Forge yield and its quality of sudangrass and cowpea under different intercropping patterns

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ABSTRACT

The objective of this study is to evaluate the effect of different intercropping patterns of sudangrass (a cereal forage) and cowpea (a leguminous forage) on forage yield and its quality. Two field experiments were carried out during 2018 and 2019 seasons at Sakha, Agricultural Research Station, Kafr El-Sheakh, Agriculture Research Center (ARC), Giza, Egypt, to study the forage yield and quality of sudangrass and cowpea under different intercropping patterns, i.e. (100% sudangrass+25% cowpea; 100% sudangrass+ 50% cowpea, 100% sudangrass+75% cowpea, 100% sudangrass+100% cowpea, 75% sudangrass+25% cowpea, 50% sudangrass+50% cowpea and 25% sudangrass+75% cowpea) of seeding rate per feddan, of sudangrass and cowpea compared to sole stands of both crops. Treatments were laid out in a randomized complete block design with three replications. The obtained results showed that, 100% sudangrass + 75% cowpea (P3 treatment) gave the highest values yield/fed (fresh and dry yields). There was an increasing in mixed cowpea plants [25% sudangrass + 75% cowpea (P7) recorded the highest (CP%)], while increasing sudangrass in mixed of 100% sudangrass + 100% cowpea (P4) recorded the highest (CF%). 100% sudangrass + 75% cowpea (P3) gave the highest values of the land equivalent ratio (LER), relative crowding coefficient (K) and net return. The best intercropping pattern of 100% sudangrass + 75% cowpea (P3) which was significantly the highest forage productivity and quality, land equivalent ratio (LER), relative crowding coefficient (K), aggressivity and net return.

Keywords: Intercropping; sudangrass, cowpea; sorghum forage; land equivalent ratio (LER); net return.

INTRODUCTON

Egypt has an area of about 1 million km^2, most of it is located in arid regions. There is a reasonable number of animal resources in Egypt that is consists of camels, sheep, goats and cattle. However, the main and most traditional approach to livestock production in Egypt is fodder crops year-round, but mostly during winter season of better such as berseem clover and the rest is supplemented by cultivated summer fodder crops (alfalfa, sorghum, grasses, straw and cowpea). Nowadays, in Egypt face a great problem concerned with the lake of summer forage production to provide the demand of animal's requirement. The shortage of green fodder quantity is caused by the decrease of area sowed with forage crops owing to the highest competition between main summer crops i.e. cotton, corn and rice. Therefore, the strategy in Egypt (Ministry of Agricultural and Land Reclamation - Agriculture Research Center, 2018) raising fodder crops production from sudangrass and cowpea per fed). Increasing forage production is necessary to bridge the gap between forage production and consumption as well as to meet demands of animals. One of the approaches to increase forage production is increasing unit area productivity. These increase in forage productivity is like to be achieved by applied the optimum agricultural practices such as intercropping patterns. Intercropping of cereal and leguminous forages could be one of this means. Intercropping, which is defined as the growing of two or more crop species simultaneously in the same field during one growing season (Ofori and Stern, 1987), the important for the sustainable development of food production systems, particularly in cropping systems with limited external inputs (Adesogan *et al*., 2002).

The objective of this study is to evaluate the effect of different intercropping patterns of sudangrass (a cereal forage) and cowpea (a leguminous forage) on forage yield and its quality.

MATERIAL AND METHODS

Two filed experiments were carried out at Sakha, Agricultural Research Station, Kafr El-Sheahk, Governorate, Agriculture Research Center (ARC), during 2018 and 2019 summer seasons. To study the forage yield and quality of sudangrass and cowpea under different intercropping patterns. Seven intercropping treatments were studied as follow:

P2 = 100% sudangrass + 50% cowpea for seeding rate per feddan.

P3 = 100% sudangrass + 75% cowpea for seeding rate per feddan.

P4 = 100% sudangrass + 100% cowpea for seeding rate per feddan.

P5 = 75% sudangrass + 25% cowpea for seeding rate per feddan.

P6 =50% sudangrass + 50% cowpea for seeding rate per feddan.

P7 = 25% sudangrass+ 75% cowpea for seeding rate per feddan. Based of sudangrass single and cowpea single according to the technical recommendations of each crop.

A randomized complete block design (RCBD) with three replications. The net plot area maintained was 12.60 m2 (0.003 fed), 6 ridges x 0.7 m width x 3m long.

The net plot area maintained was 12.60 m^2 (0.003 fed), 6 ridges each ridge (0.7 m) x 3m long.

The preceding crop was wheat in both seasons, the experiments were planted on 5th and 1stof June during 2018 and 2019 seasons, respectively.

The ridges of 70cm apart was used, and sowing was planted at hills in both sides of each ridge. Recommended seed rates of sudangrass and cowpea intercrops, were used for sowing. Sudangrass was planted on the first side of ridge and cowpea was planted on the other side of the same ridge.

A sufficient amount of a bio-fertilizer containing N_2 fixing bacteria (Rhizobium leguminosarum) was applied to cowpea seeds directly before sowing and success of nodulation was assessed after 30 days from sowing by counting more than ten active nodules per root. Sudangrass was fertilized by 50 kg urea (46.5% N) before the first irrigation and then adds the same rate after each cutting.

All plots-received phosphoric fertilizer in the form of calcium super phosphate (15.5% P_2O_5) at a rate of 150 kg/fed was applied during land preparation. Potassium sulfate was added at a rate of 50kg/fed, before first irrigation, seven irrigations were done during the entire growth period.

All other agronomic practices were done as recommended. Forage sudangrass and cowpea intercrops were harvested together at ground level just at the three cutting. The first cut after 60 days from sowing date, the second cut after 45 days from the first cut and the third cut after 35 days from the second cut.

The data of the following agronomic traits were estimated:

Fresh forage yield characters: plant height (cm), number of plants / $m^{2,}$ green leaves / stem% [weight of leaves / weight of stem] x 100) per plant) and fresh fodder yield / (ton/fed).

Dry forge yield characters: dry leaves / stem% [weight of dry leaves / weight of dry stem] x100) per plant), dry matter % (weight of dry yield / weight of fresh fodder yield x 100) and dry fodder yield / fed (ton).

Quality forge yield characters: crude protein% (CP%) and crude fiber% (CF%).

Competitive relationships and yield advantages.

Land equivalent ratio (LER) as the first criterion for competitive relationships according to **Willey (1979)** was determined as follows:

Yield of intercropped cereal / Yield of pure cereal + yield of intercropped legume / Yield of pure legume. The second coefficient was the relative crowding coefficient (K) which is a measure of the relative dominance of one species over the other in a mixture (Banik *et al*., 2006). The K was calculated as follows:

$K = (K_{cereal} \times K_{legume})$, where$K_{cereal} = Y_{cl} \times Z_{lc} / ((Y_c - Y_{cl}) \times Z_{cl})$, and

$K_{legume} = Y_{lc} \times Z_{cl} / ((Y_l - Y_{lc}) \times Z_{lc})$, where Z_{cl} and Z_{lc} are the proportions of cereal and legume in the mixture, respectively. When the values of LER and K are greater than1, there is a yield advantage; when LER and K were equal to 1, there is no yield advantage; and, when it is less than 1, there is a disadvantage (Dhima *et al*., 2007). The third index was aggressivity (A) which is often used to determine the competitive relationship between two crops used in mixed cropping (Willey, 1979). The aggressivity was formulated as follows:

$A_{legume} = (Y_{lc} / Y_l \times Z_{lc}) - (Y_{cl} / Y_c \times Z_{cl})$, and

$A_{cereal} = (Y_{cl} / Y_c \times Z_{cl}) - (Y_{lc} / Y_l \times Z_{lc})$ (Dhima *et al*., 2007).

