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Potentiality Assessment of Annual Forage Crops and Fertilization in Allway Pattern.

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Abstract

This study was conducted at the Agricultural Research and Experiments Farm , Faculty of Agriculture, Benha University during two seasons (2018/2019 & 2019/2020).This is to investigate the effect of combined fertilization rates which were (low, medium and high) yield and chemical content of some summer and winter forage crops. The experimental designed was conducted to evaluate the yield and chemical content of [some summer forage grasses guar (*Cyamopsis tetragonolobe*), cowpea (*Vigna sinensis*), pearl millet (*Pennisetum typhoides*) and summer sudan grass (*Sorghum bicolor*) and winter forage grasses berseem (*Trifolium alexandrinum*) and barley (*Hordeum vulgare*)], under three complete combined rates fertilizer of high (90:60:30 kg NPK/fed.), medium (60:40:20 kg NPK/fed.) and low (30:20:10 kg NPK/fed.), in addition to the control (without fertilization). Their interactions and its effect on yield and their chemical content, where the split plot design was used once , where the forage grasses were placed in the main plots, while the combined fertilization rates were placed in the sub-main plots, where three cuts were taken during the two study seasons. The results showed:A clear superiority of the treatment with a high rate of the combined fertilizer (90:60:30 kg NPK/fed.) for all summer and winter forage grasses in the characteristics of the contents of fresh and dry forage yield (ton/fed) during each of the two growing seasons with slight differences. The increase which was significant with successive leguminous forage grasses after forage grasses compared to cultivation of forage grasses after leguminous forage crops with the use of a high rate of complete fertilizer of (N:P:K), the results also showed the superiority of the same treatment in the parameters of the chemical content of the forage (the percentage of protein and carbohydrate content).

The results concluded that it was recommended to plant leguminous forage crops after grasses forage crops with the use of a high complete fertilizer rate (90:60:30 kg NPK/fed) in order to obtain the highest productivity and chemical content of forage grasses and maximize their utilization as animal feed to reduce the forage gap.

Key words: Summer forage crops, winter forage crops, complete fertilizer and crop rotation.

Introduction

Egypt suffers from an annual shortage of 6 million tons of fodder to fulfil this gap by growing some successive summer and winter fodder grasses and knowing the extent to which these fodder grasses contribute to their direct consumption or after preparing and processing them to mix with some manufactured feeds in animal feed.

Summer forage crops as traditional fodder sources, as cowpea is a warm season legume which is primarily grown and serve as a major source of protein and calories in sub-Saharan Africa, due to its high adaptability to both heat and drought and its association for nitrogen fixing bacteria which cowpea is a versatile crop, according to the study of **Zaghloul *et.al.*, 2017.**

Sudan grass is a summer annual drought tolerant during warm temperatures, such plant stands of 4 to 6 feet tall, with stems of about 1⁄4 inch in diameter and posses soft leaves. The plant develops only fibrous roots and does not have rhizomes, but a single seed can produce many tillers, depending on spacing. Sudan grass plants tillers extensively of rapid regrowth potentials, According to the study**,** pearl millet has the required characteristics for dry land production which pearl millet has the potential as a new grain crop for the southeastern united states. Furthermore, results demonstrated that pearl millet can be grown with limited, as n-fertilization is the major cost of producing any crop, pearl millet offers special opportunity for large number of limited resource in the region, according to the study of **(Obeng *et.al.*, 2012).** Guar also known as cluster bean, is a crop plant grown in semi-arid regions worldwide and as a forage, vegetable and green manure, following models of other warm-season, according to the study (**Adams *et.al*., 2020).**

Winter forage crops as traditional fodder sources, such as leguminous plants are also of crucial importance as an animal feed. Clovers are grown over extensive areas as forage crops for grazing or as dry hay, and they furnish not only high quality protein but also a variety of biologically active molecules such as vitamins, minerals and other nutrients according to the study. Barley is an economically important cereal crop ranking the fourth after wheat, rice and maize in the world both in terms of quantity and it is area of cultivation. Among the important traits that could exist in the landraces are earliness, high nutritional quality, disease and pest tolerance of drought and other forms of abiotic stress and characters which are useful for low input agriculture according to the study according to the study of (**Mansoor** and **Jeber, 2020)** and **(Dwivedi *et.al.*, 2021)**.

This study objective to use some successive summer and winter forage grasses with complete fertilizer levels of (N:P:K) to enhance increasing productivity and reduce forage gap.

Materials and Methods

Field study was conducted at the Agricultural Research Experiments Farm, Faculty of Agriculture, Moshtohor, Benha University, Qalyubia Governorate, Egypt, during each of the two successive cultivation seasons (2018/2019 and 2019/2020).

Potentiality assessment of subsequent rotational annual cultivated forage crops in allway pattern:

The objective of this investigation was to study the potentiality response of some common summer and winter forage crops of four combined fertilization levels NPK. Each experiment included 16 treatment which were combination of 4 summer forage crops x 4 rates of compound fertilization rates NPK in 3 replications in growing seasons (2018 & 2019). The treatments were as follows:

1- Summer season experiment:

The experiment included 16 treatment which were:

a- Forage crops: guar (*Cyamopsis tetragonolobe*), cowpea (*Vigna sinensis*), pearl millet (*Pennisetum typhoides*) and sudan grass (*Sorghum bicolor*)**.**

b- four treatments of complete fertilizer rates: high (90:60:30 kg NPK/fed.), medium (60:40:20 kg NPK/fed.) and Low (30:20:10 kg NPK/fed.) and the control (without fertilization) whereas the sources of complete fertilizer rates were nitrogen (ammonium sulfate 20.6%N), phosphorus (monocalcium superphosphate 15.5%P_2O_5) and potassium (potassium sulfate 48% K_2O), complete fertilizer rates were applied into 6 doses before irrigation two before each cut, first cut (1/6), second cut (25/7) and third cut (20/9) in growing seasons of (2018 and 2019).

Experimental practices and design:

Treatments were arranged in a split-plot design in three replicates and forage crops assigned in main plots and rates of complete fertilizer arranged in a split – plot.

