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EFFECT OF INTERCROPPING PEARL MILLET WITH COWPEA AND COMPOST SUPPLY ON QUANTITY AND QUALITY FORAGE YIELD

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ABSTRACTE : *Two field trials were conducted at Gemmeiza Agricultural Research Station (Middle Nile Delta) during 2009 and 2010 summer seasons. The trials aiming at finding out the extent to which intercropping of pearl millet (Pennisetum glaucum L.) and cowpea (Vigna sinensis L.) fodder crops and compost addition and interaction affect fresh yield, dry matter production and quality of, comparable with pure stands. The adopted treatments were assessed in the split – plot experimental design with four replicates where compost addition treatments were assigned to main plots while intercropping systems occupied the sub plots, The main results could be summarized as follows:-*

** Compost addition significantly increased the cumulative fresh yield which ranged from 2.7 to 4.3% higher than that without compost supply.*

** Intercropping seems to reduce fresh yield and dry matter production of pearl millet and cowpea, as compared with sole both crops.*

** Higher L/S ratio on either fresh yield or dry matter yield basis, in different cuts and average, were noticed due to intercropping , compared to sole pearl millet. Moreover, L/S ratio of cumulative fresh yields were 128.6 and 200.0% more than those of cumulative sole pearl millet, respectively, in 2009 and 2010 seasons.*

** Intercropping seemed to improve protein and ash yields in different cuts and total yield , comparable with sole pearl millet. On the contrary, intercropping exhibited lower fiber yield figures, in 1st, 2nd , 3rd cuts and cumulative yields, compared with sole pearl millet.*

** Land Equivalent Ratio (LER) proved that intercropping of pearl millet and cowpea was more productive, on cumulative both fresh and dry matter production basis, than sole crops. According to Competition Ratio, cowpea crop was more competitive than pearl millet one, either on fresh yield or dry matter production basis, in all cuts and cumulative yields. Aggressivity values proved that cowpea is more dominant than pearl millet in the two seasons of study.*

Key words : *Pearl millet - cow pea intercropping – compost -- fodder quality- dry matter production- Land Equivalent Ratio - Competition Ratio – Aggressivity.*

INTRODUCTION

Pearl millet is well adapted to growing areas characterized by drought, low soil fertility, and high temperature. Because of its tolerance to difficult growing conditions, it can be grown in areas where other cereal crops, such as maize and sorghum would not survive. Cowpeas are one of the most important food legume crops in the semi-arid tropics covering Asia, Africa, southern Europe and Central and South America. In addition, it is shade tolerant, therefore, its compatible as an intercrop with maize, millet, sorghum ….etc.

Intercropping is presently a major method of crop production in tropical Africa, subtropical Asia, and Central and South America. With this approach, crops are planted in such a variety of combinations that the merits of intercropping as compared with monoculture are often difficult to determine. Features of an intercropping system can differ largely with soil conditions, local climate, economic situation, and preferences of the local community. The main advantage of intercropping is the more efficient utilization of the available resources and the increased productivity compared with each sole crop of the mixture (Zhang and Li, 2003; Dhima *et al.,* 2007; Muoneke *et al.,* 2007 and Mucheru- Muna *et al.* 2010). Under intercropping, yield advantage occurs

because growth resources such as light, water, and nutrients are more completely absorbed and converted to crop biomass by the intercrop over time and space as a result of differences in competitive ability for growth resources between the component crops. Bagayoko *et al.* (1996) stated that the system productivity measured by Land Equivalent Ratio (LER) was greater for the intercropping pearl millet/cowpea than the sole crops.

One of the greatest attractions of intercropping is that a yield advantage can usually be achieved simply and cheaply by growing crops together rather than separately, particularly when components are cereals and legumes. So, intercropping is consider an important agricultural issue, particularly for small- holder farmers, aiming at sustainable agriculture under the Egyptian conditions of limited land and water resources.

The present trials were executed under the conditions of Middle Nile Delta to evaluate the extent to which intercropping pearl millet and cowpea fodder crops with compost addition affected fresh yield , dry matter production and quality indices e.g. yields of protein, fiber, and ash besides leaves/stem ratio. Some productivity parameters e.g. Land Equivalent Ratio (LER), Competition Ratio (CR) and Aggressivity (A) were considered.

MATERIALS AND METHODS

Two field trials were executed at Gemmeiza Agricultural Research Station (Middle Nile Delta, longitude 31.0 and latitude 30.79) during 2009 and 2010 summer seasons. The soil of the experimental site is silty clay in texture with water table more than 2 meters depth. Some chemical analyses for both 40 - cm top soil and the applied compost are shown in Table 1. In this trial pearl millet is the main crop while cowpea crop is the intercrop. The adopted treatments were assessed in a split – plot experimental design with four replicates, where compost addition (20 $m^3 fad^{-1}$ or Zero compost) represented the main plots and intercropping systems (sole pearl millet, sole cow pea and 1: 1 alternative rows of pearl millet and cow pea) as a sub plots.

