowpea type (22.86%), respectively. Moreover, the summer fodder grasses exerted narrow significant differences in between. Whereas; the respective descending ranking order was of sorghum sudan grass (12.27), sudan grass (11.99) and pearl millet (11.38%), respectively. This trend was noticed with ignorable magnitudes of CP content as it is clear in Table 6.

Combined analysis exerted that mixtures CP content of the three summer grasses with the three indigenous-native legumes could be ranked in descending order as follow: SG+BFC $_{(12.20)}$ > SG+CFC $_{(11.85)}$ > SSG+BFC $_{(11.80)}$ > SG+DFC $_{(11.72)}$ > SSG + DFC $_{(11.47)}$ > SSG + CFC $_{(11.09)}$ > PM + BFC$_{(10.97)}$ > PM+DFC $_{(10.88)}$ > PM+CFC $_{(10.44\ \%)}$, with significant differences among the subsequent order. It is more likely recommended that either of the two mixtures SG + BFC and SG + CFC were the superior combinations in CP content.

Similar results were reported by Mohanpillai *et al.* (1990) for mixing maize with cowpea, Abd El-Aal *et al.* (1991) for mixing sordan with guar, Sood and Sharma (1992) for mixing sorghum with Cowpea, Sudhakar *et al.* (1996) for mixing grasses with legumes, Abd El-Salam (2002) for mixing pearl millet and sudan grass with legumes, Zeidan *et al.* (2003) for mixing fodder maize with cowpea and Geren *et al.* (2008) for mixing maize with cowpea.

Seasonal variations exerted significant difference in CP content among F.cowpea type. Whereas, the respective descending ranking order of F.cowpea types was Brown F.cowpea type (27.15), then Creamy F.cowpea type (24.40) followed by Dotted F.cowpea type (22.94%) in the first season, similar trend was noticed during the second season. Meanwhile, CP content of grasses varieties could be ranked in the following descending order: sorghum sudan grass (12.66), then sudan grass (12.62) followed by pearl millet (10.92%), in the first season, being sorghum sudan grass (11.88) then Pearl millet (11.84) followed by sudan grass (11.35%) in the second season (Table 6). It should be pointed out that CP content of the proposed mixtures was much more during the second season compared with the first one.

Combined analysis cleared that the CP content was higher in the first cuts than the second ones for all of the six tested forages with various slight ignorable significant magnitudes in their pure stands and their mixtures (Table 6). In this respect, Brown F. cowpea type had the highest CP content for the first cut and the Dotted type was the lowest one in the second cut for the F. cowpea types. Meanwhile, sorghum sudan grass was the highest in CP content for the first cut and pearl millet was the lowest one in the second cut for grasses (Table 6). It should be pointed out that the obtained significant differences in CP content for each of the grown grasses and legumes were indeed due to their individual specific genetical make up that interact differently with the prevailing environmental conditions of this study in various specific patterns. These results are in general agreement with those reported by Mokoboki *et al.* (2000) in cowpea.

Table 6. Crude protein (CP) content (%) of legumes, grasses and their proposed mixtures

Pure and mixtures forages*	First season (2011)			Second season (2012)			Combined analysis		
	1st cut	2nd cut	Mean	1st cut	2nd cut	Mean	1st cut	2nd cut	Mean
Pure stands									
PM	10.77	11.08	10.92	12.17	11.52	11.84	11.47	11.30	11.38
SG	13.06	12.19	12.62	11.90	10.81	11.35	12.48	11.50	11.99
SSG	13.31	12.01	12.66	12.48	11.29	11.88	12.90	11.65	12.27
CFC	25.31	23.50	24.40	27.32	22.60	24.96	26.32	23.05	24.68
BFC	28.30	26.01	27.15	28.50	23.60	26.05	28.40	24.80	26.60
DFC	23.84	22.05	22.94	23.95	21.59	22.77	23.90	21.82	22.86
Relevant mixtures (50 + 50%)									
PM + CFC	10.76	9.79	10.27	10.99	10.24	10.61	10.87	10.02	10.44
PM + BFC	11.06	10.41	10.73	11.44	10.98	11.21	11.25	10.69	10.97
PM + DFC	11.49	10.48	10.98	11.33	10.24	10.78	11.41	10.36	10.88
SG + CFC	11.98	11.04	11.51	12.96	11.42	12.19	12.47	11.23	11.85
SG + BFC	12.67	11.84	12.25	12.84	11.48	12.16	12.75	11.66	12.20
SG + DFC	11.58	10.54	11.06	12.98	11.78	12.38	12.28	11.16	11.72
SSG + CFC	10.04	9.49	9.76	13.27	11.54	12.40	11.66	10.52	11.09
SSG + BFC	11.27	9.96	10.61	13.84	12.11	12.97	12.56	11.04	11.80
SSG + DFC	13.12	12.10	12.61	10.70	9.98	10.34	11.91	11.04	11.47
LSD at: 5% for:	F=1.17	F=1.32		F=1.25	F=1.14		F= 0.84 FY=1.18	F=0.85 FY=1.21	