Forage crops seeds, gained from field crops Research Institute - Agricultural Research Center (ARC).

Planting procedures of summer and winter forage:

The experimental design was laid out in a spilt - plot design with three replicates in each of two seasons, four common summer forage and two common winter forage previously mentioned were distributed randomly in the main plots, whereas the compound fertilization rates (NPK) were assigned randomly in the sub plots, the area of each experiment unit was 4 m² (2x2 m) of about 1050/fed. an area which contained 4 ridges of 2 m length and 50 cm width, the other recommended agronomic practices of growing forage summer and winter were applied regularly as practices in the region.

The studied parameters:

Fresh and dry forage yield for the common summer and winter yield:

Fresh forage yield of some common summer and winter under study was determined for each plant of the subsequent cuts, in each experimental unit for each of the two studied seasons and recorded in ton/fed. an using field scale of 0.5 gm sensitivity then forage yield of some common summer and winter were estimated and recorded in ton/fed., dry forage yield productivity of some common summer and winter were estimated as follows, samples of about 200 gm of fresh forage Some common summer and winter were selected randomly from each experimental unit, accurately weighted using an electric balance of 0.01 gm sensitivity, such obtained fresh samples were dried in an air forced drying oven at 70° C for 3 days till constant weight to determine the dry matter content, then dry yield of some common summer and winter forage were estimated accordingly.

2- Winter season experiment:

The experiment included 16 treatment which were:

a- Forage crops: berseem (*Trifolium alexandrinum*) and barley (*Hordeum vulgare*).

b- four treatments of complete fertilizer rates: high (90:60:30 kg NPK/fed.), medium (60:40:20 kg NPK/fed.) and Low (30:20:10 kg NPK/fed.) in addition to the control (without fertilization) whereas the sources of complete fertilizer rates were nitrogen (ammonium sulfate 20.6%N), phosphorus (monocalcium superphosphate 15.5%P_2O_5) and potassium (potassium sulfate 48% K_2O), complete fertilizer rates were applied into 6 doses before irrigation two before each cut, first cut (1/12), second cut (15/1) and third cut (1/3) in growing seasons (2018/2019 and 2019/2020).

The successive cultivation of summer and winter forage grasses were carried out as follows:

- Barley (*Hordeum vulgare*) after guar (*Cyamopsis tetragonolobe*).
- Barley (*Hordeum vulgare*) after cowpea (*Vigna sinensis*).
- Berseem (*Trifolium alexandrinum*) after pearl millet (*Pennisetum typhoides*).
- Berseem (*Trifolium alexandrinum)* after sudan grass (*Sorghum bicolor*).

Experimental practices and design:

Treatments were arranged in a split-plot design in three replicates and forage crops assigned in main plots and rates of complete fertilizer arranged in a split – plot.

Forage crops seeds, gained from field crops Research Institute - Agricultural Research Center (ARC).

Chemical constituents:

The chemically analyzed samples of the proposed treatments were analyzed for the first and second cuts in dry samples of each treatment of the three replicates in the two growing seasons in both studies under investigation. This is to represent the general effect of the imposed treatments as an average of the whole seasonal environmental variation. In other words such first and second cuts were taken for each of the two seasons for each of the two studied subjects under study. The dried samples were mixed thoroughly for the obtained three replicates of the same treatment to from a composite sample out of each of three samples, three analysis were done for each treatment. The average results of each analysis in study was recorded. Chemical analysis was conducted and presented on dry matter basis. Fresh forage of summer and winter samples were randomly taken from each experimental unit, an accurately weighted samples of the fresh forage of summer and winter about 200 gm were dried using an air forced drying oven at 70° C till a constant weight. Samples were dried in a labeled Kraft paper bags which laid in the drying oven all over the drying period. Dried samples were then cooled at room temperature, then ground finely and screened through screen of 40 michs. The fine grounded samples were stored in sealed labeled plastic bags and stored in the refrigerator at 5° C till needed for the chemical analysis. The conducted chemical analysis of dry forage of summer and winter quality components included the following:

Crude protein content (%):

Total nitrogen percentage was determined according to the modified micro kjeldahl method**. C**rude protein content was estimated by multiplying nitrogen percentage by 6.25 **(A.O.A.C. 1990).**

Total carbohydrates content (%):

It was estimated by subtracting the sum of the percentages of crude protein, crude fiber, ash and ether extract out of 100, **{TCC % = 100- (CP %+CF %+ EE % +Ash %)}** by **(A.O.A.C. 1990).**

Physical and chemical characters of the used soil are shown in Table (a), physical analysis was estimated according to **Jackson (1973)** whereas, chemical analysis was determined according to **Black, *et. al*. (1982).**

Table 1. Physical and chemical properties of the experimental soil units at Moshtohor Agric. EXP. Station during each of the two growing seasons.

Properties		Seasons	
		2018	**2019**
Physical analysis:			
Coarse sand	(%)	2.09	2.03
Fine sand	(%)	23.94	24.61
Silt	(%)	21.74	21.23
Clay	(%)	52.23	52.13
Textural class		Clay	Clay
Chemical analysis:			
$CaCo_3$	(%)	1.05	1.08
Organic matter	(%)	2.09	2.13
N available	(mg/kg)	0.88	0.92
P available	(mg/kg)	0.31	0.35
K available	(mg/kg)	0.71	0.77
E.C	(ds. m^{-1})	0.93	0.98
pH		7.68	7.75

Statistical analysis:

Each of three experiments previously presented was statistically analyzed individually according to the presented design for each of the two growing seasons (2018/2019 and 2019/2020). The analysis of variance was carried out according to the procedure described by **Snedecor and Corchran (1982)**, L.S.D. test at 5% level was used to compare between means.