Compost was incorporated into the top soil during soil bed preparation. Cowpea seeds were sown in hills 20 cm apart at 25 kg/fed rate, whereas pearl millet was sowing in hills 15 cm apart at 20 kg/fed rate. Sowing dates were May 15th and May 20th in 2009 and 2010 seasons, respectively. The sub – plot was 6 ridges at 60 cm apart and 14 m length (50.4m^2). All of the agronomic practices e.g. N &P fertilization, irrigation …etc were carried out as recommended. Berseem clover was the preceding crop in the two seasons of study.

Table 1 : Particle size distribution and some chemical analyses for the top soil (40 cm depth of the experimental site) and the applied compost

Soil analysis								
EC,dSm^{-1}	Soluble Anions, $meqL^{-1}$				Soluble Cations, $meqL^{-1}$			
	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	Cl^{-}	CO_3^{2-}	HCO_3^{-}	So_4^{2-}
1.25	3.8	3.0	5.22	0.23	2.25	-	6.44	3.56

Particle size distribution			
Sand %	Silt %	Clay %	Textural class
12.85	45.60	39.60	Silty clay

Compost analysis			
Nitrogen %	Carbon%	Organic Matter %	C/N ratio
1.35	18.5	31.89	13.7

According to compost maturity index of California Compost Quality Council, CCQC (2001),C/N ratio value indicated that the used compost is acceptable.

The studied agronomic and quality measurements were as follows :-

1- The fresh yield at each cutting and total, ton/fad.
2- The dry yield at each cutting and total, ton/fad
3- Ratio of leaves and stem, fresh weight basis.
4- Ratio of leaves and stem, dry weight basis.

5 - The fodder quality measurements. In the 2- seasons combined samples, for each sub –plot, were prepared and protein, fiber and ash % contents (on dry matter basis) were determined according to AOAC (1980), then expressed as $kgfad^{-1}$. Data of fresh yield, dry matter production, leaves / stem ratio (on fresh and dry basis) were subjected to the statistical analyses according to Snedecor and Cochran (1980) and the means were compared by LSD test at 5% level.

5 - Competition indices : The yield advantage of intercropping was determined via estimating Land Equivalent Ratio(LER), Competition Ratio(CR) and Aggressivity as described by Willey and Rao (1980) as follows :-

5.1. Land Equivalent Ratio (LER) : It is defined as the amount of land required under monoculture to obtain the same dry matter yield as produced in the intercrop. It was calculated as follows :-

Land Equivalent Ratio
(LERab) = Yab / Yaa + Yba +Ybb ..... where

Yaa and Ybb are yields of sole pearl millet and cowpea crops, while Yab and Yba represent yields of intercrop pearl millet and cowpea crops, respectively, as ton/fad. If LERab more than the unity, there is yield advantage.

5.2. Competition Ratio(CR). It gives a clear idea about which crop is more competitive in association. It was calculated as follows:-

CRa = LERa / LERb X Zba / Zab for pearl millet
CRb = LERb / LERa X Zab / Zba for cowpea ..... where

Zab = proportion of pearl millet grown in association with cowpea.
Zba = proportion of cowpea grown in association with pearl millet.

If CRa is more the unity, pearl millet crop is more competitive than cow pea one, and if the value is less than the unity, pearl millet crop is less competitive than cow pea one. The reverse is true for CRb, i.e. for cow pea crop.

5.3. Aggressivity was calculated as follows:-
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Aab = (Yab / Yaa x Zab) – (Yba /Ybb x Zba)
Aba = (Yba / Ybb x Zba) – (Yab/ Yaa x Zab)

In the herein research trial, pearl millet (a) was the main crop and cowpea (b) was the intercrop. If Aab equals Zero, the two crops are equally competitive, if the value was positive, pearl millet (a) might be considered dominant, while if Aab was negative, pearl millet (a) might be the dominated crop. The reverse is true for Aba.