For cereal example; if $A_{cereal} = 0$, both crops are equally competitive, if A_{cereal} is positive, then the cereal species is dominant, if A_{cereal} is negative, then the cereal is weak.

Net returns: = Gross revenue – production cost, the gross income for each crop was calculated in Egyptian pounds per feddan at the local market prices of LE 200 and 250 per ton of forge (sudangrass or cowpea) through the two studied seasons, respectively.

All collected data were subjected to analysis of variance according to Steel and Torrie (1984)

to sort out significant differences among treatments. Differences among treatment means were compared using LSD at 5% probability level.

RESULTS AND DISCUSSIONS

Fresh forage yield characters.

Data in table (1) showed that, plant height and number of plant / m^2 were significantly affected by intercropping patterns in both seasons.

Pattern 100% S + 25% C (P_1) was recorded the tallest plants of sudangrass145, 139 and 123cm as well as 142 ,135 and 121cm in the first, second and third cuts as compared with all other patterns in 2018 as well as 2019 seasons, respectively, while pattern 75% S + 25% C (P5) gave the tallest plants of cowpea 86 and 81cm as well as 84 and 78 cm in the second and third cuts in 2018 as well as 2019 seasons, respectively. Meanwhile (P5) pattern did not significant differ from (P_1) pattern in all cuts. However, the shortest plants of sudangrass 133, 126 and 112 cm as well as 130, 123 and 110 cm but in cowpea 77, 65 and 60 cm as well as 75, 63 and 58 cm were determined in 100% S+100% C (P4) in the first, second and third cuts as compared with all other patterns in 2018 as well as 2019 seasons, respectively. The pure stand recorded the tallest plants of both crops in both seasons. These results due to competitive between inter-specifics higher than intra-specific. Awad and Ahmed (2012) found that, mixing the cereal with the leguminous forage resulted in a significantly ($P \leq 0.05$) taller plants throughout the two seasons in all cuts.

Mean number of plants /$m^2$of sudangrass and cowpea were significantly affected by intercropping systems in the two seasons.

Data in Table (1) revealed that increasing of intercropping densities for both crops in mixture from $P_1$to P_3 patterns lead to increasing plant population /m^2. While, decreased plant population /m^2 by decreasing of intercropping densities for both crops in mixture from P_5 to P_7 Patterns. Hence intercropping pattern 50 % sudangrass + 50 % cowpea (P6) gave the lowest number of plant population /m^2 116.67 ,107.77 and 93.33 plant / m^2 as well as 110.00 , 94.44 and 86.67 plant / m^2 also it gave the lowest general means at all cuts 105.72 and 97.06, on the other hand intercropping pattern 100% sudangrass + 75% cowpea (p3) gave the highest number of plant /m^2 173.33 , 163.44 and 133.33 plant / m^2 as well as 170.00 , 155.55 and 126.67 plant / m^2 as compared with all intercropping patterns in the first , second and third cuts in 2018 as well as 2019 seasons , respectively. In this connection, the highest number of plant / m^2 as a general mean of the three cuts 156.67 and 150.79 was recorded with using intercropping pattern 100% sudangrass + 75% cowpea (p3) in 2018 and 2019 seasons, respectively. The effect of intercropping patterns on sudangrass and cowpea were also significant (Table 1), that most intercropping patterns achieved higher number of plants / m^2 than pure stands of both crops. Azraf, *et al*. (2007) found that, in respect intercropping systems, forage sorghum alone produced the highest number of plants of 58.0 and 70.2 m-2 during 2004 and 2005, respectively, while the highest plants m^{-2} were recorded in, P_2I_3 (planting sorghum 30 x 30cm with cowpea).

Data presented in Table (2) indicate that, green leaves /stem (%) and fresh forage yield (ton /fed) were significantly affected by intercropping patterns in both seasons, except 1stand 3rdcuts for sudangrass in the first season. Sudangrass recorded the highest leaves /stem ratio under intercropping pattern 50%+50% (P_6) treatment in the1st cut, but intercropping pattern 25%+75% (P7) recorded the highest leaves / stem ratio 45.69 and 44.79 % as a general mean over all cuts in 2018 and 2019 seasons, respectively. While planting cowpea in pure stand gave the highest green leaves / stem ratio in both seasons.

The increasing of green leaves / stem% values were obtained when decrease density of mixed plants (sudangrass and cowpea), on the other hand the lowest values of green leaves / stem ratio were obtained when increase density of mixed plants (sudangrass and cowpea). These results are related to the inter-specific competition between the intercrop components, also shading by the taller sudangrass under the intercropping patterns. This shading could reduce the photosynthetic rate of the lower growing plants and thereby reduce their leaves. These results are in harmony with reported by Polthance and Treloges (2003).

As for the main effects of planting patterns on mixed fresh forage yield (ton / fed) are shown in Table (2). Plants grown in mixture at high density from P_1 to P_3 gave the highest values. Sudangrass and cowpea performed better when grown as a pure stand than when grown as a mixture. Moreover, cowpea when grown in mixture with sudangrass decreased apparently in the 2nd and 3rd cuts in both seasons, indicating it inability to compete with sudangrass in the mixture. So, the mixture performed better when grown at 100%

sudangrass + 75% cowpea (P_3) which recorded the highest values of fresh forage yield (44.709 and 43.283t/fed), followed by100% sudangrass +50% cowpea (P_2) which were produced mixed forage yield of (40.244 and 38.700 t/fed) in both seasons, respectively. The lowest values (28.141 and 26.912 t/fed) were recorded by 25% sudangrass + 75%cowpea intercropping (P_7), compared with (24.259 and 23.372 t/fed) were obtained when cowpea in pure stand, which produced in the two growing seasons, respectively. The differences of intercropping patterns lead to computation for water, light, air and nutrients and also depressive effect of sudangrass a C4 species, on cowpea a C3 crop, similar fending reported by (Egbe *et al*., 2010). However, the higher intercropping densities (P_4) resulted in decreasing production than P_3 and P_2 patterns, which could be due to the direct and indirect effects of mutual shading of intercropping systems on forage morphological development and forage yield. And similar results were observed by Azraf, *et al*. (2007), Awad and Ahmed (2012), Gunjan, G, and Naveen, K. (2016) and Ugur, *et al*. (2017).

Dry forge yield characters.