Results and discussion

Potentiality assessment of subsequent rotational annual forage crops in allway pattern:

Summer forage crops (*Cyamopsis tetragonolobe, Vigna sinensis, Pennisetum typhoides and Sorghum bicolor*):

Fresh yield (ton/fed):

Results in table (2) showed that, the highest increase in the fresh yield of Sorghum bicolor in the first cut (10.58&11.00 ton/fed.), the second cut (11.15&10.53 ton/fed.) and the third cut (11.18&10.09 ton/fed.), followed by *Pennisetum typhoides* and *Vigna sinensis*, and the lowest of them was in the fresh weight of grass *Cyamopsis tetragonolobe*, which was given in the first cut (9.67&9.93 ton/fed.), the second cut (9.15&9.72 ton/fed.) and the third cut (8.17&9.52 ton/fed.) for the first and second seasons (2018 & 2019) respectively.

The data in table (2) showed that, rates of NPK fertilization were high compound fertilization rates (90:60:30 kg NPK/fed.), medium compound fertilization rates (60:40:20 kg NPK/fed.) and low compound fertilization rates (30:20:10 kg NPK/fed.) a significant increase in the fresh weight of grass (*Cyamopsis tetragonolobe*, *Vigna sinensis*, *Sorghum bicolor and Pennisetum typhoides*) for the first and second seasons, where the high rate of fertilization gave a significant increase in the fresh weight of grass for the first cut (10.27&10.90 ton/fed.), the second cut (10.65&10.30 ton/fed.) and the third cut (10.41&9.97 ton/fed.) compared to the medium rate of fertilization in the first cut (10.19&10.67 ton/fed.), the second cut (10.49&10.17 ton/fed.) and the third cut (10.00&9.87 ton/fed.), the least significant increase was the low rate of fertilization in the first cut (10.09&10.39 ton/fed.), the second cut (10.19&9.99 ton/fed.) and the third cut (9.91&9.73 ton/fed.) compared to the control (without fertilization) in the first cut (9.85&10.07 ton/fed.) the second cut (9.81&9.82 ton/fed.) and the third cut (9.49&9.59 ton/fed.) in both seasons of study.

Table 2. Potentiality assessment of fertilization rates on fresh yield (ton/fed) of summer forage grasses plants during the two seasons (2018 & 2019).

Seasons	**First season (2018)**					**Second season (2019)**				
Treatments	**C. t.**	**V. s.**	**P. t.**	**S. b.**	**Mean**	**C. t.**	**V. s.**	**P. t.**	**S. b.**	**Mea**
					First cut					
F.0 (0.0)	**9.52**	**9.81**	**9.87**	**10.19**	**9.85**	**9.63**	**10.05**	**10.19**	**10.43**	**10.07**
F.1 (L.)	**9.63**	**9.94**	**9.95**	**10.51**	**10.09**	**9.89**	**10.29**	**10.56**	**10.83**	**10.39**
F.2 (M.)	**9.73**	**10.11**	**10.13**	**10.77**	**10.19**	**10.05**	**10.51**	**10.93**	**11.17**	**10.67**
F.3 (H.)	**9.81**	**10.19**	**10.24**	**10.85**	**10.27**	**10.16**	**10.77**	**11.09**	**11.57**	**10.90**
Mean	**9.67**	**10.10**	**10.05**	**10.58**	**===**	**9.93**	**10.41**	**10.69**	**11.00**	**===**
LSD. at 5%	**A=0.16 ,**	**B=0.13 ,**	**AxB=0.25**			**A=0.05 ,**	**B=0.05 ,**	**AxB=0.11**		
					Second cut					
F.0. (0.0)	**8.67**	**9.81**	**10.16**	**10.59**	**9.81**	**9.49**	**9.71**	**9.87**	**10.21**	**9.82**
F.1 (L.)	**8.93**	**10.03**	**10.67**	**11.15**	**10.19**	**9.68**	**9.81**	**10.08**	**10.37**	**9.99**
F.2 (M.)	**9.41**	**10.19**	**11.09**	**11.28**	**10.49**	**9.81**	**9.92**	**10.29**	**10.67**	**10.17**
F.3 (H.)	**9.57**	**10.29**	**11.15**	**11.60**	**10.65**	**9.89**	**10.05**	**10.40**	**10.85**	**10.30**
Mean	**9.15**	**10.08**	**10.77**	**11.15**	**===**	**9.72**	**9.87**	**10.16**	**10.53**	**===**
LS D. at 5%	**A=0.17 ,**	**B=0.10 ,**	**AxB=0.19**			**A=0.06 ,**	**B=0.05 ,**	**AxB=0.11**		
					Third cut					
F.0 (0.0)	**7.57**	**9.55**	**10.19**	**10.67**	**9.49**	**9.23**	**9.57**	**9.65**	**9.89**	**9.59**
F.1 (L.)	**7.95**	**9.81**	**10.69**	**11.17**	**9.91**	**9.47**	**9.63**	**9.81**	**10.03**	**9.73**
F.2 (M.)	**8.37**	**9.97**	**11.09**	**11.30**	**10.00**	**9.65**	**9.73**	**9.95**	**10.16**	**9.87**
F.3 (H.)	**8.77**	**10.05**	**11.20**	**11.63**	**10.41**	**9.73**	**9.81**	**10.03**	**10.29**	**9.97**
Mean	**8.17**	**9.85**	**10.63**	**11.18**	**===**	**9.52**	**9.69**	**9.86**	**10.09**	**===**
LS D. at 5%	**A=0.16 ,**	**B=0.16 ,**	**AxB=0.32**			**A=0.05 ,**	**B=0.05 ,**	**AxB=0.09**		

F.0=Control	***C.t.=Cyamopsis tetragonolobe***	**A= Forage grasses**
F.1=Fertilization low	***V.s.=Vigna sinensis***	**B= Fertilization levels**
F.2=Fertilization medium	***P.t.=Pennisetum typhoides***	**A×B = Forage grasses × Fertilization levels**
F.3=Fertilization high	***S.b.=Sorghum bicolor***	

In addition to the results in table (2) showed that, the (*Cyamopsis tetragonolobe, Vigna sinensis, Sorghum bicolor and Pennisetum typhoides)* fertilized at a high compound fertilization rates (90:60:30 kg NPK/fed.) had a significant increase in the fresh weight of grass as the Pennisetum typhoides fertilized at the rate was given the high compound fertilization rates (90:60:30 kg NPK/fed.) significantly increased in the first cut (10.85&11.57 ton/fed.), the second cut (11.60&10.85 ton/fed.) and the third cut (11.63&10.29 ton/fed.) in both seasons, while the low compound fertilization rates (30:20:10 kg NPK/fed.) with *Cyamopsis tetragonolobe* gave the least significant increase in the fresh weight of the grass for the first cut (9.63&9.89 ton/fed.), the second cut (8.93&9.68 ton/fed.), and the third cut (7.95&9.47 ton/fed.) in comparison with control (without fertilization) in the first and second seasons respectively, this trend was true in the three cuts in the two seasons, the other treatments occupied on intermediate position between the abovementioned treatments in the two seasons.