RESULTS AND DISCUSSION

Fresh forage yield

In general, under all of the adopted treatments, the highest fresh yield was recorded in 1st cut and tended to reduce towards the 3rd cut and such trend was true in the two seasons of study. Data in Table 2 revealed that, regardless the adopted intercropping system, fresh yield was significantly increased in different cuts except the third one, due to compost addition and such findings were true in 2009 and 2010 seasons. Moreover, total fresh yield significantly increased with compost addition where the increase values reached 2.7 and 4.3%, respectively, in 2009 and

2010 seasons as compared with no compost addition treatment. In this sense, Ouédraogo et al. (2001) found that sorghum yield tripled on the 10 Mg ha^{-1} compost plots and increased by 45% on the 5 Mg ha^{-1} compost plots, compared to no-compost ones. Bilalis *et al.* (2005) in Greece, found that maize/cowpea intercrop under compost supply resulted in higher grain yield ranged from 20.4 to 22.0% more than that without compost supply. The author added that compost supply increased both sole maize and cowpea grain yields ranged from 23.6 to 29.8% and from 28.6 to 33.3%, respectively, compared with the control. Under the present trial, the limited response of fresh yield to compost addition may be attributed to many effective factors including compost origin, composting process, compost management, varietal variability and soil characteristics under investigation…etc.

Data indicated that the fresh yield either for different cuts or total was significantly altered due to intercropping. With intercropping , total fresh yield of pearl millet seemed to reduce by 48.05 and 47.14 % in 2009 and 2010 seasons, respectively, as compared with sole pearl millet. Similar trend was recorded with cow pea where the total fresh yield was reduced by 38.64 and 43.85% in 2009 and 2010 seasons, respectively, comparing with sole cow pea. Such reductions may be attributed to the competition between the intercropped pearl millet and cow pea crops for water, nutrients, light …. etc. The present results are in accordance with those of Bagayoko *et al.* (1996) who stated that intercropping reduced the stover yields of pearl millet and cowpea crops likely due to inter-and intra specific competition. It is worthy to mention that under intercropping, pearl millet stover represents 62.7 and 64.9% of total fresh yield in 2009 and 2010 seasons, respectively.

Table 2 : Fresh forage yield (tonfad^{-1}) as affected by compost addition and pearl millet / cowpea intercropping during 2009 and 2010 seasons

Treatment		2009 Season				2010 Season			
		1st cut	2nd cut	3rd cut	Total	1st cut	2nd cut	3rd cut	Total
Main plot, compost addition (A)									
20 m^3 fad^{-1} (A1)		9.8	8.7	4.3	22.8	9.6	8.4	3.8	21.8
Without (A2)		9.6	8.4	4.2	22.2	9.2	7.8	3.8	20.9
F test, 05		*	*	NS	*	*	*	NS	*
Sub plot, Intercropping system (B)									
Sole pearl millet(B1)		16.6	14.9	7.0	38.5	16.1	14.2	6.4	36.7
Sole Cowpea (B2)		8.3	6.9	4.4	19.6	8.0	6.8	3.9	18.7
Intercropped Pearl millet (B3)		8.9	8.2	2.9	20.0	8.8	7.5	3.0	19.4
Intercropped Cowpea (B4)		5.1	4.2	2.7	11.9	4.7	3.9	1.90	10.5
LSD, 05		0.180	0.144	0.120	0.230	0.169	0.185	0.141	0.246
Interaction									
A1	B1	16.9	15.4	7.1	39.4	16.8	14.7	6.5	37.9
	B2	8.3	6.9	4.4	19.6	8.0	6.8	3.8	18.6
	B3	9.3	8.5	3.1	20.9	9.1	8.0	3.0	20.1
	B4	4.9	4.1	2.5	11.5	4.5	4.1	1.9	10.5
A2	B1	16.3	14.5	6.9	37.7	15.4	13.7	6.4	35.5
	B2	8.3	6.9	4.4	19.7	8.0	6.8	3.9	18.8
	B3	8.6	7.9	2.8	19.2	8.5	7.0	3.0	18.6
	B4	5.3	4.2	2.8	12.2	4.9	3.8	1.9	10.6
LSD, 05		0.260	0.204	0.170	0.320	0.240	0.262	NS	0.348

Data in Table 2 proved that interaction significantly influenced the fresh yield. However, the highest figures, either in each cut or total, were obtained as sole pearl millet grown on the compost – received plots and such trend was true in the two seasons of study

Dry matter production

Data in Table 3 revealed that dry forage yield of the different cuts and cumulative yields did not response with compost addition, in 2009 and 2010 seasons. On the contrary, Bilalis *et al*. (2005) recorded that maize/cowpea intercrop under compost supply exhibited higher dry matter yield ranged from 28.6 to 30.5% more than that without compost supply. The author added that compost supply resulted in higher maize and cowpea dry matter yields ranged from 18.7 to 24.0% and from 45.8 to 54.1%, respectively, as compared with the control. Such different trends could be attributed to compost origin, composting conditions, compost management, experimental circumstances, prevailing weather ..... etc.

