Effect of Intercropping Cowpea (*Vigna unguiculata* L.) with Teosinte (*Zea mexicana* Schrad) on Forage Yield Productivity and Its Quality

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TWO FIELD experiments were carried out at Giza Agricultural Research Station (30° 02' N latitude and 31° 13' E longitude, altitude 22.50m above sea level), Egypt, during 2017 and 2018 seasons to investigate the effect of three intercropping patterns of cowpea (*Vigna unguiculata* L.) with teosinte (*Zea mexicana* Schrad) (1- On the other side of teosinte ridges, 1:1 and 2:2 in alternating ridges) and three seeding rates, (50%+50%, 75%+50% and 50% +75%) teosinte/cowpea of its pure stand on forage yield and its quality. A split plot design with three replicates was used. The results could be summarized as follows:-

- Intercropping pattern of 2:2 recorded the highest values for total fresh and dry forage yields whereas cowpea intercropped on the other side gave the lowest values in both seasons. Seeding rate of 75%+50% teosinte/cowpea recorded the highest values for total fresh and dry forage yields in both seasons. Intercropping pattern 2:2 with 75% teosinte+50% cowpea gave the highest value of totally fresh and dry yields. Whereas, planting cowpea on the other side with 50% seeding rates of both crops, gave the lowest values in both seasons.
- Crude protein and digestible protein percentages, crude protein and digestible protein yields fed[-1] were increased by different intercropping patterns. Seeding rates and the interaction between them compared with teosinte pure stand in both seasons, whereas fiber percentage behaved opposite trend in both season.
- Land equivalent ratio (LER) and relative crowding coefficient recorded the highest values by the interaction between 2:2 ridges and 75% teosinte+50% cowpea seeding rates of its pure stands in both seasons. Teosinte was dominant crop in 6 out of 9 treatments in both seasons.
- It could be concluded that 15kg teosinte+10kg cowpea and 2:2 intercropping pattern in alternate to obtain the highest mixture yield and quality.

Keywords: Cowpea (*Vigna unguiculata* L.), Toesinte (*Zea mexicana* Schrad), Seeding rate, Intercropping patterns.

Introduction

Teosinte (*Zea mexicana* Schrad L.) is one of the most important summer forage crops which closely related to maize in most allometric trait. It has the advantage of tillering and regeneration as a fodder crop (Lal et al., 1980). Sarhan & Atia (2000) revealed that teosinte+cowpea mixture was superior to monocropping with an increase in forage and protein yields. Mixed intercrop was used to investigate on forage yield as well as the effect of intercropping on maize forage quality. Abd El-Shafy (2002) reported that total fresh and dry forage yields when teosinte intercropped with guar were significantly higher than those obtained from guar monoculture, but lower than those obtained from teosinte sole cropping. Hassan (2003) revealed that guar plant height significantly decreased due to planting in association with fodder maize. Thus, guar plants in pure stand

were the highest as compared with those in mixed cropping. Zeidan et al. (2003) stated that fodder maize sole planting gave higher fresh and dry forage yields than either cowpea or guar whereas, planting cowpea in pure stand gave higher protein yield/fed when compared with fodder maize and guar. Intercropping including legumes is known to enhance forage crude protein concentration compared with cereal sole cropping and to use resources more efficiently (Papastylianou, 2004). Abd El-Shafy et al. (2009) concluded that forage mixture were of more crude protein (CP) content than teosinte but less than cowpea in its pure stand, while crude fiber (CF) content was less in than teosinte and more in cowpea pure stands. Digestible protein (DP) content was more in cowpea and less in teosinte pure stands. The intercropping pattern of 2:2 gave the highest yield advantage and caused an increase in land usage of 36% and 34% in the two respective summer seasons. Dahmardeh et al. (2009) concluded that intercropping of maize and cowpea resulted in more digestible dry matter and also crude protein content than maize sole cropping. Hamdollah & Ahmad (2009) showed that intercropping systems had a significant effect on forage dry weight, where dry matter yield was increased by intercropping as compared with maize and cowpea sole crops. Javanmard et al. (2009) worked on intercropping of maize with different legumes and indicated that dry matter yield and crude protein yield of forage increased by all intercropping compositions as compared with maize monoculture. Maurice et al. (2010) reported that cowpea/maize intercropping reduced the yield of cowpea due the maize canopy that interferes with light penetration. Sharawy et al. (2011) indicated that plant height of teosinte, cowpea and guar decreased significantly by intercropping compared with their pure stands. Total fresh and dry forage yields were significantly reduced by intercropping teosinte with cowpea or guar compared with teosinte as a sole crop. Eskadari (2012) reported that the intercropping was attributed to higher forage production by intercrops and also protein content. Reza (2012) indicated that the crude protein and dry matter yields of sorghum (*Sorghum bicolor* L. Moench) increased with legumes compared with sorghum monoculture. Abraha (2013) found that the higher Land equivalent ratio (LER) was obtained from cowpea intercrops (1.71) which indicates the intercropping of maize-cowpea was advantageous than mono crop maize. Hassan et al. (2017) resulted that the planting of grasses intercropped with

legumes caused increase in total land equivalent ratio (LER) for the total three cuts of both crops which was greater than one in all intercropping treatments.

So, this present experiment was aimed to investigate the effect of some intercropping patterns and seeding rates of teosinte and cowpea for obtaining a good fodder yield of improved quality, an accurate balance of teosinte and cowpea in a mixture is very essential as well as land use efficiency.

Materials and Methods

A field experiment was conducted through 2017 and 2018 seasons at Giza Experimental Research Station Farm (30° 02' N latitude and 31° 13' E longitude, altitude 22.50m above sea level). Agricultural Research Center to study the effect of three intercropping cowpea (*Vigna unguiculata* (L.) with teosinte (*Zea mexicana* Schrad) on forage yield productivity and its quality.

The treatments were as follows:
Intercropping patterns for cowpea with teosinte
1- Intercropping cowpea on the other side of teosinte ridges
2- Intercropping cowpea on one ridge cowpea: one ridge teosinte in alternate
3- Intercropping cowpea on two ridges cowpea: two ridges tosinte in alternate.

Three seeding rates of both components as follows:
1- 50% (10kg/fed^{-1}) teosinte+50% (10kg/fed^{-1}) cowpea
2- 75% (15kg/ fed^{-1}) teosinte+50% (10kg/fed^{-1}) cowpea
3- 50% (10kg/fed^{-1}) teosinte+75% (15kg/fed^{-1}) cowpea of its pure stands. Beside of pure stand teosinte and cowpea as recommended (20kg/fed^{-1}).

The experimental design was factorial experiment conducted in a split-plot design with three replications was used. Intercropping patterns were allocated at main plots and seeding rates were arranged in sub-plots. Sub-plot was 14.4m^2 included 8 ridges (o.6m ridge width and ridge length was 3.0m).

Physical and chemical analysis of soil at Giza (average of the two seasons) was recorded in Table 1.