These results were in agreement with **Lal and Shaik (2000)** on sudan grass, **Abd El-Aziz (2002)** on millet, **Ammaji and Suryamarayoma (2003) on** sudan grass, **Ronald and Robert (2005)** on sudan grass, **Ayub *et.al.*, (2009)** on millet, **Sajid *et.al.*, (2009)** on guar, **Obeng *et.al.*, (2012)** on millet, **Hamdan and Fezaa (2017)** on sudan grass and **Zaghloul *et.al.*, (2017)** on cowpea.

Dry yield (ton/fed):

Data in table (3) showed that, the highest increase in the dry yield of grass *Sorghum bicolor* in the first cut (1.26&1.16 ton/fed.), the second cut (1.33&1.11 ton/fed.) and the third cut (1.34&1.06 ton/fed.), followed by *Pennisetum typhoides* and *Vigna sinensis*, and the lowest of them was in the dry weight of grass *Cyamopsis tetragonolobe*, which was given in the first cut (0.96&1.04 ton/fed.), the second cut (0.91&1.02 ton/fed.) and the third cut (0.76&1.00 ton/fed.) for the first and second seasons (2018 & 2019) respectively.

Table (3): Potentiality assessment of fertilization rates on dry yield (ton/fed) of summer forage grasses plants during the two seasons (2018 & 2019).

Seasons	First season (2018)					Second season (2019)				
Treatments	**C. t.**	**V. s.**	**P. t.**	**S. b.**	**Mean**	**C. t.**	**V. s.**	**P. t.**	**S. b.**	**Mean**
					First cut					
F.0. (0.0)	**0.95**	**0.98**	**1.08**	**1.22**	**1.06**	**1.01**	**1.05**	**1.07**	**1.10**	**1.06**
F.1 (L.)	**0.96**	**0.99**	**1.09**	**1.25**	**1.08**	**1.04**	**1.05**	**1.11**	**1.14**	**1.08**
F.2 (M.)	**0.97**	**1.01**	**1.09**	**1.29**	**1.09**	**1.06**	**1.10**	**1.15**	**1.17**	**1.12**
F.3 (H.)	**0.98**	**1.01**	**1.12**	**1.30**	**1.10**	**1.07**	**1.13**	**1.16**	**1.22**	**1.14**
Mean	**0.96**	**1.00**	**1.10**	**1.26**	**===**	**1.04**	**1.08**	**1.12**	**1.16**	**===**
LS D. at 5%	**A=0.01 , B=0.01 , AxB= 0.01**					**A=0.01 , B=0.01 , AxB= 0.01**				
					Second cut					
F.0. (0.0)	**0.87**	**0.98**	**1.11**	**1.26**	**1.05**	**1.00**	**1.02**	**1.04**	**1.07**	**1.03**
F.1 (L.)	**0.90**	**1.00**	**1.17**	**1.33**	**1.10**	**1.02**	**1.03**	**1.06**	**1.09**	**1.05**
F.2 (M.)	**0.94**	**1.01**	**1.22**	**1.35**	**1.13**	**1.03**	**1.04**	**1.08**	**1.12**	**1.07**
F.3 (H.)	**0.96**	**1.03**	**1.22**	**1.39**	**1.15**	**1.04**	**1.06**	**1.09**	**1.14**	**1.08**
Mean	**0.91**	**1.00**	**1.18**	**1.33**	**===**	**1.02**	**1.04**	**1.07**	**1.11**	**===**
LS D. at 5%	**A=0.01 , B=0.01 , AxB= 0.01**					**A=0.01 , B=0.01 , AxB= 0.01**				
					Third cut					
F.0. (0.0)	**0.76**	**0.95**	**1.11**	**1.27**	**1.02**	**0.97**	**1.01**	**1.01**	**1.04**	**1.01**
F.1 (L.)	**0.79**	**0.98**	**1.17**	**1.34**	**1.07**	**0.99**	**1.01**	**1.03**	**1.05**	**1.02**
F.2 (M.)	**0.83**	**0.99**	**1.22**	**1.35**	**1.10**	**1.01**	**1.02**	**1.04**	**1.07**	**1.04**
F.3 (H.)	**0.88**	**1.00**	**1.23**	**1.39**	**1.13**	**1.02**	**1.03**	**1.05**	**1.08**	**1.05**
Mean	**0.76**	**0.98**	**1.18**	**1.34**	**===**	**1.00**	**1.02**	**1.04**	**1.06**	**===**
LS D. at 5%	**A=0.01 , B=0.01 , AxB= 0.01**					**A=0.01 , B=0.01 , AxB= 0.01**				

F.0=Control	***C.t.=Cyamopsis tetragonolobe***	**A= Forage grasses**
F.1=Fertilization low	***V.s.=Vigna sinensis***	**B= Fertilization levels**
F.2=Fertilization medium	***P.t.=Pennisetum typhoides***	**A×B = Forage grasses × Fertilization levels**
F.3=Fertilization high	***S.b.=Sorghum bicolor***	