Table 3: Dry forage yield (tonfad^{-1}) as affected by compost addition and pearl millet / cowpea intercropping during 2009 and 2010 seasons

Treatment		2009 Season				2010 Season			
		1st cut	2nd cut	3rd cut	Total	1st cut	2nd cut	3rd cut	Total
Main plot, compost addition (A)									
20 m3 fad-1(A1)		1.10	1.40	0.80	3.30	1.10	1.30	0.70	3.10
Without (A2)		1.20	1.40	0.80	3.30	1.10	1.30	0.70	3.10
F test, 05		NS	NS	NS	NS	NS	NS	NS	NS
Sub plot, Intercropping system (B)									
Sole pearl millet (B1)		1.90	2.30	1.20	5.40	1.90	2.10	1.10	5.10
Sole Cowpea (B2)		1.10	1.20	0.90	3.10	1.00	1.20	0.80	3.00
Intercropped Pearl millet (B3)		1.00	1.30	0.50	2.80	1.00	1.10	0.50	2.70
Intercropped Cowpea (B4)		0.70	0.70	0.50	1.90	0.60	0.70	0.40	1.70
LSD, 05		0.033	0.033	0.033	0.060	0.033	0.047	0.033	0.047
Interaction									
A1	B1	1.90	2.30	1.20	5.40	2.20	2.20	1.10	5.30
	B2	1.10	1.20	0.80	3.10	1.20	1.20	0.80	2.90
	B3	1.00	1.30	0.50	2.90	1.20	1.20	0.50	2.80
	B4	0.60	0.70	0.50	1.80	0.70	0.70	0.40	1.60
A2	B1	1.90	2.20	1.20	5.30	2.10	2.10	1.10	5.00
	B2	1.10	1.20	0.90	3.20	1.20	1.20	0.80	3.00
	B3	1.00	1.20	0.50	2.70	1.10	1.10	0.60	2.60
	B4	0.70	0.70	0.60	2.00	0.70	0.70	0.40	1.70
LSD, 05		0.047	0.047	0.047	0.081	0.066	0.07	NS	0.066

Intercropping exerted significant effect to influence dry matter production in different cuts and cumulative yields in 2009 and 2010 seasons. Data in Table 3 showed that dry matter production started lower in 1st cut and reached the highest value in 2nd cut and then tended to decline in 3rd one. That trend was observed for sole pearl millet, sole cowpea and intercropping in the two seasons of study. Intercropping exhibited lower total dry matter production figures comprised 48.15 and 38.71% in 2009 and 47.06 and 43.33% in 2010, respectively, comparable with both sole pearl millet and cowpea. This results are in parallel with those of Allen and Obura (1983) who found that dry matter yield of the monocrops were higher than the individual components in intercropped corn and cowpea which may be due to competition for soil N. In addition, Bilalis *et al*. (2005) found that maize/cowpea intercropping resulted in lower dry matter production ranged from 13.0 to 14.3% less than sole maize. Data in Table 3 indicated that under intercropping, the contribution of pearl millet in cumulative dry matter production amounted to 59.70 and 61.36% in 2009 and 2010 seasons.

Interaction exerted significant influence to alter dry matter production for the different cuts and cumulative yields in the two seasons of study. Data in Table 3 cleared out that pearl millet as interacted with, either compost addition or without compost addition treatments, exhibited higher dry matter production values in 2009 and 2010 seasons.

Leaves/stem ratio (fresh weight basis)

Leaves/stem ratio is an important index for fodder quality since higher L/S value indicates higher soft tissues content i.e. leaves which are characterized with higher nutritive value owing to its content of photosynthetic assimilates which including carbohydrates, vitamins, more digestible proteins and other macro and micro nutrients compared with stem.

Data in Table 4 revealed that compost addition did not significantly influence leaves/stem ratio (on fresh basis) in 1st and 2nd cuts, whereas in 3rd one and average, the effect was significant and such trend was true in the two seasons of study.

Leaves/stem ratio of sole cowpea surpassed those recorded with sole pearl millet in different cuts and averages, in the two seasons of study, which is attributed mainly to differed growth pattern and characteristics of each crop. Intercropping pearl millet and cowpea resulted in higher L/S ratio for fresh yield in different cuts and average, comparable with sole pearl millet, ranged from 26.0 to 187.6% and from 73.6 to 200.0% in 2009 and 2010 seasons, respectively. In this sense, Mureithi *et al.* (1995) and Njoka – Njiru *et al*.(2006) stated that herbaceous forage legume crops increased herbage production of grass and quality of produced feed.

Data in Table 4 showed that interaction did not distinguish a consistent trend to alter leaves/stem ratio in different cuts in the two seasons of study, however, intercropping still exhibited higher L/S ratio more than those recorded for sole pearl millet under with compost addition or without.