Data in Table (3) indicated that, dry leaves /stem (%) and dry matter (%) as affected by intercropping patterns in both seasons. The main effects of planting patterns on mixed of dry leaves / stem percentage were significant different in all the three cuts in the two studied seasons, except cowpea and sudangrass at 1st cut in 2019 season, along cowpea when planted at the low density in mixture and pure stand in the three cuts. Direct and indirect effects of mutual shading of intercropping systems on forage quality, morphological development and forage yield have been reported, these differences may have resulted from species variation, length of shading period, change in leaf-to-stem ratio or environmental conditions (Buxton and Fales, 1993).

Dry matter (%) was significantly affected by intercropping patterns in all three cuts in 2019 season only, except cowpea at 3st cut, while the mean of the three cuts was significantly differed in both seasons. Sudangrass produced higher dry matter (%) than cowpea and recorded the highest values when planted under pattern {100% S + 50% C (P_2)} and pure stand. The highest dry matter of cowpea was recoded when sowing mixture of {100% + 25% (P_1)}. The highest dry matter (%) (21.13 and 21.04%) were obtained when sowing the mixture at the pattern (P_2). While the lowest dry matter (%) (19.59 and 19.08%) were resulted when planted sudangrass and cowpea in mixed (P4). The sowing mixture gave higher values than cowpea a monoculture crop in all intercropping treatments. Mixed cropping especially with forage legume can improve the forage yield and quality, because legume are good sources for protein (Moreira, 1989). Sorghum+cowpea in the pattern of 45 cm spaced double row strips was found more adaptable system with high quality nutritious fodder in Pakistan (Ahmad *et al*., 2007).

Dry yield (ton/fed) was significantly affected by intercropping treatments in all cuts in both seasons as in shown (Table 4). Sudangrass grown sole produced dry forage yield higher than the intercropped sudangrass. Cowpea grown as mixture (P1 and P5) treatments gave the lowest cowpea grown as mixture (P1 and P5) were recorded the lowest dry forage yield/ fed. The patterns of {100% S + 50%C) and (100%S + 75%C) (P2 and (P3)} produced significantly the highest dry fodder yield (8.918 and 8.630, 9.048 and 8.511 ton/fed) in the two studied seasons, respectively. Whereas the minimum values (5.226 and 4.800 ton/fed) for recorded with mixture planted in {25%S + 75%C (P7)} pattern in both seasons, respectively. Patel and Rajagopal (2002) under Madhya Pradesh conditions found that sorghum + cowpea in 4:3 row ratio gave highest green fodder yield (502.69 q/ha) and dry fodder yield (91.54 q/ha) oversold stand of sorghum, and similar results by Singh *et al*. (2005). Aurangabad, intercropping system was found to be beneficial when the two crops were cultivated in 1:1 proportion i.e. alternating rows of sorghum and cowpea. This intercropping system led to higher fodder yield (Rathor, 2015). On the other hand, cowpea as an intercrop in maize gave higher green and dry fodder yield as compare to sole crop (Babu *et al*., 1994), and Barik and Tiwari (1996) at Anjora (MP) intercropped sorghum with groundnut assessed sweet sudangrass as better yielder.

Quality forge yield characters.

Data presented in table (5) indicated that, crude protein percentage (CP%) and crude fiber percentage (CF%) in both seasons.

Crude protein percentage (CP%) of sudangrass in respect to planting pattern with cowpea, was observed to be significant in the three cuts during in2018 and 2019 seasons. The CP% decreased in mixed forge from 1stcut to 3rd cut and the CP% of mixed forage increased benefit with the addition of cowpea in the intercropping which were 14.55 and 14.25, 12.32 and 12.29 and 11.31 and 11.22% compared with planting sudangrass as a monoculture crop

which were 9.44 and 9.24, 8.19and 8.15 and 7.39 and 7.28% at the three cuts during the two seasons, respectively. CP% of pure sudangrass as an average from 8.90 to 8.74% in both seasons, while crude protein of mixed forage from 12.73 to 12.59% in 2018 and 2019 seasons, respectively. The data showed that individual effects of intercropping systems on CP% of mixed forage were significant in the first and second seasons. During 2018 and 2019 seasons, the maximum CP% values (15.35 and 15.10%) were recorded for25% sudangrass + 75% cowpea mixed forage (P_7) at 1st cut, while the minimum values (8.17 and 8.13%) were found in sudangrass in pure stand during the two seasons. Similar trend was exhibited in2005 with the highest CP percentage (16.74 %) in mixed sorghum + sesbania forage against the minimum (9.74%) in sorghum forage grown alone (Azraf, *et al*., 2007).

Crude fiber percentage (CF%) of sudangrass in respect of planting patterns with cowpea, intercropping systems were significantly in the three cuts in the two growing seasons. The CF% of mixed forge from of mixed forge increased from 1st cut to 3rd cut, while the CF% of mixed forage with the addition of cowpea in the intercropping which were (30.29 and30.34%, 36.16 and 35.21%, 38.62 and 37.66%) compared with planting sudangrass as pure stand which were (37.31 and 37.01%, 38.53 and 38.17%, 39.61 and 38.90%) at three cuts during the two seasons, respectively. Crude fiber (CF%) of sudangrass on an average were 38.48 and 38.03%, comparing with (35.02 and 34.40%) for mixed forage during 2018 and 2019 seasons, respectively. Mixing sudangrass with cowpea significantly improved forage quality in terms of decreasing the crude fiber% and increasing the digestibility of true the mixture compared to sudangrass when grown as a pure stand. Awad and Ahmed (2012) found that, the nutritive value of sudangrass forage, in terms of CP, CF, Ca,Mg, K, P and Na, as affected by the fertilizer and intercropping treatments. Mixing Sudangrass with Cowpea significantly improved forage quality in terms.

Competitive relationships.

Concerning the effect of intercropping patterns in Table (6). Land equivalent ratio (LER) is a quantitative index, used to evaluate the output efficiencies of intercropping patterns. Show that, it is the most suitable parameter used to measure the impact of growing different crop plants at the same time on the same land. Resulted indicated that mean values of LER ranged from 1.01 to 1.47, except in case [75S + 25%C (P_5)] the LER was equal one, in both seasons. Land equivalent ratio in all cuts during both seasons was greater to 1.00. (LER) dropped than 1.00 during 2nd and 3rd cuts under intercropping pattern (P_5) due to the disappearance of Cowpea, followed by 3rdcut under intercropping pattern (P_6) in both seasons. Liu and Zhang (2006) reported that land use efficiency under intercrops was raised by 61% compared to single cropping. Dariush *et al*. (2006) reported that LER was significantly affected by intercropping when planting sorghum with legumes and the LER ranged between 1.70 to 1.89 which indicated yield advantage of intercropping over sole cropping. Awad and Ahmed (2012) found that, intercropping of Sudangrass and Cowpea significantly ($P \leq 0.05$) increased forage productivity and improved forage quality and land equivalent ratio (LER).