The data in table (3) showed that, rates of NPK fertilization were high compound fertilization rates (90:60:30 kg NPK/fed.), medium compound fertilization rates (60:40:20 kg NPK/fed.) and low compound fertilization rates (30:20:10 kg NPK/fed.) a significant increase in the dry weight of grass (*Cyamopsis tetragonolobe, Vigna sinensis, Sorghum bicolor and Pennisetum typhoides*) for the first and second seasons, where the high rate of fertilization gave a significant increase in the dry weight of grass for the first cut (1.10&1.14 ton/fed.), the second cut (1.15&1.08 ton/fed.) and the third cut (1.13&1.05 ton/fed.) compared to the medium rate of fertilization in the first cut (1.09&1.12 ton/fed.), the second cut (1.13&1.07 ton/fed.) and the third cut (1.10&1.04 ton/fed.), the least significant increase was the low rate of fertilization in the first cut (1.08&1.08 ton/fed.), the second cut (1.10&1.05 ton/fed.) and the third cut (1.07&1.02 ton/fed.) compared to the control (without fertilization) in the first cut (1.06&1.06 ton/fed.), the second cut (1.05&1.03 ton/fed.) and the third cut (1.02&1.01 ton/fed.) in both seasons of study.

In addition to the results in table (3) showed that, the (*Cyamopsis tetragonolobe, Vigna sinensis, Sorghum bicolor and Pennisetum typhoides)* fertilized at a high compound fertilization rates (90:60:30 kg NPK/fed.) had a significant increase in the dry weight of grass as the *Pennisetum typhoides* fertilized at the rate was given the high compound fertilization rates (90:60:30 kg NPK/fed.) significantly increased in the first cut (1.30&1.22 ton/fed.), the second cut (1.39&1.14 ton/fed.) and the third cut (1.39&1.08 ton/fed.) in both seasons, while the low compound fertilization rates (30:20:10 kg NPK/fed.) with *Cyamopsis tetragonolobe* gave the least significant increase in the dry weight of the grass for the first cut (0.96&1.04 ton/fed.), the second cut (0.90&1.02 ton/fed.), and the third cut (0.79&0.99 ton/fed.) in comparison with control (without fertilization) in the first and second seasons, respective this trend was true in the three cuts in the two seasons, the other treatments occupied on intermediate position between the abovementioned treatments in the two seasons.

These results were in agreement with **Lal and Shaik (2000)** on sudan grass, **Abd El-Aziz (2002)** on millet, **Ammaji and Suryamarayoma (2003) on** sudan grass, **Ronald and Robert (2005)** on sudan grass, **Ayub *et.al.*, (2009)** on millet, **Sajid *et.al*., (2009)** on guar, **Obeng *et.al.*, (2012)** on millet, **Hamdan and Fezaa (2017)** on sudan grass and **Zaghloul *et.al.*, (2017)** on cowpea.

Crude protein content (%):

The results in table (4) showed that, the highest significant increase in the crude protein content of the forage *Vigna sinensis* in the first cut (19.08 & 19.48 %), the second cut (19.28 & 19.95 %) and the third cut (12.54 & 20.83 %) in the first and second seasons (2018 & 2019) respectively, followed by *Cyamopsis tetragonolobe* in the first cut (13.73 & 14.63 %) the second cut (13.93 & 14.20 %) and the third cut (11.29 & 14.32 %) in both seasons cultivation respectively, then *Sorghum bicolor* in the first cut (11.41 & 13.81 %), the second cut (11.49 & 13.86 %) and the third cut (9.63 & 14.38 %) in the first and second seasons respectively. While *Pennisetum typhoides* had the lowest significant increase in the first cut (11.21 & 13.67 %), the second cut (11.27 & 13.69 %) and the third cut (8.13 & 13.75 %) in the first and second seasons respectively.

Data in table (4) showed that, all levels of NPK fertilization were high compound fertilization rates (90:60:30 kg NPK/fed.), medium compound fertilization rates (60:40:20 kg NPK/fed.) and low compound fertilization rates (30:20:10 kg NPK/fed.) had a significant increase in the crude protein content of the summer forage under study in both seasons. Where the high rate of fertilization recorded the highest significant increase in the first cut (14.06 & 15.89 %), the second cut (14.17 & 15.67 %) and the third cut (10.78 & 15.99 %) in the first and second seasons (2018 & 2019) respectively, then the medium rate of fertilization in the first cut (13.98 & 15.33 %), the second cut (14.09 & 15.52 %) and the third cut (10.48 & 15.83 %) in the first and second seasons respectively, and the lowest rate of fertilization in the first cut (13.83 & 15.31 %), the second cut (14.09 & 15.33 %) and the third cut (10.18 & 15.72 %) in the first and second seasons (2018 & 2019) respectively compared to the unfertilized control plants in the first cut (13.56 & 15.05 %), the second cut (13.69 & 15.18 %) and the third cut (9.63 & 15.51 %) in the first and second seasons (2018 & 2019).

Results in table (4) showed that, plants (*Cyamopsis tetragonolobe, Vigna sinensis, Pennisetum typhoides* and *Sorghum bicolor*) fertilized with high, medium and low rates of fertilization had a significant increase in the percentage of crude protein content in the first cut (19.37 & 19.79 %), the second cut (19.60 & 20.21 %) and the third cut (13.47 & 21.25 %) in the first and second seasons respectively, compared to other treatments under study in both seasons (2018 & 2019), this trend was true in the three cuts in the two seasons, the other treatments occupied on intermediate position between the abovementioned treatments in the two seasons.

These results were in agreement with **Lal and Shaik (2000)** on sudan grass, **Abd El-Aziz (2002)** on millet, **Ammaji and Suryamarayoma (2003) on** sudan grass, **Ronald and Robert (2005)** on sudan grass, **Ayub *et.al.*, (2009)** on millet, **Sajid *et.al*., (2009)** on guar, **Obeng *et.al.*, (2012)** on millet, **Hamdan and Fezaa (2017)** on sudan grass and **Zaghloul *et.al.*, (2017)** on cowpea.

Table (4): Potentiality assessment of fertilization rates on crude protein content (%) of summer forage grasses plants during the first and second seasons (2018 & 2019).