Leaves/stem ratio (dry matter basis)

Data in Table 5 indicated that compost supply insignificantly influence leaves/stem ratio in different cuts and as average in 2009 season. In 2010 season, such trend was slightly different where the significant effect, due to compost supply, was noticed in the 3rd cut and average only. Compost supply increased leaves/stem ratio by 14.29 and 14.44%, respectively, more than without compost addition in 2009 and 2010 seasons. Such findings could be attributed to enhancing effect of compost on the plant growth. In connection, Bilalis *et al.* (2005) in Greece, found that compost supply increased root length density, root mass density and leaf area index of both pure maize and cowpea crops.

Table 4 : Leaves/stem ratio on fresh weight basis as affected by compost addition and pearl millet / cowpea intercropping during 2009 and 2010 seasons

Treatment		2009 Season				2010 Season			
		1st cut	2nd cut	3rd cut	Average	1st cut	2nd cut	3rd cut	Average
Main plot, compost addition (A)									
20 m^3 fad^{-1} (A1)		0.48	0.63	1.33	0.81	0.55	0.75	0.55	0.62
Without (A2)		0.48	0.65	0.90	0.68	0.60	0.78	0.75	0.73
F test, 05		NS	NS	*	*	NS	NS	*	*
Sub plot, Intercropping system (B)									
Sole pearl millet (B1)		0.35	0.40	0.40	0.35	0.55	0.35	0.35	0.45
Sole Cowpea (B2)		0.65	0.90	1.80	1.15	0.65	1.05	1.00	0.90
Intercropped Pearl millet (B3)		0.40	0.45	0.50	0.60	0.45	0.40	0.45	0.45
Intercropped Cowpea (B4)		0.50	0.80	1.80	1.00	0.65	1.25	0.80	0.90
LSD, 05		0.105	0.403	0.210	0.156	0.120	0.145	0.115	0.094
Interaction									
A1	B1	0.30	0.40	0.40	0.30	0.60	0.30	0.30	0.40
	B2	0.70	0.90	2.20	1.30	0.60	1.20	0.90	0.90
	B3	0.40	0.40	0.40	0.40	0.40	0.40	0.30	0.40
	B4	0.50	0.80	2.30	1.20	0.60	1.10	0.70	0.80
A2	B1	0.40	0.40	0.40	0.40	0.50	0.40	0.40	0.50
	B2	0.60	0.90	1.40	1.00	0.70	0.90	1.10	0.90
	B3	0.40	0.50	0.60	0.50	0.50	0.40	0.60	0.50
	B4	0.50	0.80	1.20	0.80	0.70	1.40	0.90	1.00
LSD, 05		NS	NS	0.300	0.220	NS	0.205	NS	NS

Table 5 : Leaves/stem ratio on dry matter production basis as affected by compost addition and pearl millet /cowpea intercropping during 2009 and 2010 seasons

Treatment		2009 Season				2010 Season			
		1st cut	2nd cut	3rd cut	Average	1st cut	2nd cut	3rd cut	Average
Main plot, compost addition (A)									
20 m^3 fad^{-1} (A1)		1.13	1.08	1.33	1.20	1.05	1.18	0.85	1.03
Without (A2)		0.75	0.93	1.50	1.05	0.88	1.08	0.65	0.90
F test, 05		NS	NS	NS	NS	NS	NS	*	*
Sub plot, Intercropping system (B)									
Sole pearl millet (B1)		0.75	0.65	0.55	0.65	0.70	0.70	0.50	0.75
Sole cow pea (B2)		0.90	1.20	2.25	1.45	1.15	1.40	1.10	1.20
Intercropped Pearl millet(B3)		0.85	0.80	0.70	0.80	0.75	0.80	0.50	0.65
Intercropped Cowpea (B4)		0.65	1.25	2.00	1.30	1.25	1.70	0.90	1.25
LSD, 05		0.159	NS	0.361	0.207	0.215	0.169	0.115	0.094
Interaction									
A1	B1	0.80	0.70	0.50	0.70	0.80	0.80	0.60	0.80
	B2	1.00	1.30	2.10	1.50	1.20	1.30	1.20	1.20
	B3	0.90	0.90	0.80	0.90	0.80	0.80	0.60	0.70
	B4	1.80	1.40	1.90	1.70	1.40	1.80	1.00	1.40
A2	B1	0.70	0.60	0.60	0.60	0.60	0.60	0.40	0.70
	B2	0.80	1.10	2.40	1.40	1.10	1.50	1.00	1.20
	B3	0.80	0.70	0.60	0.70	0.70	0.80	0.40	0.60
	B4	0.70	1.30	2.40	1.50	1.10	1.40	0.80	1.10
LSD, 05		NS	NS	0.510	NS	NS	0.240	NS	0.133

As for the interaction, Intercropping pearl millet and cowpea resulted in higher L/S ratio , on dry matter basis, in 1st, 2nd, 3rd cuts and average as well, comparing with sole pearl millet and such trend was true in the two seasons of study. The increases in L/S ratios ranged from 57.7 to 145.4% in 2009 season and from 42.9 to 78.6% in 2010 one due to intercropping, comparable with sole pearl millet.