TABLE 1. Some physical and chemical properties of the soil at the experimental site.

Soil fraction	Content%
Coarse sand	2.91
Find sand	13.40
Silt	30.51
Clay	53.18
Textural class	Clay
Soil chemical analyses	Content
Organic matter	1.80%
Available N(KCl-extract)	40.0mg kg^{-1}
Available P(Na-bicarbonate -extract)	19.0mg kg^{-1}
Available K(NH4 a acetate extract)	304mg kg^{-1}
pH (1:2.5, soil: water extract)	7.4

The preceding crop for both seasons was wheat (*Triticum aestivum* L.). Sowing dates of both crops were at May15, 2017 and May 20, 2018 seasons. Experimental land was prepared by calcium superphosphate (15.5% P$_2$O$_5$) was added before sowing at rate of 100kg fad^{-1}., potassium sulphate (48% K$_2$O) was added at the rate of 50kg fed^{-1}. and 75kg N fed^{-1}., as urea (46.5% N) applied at three equal doses, i.e., at the first irrigation, after the 1st and the 2nd cut, respectively. The three cuts were taken in both seasons, the first cut was after 65 days of planting and the following cuts were 30 days intervals in both seasons.

At cutting time, plants of in sub-plots were cut from the four inner ridges to determine the following parameters:

Growth character
Plant height (cm) for each sole crop as well as for both components of intercropped.

Forage yield
Fresh forage yield (ton fed^{-1}): Subplots were hand clipped and weighed in kg subplot^{-1}, then adjusted into ton fed^{-1}

Dry forage yield (ton fed^{-1}) was calculated by multiplying fresh forage yield (ton/fed^{-1}) X dry matter percentage (DM%) (Norman & Jarvis, 1975).

Crude protein yield (kg fed^{-1}) was calculated as: Dry forage yield X Crude protein percentage in forage.

Digestible protein yield (kg fed^{-1}) was calculated as: Dry forage yield X digestible protein percentage.

Chemical analysis
Plants samples of each cut in both years were analyzed in the Forage Crops Research Dept. Lab at Giza to determine :

1-Dry matter %: Fresh samples (250gm) were dried at 70 ^{O}C to a constant weight in an electrical oven and dry matter% was calculated as: (Weight of dry plants)/(Weight of fresh plants) X100

2- Crude protein percentage (CP %): N content in forage was determined by the Microkelahl method (A.O.A.C., 2000) and the crude protein % was obtained by multiplying N content by a factor of 6.25 (Hymowitz et al., 1972).

3- Digestible crude protein (DCP %) was calculated according to the equation of Churach (1979) as: (DCP%)= (CP% X 0.929) – 3.48.

4- Crude fiber percentage (CF %): Forage samples were digested in sulphuric acid and sodium hydroxide (1.25N), and crude fiber was determined by the method of A.O.A.C. (2000).

Competitive relationships
Land equivalent ratio (LER)
It was calculated according to Willey (1979):

$$LER = \frac{y_{ab}}{y_{aa}} + \frac{y_{ba}}{y_{bb}}$$

where : Y_{ab}= Yield of intercrop a (teosinte) with b (cowpea), Y_{ba}= Yield of intercrop b (cowpea).with a (teosinte), Y_{aa} = Pure stand yield of a (teosinte), Y_{bb}= Pure stand yield of b (cowpea).

Relative crowding coefficient (RCC)
Relative crowding coefficient was calculated according to De-Wit (1960) by the following formula:

$$K_{ab} = \frac{Y_{ab} \times Z_{ba}}{(Y_{aa} - Y_{ab}) \times Z_{ab}} \qquad K_{ba} = \frac{Y_{ba} \times Z_{ab}}{(Y_{bb} - Y_{ba}) \times Z_{ba}}$$

where: Z_{ab}%= Area occupied by teosinte mixture, Z_{ba}% = Area occupied by crops cowpea mixture, K= K_{ab} X K_{ba}

Aggressivity (Agg): (Mc-Gilchrist, 1965)
It was measured by the following formula:

Agg. A= A1-A2 for teosinte intercropped, A2-A1for cowpea intercropped.

$$\text{Agg. teosinte} = \frac{Y_{ab}}{Y_{aa} \, X \, Z_{ab}\%} - \frac{Yba}{Y_{bb} \, X \, Z_{ba}\%}$$

$$\text{Agg. cowpea intercropped} = \frac{Y_{ba}}{Y_{bb} X Z_{ba}\%} - \frac{Y_{ab}}{Y_{aa} \, X \, Z_{ab}\%}$$

Statistical analysis

The obtained data were statistically analyzed according to Steel et al. (1980). The assumption of all obtained results was statistically analyzed to compare the means through L.S.D. test at probability of 0.05 as described by Snedcor & Cochran (1981).

Results and Discussion

Plant height

Effect of intercropping patterns

Data presented in Table 2 indicated that the plant height of teosinte or cowpea were significantly affected by intercropping patterns in both seasons. Plant heights of both components in monoculture recorded the highest values compared with intercropping patterns in both seasons. The intercropping pattern of 2:2 was a superior for plant heights of both crops in 1st cut, 2nd cut 2 and 3rd cut followed by 1:1 intercropping patterns, but intercropping cowpea on the other side of ridge showed the lowest values in both seasons. This results may be due to the intercropping pattern of 2:2 was able to complement each other in growth integration and reduce intra-specific competition between teosinte and cowpea plants than other intercropping patterns. Similar results were obtained by Abd EL-Shafy (2002) and Sharawy et al. (2011).

Effect of seeding rates

Results revealed that seeding rates significantly affected on plant heights of teosinte and cowpea in both seasons as shown in Table 2. Data revealed that 50%+50% seeding rates for both crops of its pure stands recorded the highest values followed by 50 % teosinte+75% cowpea and the lowest values were obtained at 75% teosinte+50% cowpea. This is completely true for cut 1, cut 2 and cut 3 in both seasons. This results may be due to increasing plant population/unite area from 50 up to 75% of its pure stands either teosinte or cowpea increased competition (inter or intra-specific) for light, water and nutrients specially teosinte plants under

75% teosinte +50% cowpea. Similar results were obtained by Abd EL-Shafy et al. (2009).

Interaction effects

Data in Table 2 showed that plant height of teosinte or cowpea insignificantly affected by the interaction between intercropping patterns X seeding rates in both seasons.