Seasons	First season (2018)					Second season (2019)				
Treatments	**C. t.**	**V. s.**	**P. t.**	**S. b.**	**Mean**	**C. t.**	**V. s.**	**P. t.**	**S. b.**	**Mean**
					First cut					
F.0. (0.0)	13.50	18.77	10.93	11.03	13.56	13.73	19.17	13.60	13.71	15.05
F.1 (L.)	13.70	18.97	11.23	11.43	13.83	14.48	19.38	13.67	13.73	15.31
F.2 (M.)	13.83	19.23	11.30	11.53	13.98	14.27	19.58	13.69	13.77	15.33
F.3 (H.)	13.87	19.37	11.37	11.63	14.06	14.38	19.79	13.71	14.00	15.89
Mean	13.73	19.08	11.21	11.41	-----	14.63	19.48	13.67	13.81	-----
LS D. at 5%	A=0.11 ,	B=0.10 ,	AxB=0.20			A=0.31 ,	B=0.62 ,	AxB=1.24		
					Second cut					
F.0. (0.0)	13.80	18.87	10.97	11.11	13.69	13.77	19.58	13.65	13.73	15.18
F.1 (L.)	13.93	19.23	11.30	11.57	14.02	14.08	19.79	13.67	13.78	15.33
F.2 (M.)	13.97	19.40	11.37	11.63	14.09	14.38	20.21	13.71	13.79	15.52
F.3 (H.)	14.00	19.60	11.40	11.67	14.17	14.58	20.21	13.73	14.15	15.67
Mean	13.93	19.28	11.27	11.49	-----	14.20	19.95	13.69	13.86	-----
LS D. at 5%	A=0.25 ,		B=0.14 ,		AxB=0.29	A=0.36 ,		B=0.17 ,		AxB=0.35
					Third cut					
F.0. (0.0)	10.33	11.57	7.67	8.97	9.63	14.17	20.21	13.69	13.96	15.51
F.1 (L.)	11.23	12.40	7.87	9.23	10.18	14.17	20.83	13.71	14.17	15.72
F.2 (M.)	11.73	12.73	8.00	9.43	10.48	14.38	21.04	13.73	14.17	15.83
F.3 (H.)	11.87	13.47	8.13	9.63	10.78	14.58	21.25	13.75	14.38	15.99
Mean	11.29	12.54	7.92	9.32	-----	14.32	20.83	13.72	14.17	-----
LS D. at 5%	A=0.25 ,		B=0.14 ,		AxB=0.28	A=0.13 ,		B=0.25 ,		AxB=0.51

F.0=Control	**C.t.=*Cyamopsis tetragonolobe***	**A= Forage grasses**
F.1=Fertilization low	**V.s.=*Vigna sinensis***	**B= Fertilization levels**
F.2=Fertilization medium	**P.t.=*Pennisetum typhoides***	**A×B = Forage grasses × Fertilization**
F.3=Fertilization high	**S.b.=*Sorghum bicolor***	

Total carbohydrates content (%):

Results in table (5) showed that, the highest significant increase in the percentage of total carbohydrates content of the forage *Vigna sinensis* in the first cut (55.45 & 55.96 %), the second cut (55.17 & 52.74 %) and the third cut (60.83 & 50.98 %) in the first and second seasons (2018 & 2019) respectively, followed by *Cyamopsis tetragonolobe* in the first cut (50.29 & 51.75 %), the second cut (50.01 & 49.80 %) and the third cut (51.12 & 48.05 %) in the both growing seasons respectively, followed by *Pennisetum typhoides* in the first cut (48.78 & 47.43 %), the second cut (48.56 & 45.72 %) and the third cut (49.32 & 45.15 %) in the first and second seasons, respectively, while *Sorghum bicolor* had the lowest significant increase in the first cut (48.75 & 45.55 %), the second cut (47.52 & 43.87 %) and the third cut (47.71 & 41.14 %) in the first and second seasons (2018 & 2019) respectively. The data in table (5) showed that, all rates of NPK fertilization were high compound fertilization rates (90:60:30 kg NPK/fed.), medium compound fertilization rates (60:40:20 kg NPK/fed.) and low compound fertilization rates (30:20:10 kg NPK/fed.), there were no significant differences in the percentage of total carbohydrate content in the summer forage under study compared to the control plants that were not fertilized in both seasons (2018 & 2019).

Results in table (5) showed that, all plants (*Cyamopsis tetragonolobe*, *Vigna sinensis*, *Pennisetum typhoides* and *Sorghum bicolor*) fertilized with high, medium and low rates of fertilization, there were no significant differences in the percentage of total carbohydrate content in the first and second seasons respectively, compared to control plants in both seasons of the study (2018 & 2019), this trend was true in the three cuts in the two seasons, the other treatments occupied on intermediate position between the abovementioned treatments in the two seasons.

These results were in agreement with **Lal and Shaik (2000)** on sudan grass, **Abd El-Aziz (2002)** on millet, **Ammaji and Suryamarayoma (2003) on** sudan grass, **Ronald and Robert (2005)** on sudan grass, **Ayub *et.al.*, (2009)** on millet, **Sajid *et.al.*, (2009)** on guar, **Obeng *et.al.*, (2012)** on millet,

Hamdan and Fezaa (2017) on sudan grass and **Zaghloul *et.al.*, (2017)** on cowpea

Table (5): Potentiality assessment of fertilization rates on total carbohydrates content (%) of summer forage grasses plants during the first and second seasons (2018&2019).