Crud Protein yield

Data in Table 6 indicated that crud protein yield tended to increase in 2nd cut and then drastically lowered in 3rd one, and such trend was observed with either compost addition or without compost addition. However, compost addition resulted in higher total crude protein yield reached 4.44% more than that under without compost supply. In this sense, Bilalis *et al.* (2005) found that higher N yield was recorded for maize/cowpea intercrop under compost supply ranged from 31.9 to 32.1% more than that without compost supply. The author added that both sole maize and cowpea N yields were increased and ranged from 29.5 to 33.8% and from 63.3 to 66.1% due to compost supply, respectively, comparable with the control.

The interaction cleared that intercropping improved protein yield comprised 46.1, 80.9, 45.2% in 1st, 2nd and 3rd cuts, comparable with sole pearl millet, , respectively. Furthermore, intercropping exhibited higher values of total crude protein yield reached 60.20 % more than that recorded with sole pearl millet crop, Table 6. Such results are in parallel with those of Kouamé *et al.*(1993) who found that total CP yield of the harvested fodder was 3 times greater in intercrop than sole millet due to intercropping millet with forage legumes *Stylosanthes fruticosa* (Retz.) Alston or *S. hamata* (L.) Taub. In addition, Sharma and Gupta (2002) found that pearl millet as a sole crop accumulated significantly less concentrations of nitrogen (N) and protein in stover, as compared to that grown with legumes. Furthermore, Mpairwe *et al.* (2002) stated that intercropping forage legumes with cereals generally resulted in fodder with higher fodder CP concentration. Intercropping common bean with corn, in two row-replacements, improved silage yield and protein content of forage, compared with sole crops (Lithourgidis *et al.*,2008). In addition, Dahmardeh *et al.* (2009) stated that maize and cowpea intercrops led to increased forage quality e.g. crude protein and dry matter digestibility concentration more than maize monoculture. Javanmard *et al.* (2009) also found that intercropping legumes with maize resulted in higher crude protein yield, compared with maize monoculture.

Interaction data indicated that the highest crude protein yield figures were observed at 2nd cut and in total yield due to intercropping pearl millet and cowpea crops without compost addition.

Fiber yield

Compost addition increased total fiber yield by 11.83% more than without compost, which may be attributed to improving the crop performance and fresh yield, Table 7. In this sense, Bilalis *et al.* (2005) found that compost supply increased root length density, root mass density and leaf area index of both pure maize and cowpea crops.

Data in Table 7 indicated that intercropping resulted in lower fiber yield values in 1st, 2nd , 3rd cuts and total which amounted to 32.8, 20.4, 29.1 and 27.4% ,as compared with sole pearl millet, respectively. In connection, Javanmard *et al.*(2009) stated that intercropping legumes with maize significantly reduced both neutral and acid detergent fiber contents, thus, increasing forage digestibility and quality.

Interaction data clearly indicated that higher fiber yield values, in different cuts and accumulated yield, were observed with pearl millet as interacted with both compost addition or without, whereas the lowest figures were recorded for cow pea as interacted with both compost supply and without compost supply.

Table 6 : Crud Protein yield (kgfed^{-1}) as affected by compost addition and pearl millet / cowpea intercropping (2009 and 2010 seasons mean)

Treatment		1st cut	2nd cut	3rd cut	Total
Main plot, compost addition (A)					
20 m^3 fad^{-1} (A1)		253	280	149	682
Without (A2)		240	279	133	653
Sub plot, Intercropping system (B)					
Sole pearl millet (B1)		191	205	104	500
Sole Cowpea (B2)		270	264	169	703
Intercropping		279	371	151	801
Interaction					
A1	B1	195	214	108	517
	B2	276	280	164	731
	intercropping	288	347	175	799
A2	B1	186	195	100	481
	B2	264	248	137	649
	intercropping	270	395	163	828

Table 7 : Fiber yield (kgfed^{-1}) as affected by compost addition and pearl millet / cowpea intercropping (2009 and 2010 seasons mean)

Treatment		1st cut	2nd cut	3rd cut	Total
Main plot, compost addition (A)					
20 m^3 fad^{-1} (A1)		306	376	254	936
Without (A2)		326	284	227	837
Sub plot, Intercropping system (B)					
Sole pearl millet (B1)		485	457	347	1289
Sole Cowpea (B2)		138	170	129	437
Intercropping		326	364	246	936
Interaction					
A1	B1	474	588	351	1413
	B2	141	176	118	435
	intercropping	303	365	292	960
A2	B1	495	326	343	1164
	B2	134	163	139	436
	intercropping	349	362	200	696

Ash yield

Data in Table 8 revealed that compost addition led to increase ash yields for 2nd, 3rd cuttings and cumulative yield as well by 26.34, 13.89and 11.86%, compared to without compost addition. Such results may attributed to enhancing nutrient absorbing from the rhizosphere under compost supply. In this sense, Perner *et al.* (2006) found that compost addition increased P and K concentrations in the young leek plants.