Data in Table (6) indicated that the total of relative crowding coefficient (RCC) or (K) was much higher than one, except in the case of 2nd and 3rd cuts under intercropping pattern (P_5) and in case of 3rd cut under intercropping pattern (P_6) in both seasons due to the disappearance of cowpea. On the other hand, the main K values were close to one, except in case (P_5) pattern (Table 6). This result was expected because cereals are more competitive than legumes. In addition, the increase of seed rate of cereals especially with large canopy could drastically overcrowd legumes. In a groundnut-cereal mixture, cereals overcrowded groundnut (K_{cereal} values > 1; Ghosh, 2004). In the present study, we also found that variation in K values may change when the density and types of plants were modified. When sudangrass-cowpea intercropping was considered in close rates such as 100+50 or 100+75 ratios.

Data presented in Table (6) showed that sudangrass was the dominant species in cases P_3, P_4, P_5 and P_7 patterns, while cowpea was the dominant species in cases P_1, P_2 and P_6 patterns in the first season. In the second season in most planting patterns, positive cowpea values showed that cowpea was the dominant specie in cases P_1, P_2, P_3 P_6 and P_7 patterns, while sudangrass was the dominant species in cases P_4 and P_5 patterns, these results has been attributed to inter-specific high competition than the intra-specific. Ahmad *et al*. (2006) in Pakistan demonstrated that in sorghum + legumes intercropping systems, sorghum appeared a dominant crop with higher values of relative crowding coefficient and competitive ratio and positive aggressivity. Zen El-Dein (2015) showed that cowpea had less aggressive

plants than each of soybean and sesame when intercropped with maize.

Economics: monetary advantages of sudangrass in respect of planting with cowpea, in intercropping systems were observed to significant during the two seasons (Table 7). Intercropping or mixed cropping is successful preposition when overall economics in terms of net returns from the systems is concerned. Data in Table (7) showed that, the lowest net returns (LE 2151.30 and 2763.07 LE/fed) were obtained when growing cowpea in pure stand. The highest gross and net returns (LE 5091.87 and 6353.33 net return/fed) were obtained when intercropped cowpea with sudangrass in {100% sudangrass + 75% (P_3)} compared with planting sudangrass and cowpea in pure stands which gave L.E 3685.53, 4606.07 and 2151.80, 2763.07/fed, respectively in the two seasons. All intercropping systems recorded gross returns and net return higher than cowpea in pure stand. The experimental findings of Ram and Singh (2003) at Faizabad, Uttar Pradesh obtained better monetary advantage in terms of net returns in sorghum + cowpea intercropping system supplied with 80 kg N per hectare. Ahmad *et al*. (2006) earned high monetary returns when sorghum + cowpea were grown in planting pattern of 1:1row arrangement in additive series. Higher B: C ratio et returns were also recorded by intercropping of sorghum sudangrass with cowpea over sole sorghum sudangrass as well as sole cowpea. Sowing of sorghum with legumes using different row proportions was also profitable (Sharma *et al*., 2008 and Sharma *et al*. 2009). Surve *et al*. (2011) also reported that intercropping of sorghum with cowpea in row ratio of 2:1 gave maximum gross return and net returns along with high B: C ratio.

Conclusion

This study demonstrated that 100% sudangrass + 75% cowpea per fed (P_3) was the extra benefit, which lead to the highest yield, LER and net return at Sakha, Kafr El-Sheakh Governorate, Egypt.

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Table 1. Effect of intercropping patterns on plant height (cm) and number of plant /m² of sudangrass and cowpea during 2018 and 2019 seasons.

Treatments	Plant height (cm)						Number of plant / m²									
	1st cut		2nd cut		3rd cut		1st cut		Mixed of forage	2nd cut		Mixed of forage	3rd cut		Mixed of forage	Mean
	S. grass	Cowpea	S. grass	Cowpea	S. grass	Cowpea	S. grass	Cowpea		S.grass	Cowpea		S.grass	Cowpea		
							2018									
P1(100+25)	145	90	139	85	123	79	107.76	33.33	141.09	106.67	26.67	133.34	97.78	20.00	117.78	130.74
P2(100+50)	142	81	135	76	121	75	103.33	56.67	160.00	103.33	50.00	153.33	93.33	35.56	128.89	147.41
P3(100+75)	140	85	132	75	117	72	90.00	83.33	173.33	86.67	76.67	163.34	80.00	53.33	133.33	156.67
P4(100+100)	133	77	126	65	112	60	84.44	73.33	157.77	66.67	64.44	131.11	60.00	48.89	108.89	132.59
P5(75+25)	141	90	136	86	121	81	83.33	33.33	116.66	80.00	30.00	110.00	70.00	23.33	93.33	106.67
P6(50+50)	138	92	132	85	120	78	60.00	56.67	116.67	54.44	53.33	107.77	50.00	43.33	93.33	105.72
P7(25+75)	140	86	135	84	123	76	36.67	83.33	120.00	36.67	82.22	118.89	30.00	63.33	93.33	110.74
Mean	139.86	85.86	134.63	80.63	120.25	75.63	80.79	60.00	140.79	76.35	54.76	131.11	68.73	41.11	109.83	127.22
L.S.D. at 5%	2.99	4.03	4.85	4.28	5.14	5.34	6.78	6.33	12.91	7.84	7.77	14.94	7.68	8.76	15.73	5.13
Pure stand	157	---	142	---	125	---	113.33	---	113.33	106.67	---	106.67	100.00	---	100.00	106.67
Cowpea pure	---	93	---	89	---	84	---	106.67	106.67	---	100.00	100.00	---	84.44	84.44	97.04
							2019									
P1(100+25)	142	88	135	83	121	77	103.33	30.00	133.33	101.11	24.44	125.55	93.33	18.89	112.22	123.70
P2(100+50)	138	78	132	74	118	73	97.78	53.33	151.11	98.89	48.89	147.78	91.11	33.33	124.44	143.33
P3(100+75)	137	82	128	72	115	70	90.00	80.00	170.00	82.22	73.33	155.55	76.67	50.00	126.67	150.74
P4(100+100)	130	75	123	63	110	58	83.33	70.00	153.33	61.11	57.78	118.89	57.78	46.67	104.45	125.56
P5(75+25)	138	87	133	84	118	78	80.00	30.00	110.00	74.44	27.78	102.22	66.67	21.11	87.78	100.00
P6(50+50)	135	89	130	82	117	75	56.67	53.33	110.00	50.00	44.44	94.44	46.67	40.00	86.67	97.06
P7(25+75)	137	84	133	81	120	74	33.33	80.00	113.33	33.33	78.89	112.22	27.78	60.00	87.78	104.44
Mean	138.88	84.13	131.75	78.13	117.75	73.38	77.78	56.67	134.45	71.59	50.79	122.38	65.72	38.57	104.29	120.69
L.S.D. at 5%	5.59	4.29	4.81	4.39	4.50	4.28	6.44	5.90	11.83	7.70	7.31	14.09	5.62	5.66	10.81	3.19
S. grass pure	154	---	140	---	123	---	110.00	---	110.00	101.11	---	101.11	96.67	---	96.67	102.59
Cowpea pure	---	90	---	86	---	82	---	103.33	103.33	---	93.33	93.33	--	80.00	80.00	92.22