* PM = Pearl millet, SG = Sudan grass, SSG = Sorghum sudan grass, CFC = Creamy fodder cowpea, BFC = Brown fodder cowpea, DFC = Dotted fodder cowpea.

Crude fiber (CF) content

Results in Table 7 did not show noticeable or significant differences in crude fiber (CF) contents between either the 3-grown F. cowpea types (Creamy, Brown and Dotted types) or the 3-grown fodder grasses varieties (pearl millet, sudan grass and sorghum sudan grass). It could be understood that such trait is similar in their genetical makeup and/or gene expression in CF content.

Combined analysis showed that there were no significant differences among the grown F. cowpea types in their CF contents during each of the two growing seasons. Dotted F. cowpea type had the highest CF content (32.13), followed by Brown F. cowpea type (30.88), then Creamy F. cowpea type (29.52%), respectively. On the other hand, the summer fodder grasses did not exerted appreciable significant differences in between. Whereas; the respective descending ranking order was of sudan grass (31.34), sorghum sudan grass (31.19) and pearl millet (31.04%), respectively. This trend was more or less ignorable magnitudes during the two growing seasons of CF content as it is clear in Table 7.

Concerning the mixtures CF content of the three summer grasses with the three indigenous-native legumes, results of the combined analysis could be ranked in descending order as follow: SSG+BFC $_{(31.93)}$ > SG+DFC $_{(31.04)}$ > SG+BFC $_{(30.87)}$ >SSG+DFC$_{(30.82)}$>PM+DFC$_{(30.78)}$> SG+CFC $_{(30.52)}$ > PM+BFC$_{(30.43)}$> SSG+CFC$_{(30.21)}$> PM+CFC$_{(30.17\ \%)}$, without appreciable significant differences among the subsequent order. It is more likely recommended that either of the two superior mixtures SSG+BFC and SG+DFC were the best combinations in CF content. Similar results were

Table 7. Crude fiber (CF) content (%) of legumes, grasses and their proposed mixtures

Pure and mixtures forages*	First season (2011)			Second season (2012)			Combined analysis		
	1st cut	2nd cut	Mean	1st cut	2nd cut	Mean	1st cut	2nd cut	Mean
				Pure stands					
PM	29.16	31.76	30.46	30.15	33.09	31.62	29.66	32.42	31.04
SG	29.40	32.19	30.79	31.86	31.93	31.89	30.63	32.06	31.34
SSG	28.69	33.23	30.69	29.96	32.90	31.43	29.33	33.06	31.19
CFC	27.40	29.24	28.32	29.03	32.40	30.71	28.22	30.82	29.52
BFC	28.20	31.48	29.84	30.82	33.05	31.93	29.51	32.26	30.88
DFC	31.56	31.48	31.52	30.82	34.67	32.74	31.19	33.07	32.13
			Relevant mixtures (50 + 50%)						
PM + CFC	27.16	30.95	29.05	28.44	34.13	31.28	27.80	32.54	30.17
PM + BFC	27.87	30.24	29.05	30.98	32.62	31.80	29.43	31.43	30.43
PM + DFC	27.07	31.15	29.11	30.46	34.45	32.45	28.77	32.80	30.78
SG + CFC	27.54	32.84	30.19	29.23	32.47	30.85	28.39	32.65	30.52
SG + BFC	28.75	32.02	30.38	30.97	31.74	31.35	29.86	31.88	30.87
SG + DFC	30.80	30.23	30.51	30.73	32.42	31.57	30.76	31.33	31.04
SSG + CFC	29.95	30.67	30.31	29.22	31.04	30.13	29.58	30.85	30.21
SSG + BFC	30.24	31.83	31.03	31.27	34.39	32.83	30.76	33.11	31.93
SSG + DFC	30.76	33.38	32.07	29.06	30.10	29.58	29.91	31.74	30.82
LSD at: 5% for:	F=1.26	F=1.89		F=1.25	N.S		F= 0.87 Y= 18 FY=1.23	FY=1.99	