Table 8 : Ash yield (kgfed^{-1}) as affected by compost addition and pearl millet / cowpea intercropping (2009 and 2010 seasons mean)

Treatment		1st cut	2nd cut	3rd cut	cumulative
Main plot, compost addition (A)					
20 m^3 fad^{-1} (A1)		209	259	164	632
Without (A2)		216	205	144	565
Sub plot, Intercropping system (B)					
Sole pearl millet (B1)		261	250	161	672
Sole Cowpea (B2)		317	177	.166	660
Intercropping		219	270	185	674
Interaction					
A1	B1	269	331	163	763
	B2	153	178	106	437
	intercropping	227	269	223	719
A2	B1	253	169	159	581
	B2	164	176	126	466
	intercropping	211	270	146	627

Intercropping increased the ash yields in 2nd, 3rd cuts and cumulative yield, comparable with sole pearl millet, by 8.00,14.91and 0.29%, respectively. In connection, Javanmard *et al*. (2009) found that ash content of maize forage increased by intercropping with legumes, compared with maize monoculture. Interaction data clearly pointed out that most of highest figures of ash yield were recorded with pearl millet as grown under compost supply.

Interaction data clearly pointed out that most of highest figures of ash yield were recorded with pearl millet as grown under compost supply.

Intercropping productivity measurements :

The intercropping productivity measurements were determined via estimated the competition indices e.g. Land Equivalent Ratio(LER), Competition Ratio (CR) and Aggressivity (A).

Land Equivalent Ratio (LER)

Land Equivalent Ratio shows the efficiency of intercropping for using the environmental resources compared with monocropping with the value of unity to be the critical value. When LER is greater than one (unity) the intercropping favours the growth and yield of the species, whereas when LER is lower than one the intercropping negatively affects the growth and yield of the intercropped plants (Willey, 1979; Willey and Rao, 1980).

Data in Table 9 revealed that, as LER was estimated on fresh and dry matter basis, intercropping was more productive than sole crops, in all cuts and total yield, except in the third cut in 2010 season, and such trend was true in 2009 and 2010 seasons. In connection, Willey (1990) reported that intercropping of cereals with legume grain crops gave higher yields than sole cropping as indicated by LER values. Moreover, Reddy *et al*. (1992), found that land-equivalent ratios (LER) were 1.48 and 1.43, in millet/cowpea intercrop, as cowpea was planted 1 and 2 weeks after millet planting, respectively. In addition, Bagayoko *et al* (1996) stated that in spite of intercropping millet and cowpea reduced the stover yields of both crops, the system productivity measured by LER was greater for the intercropping system than the sole crops.

Competition Ratio(CR)

If the CR value for pearl millet is more than the unity this mean that pearl millet is more competitive than cowpea and if the value is less than the unity, pearl millet is less competitive than cowpea. The reverse is true for CR for cowpea crop. On this basis, data in Table 10 indicated that, under intercropping, cowpea crop was more competitive than pearl millet one either on fresh yield or dry matter production basis in all cuts and total yield, and such trend was true in 2009 and 2010 seasons. Willey and Rao (1980) stated that a better measure of competitive ability of the crops can be obtained from CR , which is also an advantageous index over relative crowding and Aggressivity .

Aggressivity (A)

Data in Table 11 clearly pointed out, on fresh yield and dry matter production basis, that the Aggressivity values of pearl millet were negative in different cuts and total yield as well in the two seasons of study. Such results referred that pearl millet is the less dominant crop in the studied intercropping system. But the positive Aggressivity values of cow pea proved that cow pea is more dominant than pearl millet. Such results may be attributed to shade – tolerant characteristic of cow pea crop under the present experimental situations as stated by Singh *et al*. (2003).

On conclusion, although the reduction in fresh and dry matter production yields under intercropping, comparable with sole pearl millet, it is still evident that pearl millet / cowpea intercropping was advantageous via higher Land Equivalent Ratio and improving the fodder quality e.g. both higher leaves/ stem ratio, protein and ash yields .