Table 2. Effect of intercropping patterns on green leaves / stem (%) and fresh yield (ton/fed) of sudangrass and cowpea during 2018 and 2019 seasons**.**

Treatments	Green leaves / stem (%)										Fresh yield (ton / fed)									
	1st cut		GL/S% of forge	2nd cut		GL/S % of forge	3rd cut		GL/S% of forge	Mean	1st cut		Mixed of forage	2nd cut		Mixed of forage	3rd cut		Mixed of forage	Mean
	S. grass	Cowpea		S. grass	Cowpea		S. grass	Cowpea			S. grass	Cowpea		S.grass	Cowpea		S.grass	Cowpea		
										2018										
P1(100+25)	29.63	66.76	48.20	24.66	61.62	43.14	22.94	58.64	40.79	44.04	11.333	3.056	14.389	9.611	2.194	11.805	8.095	1.472	9.567	35.762
P2(100+50)	28.56	63.80	46.18	23.95	59.79	41.87	20.74	56.78	38.76	42.27	10.667	5.833	16.500	9.233	4.511	13.744	7.711	2.589	10.300	40.244
P3(100+75)	23.79	74.47	49.13	22.55	59.02	40.79	20.52	56.61	38.57	42.83	10.055	8.333	18.388	8.800	6.344	15.144	5.435	3.930	9.365	44.709
P4(100+100)	28.57	70.91	49.74	21.64	55.47	38.56	18.57	45.30	31.94	40.08	9.111	7.389	16.500	7.200	6.078	13.278	5.165	3.209	8.374	38.185
P5(75+25)	26.41	75.42	50.92	23.45	64.21	43.83	21.47	60.29	40.88	45.21	9.389	3.167	12.556	7.433	2.372	9.805	6.178	1.736	7.914	30.276
P6(50+50)	23.52	81.79	52.66	22.45	60.92	41.69	21.20	58.56	39.88	44.74	6.389	6.000	12.389	5.455	4.817	10.272	4.421	2.822	7.243	29.917
P7(25+75)	30.21	74.47	52.34	26.25	63.23	44.74	23.40	56.59	40.00	45.69	3.444	8.444	11.888	2.705	6.711	9.416	2.389	4.447	6.836	28.141
Mean	27.24	72.52	49.88	23.56	60.61	42.09	21.26	56.11	38.69	43.40	8.627	6.032	14.659	7.206	4.718	11.924	5.628	2.887	8.515	35.319
L.S.D. at 5%	NS	17.98	5.93	1.31	2.07	1.67	NS	3.02	1.69	3.23	0.455	0.534	0.899	0.280	0.210	0.501	0.823	0.345	1.159	1.381
Pure stand	27.94	---	27.94	25.59	---	25.59	23.50	---	23.69	25.74	12.666	---	12.666	10.144	---	10.144	8.117	---	8.117	30.927
Cowpea pure	---	71.12	71.12	---	65.69	65.69	---	61.58	61.58	66.13	---	10.000	10.000	---	8.467	8.467	---	5.792	5.792	24.259
P1(100+25)	28.50	65.66	47.08	24.31	60.65	42.48	22.40	58.22	40.31	43.29	11.066	2.856	13.922	9.389	2.045	11.434	7.883	1.372	9.255	34.611
P2(100+50)	27.51	62.39	44.94	23.28	59.24	41.26	20.00	56.17	38.09	41.43	10.222	5.444	15.666	9.000	4.367	13.367	7.256	2.411	9.667	38.700
P3(100+75)	22.42	72.32	47.37	22.13	58.52	40.33	19.80	55.57	37.69	41.79	9.745	7.911	17.656	8.600	6.144	14.744	7.100	3.783	10.883	43.283
P4(100+100)	27.53	69.05	48.29	21.23	54.69	37.96	17.92	44.72	31.32	39.19	8.756	7.111	15.867	7.044	5.889	12.933	5.033	3.083	8.116	36.917
P5(75+25)	25.34	72.44	48.89	23.05	63.63	43.34	20.87	59.22	40.05	44.09	9.145	2.911	12.056	7.167	2.233	9.400	6.034	1.678	7.712	29.167
P6(50+50)	22.59	77.62	50.11	21.75	60.34	41.05	20.64	57.77	39.21	43.45	6.167	5.811	11.978	5.244	4.589	9.833	4.267	2.667	6.934	28.744
P7(25+75)	29.31	72.46	50.89	25.77	62.80	44.29	22.71	55.70	39.21	44.79	3.200	8.133	11.33	2.522	6.545	9.067	2.267	4.244	6.511	26.912
Mean	26.17	70.28	48.13	23.07	59.98	41.53	20.62	55.34	37.98	42.58	8.329	5.740	14.069	6.995	4.545	11.540	5.681	2.749	8.430	34.048
L.S.D. at 5%	1.73	3.44	2.49	0.83	1.39	1.13	1.43	1.42	1.39	1.24	0.482	0.404	0.901	0.350	0.224	0.571	0.274	0.217	0.488	0.614
S. grass pure	26.76	---	26.76	24.46	---	24.46	23.02	---	23.02	24.75	12.411	---	12.411	9.811	---	9.811	7.922	---	7.922	30.144
Cowpea pure	---	69.49	69.49	---	63.57	63.57	--	60.92	60.92	64.66	---	9.556	9.556	---	8.145	8.145	--	5.672	5.672	23.373

Table 3. Effect of intercropping patterns on dry leaves / stem (%) and dry matter (%) of sudangrass and cowpea during 2018 and 2019 seasons.