Fresh and dry forage yields

Effect of intercropping patterns

Data showed that fresh and dry forage yields were significantly affected by different intercropping patterns in both seasons as shown in Table 3. The intercropping pattern of 2:2 was superior in fresh and dry forage yields production followed by 1:1 intercropping pattern and intercropping cowpea on the other side recorded the lowest value. This is completely true in the first and second seasons. Total forage behaved the same trend and recorded (34.72 and 34.41ton fed^{-1}), (32.67 and 30.94) and (31.36 and 29.58) for fresh forage yield (7.00 and 6.65), (6.67 and 6.42) and (6.41 and 5.95) for dry forage yield in the first and second seasons, respectively. Data revealed that 2nd cut recorded the highest value of fresh and dry forage yields, followed by 1st cut while the third cut gave the lowest one. Such trend could be explained by the limited growth behavior from sowing date to cutting time (65 days), where the plants establish their rooting system, whereas, during the growth period for the 2nd cut, plants received more better and warmer condition to improve their vegetative growth which led to an increase in plant height growth. However plants at the 3rd cut growing period tended to initiate flowering and the more warm environmental conditions at that period of growth cause and extra expenditure of energy in flowering and seed initiation as well as for respiration of plants rather than in vegetative growth (Abd EL-Shafy et al., 2009). Similar results Sarhan & Attia (2000), Riza (2012) for fresh forage yield; and Dahmardeh et al. (2009) and Reza (2012) for dry forage yield.

Seeding rates

Data presented in Table 3 indicated that fresh and dry forage yields were significantly affected by seeding rates in both seasons except in 2nd cut and 3rd cut in the second seasons onley. Data revealed that 50% teosinte+75% cowpea gave the highest value for fresh forage yield in both seasons at 1st cut and 75 % teosinte+50 % cowpea gave the highest value at 2nd cut, 3rd cut and total yield in both seasons; whereas 50%+50% seed rate of its

pure stands showed the lowest values at three cuts and total yield in both seasons. Fresh yield was increased by increasing seeding rates of teosinte or cowpea and more increase with 75% teosinte+50% cowpea. With respect to dry yield, data revealed that dry forage yield behaved the same trend of fresh forage yield in three cuts as well as total dry yield in both seasons as shown in Table 3. Seeding rate of 75% teosinte+50% cowpea achieved the highest value for dry yield as a total yield of 7.12 and 6.50ton fed^{-1} in the first and second seasons, respectively, whereas 50%+50% produced the lowest values were 6.23 and 6.05ton fed^{-1} in the first and second seasons, respectively. Similar results were coincided with those obtained by Papastylianou (2004) and Hamadollah & Ahmed (2009) for fresh forage yield; Hassan et al. (2017) for dry forage yield.

Interaction effects

Data in Table 3 indicated that 2nd cut in both seasons, 1st cut, 3rd cut and total yield of fresh forage in second season were significantly affected by the interaction between intercropping pattern with seeding rates. Also, data revealed that 3rd cut in the first seasons,1st cut, 2nd cut in the second seasons and total yield of dry forage in two seasons were significantly affected by the interaction between two factors under study. In general 2:2 intercropping pattern with seeding rate 75% teosinte+50% cowpea superior for total in fresh and dry forage production which produced (37.17 and 35.75ton fed^{-1}) for fresh forage yield and (7.43 and 6.94ton fed^{-1}) for dry forage yield in the first and second seasons, respectively. Similar results were obtained by Sarhan & Attia (2000) and Eskadari (2012) for fresh forage yield and Abd EL-Shafy (2002) and Javanmard et al. (2009) for dry forage yield.

Chemical traits
Effect of intercropping patterns

Data in Table 4 indicated that different intercropping patterns significantly affected on three cuts as well as mean of crude protein % (CP%), digestible crude protein % (DCP%) and crude fiber% (CF%) in both seasons, except mean of crude fiber in both seasons. Data revealed that cowpea pure stand was more CP% and DCP% compared with all intercropping patterns and teosinte pure stand in both seasons. Also, data revealed that the highest values of CP% and DCP% of intercropping patterns were recorded at 2:2 intercropping pattern as a mean in both seasons. On

the other hand, the lowest values of these characters were showed when cowpea intercropped on the other side of teosinte ridges in both seasons. This result may be due to cowpea as a legume crop had more riches of protein content in its alternative 2:2 and in pure stand and this reflected that on DCP% at different intercropping patterns.

Concerning CF%, data revealed that teosinte pure stand had more CF% than cowpea pure stand and different intercropping patterns. Data revealed that CF% all intercropping patterns behaved opposite trend of CP% and DCP % in both seasons. So, 2:2 intercropping pattern gave the lowest value for CF% and the highest value was obtained when cowpea intercropped at the other side of teosinte ridges in both seasons. These results were obtained by Abd EL-Shafy et al. (2009) for CP%, Dahmaradeh et al. (2009) for CF% and Eskadari (2012) for DCP%.

Effect of seeding rates

Data presented in Table 4 showed that three cuts and its average were significantly affected by seeding rates in both seasons except an average of CF%. Data revealed that 50% teosinte+75% cowpea of its pure stands recorded the highest values for CP % and DCP % while it recorded the lowest value for CF % in both seasons. on the other hand, 50% teosinte+50% cowpea showed the lowest values for CP % and DCP %; and the highest value for CF % in both seasons. This result may be due to increase cowpea seeding rate from 50% to 75% increased % of CP and DCP % beside of reduce CF% in dry forage yield because of cowpea more riches in CP content as shown at cowpea pure stand. Similar results were accorded with Eskadari (2012) and Reza (2012) for CP %, Maurice et al. (2010) and Zeidan et al. (2003) for DCP % as well as Abd EL-Shafy et al. (2009) for CF %.

Interaction effects

Data presented in Table 4 indicated that the interaction between factors under study significantly affected on three cuts and its averages of CP %, DCP % and CF % in 2nd season only. Data revealed that increasing cowpea seeding rate from 50% to 75% with 50% teosinte under 2:2 intercropping pattern increased CP% and DCP% while reduced CF% than other treatments.Similar results were obtained with Abraha (2013) for CP %, Hamdollah & Ahmed (2009) for DCP % and Abd EL-Shafy (2002) and Abd EL-Shafy et al. (2009) for CF%.

TABLE 2. Plant height as affected by intercropping patterns, seeding rates as well as interaction between them in 2017 and 2018