Table 9 : Land Equivalent Ratio (LER) on fresh and dry matter yields basis as influenced by pearl millet / cowpea intercropping in 2009 and 2010 seasons

2009 season				2010 season			
1st cut	2nd cut	3rd cut	cumulative	1st cut	2nd cut	3rd cut	cumulative
On fresh yield basis							
1.15	1.16	1.03	1.13	1.13	1.15	0.96	1.06
On dry matter production basis							
1.27	1.17	1.11	1.23	1.13	1.11	0.95	1.10

Table 10 : Competition Ratio(CR) on fresh and dry matter yields as influenced by pearl millet / cowpea intercropping in 2009 and 2010 seasons

Crop	2009 season				2010 season			
	1st cut	2nd cut	3rd cut	Total	1st cut	2nd cut	3rd cut	Total
pearl millet	On fresh yield basis							
	0.89	0.90	0.67	0.85	0.93	0.93	0.96	0.95
	On dry matter production basis							
	0.83	0.98	0.75	0.85	0.88	0.90	0.90	0.92
cowpea	On fresh yield basis							
	1.13	1.11	1.49	1.17	1.07	1.08	1.04	1.06
	On dry matter production basis							
	1.21	1.01	1.33	1.17	1.13	1.16	1.11	1.08

Table 11 : Aggressivity on fresh and dry matter yields as influenced by pearl millet / cowpea intercropping in 2009 and 2010 seasons

Crop	2009 season				2010 season			
	1st cut	2nd cut	3rd cut	Total	1st cut	2nd cut	3rd cut	Total
pearl millet	On fresh yield basis							
	- 0.08	- 0.06	- 0.20	- 0.09	- 0.04	- 0.05	- 0.02	- 0.03
	On dry matter production basis							
	- 0.11	- 0.02	- 0.14	- 0.04	- 0.07	- 0.06	- 0.03	- 0.04
cowpea	On fresh yield basis							
	0.08	0.06	0.20	0.09	0.04	0.05	0.02	0.03
	On dry matter production basis							
	0.11	0.02	0.14	0.09	0.07	0.06	0.05	0.04

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تأثير إضافة الكمبوست وتحميل لوبيا العلف على الدخن على كمية وجودة كلا المحصولين

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الملخص العربي

أقيمت تجربتان حقليتان بمحطة البحوث الزراعية بالجميزة – محافظة الغربية في موسمي 2009 و 2010 لمعرفة تأثير اضافة الكمبوست و تحميل لوبيا العلف علي الدخن (1:1) علي أداء كلا المحصولين مقارنة بزراعة كلا المحصولين منفردا. درست صفات المحصول الطازج – المحصول الجاف – جودة المحصول مثل نسبة الأوراق إلي الساق ، محصول كل من البروتين الخام ، الألياف ، الرماد. تم دراسة تأثر دلائل الإنتاجية مثل نسبة المكافئ الأرضي – نسبة التنافس –العدوانية كنتيجة لنظام التحميل تحت الدراسة. اختبرت العوامل تحت الدراسة في التصميم الإحصائي القطع المنشقة في ثلاث مكررات حيث خصصت القطع الرئيسية لإضافة الكمبوست وعدمه بينما خصصت القطع المنشقة لنظم التحميل . أهم النتائج المتحصل عليها يمكن إيجازها كالآتي :-

* إضافة الكمبوست أدت إلي زيادة المحصول الكلي الطازج .
* أدي تحميل لوبيا العلف علي الدخن إلي نقص في المحصول الطازج و كذا محصول المادة الجافة مقارنة بزراعتهما منفردين.
* أدي التحميل إلي تحسين نسبة الأوراق إلي الساق في الحشات المختلفة و كذا المحصول الكلي (محصول طازج أو مادة جافة) مقارنة بالدخن المنفرد.
* زاد محصولي البروتين والرماد بينما انخفض محصول الألياف تحت ظروف التحميل في الحشات المختلفة و كذا للمحصول الكلي ، مقارنة بالدخن المنفرد.
* أظهرت نسبة المكافئ الأرضي LER ميزة التحميل (علي أساس كلا من المحصول الطازج و الجاف) عن زراعة المحصولين منفردين. كان محصول لوبيا العلف أكثر منافسة وعدوانية للدخن في الحشات المختلفة و كذا المحصول الكلي تبعا لمقياسي نسبة التنافس و العدوانية (علي أساس المحصول الطازج و الجاف) .
* بالرغم من نقص محصولي العلف الطازج و الجاف مقارنة بالدخن المنفرد فان تحميل لوبيا العلف علي الدخن ذو ميزة عن كلا المحصولين منفردين طبقا لمقياس نسبة المكافئ الأرضي .أدي التحميل أيضا إلي تحسن جودة الناتج من حيث زيادة نسبة الأوراق /الساق ، زيادة محصولي البروتين و الرماد و انخفاض محصول الألياف .