Treatments	Dry leaves / stem (%)										Dry matter (%)									
	1st cut		DL/S% of forge	2nd cut		DL/S % of forge	3rd cut		DL/S% of forge	Mean	1st cut		DM% of forage	2nd cut		DM% of forage	3rd cut		DM% of forage	Mean
	S. grass	Cowpea		S. grass	Cowpea		S. grass	Cowpea			S. grass	Cowpea		S.grass	Cowpea		S.grass	Cowpea		
											2018									
P1(100+25)	42.40	79.05	60.73	37.53	68.44	52.99	34.76	62.72	48.74	54.15	21.40	14.56	17.98	25.73	16.70	21.22	29.47	19.99	24.73	21.31
P2(100+50)	43.43	72.78	58.11	36.21	66.54	51.38	33.49	61.51	47.50	52.33	22.20	14.00	18.10	27.60	16.63	22.12	29.52	19.80	24.66	21..13
P3(100+75)	38.18	78.79	58.49	35.45	65.56	50.51	32.01	59.55	45.78	51.59	20.71	12.94	16.83	24.65	15.70	20.18	27.54	18.79	23.17	20.06
P4(100+100)	38.68	79.92	59.30	30.97	58.36	44.67	28.49	53.24	40.87	48.28	21.51	11.88	16.70	23.80	15.45	19.63	26.36	18.55	22.46	19.59
P5(75+25)	33.13	80.29	56.71	35.71	68.54	52.13	33.59	63.42	48.51	52.45	23.22	13.66	18.44	24.98	16.66	20.82	27.47	19.78	23.63	20.96
P6(50+50)	31.65	84.96	58.31	35.73	67.39	51.56	34.59	61.79	48.19	52.69	22.86	12.96	17.91	25.06	16.41	20.74	28.36	19.60	23.98	20.87
P7(25+75)	38.33	81.70	60.02	36.46	66.53	51.50	34.67	60.86	47.77	53.10	20.04	13.82	16.93	25.42	16.45	20.89	29.55	19.47	24.51	20.79
Mean	37.97	79.64	58.81	35.44	65.91	50.68	33.09	60.44	46.77	52.08	21.71	13.40	17.56	25.32	16.29	20.81	28.32	19.43	23.88	20.67
L.S.D. at 5%	NS	NS	NS	1.66	0.44	1.07	4.11	4.76	4.38	3.93	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.95
S. grass pure	41.79	---	41.79	38.38	---	38.38	35.52	---	35.52	38.56	23.17	---	23.17	26.29	---	26.29	30.50	---	30.50	26.65
Cowpea pure	---	76.87	76.87	---	70.92	70.92	---	64.44	64.44	70.74	---	13.41	13.41	---	17.42	17.42	---	20.64	20.64	17.16
											2019									
P1(100+25)	40.62	76.08	58.35	36.60	67.70	52.15	33.73	61.62	47.68	652.73	20.85	14.17	17.51	24.71	16.32	20.52	28.67	19.23	23.95	20.66
P2(100+50)	41.49	72.63	57.06	35.60	66.05	50.83	32.67	60.59	46.63	51.51	21.72	13.49	17.61	26.91	16.17	21.54	28.73	19.17	23.96	21.04
P3(100+75)	36.98	75.96	56.47	34.52	64.59	49.56	31.39	58.72	45.06	50.42	19.92	12.33	16.13	24.23	15.28	19.76	26.76	17.67	22.22	19.37
P4(100+100)	37.73	77.43	57.58	30.12	57.50	43.81	27.49	52.51	40.00	47.13	21.01	11.70	16.36	23.33	15.06	19.20	25.64	17.76	21.70	19.08
P5(75+25)	31.77	78.11	54.94	34.66	67.56	51.11	32.61	62.61	47.61	51.22	22.75	13.12	17.94	24.43	16.27	20.35	26.59	18.76	22.68	20.32
P6(50+50)	31.24	82.42	56.83	34.81	66.77	50.79	33.32	60.73	47.03	51.55	22.20	12.39	17.30	24.44	15.88	20.16	27.47	18.76	23.12	20.19
P7(25+75)	37.23	80.67	58.95	35.53	65.44	50.49	33.52	59.64	46.58	52.01	19.27	13.21	16.24	24.70	16.01	20.36	28.65	18.52	23.59	20.06
Mean	36.72	77.61	57.17	34.55	65.09	49.82	32.10	59.49	45.80	50.94	21.10	12.92	17.01	24.68	15.86	20.27	27.50	18.55	23.03	20.10
L.S.D. at 5%	2.29	3.52	2.87	1.63	1.57	1.66	1.73	1.69	1.70	1.42	1.09	0.93	0.98	1.01	0.74	0.85	1.06	NS	0.91	0.38
S. grass pure	40.27	---	40.27	37.57	---	37.57	34.57	---	34.57	37.50	22.49	---	22.49	25.51	---	25.51	29.66	---	29.66	25.89
Cowpea pure	---	75.24	75.24	---	70.25	70.25	--	63.60	63.60	69.69	---	12.97	12.97	---	16.78	16.78	---	19.87	19.87	16.54

Table 5. Effect of intercropping patterns on crude protein percentage (CP%) and crude fiber percentage (CF%) of sudangrass and cowpea during 2018 and 2019 seasons.

Treatments	Crude protein percentage (CP%)										Crude fiber percentage (CF%)									
	1st cut		CP% of forge	2nd cut		CP% of forge	3rd cut		CP% of forge	Mean	1st cut		CF% of forage	2nd cut		CF% of forage	3rd cut		CF% of forage	Mean
	S. grass	Cowpea		S. grass	Cowpea		S. grass	Cowpea			S. grass	Cowpea		S.grass	Cowpea		S.grass	Cowpea		
											2018									
P1(100+25)	10.09	18.12	14.11	8.57	16.72	12.65	7.97	15.91	11.94	12.90	36.74	27.62	32.09	39.01	31.90	35.45	39.90	34.37	37.14	34.89
P2(100+50)	9.93	17.31	13.62	8.32	16.22	12.27	7.21	15.41	11.31	12.40	36.99	30.09	33.54	39.37	33.42	36.40	41.04	35.92	38.48	36.14
P3(100+75)	8.27	20.13	14.20	7.84	16.02	11.93	7.13	15.36	11.25	12.46	39.46	21.21	30.34	40.10	34.06	37.08	41.15	36.05	38.60	35.34
P4(100+100)	9.93	19.24	14.59	7.52	15.05	11.28	6.45	12.30	9.38	11.75	36.99	24.18	30.58	40.57	37.01	38.79	42.16	45.46	43.81	37.73
P5(75+25)	9.18	20.47	14.82	8.15	17.42	12.79	7.46	16.36	11.91	13.17	38.10	20.43	29.27	39.63	29.74	34.69	40.66	33.01	36.83	33.60
P6(50+50)	8.18	22.20	15.19	7.80	16.53	12.17	7.37	15.90	11.63	13.01	39.59	15.13	27.36	40.15	32.48	36.32	40.80	34.34	37.62	33.77
P7(25+75)	10.50	20.21	15.35	9.12	17.16	13.14	8.13	15.36	11.74	13.41	36.21	21.22	28.72	38.20	30.56	34.38	39.66	36.08	37.87	33.66
Mean	9.44	19.67	14.55	8.19	16.45	12.32	7.39	15.23	11.31	12.73	37.73	22.84	30.29	39.58	32.74	36.16	40.77	36.47	38.62	35.02
L.S.D. at 5%	0.95	1.87	0.88	0.46	0.56	0.47	0.67	0.81	0.83	0.95	2.40	8.55	3.18	0.69	1.72	1.12	1.02	0.79	1.75	2.02
S. grass pure	9.71	---	9.71	8.83	---	8.83	8.17	---	8.17	8.90	37.31	---	37.31	38.53	---	38.53	39.61	---	39.61	38.48
Cowpea pure	---	19.30	19.30	---	17.83	17.83	---	16.71	16.71	19.52	---	24.01	24.01	---	28.51	28.51	---	31.92	31.92	28.15
											2019									
P1(100+25)	10.06	17.98	14.02	8.58	16.61	12.60	7.91	15.94	11.93	12.85	36.13	27.06	31.60	38.25	31.02	34.64	39.21	32.93	36.07	34.10
P2(100+50)	9.72	17.08	13.40	8.22	16.22	12.22	7.06	15.38	11.22	12.28	36.36	29.64	33.14	38.77	32.13	35.45	40.42	34.55	37.49	35.36
P3(100+75)	7.92	19.80	13.86	7.81	16.03	11.92	6.99	15.22	11.10	12.29	39.20	21.82	30.51	39.35	32.70	36.03	40.53	35.02	37.78	34.77
P4(100+100)	9.72	18.91	14.32	7.51	14.98	11.24	6.33	12.25	9.29	11.62	36.62	24.40	30.38	39.80	35.72	37.76	41.48	43.58	42.53	36.89
P5(75+25)	8.95	19.84	14.40	8.14	17.42	12.78	7.37	16.22	11.79	12.99	37.73	21.72	29.62	38.88	28.67	33.78	39.99	32.14	36.07	33.16
P6(50+50)	7.98	21.26	14.62	7.68	16.52	12.10	7.29	15.82	11.55	12.76	39.12	17.64	28.38	39.54	31.26	35.40	40.11	33.29	36.71	33.50
P7(25+75)	10.35	19.84	15.10	9.10	17.20	13.15	8.02	15.25	11.64	13.30	35.72	21.71	28.72	37.51	29.33	33.42	39.05	34.92	36.99	33.04
Mean	9.24	19.25	14.25	8.15	16.43	12.29	7.28	15.15	11.22	12.59	37.27	23.43	30.34	38.87	31.55	35.21	40.11	35.20	37.66	34.40
L.S.D. at 5%	0.61	0.94	0.31	0.29	0.31	0.19	0.40	0.39	0.27	0.27	0.87	2.70	0.99	0.43	0.90	0.47	0.53	1.12	0.63	0.70
S. grass pure	9.45	---	9.45	8.63	---	8.63	8.13	---	8.13	8.74	37.01	---	37.01	38.17	---	38.17	38.90	---	38.90	38.03
Cowpea pure	---	19.03	19.03	---	17.41	17.41	---	16.68	16.68	19.38	---	24.05	24.05	---	28.72	28.72	---	30.81	30.81	27.86