* PM = Pearl millet, SG = Sudan grass, SSG = Sorghum sudan grass, CFC = Creamy fodder cowpea, BFC = Brown fodder cowpea, DFC = Dotted fodder cowpea.

reported by Mohamed (1992) for mixing sorghum with cowpea, Abd El-Salam (2002) for mixing pearl millet and sudan grass with legumes and Ibrahim *et al.* (2006) for mixing maize with cowpea.

It is obviously clear that, CF content of F. cowpea types could be ranked in the following descending order: Dotted F. cowpea type (31.52), then Brown F. cowpea type (29.84) followed by Creamy F. cowpea type (28.32%) in the first season, similar trend was noticed during the second season (Table 7). Meanwhile, the respective descending ranking order of grasses varieties was sorghum sudan grass (30.96), then sudan grass (30.79) followed by pearl millet (30.46%) in the first season, being sudan grass (31.89) then pearl millet (31.62) followed by sorghum sudan grass (31.43%) in the second season. Also, CF content was relatively higher in the second season than the first one as it is noticed from Table 7. It should be pointed out that CF content of the proposed mixtures was much more during the second season compared with the first one.

It is also clear from the combined analysis, Dotted F. cowpea type was the highest CF content for the first cut and the Creamy type was the lowest one in the second cut for F. cowpea type. Meanwhile, sudan grass was the highest in CF content for the first cut and the lowest one in the second cut for grasses (Table 7). Similar results were reported by Foster *et al.* (2009) in soybean and cowpea. In this respect, CF content of F. cowpea types and fodder grasses were relatively higher in the second cut than the first one during the pure stands and their mixtures (Table 7).

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مقارنة المحصول والجودة لخلط طرز لوبيا العلف مع النجيليات المختلفة

أحمد محمد سعد إبراهيم

قسم المحاصيل – كلية الزراعة – جامعة بنها – مصر

أقيمت تجربتان حقليتان بمزرعة مركز البحوث والتجارب الزراعية بكلية الزراعة بمشتهر - جامعة بنها وذلك خلال موسمي الزراعة الصيفين ٢٠١١ ، ٢٠١٢م بهدف تقييم الإنتاجية المحصولية (المحصول الأخضر والجاف) وقياسات النمو لثلاثة أصناف من النجيليات العلفية الصيفية (الدخن - حشيشة السودان - هجين مبروك) مع ثلاث طرز من لوبيا العلف حسب لون الغلاف البذرى (الكريمى - البنى - المنقط) وخلطهما معاً بنسبة ٥٠ :٥٠ % وإجراء التوافيق الممكنة واستخدم تصميم قطاعات كاملة العشوائية في أربعة مكررات، ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلي : أظهر طراز لوبيا العلف البنى تفوقاً فى محصول العلف الأخضر والجاف ومحتوى البروتين الخام، كما أظهر طراز لوبيا العلف الكريميّ تفوقاً فى نسبة الأوراق للسيقان، طول النبات و نقص نسبة الألياف الخام، أوضحت النتائج تفوق صنف الدخن فى محصول العلف الأخضر والجاف، نسبة الأوراق للسيقان، ونقص نسبة الألياف الخام بينما أعطى صنف مبروك أطول النباتات وأعلى محتوى من البروتين الخام، تفوقت مخاليط: حشيشة السودان + لوبيا العلف الكريمى، حشيشة السودان + لوبيا العلف البنى، الدخن+ لوبيا العلف الكريمى وأنتجت أعلى معدلات فى كمية العلف الأخضر والجاف ، طول النبات ومحتوى البروتين الخام ، نسبة الأوراق للسيقان ونقص محتوى الألياف الخام على التوالى.

المحكمون :

١- أ.د. سيف الدين عطا الله سيف	أستاذ المحاصيل – كلية الزراعة بمشتهر – جامعة بنها.
٢- أ.د. السيد محمد إبراهيم زيدان	أستاذ المحاصيل المتفرغ – كلية الزراعة – جامعة الزقازيق.