Seasons / Treatments	First season (2018)					Second season (2019)				
	C. t.	V. s.	P. t.	S. b.	Mean	C. t.	V. s.	P. t.	S. b.	Mean
					First cut					
F.0. (0.0)	51.38	56.46	48.85	48.19	51.22	51.50	58.43	47.02	44.25	50.30
F.1 (L.)	49.83	55.40	48.60	46.76	50.15	51.17	55.18	48.97	48.15	50.87
F.2 (M.)	49.89	55.49	48.73	47.85	50.49	52.20	55.28	46.82	44.78	49.77
F.3 (H.)	50.07	54.45	48.95	48.20	50.42	52.12	54.94	46.91	44.97	49.75
Mean	50.29	55.45	48.78	48.75	-----	51.75	55.96	47.43	45.55	-----
LS D. at 5% for	A=0.30 , B=0.02 , AxB=0.52					A=2.22 , B=2.08 , AxB=4.16				
					Second cut					
F.0. (0.0)	51.04	56.33	48.56	47.98	50.98	49.96	52.83	45.70	43.55	48.01
F.1 (L.)	49.55	55.08	48.36	46.49	49.87	49.77	52.83	45.60	43.86	48.01
F.2 (M.)	49.71	55.16	48.49	47.45	50.20	50.06	52.38	45.73	44.16	48.08
F.3 (H.)	49.78	54.12	48.82	48.16	50.21	49.40	52.93	45.85	43.91	48.02
Mean	50.01	55.17	48.56	47.52	-----	49.80	52.74	45.72	43.87	-----
LS D. at 5% for	A=0.19 , B=0.24 , AxB=0.47					A=1.03 , B=0.63 , AxB=0.26				
					Third cut					
F.0. (0.0)	52.64	62.27	49.90	48.91	53.43	48.28	51.53	44.64	40.56	46.25
F.1 (L.)	51.18	61.17	49.15	47.42	52.23	48.07	50.83	44.71	41.35	46.24
F.2 (M.)	50.45	60.83	49.12	47.45	51.96	47.79	50.69	45.60	41.45	46.38
F.3 (H.)	50.20	59.05	49.12	47.06	48.39	48.06	50.85	45.67	41.19	46.44
Mean	51.12	60.83	49.32	47.71	-----	48.05	50.98	45.15	41.14	-----
LS D. at 5% for	A=0.31 , B=0.30 , AxB=0.61					A=0.59 , B=0.77 , AxB=1.55				

F.0=Control | ***C.t.=Cyamopsis tetragonolobe*** | **A= Forage grasses**
F.1=Fertilization low | ***V.s.=Vigna sinensis*** | **B= Fertilization levels**
F.2=Fertilization medium | ***P.t.=Pennisetum typhoides*** | **A×B = Forage grasses × Fertilization levels**
F.3=Fertilization high | ***S.b.=Sorghum bicolor***

Winter forage crops (*Trifolium alexandrinum and Hordeum vulgare):*

Fresh yield (ton/fed):

Results in table (6) showed that, the cultivation of *Hordeum vulgare* after *Vigna sinensis* gave a significant increase in the fresh weight of grass in the first cut (4.50&4.53 ton/fed.), the second cut (4.63&4.79 ton/fed.) and the third cut (4.09&4.59 ton/fed.) during the two seasons of the study compared to the cultivation of *Hordeum vulgare* after the *Cyamopsis tetragonolobe* where it was given in the first cut (4.17&4.23 ton/fed.), the second cut (4.25&4.43 ton/fed.) and the third cut (3.95&4.27 ton/fed.), followed by the fresh weight of *Trifolium alexandrinum* grown after *Sorghum bicolor* in the first cut (3.67&3.71 ton/fed.),

Table 6. Potentiality assessment of fertilization rates on fresh yield (ton/fed) of winter forage grasses plants during the two seasons (2018/2019 & 2019/2020).

Seasons / Treatments	First season (2018/2019)					Second season (2019/2020)				
	H.v After C.t	**H.v After V.s**	**T.a After P.t**	**T.a After S.b**	**Mean**	**H.v After C.t**	**H.v After V.s**	**T.a After P.t**	**T.a After S.b**	**Mean**
First cut										
F.0 (0.0)	**3.65**	**3.95**	**2.83**	**3.15**	**3.39**	**3.73**	**4.00**	**3.07**	**3.20**	**3.50**
F.1 (L.)	**3.97**	**4.35**	**3.17**	**3.33**	**3.71**	**4.05**	**4.37**	**3.25**	**3.39**	**3.77**
F.2 (M.)	**4.29**	**4.69**	**3.81**	**4.00**	**4.20**	**4.37**	**4.75**	**3.89**	**4.05**	**4.27**
F.3 (H.)	**4.77**	**5.01**	**4.11**	**4.21**	**4.53**	**4.77**	**5.01**	**4.11**	**4.19**	**4.52**
Mean	**4.17**	**4.50**	**3.48**	**3.67**	**===**	**4.23**	**4.53**	**3.58**	**3.71**	**===**
LS D. at 5% for	**A=0.06 , B=0.06 , AxB=0.12**					**A=0.03 , B=0.04 , AxB=0.08**				
Second cut										
F.0 (0.0)	**3.81**	**4.05**	**2.91**	**3.25**	**3.51**	**3.97**	**4.11**	**3.12**	**3.49**	**3.67**
F.1 (L.)	**4.03**	**4.59**	**3.25**	**3.41**	**3.82**	**4.24**	**4.75**	**3.55**	**3.63**	**4.04**
F.2 (M.)	**4.37**	**4.77**	**3.81**	**4.05**	**4.25**	**4.53**	**5.04**	**3.92**	**4.21**	**4.43**
F.3 (H.)	**4.80**	**5.09**	**4.16**	**4.21**	**4.57**	**4.96**	**5.25**	**4.13**	**4.37**	**4.68**
Mean	**4.25**	**4.63**	**3.53**	**3.73**	**===**	**4.43**	**4.79**	**3.68**	**3.93**	**===**
LS D. at 5% for	**A=0.06 , B=0.05 , AxB=0.11**					**A=0.07 , B=0.08 , AxB=0.16**				
Third cut										
F.0 (0.0)	**3.47**	**3.60**	**2.77**	**2.99**	**3.21**	**3.81**	**4.03**	**3.07**	**3.33**	**3.56**
F.1 (L.)	**3.76**	**3.87**	**3.07**	**3.25**	**3.49**	**4.05**	**4.43**	**3.39**	**3.47**	**3.83**
F.2 (M.)	**4.08**	**4.21**	**3.57**	**3.75**	**3.88**	**4.37**	**4.80**	**3.89**	**4.08**	**4.29**
F.3 (H.)	**4.51**	**4.67**	**3.89**	**4.05**	**4.28**	**4.83**	**5.09**	**4.13**	**4.27**	**4.58**
Mean	**3.95**	**4.09**	**3.33**	**3.49**	**===**	**4.27**	**4.59**	**3.62**	**3.79**	**===**
LS D. at 5% for	**A=0.16 , B=0.12 , AxB=0.23**					**A=0.06 , B=0.05 , AxB=0.09**				