Table 6. Effect of intercropping patterns on land equivalent ratio (LER), relative crowding coefficient (K), and aggressivity (A) of sudangrass and cowpea during 2018 and 2019 seasons.

Treatments	Land equivalent ratio (LER)										Relative crowding coefficient (K)										Aggressivty (A)					
	1st cut			2nd cut			3rd cut			Mean	1st cut			2nd cut			3rd cut			Mean	1st cut		2nd cut		3rd cut	
	Ls	Lc	LER	Ls	Lc	LER	Ls	Lc	LER		Ks	Kc	K	Ks	Kc	K	Ks	Kc	K		As	Ac	As	Ac	AS	Ac
													2018														
P1(100+25)	0.83	0.33	1.16	0.93	0.25	1.18	0.96	0.25	1.21	1.18	1.19	2.00	2.37	3.17	1.33	4.20	6.65	1.31	8.73	5.10	-0.63	+0.63	-0.08	+0.08	-0.03	+0.03
P2(100+50)	0.81	0.61	1.42	0.85	0.51	1.36	0.88	0.43	1.31	1.36	2.07	3.10	6.41	2.82	2.10	5.91	3.78	1.52	5.75	6.02	-0.64	+0.64	-0.27	+0.27	+0.02	-0.02
P3(100+75)	0.71	0.80	1.51	0.81	0.67	1.48	0.80	0.62	1.42	1.47	1.84	5.28	9.72	3.26	2.74	8.95	3.04	2.16	6.56	8.41	-0.62	+0.62	-0.15	+0.15	-0.04	+0.04
P4(100+100)	0.67	0.65	1.32	0.65	0.64	1.29	0.55	0.50	1.05	1.22	2.01	1.89	3.79	1.88	1.74	3.27	1.21	0.99	1.20	2.75	+0.03	-0.03	+0.03	-0.03	+0.10	-0.10
P5(75+25)	0.74	0.32	1.06	0.70	0.27	0.97	0.78	0.29	0.97	1.00	8.67	0.15	1.35	6.87	0.12	0.84	6.44	0.14	0.86	1.02	+2.55	-2.55	+2.43	-2.43	+2.35	-2.35
P6(50+50)	0.50	0.58	1.08	0.51	0.56	1.07	0.50	0.46	0.96	1.04	1.01	1.38	1.39	1.05	1.28	1.16	1.02	0.86	0.87	1.20	-0.15	+0.15	-0.10	+0.10	+0.08	-0.08
P7(25+75)	0.24	0.87	1.11	0.26	0.75	1.02	0.29	0.72	1.01	1.05	0.92	2.29	2.11	1.04	0.99	1.20	0.87	1.04	1.04	1.39	-0.22	+0.22	+0.04	-0.04	+0.02	-0.18
S. grass pure	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	--	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	---		--	--	---	---	---	---
Cowpea pure	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	--	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	---		---	--	---	---	---	---
													2019													
P1(100+25)	0.83	0.33	1.16	0.93	0.24	1.17	0.96	0.25	1.19	1.17	1.19	1.94	2.31	3.23	1.29	4.17	6.27	1.23	7.69	4.72	-0.60	+0.60	-0.06	+0.06	+0.03	-0.03
P2(100+50)	0.80	0.59	1.39	0.97	0.52	1.49	0.88	0.43	1.30	1.39	1.92	2.95	5.67	14.9	2.17	32.3	3.89	1.42	5.50	6.48	-0.61	+0.61	-0.12	+0.12	+0.08	-0.08
P3(100+75)	0.70	0.79	1.49	0.83	0.69	1.52	0.80	0.62	1.40	1.47	1.72	4.93	8.49	3.77	2.90	10.9	3.18	1.94	6.18	8.54	-0.61	+0.61	-0.13	+0.13	+0.04	-0.04
P4(100+100)	0.66	0.67	1.33	0.66	0.65	1.31	0.55	0.50	0.99	1.21	1.93	2.04	3.94	1.92	1.84	3.53	1.22	0.78	0.95	2.81	-0.02	+0.02	+0.02	+0.02	+0.22	-0.22
P5(75+25)	0.75	0.31	1.06	0.70	0.27	0.97	0.68	0.29	0.96	1.00	8.77	0.15	1.31	6.99	0.12	0.84	6.45	0.13	0.84	1.00	+2.57	-2.57	+2.45	-2.45	+2.36	-2.36
P6(50+50)	0.49	0.58	1.07	0.51	0.52	1.03	0.50	0.46	0.92	1.01	0.96	1.39	1.34	1.05	1.10	1.16	0.99	0.81	0.80	1.10	-0.18	+0.18	-0.02	+0.02	+0.11	-0.11
P7(25+75)	0.22	0.87	1.09	0.25	0.77	1.02	0.29	0.72	0.97	1.03	0.85	2.17	1.85	1.00	1.09	1.09	1.25	0.77	0.96	1.30	-0.27	+0.27	-0.04	+0.04	+0.17	-0.17
S. grass pure	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	---	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	---		--	--	---	---	---	---
Cowpea pure	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	---	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	---		---	--	---		---	….

Table 4. Effect of intercropping patterns on dry yield (ton/fed) and during 2018 and 2019 seasons.