Treatments		Season 2017						Season 2018					
		1st cut		2nd cut		3rd cut		1st cut		2nd cut		3rd cut	
		Teoisent	Cowpea	Teoisent	Cowpea	Teoisent	Cowpea	Teoisent	Cowpea	Teoisent	Cowpea	Teoisent	Cowpea
Intercropping patterns of T:C													
Side:Side		67.60	57.33	127.71	49.90	115.07	41.73	73.43	64.57	135.59	57.60	120.13	48.97
1 ridge:1 ridge		70.60	61.20	130.82	52.71	118.78	43.67	74.83	68.60	136.34	58.97	122.47	50.54
2 ridges:2 ridges		72.53	63.52	132.82	54.27	120.62	45.03	78.22	69.38	138.97	62.33	124.92	51.40
L.S.D $_{0.05}$		1.73	0.68	1.73	0.76	1.35	0.86	1.75	2.53	1.77	1.14	1.86	1.19
Seeding rates													
50%+50%		72.77	62.62	132.93	54.13	120.80	45.20	78.29	69.28	139.34	63.17	125.16	52.07
75%+50%		67.97	58.70	128.04	50.31	115.13	41.77	72.73	65.36	134.27	56.37	119.13	48.23
50 %+75 %		70.00	60.73	130.38	52.43	118.53	43.47	75.47	67.91	137.29	59.37	123.23	50.61
L.S.D $_{0.05}$		0.89	0.92	1.27	0.75	1.45	0.91	1.26	2.12	1.48	1.23	1.75	0.85
Inter-cropping													
Side:Side	50%+50%	69.70	59.70	130.80	51.60	118.90	43.10	75.00	64.83	138.07	61.10	123.50	51.20
	75%+50%	65.80	55.80	125.27	48.70	110.60	40.30	71.50	63.07	132.80	54.90	117.10	46.10
	50 %+75 %	67.30	56.50	127.07	49.40	115.70	41.80	73.80	65.80	135.90	56.80	119.80	49.60
1 ridge:1 ridge	50%+50%	73.80	63.10	133.50	54.90	121.13	45.60	78.80	71.10	139.07	63.50	124.90	52.10
	75%+50%	67.80	58.70	127.97	50.13	116.50	41.90	71.70	65.90	133.07	55.30	119.50	48.80
	50 %+75 %	70.20	61.80	131.00	53.10	118.70	43.50	74.00	68.80	136.90	58.10	123.00	50.73
2 ridges:2 ridges	50%+50%	74.80	65.07	134.50	55.90	122.37	46.90	81.07	71.90	140.90	64.90	127.07	52.90
	75%+50%	70.30	61.60	130.90	52.10	118.30	43.10	75.00	67.10	136.93	58.90	120.80	49.80
	50 %+75 %	72.50	63.90	133.07	54.80	121.20	45.10	78.60	69.13	139.07	63.20	126.90	51.50
L.S.D $_{0.05}$		n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
Pure stand		80.3	70.2	141.10	61.2	126.3	50.10	86.2	74.3	144.2	66.20	128.10	55.6

T: Teoisent , C: Cowpea

TABLE 3. Forage yield of fresh and dry as affected by intercropping patterns, seeding rates as well as interaction between them in 2017 and 2018.

Treatments	Trait	Fresh forage yield (ton fad⁻¹)								Dry forage yield (ton fad⁻¹)							
		2017				2018				2017				2018			
		1st cut	2nd cut	3rd cut	Total cuts	1st cut	2nd cut	3rd cut	Total cuts	1st cut	2nd cut	3rd cut	Total cuts	1st cut	2nd cut	3rd cut	Total cuts
Intercropping patterns of T:C																	
Side:Side		10.28	12.25	8.83	31.36	9.42	11.92	8.25	29.58	2.09	2.52	1.80	6.41	1.90	2.39	1.66	5.95
1 ridge:1 ridge		10.58	12.67	9.42	32.67	10.00	12.36	8.58	30.94	2.17	2.59	1.91	6.67	2.06	2.59	1.77	6.42
2 ridges:2 ridges		11.42	13.47	9.83	34.72	10.58	13.83	10.00	34.41	2.30	2.72	1.98	7.00	2.13	2.48	2.04	6.65
L.S.D at 0.05		0.82	0.65	0.69	0.85	0.34	0.11	0.34	0.91	0.18	0.08	0.07	0.26	0.07	0.13	0.13	0.18
Seeding rates																	
50%+50%		10.00	11.83	8.67	30.50	9.33	12.17	8.25	29.75	2.02	2.45	1.76	6.23	1.88	2.50	1.67	6.05
75%+50%		10.67	13.89	10.33	34.89	10.08	13.42	9.50	33.0	2.19	2.84	2.09	7.12	2.06	2.46	1.98	6.50
50 %+75 %		11.61	12.67	9.08	33.36	10.58	12.53	9.08	32.19	2.36	2.54	1.83	6.73	2.14	2.49	1.83	6.47
L.S.D at 0.05		0.62	0.49	0.38	0.69	0.264	0.325	0.359	0.595	0.07	0.10	0.05	0.11	0.09	n.s	n.s	0.10
Inter-cropping																	
Sid :Side	50%+50%	9.50	11.00	8.50	29.00	8.75	11.00	7.75	27.50	1.92	2.40	1.74	6.06	1.75	2.22	1.55	5.52
	75%+50%	10.00	14.00	9.50	33.50	9.50	12.75	9.00	31.25	2.02	2.80	1.93	6.75	1.92	2.55	1.82	6.29
	50 %+75 %	11.33	11.75	8.50	31.58	10.00	12.00	8.00	30.00	2.33	2.35	1.72	6.40	2.02	2.40	1.62	6.04
1 ridge:1 ridge	50%+50%	9.75	12.25	8.50	30.50	9.25	12.00	7.50	28.75	1.96	2.40	1.72	6.08	1.86	2.57	1.56	5.99
	75%+50%	10.50	13.00	10.50	34.00	10.00	13.00	9.00	32.00	2.22	2.81	2.15	7.18	2.11	2.82	1.90	6.83
	50 %+75 %	11.50	12.75	9.25	33.50	10.75	12.08	9.25	32.08	2.32	2.57	1.85	6.74	2.20	2.37	1.86	6.43
2 ridges:2 ridges	50%+50%	10.75	12.25	9.00	32.00	10.00	13.50	9.50	33.00	2.16	2.56	1.82	6.54	2.02	2.72	1.90	6.64
	75%+50%	11.50	14.67	11.00	37.17	10.75	14.50	10.50	35.75	2.32	2.91	2.20	7.43	2.16	2.72	2.21	6.94
	50 %+75 %	12.00	13.50	9.50	35.00	11.00	13.50	10.00	34.50	2.42	2.70	1.92	7.04	2.21	2.71	2.02	6.39
L.S.D at 0.05		n.s	0.86	n.s	n.s	0.46	0.57	0.63	1.04	n.s	n.s	0.08	0.19	0.16	0.15	n.s	0.15
Teosinte pure		8.00	14.00	10.00	32.00	7.00	13.50	9.50	30.00	1.62	2.83	2.01	6.46	1.41	2.71	1.92	6.04
Cowpea pure		10.50	7.50	5.00	23.00	10.00	7.50	4.00	21.50	2.03	1.52	1.01	4.56	2.02	1.52	0.81	4.35

T: Teoisent ; C: Cowpea

TABLE 4. Percentages of CP, DCP, and CF as affected by intercropping patterns, seeding rates as well as interaction between them in 2017 and 2018.