Treatments	Dry yield (ton/fed)									
	1st cut		Mixed of forge	2nd cut		Mixed of forge	3rd cut		Mixed of forge	Total mixed(t/f)
	S. grass	Cowpea		S. grass	Cowpea		S. grass	Cowpea		
				2018						
P1(100+25)	2.425	0.447	2.872	2.474	0.367	2.841	2.393	0.295	2.688	8.401
P2(100+50)	2.371	0.816	3.187	2.272	0.751	3.023	2.197	0.511	2.708	8.918
P3(100+75)	2.082	1.073	3.155	2.167	0.997	3.164	1.989	0.740	2.729	9.048
P4(100+100)	1.959	0.878	2.837	1.741	0.939	2.680	1.360	0.593	1.953	7.470
P5(75+25)	2.181	0.428	2.609	1.858	1.378	3.236	1.694	0.342	2.036	6.900
P6(50+50)	1.475	0.778	2.253	1.369	0.831	2.200	1.251	0.552	1.803	6.613
P7(25+75)	0.691	1.171	1.862	0.688	1.104	1.792	0.710	0.862	1.572	5.226
Mean	1.883	0.799	2.682	2.081	0.769	2.850	1.656	0.556	2.212	7.511
L.S.D. at 5%	0.317	0.148	.0475	0.202	0.119	0.323	0.327	0.079	0.411	0.634
S. grass pure	2.936	---	2.936	2.669	---	2.669	2.483	---	2.483	8.089
Cowpea pure	---	1.342	1.342	---	1.478	1.478	---	1.194	1.194	4.014
				2019						
P1(100+25)	2.308	0.405	2.713	2.321	0.334	2.655	2.259	0.264	2.523	7.891
P2(100+50)	2.222	0.735	2.957	2.421	0.706	3.127	2.085	0.462	2.547	8.630
P3(100+75)	1.943	0.977	2.920	2.084	0.939	3.023	1.899	0.669	2.568	8.511
P4(100+100)	1.840	0.832	2.672	1.643	0.887	2.530	1.289	0.494	1.783	6.986
P5(75+25)	2.081	0.383	2.464	1.750	0.363	2.113	1.603	0.315	1.918	6.495
P6(50+50)	1.370	0.721	2.091	1.283	0.716	1.999	1.173	0.501	1.674	5.763
P7(25+75)	0.618	1.075	1.693	0.624	1.048	1.672	0.649	0.786	1.435	4.800
Mean	1.769	0.733	2.502	1.732	0.713	2.445	1.565	0.499	2.064	7.011
L.S.D. at 5%	0.186	0.095	0.285	0.128	0.054	0.179	0.083	0.090	0.168	0.182
S. grass pure	2.793	---	2.793	2.501	---	2.501	2.349	---	2.349	7.643
Cowpea pure	---	1.240	1.240	---	1.368	1.368	---	1.126	1.126	3.734

Table 7. Effect of intercropping patterns on economic (LE) during 2018 and 2019 seasons.

Treatments	Economic (LE)						
	S. grass		Cowpea		Gross return of forge	Costs of production	Net return
	Ton/fed	Price	Ton/fed	Price			
				2018			
P1(100+25)	29.040	5808.00	6.722	1344.47	7152.47	2950.00	4202.47
P2(100+50)	27.311	5462.20	12.933	2606.67	8048.87	3400.00	4648.87
P3(100+75)	26.102	5220.40	18.607	3721.47	8941.87	3850.00	5091.87
P4(100+100)	21.476	4301.87	16.676	3335.20	7637.07	4300.00	3337.07
P5(75+25)	23.000	4600.00	7.275	1455.07	6055.13	2550.00	3505.13
P6(50+50)	16.265	3253.07	13.639	2727.73	5983.47	2600.00	3383.47
P7(25+75)	8.835	1707.67	19.602	3920.47	5628.13	2650.00	2978.13
Mean							
L.S.D. at 5%	1.389	206.26	1.030	184.32	281.02	143.45	281.02
S. grass pure	30.928	6185.53	---	---	6185.53	2500.00	3685.53
Cowpea pure	---	---	24.259	4851.80	4851.80	2700.00	2151.80
				2019			
P1(100+25)	28.338	7084.58	6.273	1568.17	8652.75	3442.50	5210.23
P2(100+50)	26.478	6619.50	12.222	3055.58	9675.08	3955.00	5720.08
P3(100+75)	25.445	6361.17	17.839	4459.67	10820.83	4467.50	6353.33
P4(100+100)	20.833	5208.33	16.083	4020.83	9229.17	4980.00	4249.17
P5(75+25)	22.345	5586.17	6.822	1705.58	7291.75	2967.50	4324.25
P6(50+50)	15.678	3919.42	13.067	3266.67	7186.08	3005.00	4181.08
P7(25+75)	7.989	1997.33	18.922	4730.58	6727.92	3042.50	3685.42
Mean							
L.S.D. at 5%	0.589	157.37	0.476	62.17	174.66	89.35	174.66
S. grass pure	30.144	7536.08	---	---	7536.08	2930.00	4606.07
Cowpea pure	---	---	23.372	5843.08	5843.08	3080.00	2763.07

جودة ومحصول العلف لحشيشة السودان ولوبيا العلف تحت نظم تحميل مختلفة

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الملخص العربي

الهدف من هذه الدراسة هو تقييم تأثير أنماط الزراعة البينية المختلفة لحشيشة السودان (حبوب) ولوبيا العلف (بقول) على محصول العلف وجودته. تم إجراء تجربتين حقليين في موسمي (2018 و2019) بمحطة البحوث الزراعية، سخا كفر الشيخ. لتحميل لوبيا العلف مع حشيشة السودان باستخدام نظم تحميل مختلفة كالأتى (100+25, 100+50, 100+75, 100+100, 75+25, 50+50 و25+75%) من تقاوى الفدان لحشيشة السودان ولوبيا العلف على الترتيب. مقارنة بالزراعة المنفردة لكلا المحصولين, في تصميم قطاعات كاملة العشوائية في ثلاث مكررات. أظهرت النتائج أن, نظام التحميل 100% حشيشة السودان + 75% لوبيا العلف (P_3) أعطى أعلى قيم في صفات محصول العلف الأخضر ر والجاف للفدان. زيادة تقاوي لونيا العلف في المخلوط 25% حشيشة السودان + 75% لوبيا العلف (P_7) سجل أعلى نسبة برتين خام (CP%) بالعلف, بينما زيادة تقاوي حشيشة السودان في المخلوط 100% حشيشة السودان + 100% لوبيا العلف (P4) سجل أعلى نسبة الياف خام (CF%). النظام 100% حشيشة السودان + 75% لوبيا العلف (P3) أعطى أعلى قيم في المكافئ الأرضي (LER), ومعامل الحشد النسبي (K) وصافي العائد. كان أفضل نظام تحميل 100% حشيشة السودان + 75% لوبيا العلف (P3) الذي أعطى أعلى إنتاج والجودة للعلف، والمكافئ الأرضي (LER)، ومعامل الحشد النسبى (K) وصافى العائد من وحدة المساحة.

الكلمات المفتاحية: نظم التحميل، حشيشة السودان، لوبيا العلف.