Trait / Treatments	CP%				DCP%				CF%			
	1st cut	2nd cut	3rd cut	Mean cuts	1st cut	2nd cut	3rd cut	Mean cuts	1st cut	2nd cut	3rd cut	Mean cuts
Intercropping patterns of T:C												
Side:Side	12.89	12.10	10.90	11.96	8.49	7.76	6.65	7.63	27.89	28.92	29.35	28.49
1 ridge:1 ridge	13.00	12.27	11.09	12.12	8.59	7.92	6.82	7.78	27.71	29.08	29.27	28.71
2 ridges:2 ridges	13.32	12.37	11.34	12.34	8.89	8.02	7.05	7.99	27.38	28.5	28.56	28.38
L.S.D at 0.05	0.14	0.10	0.21	0.04	0.14	0.08	0.07	0.08	0.11	0.12	0.13	n.s
Seeding rates												
50%+50%	12.88	12.11	10.97	11.98	8.48	7.77	6.71	7.66	28.26	29.21	29.30	28.92
75%+50%	13.00	12.25	11.03	12.09	8.60	7.90	6.77	7.76	27.47	28.73	29.08	28.42
50 %+75 %	13.32	12.39	11.32	12.34	8.90	8.03	7.04	7.99	27.25	28.56	28.91	28.24
L.S.D at 0.05	0.10	0.08	0.17	0.05	0.12	0.06	0.05	0.06	0.06	0.07	0.07	n.s
Inter-cropping												
Side:Side 50%+50%	12,68	12.00	10.80	11.83	8.30	7.67	6.55	7.51	28.90	29.48	29.55	29.31
75%+50%	12.98	12.08	10.85	11.97	8.58	7.74	6.60	7.64	27.43	28.85	29.30	28.53
50 %+75 %	13.00	12.23	11.05	12.09	8.60	7.88	6.79	7.77	27.35	28.43	29.20	28.33
1 ridge:1 ridge 50%+50%	12.83	12.19	10.88	11.97	8.44	7.85	6.63	7.64	27.98	29.43	29.50	28.97
75%+50%	12.84	12.25	11.00	11.92	8.45	7.90	6.74	7.70	27.58	28.93	29.20	28.57
50 %+75 %	13.32	12.38	11.38	12.20	8.89	8.02	7.09	8.00	27.58	28.88	29.10	28.52
2 ridges:2 ridges 50%+50%	13.12	12.15	11.23	12.05	8.71	7.81	6.95	7.82	27.90	28.73	28.85	28.49
75%+50%	13.18	12.42	11.25	12.20	8.76	8.06	6.97	7.93	27.40	28.40	28.73	28.18
50 %+75 %	13.65	12.55	11.53	12.58	9.20	8.18	7.23	8.20	26.83	28.38	28.43	27.88
L.S.D at 0.05	0.17	N.S	N.S	N.S	0.21	0.10	0.08	n.s	0.11	0.13	0.12	0.11
Teosinte pure	8.93	8.21	8.15	8.43	5.46	4.15	4.09	4.57	29.30	31.50	32.25	30.68
Cowpea pure	17.01	16.85	14.25	16.06	12.32	12.17	9.76	11.42	26.18	26.45	27.45	26.70

Season 2017

T: Teoisent , C: Cowpea

TABLE 4. Cont.

Treatments		Season 2018											
		Cp%				DCP%				CF%			
		1st cut	2nd cut	3rd cut	Mean cuts	1st cut	2nd cut	3rd cut	Mean cuts	1st cut	2nd cut	3rd cut	Mean cuts
Intercropping patterns of T:C													
Side:Side		13.22	12.35	10.97	12.18	8.80	7.99	6.71	7.84	27.03	28.79	28.86	28.56
1 ridge:1 ridge		13.52	12.40	11.14	12.35	9.08	8.04	6.87	8.00	26.94	28.23	29.01	28.18
2 ridges:2 ridges		13.52	12.59	11.37	12.49	9.08	8.22	7.08	8.13	27.23	28.97	29.23	28.04
L.S.D at $_{0.05}$		0.22	0.0.18	0.06	0.14	0.13	0.06	0.09	0.04	0.12	0.10	0.11	n.s
Seeding rates													
50%+50%		13.04	12.24	11.02	12.15	8.64	7.89	6.76	7.76	27.43	28.95	29.19	28.53
75%+50%		13.44	12.51	11.16	12.37	9.01	8.14	6.89	8.01	26.95	28.76	29.05	28.24
50 %+75 %		13.77	12.59	11.31	12.56	9.31	8.22	7.03	8.12	26.83	28.00	28.86	28.00
L.S.D at $_{0.05}$		0.12	0.05	0.06	0.05	0.11	0.03	0.07	0.03	0.05	0.05	0.04	n.s
Inter-cropping													
Side:Side	50%+50%	12.80	12.20	10.92	11.97	8.41	7.85	6.67	7.64	28.10	29.52	29.40	29.01
	75%+50%	13.40	12.35	11.00	12.25	8.97	7.99	6.74	7.90	27.08	28.95	29.35	28.46
	50 %+75 %	13.45	12.50	11.00	12.32	9.02	8.13	6.74	7.96	26.93	28.73	28.95	28.20
1 ridge:1 ridge	50%+50%	13.15	12.20	10.95	12.10	8.74	7.85	6.69	7.76	27.10	28.88	29.18	28.39
	75%+50%	13.53	12.48	11.03	12.35	9.09	8.11	6.77	7.99	26.93	28.78	28.95	28.22
	50 %+75 %	13.88	12.53	11.45	12.62	9.42	8.16	7.16	8.24	26.80	28.10	28.90	27.93
2 ridges:2 ridges	50%+50%	13.18	12.33	11.18	12.39	8.76	7.98	6.91	7.88	27.10	28.45	29.00	28.18
	75%+50%	13.40	12.70	11.45	12.52	8.97	8.32	7.16	8.15	26.85	28.45	28.85	28.05
	50 %+75 %	13.98	12.75	11.48	12.74	9.51	8.37	7.19	8.35	26.75	28.15	28.73	27.88
L.S.D at $_{0.05}$		0.21	0.08	0.10	0.08	0.19	0.06	0.13	0.06	0.14	0.12	0.10	0.10
Teosinte pure		9.72	9.29	8.10	9.03	5.55	5.15	4.04	4.91	28.95	31.65	31.88	30.54
Cowpea pure		18.01	17.75	14.45	16.76	13.25	13.01	9.94	12.07	25.85	26.15	26.85	36.28

T: Teoisent , C: Cowpea

Feeding units (crude protein and digestable crude protein yield)

Effect of intercropping patterns

Data presented in Table 5 reveled that total of crude protein and digestible crude protein yields were significantly affected by different intercropping patterns in both seasons. Data indicated that crude protein and digestible crude protein yields of cowpea pure stand surpassed each of teosinte pure stand and different intercropping patterns (three cuts as well as total yields) in both seasons.

Also, data revealed that 2:2 intercropping pattern was superior in all cuts and total yields for crude protein and digestible crude protein and 1:1 intercropping pattern occupied the second ranking whereas, cowpea intercropped on the other side of teosinte ridges was the lowest one in both seasons. This result may be due to the increase of crude protein and digestible crude protein contents of teosinte and cowpea mixture as a result of symbiotic rhizobial biological functions of legume in fixing and supplying nitrogen to the companion teosinte beside of creating better microenvironment within plant canopies for better growth and quality and thus reflected on the improvement and quality of digestible crude protein.

Effect of seeding rates

Data presented in Table 5 showed that different seeding rates were significantly affected on all cuts as well as total of crude protein and digestable crude protein yield in both seasons. Data revealed that total of crude protein and digestible crud protein yield were achieved with 75% teosinte+ 50% cowpea in both seasons followed by 50% teosinte+75% cowpea and 50%+50% showed the lowest value in both seasons. Also, results indicated that cowpea pure stand recorded the highest value for treatments compared with other different seeding rates treatments and teosinte pure stand. Similar results were obtained by Abd El-Shafy (2002) for crude protein yield Zeidan et al. (2003) for digestible crude protein yield.

Interaction effects

Data presented in Table 5 indicated that total crude protein and digestible crude protein yields were significantly affected by the interaction between the intercropping patterns and seeding rates in both seasons. Data revealed that cut 2, cut 3 and total yield of crude protein recorded the highest value at 2:2 intercropping pattern with 75%+50% teosinte/cowpea in both seasons. Total

crude protein yield were 914.70 and 887.92kg fed^{-1} in the first and second seasons respectively. With respect to digestible crude protein yield 1st cut in both seasons gave the highest value with treatment of 2:2 intercropping pattern and seed rate of 50% teosinte+75% cowpea. Also, data revealed that 2nd cut and 3rd cut achieved the highest values at 2:2 intercropping pattern with 75% teosinte+50% cowpea for these characters in both seasons. In general, total of digestible crude protein gave the highest value (591.19kg fad^{-1}) by 75% teosinte+50% cowpea seed rate of its pure stand under 2:2 intercropping pattern in the first seasons ; and (581.51kg fed^{-1}) at 50% teosinte +75% cowpea under 2:2 intercropping pattern in the second seasons.

Competitive relationships and yield advantages

Land equivalent ratio (LER)

Land equivalent ratio (LER) was increased than one in all treatments by the interactions between intercropping patterns with seeding rates in the first and second seasons as shown in Table 6. Results revealed that the increases were ranged from 3% up to 30% and 4% up to 33% in the first and second seasons, respectively. In all treatment Lt was higher than L$_c$ except treatments which included 75% seeding rate of cowpea in the first and second seasons. Data indicated that the highest value was recorded with 2:2 intercropping pattern which included 75% teosinte (30% and 33%) in the first and second seasons, respectively. On the other hand, the lowest values for LER (3% and 4%) when cowpea was intercropped on the other side of teosinte ridges by 50% teosinte+50% cowpea seeding rate in the first and second seasons, respectively. Similar results were obtained by Abd EL-Shafy (2002) and Sharawy et al. (2011).

Relative crowding coefficient

All results which resulted from the interaction between intercropping patterns and seeding rate were achieved yield advantages compared with pure stand of teosinte or cowpea as shown in Table 7. Data revealed that the highest value for K was achieved when cowpea was intercropped by 50% with teosinte+75% of cowpea seeding rate of its pure stand under 2:2 intercropping patterns (3.89 and 4.89) in the first and second seasons, respectively, and opposite, the lowest value for K was showed with 50% +50% seed rate for both crops and intercropping cowpea on the other side of teosinte ridges. Similar results were obtained by Abd EL-Shafy et al. (2009) and Reza (2012)

TABLE 5. Ccrude protein and digestible crude protein yields as affected by intercropping patterns, seeding rates as well as interaction between them in 2017 and 2018

Treatments	CP yield (kg fad^{-1})								DCP yield (kg fad^{-1})							
	2017				2018				2017				2018			
	1st cut	2nd cut	3rd cut	Total cuts	1st cut	2nd cut	3rd cut	Total cuts	1st cut	2nd cut	3rd cut	Total cuts	1st cut	2nd cut	3rd cut	Total cuts
Intercropping patterns of T:C																
Side:Side	269.52	304.55	195.71	769.86	250.99	295.26	182.55	728.80	177.65	195.35	119.37	492.36	167.17	191.12	111.71	469.99
1 ridge:1 ridge	281.85	318.32	211.39	811.55	278.48	320.81	197.79	797.08	186.44	205.47	130.03	521.93	187.13	208.02	122.03	517.18
2 ridges:2 ridges	306.50	337.51	224.42	868.43	288.21	342.11	232.45	862.78	204.70	218.66	139.58	562.94	193.62	223.28	144.84	561.75
L.S.D at 0.05	7.42	4.45	4.39	13.25	6.81	13.80	8.73	14.80	5.3	6.7	4.7	1.09	5.3	4.7	5.3	4.80
Seeding rates																
50%+50%	259.44	297.60	193.15	750.19	244.94	306.59	18417	735.69	170.95	190.98	118.19	480.12	162.24	197.70	112.98	472.92
75%+50%	284.34	347.96	231.05	863.44	277.40	337.43	220.94	835.77	188.06	224.43	141.88	554.36	185.90	219.63	136.46	542.00
50%+75%	314.08	314.81	207.32	836.21	295.34	314.16	207.69	817.19	209.77	204.06	128.92	542.76	199.78	205.09	129.14	534.01
L.S.D at 0.05	3.76	3.39	3.41	10.21	4.54	9.68	6.68	11.64	6.3	7.2	3.4	2.64	8.2	3.2	6.2	3.27
Inter-cropping																
Side:Side 50%+50%	243.46	288.00	187.92	719.38	224.00	270.84	169.26	664.10	159.35	184.03	114.03	457.41	147.20	174.35	103.30	424.85
Side:Side 75%+50%	262.20	338.24	209.14	809.84	257.28	314.93	200.20	772.40	173.28	216.79	127.37	517.44	172.20	203.83	122.65	498.67
Side:Side 50%+75%	302.90	287.40	190.06	780.36	271.69	300.00	178.20	749.89	200.31	185.22	116.71	502.24	182.10	195.18	109.17	486.46
1 ridge:1 ridge 50%+50%	251.47	292.56	187.14	731.16	244.59	313.54	170.82	728.95	165.41	188.27	113.99	467.67	162.50	201.84	104.40	468.74
1 ridge:1 ridge 75%+50%	285.05	344.23	236.50	865.77	285.48	351.94	209.57	846.99	187.55	222.00	144.89	554.44	191.79	228.81	128.57	549.17
1 ridge:1 ridge 50%+75%	309.02	318.17	210.53	837.72	305.36	296.96	212.97	815.29	206.35	206.14	131.20	543.69	207.12	193.40	133.12	533.64
2 ridges:2 ridges 50%+50%	283.39	312.25	204.39	800.03	266.24	335.38	212.42	814.03	188.10	200.65	126.54	515.29	177.04	216.91	131.22	525.16
2 ridges:2 ridges 75%+50%	305.78	361.42	247.50	914.70	289.44	345.53	253.05	887.92	203.33	234.49	153.37	591.19	193.72	226.69	158.17	578.15
2 ridges:2 ridges 50%+75%	330.33	338.85	221.38	890.56	308.96	345.44	231.90	886.38	222.66	220.83	138.84	582.33	210.11	226.26	145.14	581.51
L.S.D at 0.05	6.52	5.87	5.91	17.68	7.87	16.77	11.58	20.16	10.90	4.00	4.20	4.56	6.5	11.50	10.80	5.66
Teosinte pure	144.7	232.3	163.8	540.8	137.1	251.8	155.5	544.4	88.45	117.40	82.20	288.05	64.16	139.57	77.57	281.30
Cowpea pure	345.30	256.12	143.93	745.35	363.80	269.8	117.05	750.65	250.10	184.98	98.58	533.66	267.65	197.75	80.51	545.91

T: Teoisent, C: Cowpea.

TABLE 6. LER of total forage yield as affected by interaction between intercropping patterns and seeding rates in 2017 and 2018

Treatments Inter-cropping	Characters	2017					2018				
		Total cuts		Land equivalent ratio			Total cuts		Land equivalent ratio		
		T	C	L_T	L_C	LER	T	C	L_T	L_C	LER
Side:Side	50%+50%	18.0	11.0	0.56	0.47	1.03	17.0	10.5	0.56	0.48	1.04
	75%+50%	23.7	10.0	0.73	0.43	1.16	21.5	9.75	0.70	0.45	1.15
	50%+75%	17.5	14.1	0.54	0.59	1.13	16.5	13.5	0.53	0.61	1.14
1 ridge:1 ridg	50%+50%	18.5	12.0	0.57	0.52	1.09	19.0	10.8	0.63	0.50	1.13
	75%+50%	24.0	11.5	0.76	0.50	1.23	23.0	10.5	0.76	0.48	1.24
	50%+75 %	18.0	15.5	0.56	0.66	1.22	18.5	13.8	0.61	0.62	1.23
2 ridges:2 ridges	50%+50%	19.5	12.5	0.60	0.54	1.14	20.5	12.0	0.68	0.55	1.23
	75%+50%	25.0	12.0	0.78	0.52	1.30	24.8	11.0	0.82	0.51	1.33
	50%+75%	18.5	16.5	0.57	0.71	1.28	20.0	14.5	0.66	0.64	1.30
Pure stand		32.00	23.00			---	30.00	21.50			----

T: Teoisent , C: Cowpea**.**

TABLE 7. Relative Crowding Coefficient (RCC) of total forage yield as affected by interaction between intercropping Patterns and seeding rates in 2017 and 2018

Treatments	Characters	2017			2018		
		Relative crowding coefficient			Relative crowding coefficient		
		K_t	K_C	K	K_t	K_C	K
Side:Side	50%+50%	1.28	0.91	1.16	1.30	0.95	1.23
	75%+50%	2.76	0.76	2.09	2.52	0.82	2.06
	50%+75%	2.05	1.48	3.03	1.22	1.68	2.04
1 ridge:1 ridg	50%+50%	1.28	1.09	1.39	1.72	1.00	1.72
	75%+50%	3.00	1.00	3.00	3.28	0.95	3.11
	50%+75 %	1.28	2.06	2.63	1.60	1.68	2.68
2 ridges:2 ridges	50%+50%	1.58	1.19	1.88	2.15	1.26	2.70
	75%+50%	3.57	1.89	3.89	4.71	1.04	4.89
	50%+75%	1.37	2.53	3.46	2.00	2.07	4.14

Aggressivety (A)

Results in Table 8 indicated that teosinte was the dominant crop in 6 treatments and was dominated in 3 treatments out of 9 treatments in both seasons. A_t vlue was positive when cowpea was intercropped with teosinte by 50% seeding rate of its pure stand. On other hand. A_C value was positive when cowpea was intercropped with teosinte by 75% seeding rate of its pure stand. Similar results were obtained by Abd EL-Shafy et al. (2009) and Hassan et al. (2017).

Conclusion

From the previous results could be concluded

that intercropping cowpea with teosinte at 2:2 intercropping pattern and using 75% teosinte + 50% cowpea seeding rate of its pure stand to maximize forage production and good quality as well as Land use efficiency.

It could be concluded that to obtain the best forage production and good quality fodder and increasing Land use efficiency in summer season must be planting 15kg teosinte+10kg cowpea seeding rates/fed (75%+50%) under 2:2 intercropping pattern in alternating ridges.

TABLE 8. Aggressivity of total fresh yield as affected by intercropping patterns and seeding rates in 2017 and 2018 seasons.

Treatments \ Characters		2017		2018	
		$A_{teosinte}$	A_{cowpea}	$A_{teosinte}$	A_{cowpea}
Side:Side	50%+50%	+0.25	-0.25	+0.16	-0.16
	75%+50%	+0.60	-0.60	+0.53	-.0.53
	50%+75%	-0.10	+0.10	-0.15	+0.15
1 ridge:1 ridg	50%+50%	+0.11	-0.11	+0.25	-0.25
	75%+50%	+0.50	-0.50	+0.54	-0.54
	50%+75 %	-0.22	+0.22	-0.02	+0.02
2 ridges:2 ridges	50%+50%	+0.13	-.0.13	+0.25	-0.25
	75%+50%	+0.52	-0.52	+0.63	-0.63
	50%+75%	-0.28	+0.28	-0.01	+0.01

References

Abd El-Shafy, A.S. (2002) Intercropping teosinte with guar under different plant population densities. *Fayoum J. Agric, and Dev.* **16**(2), 91-97.

Abd El-Shafy, A.S., Tarrad, M.M. and Fahmy, A.H. (2009) Effect of intercropping patterns of teosinte with cowpea on yield, quality and their competitive relationships. *Ann of Agric. Sci., Moshtohor,* **47**(3), 215-224.

Abraha, L. (2013) The effect of intercropping maize with cowpea And lablab on crop yield. *Her. J. Agric. Food Sci. Res.* **2**(5), 156-170.

A.O.A.C. (2000) "*Official Methods of Analysis*",17th Ed. Association of Official Analytical Chemists, Washington, DC, USA.

Churach, D.C. (1979) "*Livestock Feeds and Feeding*" 4th ed. pp 79.O & Books Inc; Corallis, Dragon 97330, U.S.A.

Dahmardeh, M.A., Ghanbari, B.S. and Ramroudi, M. (2009) Effect of intercropping maize with cowpea on green forage yield and quality evaluation. *Asian Plant Sci.* **8**(3), 235-239.

De-Wit, C.T. (1960) On comperition versug land-*Bouwkudige Onder Zoek,* **66**(8), 1-82.

Eskadari, H. (2012) Yield and quality of forage produced inintercropping of maize (*Zea mays*) with cowpea *(Vigna sinensis)* and mungbean *(Vigna radiate)* as double cropped. *J. Basic Appl. Sci. Res.* **1**, 93-97.

Hamdollah, E.A. and Ahmad, G. (2009) Intercropping of maize (*Zea mays*) and cowpea (*Vigna sinensis*) as whole-crop forage: Effect of different planting pattern on total dry matter production and maize forage quality. *Not. Bot. Hort. Agrobot. Cluj.* **37**(2) 152-155.

Hassan, H.H.M. (2003) Studies on some forage mixtures. *M.Sc. Thesis*, Fac. Agric. Zagazig Univ., Egypt.

Hassan, H.H.M., Sayed, Mervat R.I. and Mousa, Walaa M.E. (2017) Effect of intercropping on forage yield and land use efficiency of some summer fodder crops. *Zagazig J. Agric. Res.* **44**(6A), 2007-2020.

Hymowitz, T.F., Collins, P. and Walker, W.M (1972) Relationship between the content of oil, protein and sugar un soybean seed. *Agron. J.* **64**, 613-616.

Javanmard, A., Mohammadi-Nasab, A.D., Javanshir, A., Moghaddam, M. and Janmohammadi, H. (2009) Forage yield and quality in intercropping of maize with different legumes as double- cropped. J. *Food Agric Enviro.* **7**(1), 163-166.

Lal, M., Relwainy, L.L. and Singh, J.P. (1980) Influence of cutting management and nitrogen fertilization on forage yield and regeneration of teosinte. *Forage Res.* **6**(1), 99-102.

Maurice, G., Albert, N., Isidor, T. and Francois, A.A (2010) Altering the time of intercropping cowpea (*Vibna unguiclata* L. Walp.) relative to maize (Zea mays L.): A food production strategy to increase crop yield attributes in Adamawa-Camroon. *World J. Agric. Sci.* **6**, 473-479.

Mc-Gilchrist, C.A. (1965) Analysis of competition experiments. *Biometrics*, **1**, 975-985.

Norman, L.M. and Jarvis, P.G. (1975) Photosynthesis in Sitka spruce [*Picea sitchensis* (Bong.) Carr.] III. Measurements of canopy structure and interception of radiation. *J. Appl. Ecol.* **12**, 839-878.

Papastylianou, I. (2004) Effect of rotation system and N fertilizer on barley and common vetch grown in various crop combinations and cycle lengths. *J.Agric. Sci.* **142**, 41-48.

Reza, Z.O. (2012) Evaluation of quantitative and qualitative traits of forage sorghum and lime bean under different nitrogen fertilizer regimes in addititive-replacement series. *Int. J. Agric. Sci.* **4**, 223-238.

Sarhan, G.M. and Atia, A.A. (2000) Study the behavior of some fodder cpwpea (*Vigna sinensis* L. Walp) cultivar mixed with teosinte *(Euchlaena Mexicana)* on forage production and nutritive quality. *Asssiut J. Agric.Sci.* **31**(1), 195-205.

Sharawy, Wafaa M., Helmy, Amal A. and Abd El Shafy, A.S. (2011) Intercropping teosinte with cowpea or guar and their effects on forage yield, quality and competitive relationships. *Egypt. J. Appl. Sci.* **26** (4), 284-295.

Snedecor, G.W. and Cochran, W.G. (1981) "*Statistical Methods*" Oxford and IBH. Puplishing G. 6th ed., pp. 299-310.

Steel, R.G.D. and Torrie, J.H. (1980) "*Principles and Procedures of Statistics*". Mc. Grow- Hill Book Co.Inc., New York.

Willey, R.W. (1979) Intercropping its importance and research needs 1. Competition and yield advantage and 2. Agronomy and research approaches. *Field Crop Abstracts,* **32**, 73-85.

Zeidan, E.M., Ramadan, I.E., Gomaa, M.A. and Hassan, H.H.M. (2003) Effect of sowing date, mixture pattern and cutting date on forage yield productivity of fodder maize, cowpea and guar. *Zagazig J. Agic. Res.* **30**, 1311-1326.

تأثير تحميل لوبيا العلف مع الذره الريانة على انتاجية محصول العلف وجودته

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أقيمت تجربتان حقليتان بمحطة البحوث الزراعية بالجيزة - مصر، خلال موسمى الزراعه 2017 و2018 لدراسة تأثير ثلاث نظم تحميل لوبيا العلف مع الذرة الريانه 1- تحميل لوبيا العلف على نفس الخط 2- تحميل لوبيا العلف على خط وخط 3- تحميل لوبيا العلف على خطين وترك خطين بالتبادل وثلاث معدلات تقاوى (50%+50%)، (75%+50%) و(75%+50%) من معدلات التقاوى الموصى بها لكل من الذرة الريانه و لوبيا العلف على التوالى على إنتاجية محصول العلف وجودته. واستخدم تصميم القطع المنشقه مرة واحدة فى ثلاث مكررات وكانت أهم النتائج كالاتى:

– سجل نظام التحميل خطين : خطين سجل أعلى القيم لمحصول العلف الكلى الأخضر والجاف للفدان بينما سجل نظام تحميل لوبيا العلف على الجانب الأخر للذرة الريانه أقل القيم خلال موسمى الدراسه. سجل معدل التقاوى 75% ذرة الريانه +50% لوبيا العلف أعلى القيم لمحصول العلف الكلى الأخضر و الجاف للفدان خلال موسمى الدراسه. أعطى تحميل لوبيا العلف مع الذره الريانه بنظام التحميل 2:2 و معدل التقاوى 75% ذرة ريانه + 50% لوبيا العلف أعلى القيم للمحصول الكلى للعلف الأخضر والجاف للفدان خلال موسمى الدراسه، بينما زراعة لوبيا العلف على الجانب الأخر لخطوط الذره الريانه مع معدل التقاوى 50% لكلا المحصولين أقل القيم خلال موسمى الدراسة.

– زاد محتوى البروتين والنسبة المئويه للبروتين المهضوم وكذلك محصول الفدان للبروتين الخام والبروتين المهضوم تحت نظم التحميل المختلفة ومعدلات التقاوى والتفاعل بينهما خلال الموسمن، بينما سجلت النسبه المئويه للألياف خلال الموسمن العكس مقارنة بالزراعة المنفردة للذرة الريانه.

– سجل معامل استغلال الأرض ومعامل الحشد النسبى أعلى القيم نتيجة التفاعل بين نظام التحميل خطين : خطين مع معدل تقاوى 75% ذرة رياته + 50% لوبيا العلف خلال موسمى الدراسه، كان محصول الذرة الريانه هو السائد فى 6 معاملات من 9 خلال موسمي الدراسه.

–نستنتج أن الزراعه بمعدل تقاوى 15 كيلو جرام ذرة ريانه مع 10 كيلو جرام لوبيا علف للفدان بنظام التحميل خطين : خطين بالتبادل من كل منهما أعطت أعلا محصول علف من حيث الإنتاجيه والجودة.