F.0=Control
F.1=Fertilization low
F.2=Fertilization medium
F.3=Fertilization high

C.t. =Cyamopsis tetragonolobe
V.s. =Vigna sinensis
P.t. =Pennisetum typhoides
S.b. =Sorghum bicolor
H.v. =Hordeum vulgare
T.a. =Trifolium alexandrinum

A= Winter forage grasses
B= Fertilization levels
A×B = Winter forage × Fertilization levels

the second cut (3.73&3.93 ton/fed.) and third cut (3.49&3.79 ton/fed.) in both seasons respectively. While *Trifolium alexandrinum* grown after *Pennisetum typhoides* had the least significant increase in the fresh weight of grass in the first cut (3.48&3.58 ton/fed.), the second cut (3.53&3.68 ton/fed.) and the third cut (3.33&3.62 ton/fed.) in the first and second seasons (2018/2019 & 2019/2020).

The data in table (6) also showed that, rates of NPK fertilization were high compound fertilization rates (90:60:30 kg NPK/fed.), medium compound fertilization rates (60:40:20 kg NPK/fed.) and low compound fertilization rates (30:20:10 kg NPK/fed.) a significant increase in the fresh weight of grass plants (*Hordeum vulgare* grown after *Cyamopsis tetragonolobe* and *Vigna sinensis* as well as *Trifolium alexandrinum* grown after *Pennisetum typhoides* and *Sorghum bicolor*) for the first and second seasons. Where the high rate of fertilization gave a significant increase in the fresh weight of the grass for the first cut (4.53 & 4.52 ton/fed.), the second cut (4.57 & 4.68 ton/fed.) and the third cut (4.28 & 4.58 ton/fed.) in comparison to the medium rates of fertilization in the first cut (4.20 & 4.27 ton/fed.), the second cut (4.25 & 4.43 ton/fed.) and the third cut (3.88 & 4.29 ton/fed.) had the least significant increase in the low rate in the first cut (3.71 & 3.77 ton/fed.), the second cut (3.82 & 4.04 ton/fed.) and the third cut (3.49 & 3.83 ton/fed.) compared to the control plants in the first cut (3.39 & 3.50 ton/fed.), the second cut (3.51 & 3.67 ton/fed.) and the third cut (3.21 & 3.56 ton/fed.) in the first and second seasons (2018/2019 & 2019/2020) respectively.

In addition to the results in table (6) showed that, plants (*Hordeum vulgare* grown after *Cyamopsis tetragonolobe* and *Vigna sinensis,*as well as *Trifolium alexandrinum* grown after *Pennisetum typhoides* and *Sorghum bicolor*) and fertilized at a high compound fertilization rates (90:60:30 kg NPK/fed.) significantly increased the fresh weight of the grass as the *Hordeum vulgare* plant grown after *Vigna sinensis* gave a significant increase in the first cut (5.01 & 5.01 ton/fed.), the second cut (5.09 & 5.25 ton/fed.) and the third cut (4.67 & 5.09 ton/fed.) in both seasons. While *Trifolium alexandrinum* was given sowed after *Pennisetum typhoides* and fertilized with low rate of fertilization in the first cut (3.17 & 3.25 ton/fed.), second cut (3.25 & 3.55 ton/fed.) and third cut (3.07 & 3.39 ton/fed.) in the first and second seasons respectively, compared to plants unfertilized control in both seasons (2018/2019&2019/2020). This trend was true in the three cuts in the two seasons, the other treatments occupied on intermediate position between the abovementioned treatments in the two seasons. These results were in agreement with **Awasthi and Suraj (1983)** on barley**, Dwivedi *et.al.*, (2021)** on barley and **Muhammad *et.al.*, (2021)** on clover.

Dry yield (ton/fed):

Results in table (7) showed that, the cultivation of *Hordeum vulgare* after *Vigna sinensis* gave a significant increase in the dry weight of grass in the first cut (0.68&0.73 ton/fed.), the second cut (0.74&0.79 ton/fed.) and the third cut (0.57&0.78 ton/fed.) during the two seasons of the study compared to the cultivation of *Hordeum vulgare* after the *Cyamopsis tetragonolobe* where it was given in the first cut (0.67&0.68 ton/fed.), the second cut (0.72&0.73 ton/fed.) and the third cut (0.59&0.73 ton/fed.), followed by the dry weight of *Trifolium alexandrinum* grown after *Sorghum bicolor* in the first cut (0.44&0.48 ton/fed.), the second cut (0.50&0.53 ton/fed.) and the third cut (0.42&0.53 ton/fed.) in both seasons respectively. While *Trifolium alexandrinum* grown after *Pennisetum typhoides* had the least significant increase in the dry weight of grass in the first cut (0.42&0.47 ton/fed.), the second cut (0.46&0.50 ton/fed.) and the third cut (0.40&0.51 ton/fed.) in the first and second seasons (2018/2019 & 2019/2020).

The data in table (7) also showed that, rates of NPK fertilization were high compound fertilization rates (90:60:30 kg NPK/fed.), medium compound fertilization rates (60:40:20 kg NPK/fed.) and low compound fertilization rates (30:20:10 kg NPK/fed.) a significant increase in the dry weight of grass plants (*Hordeum vulgare* grown after *Cyamopsis tetragonolobe* and *Vigna sinensis* as well as *Trifolium alexandrinum* grown after *Pennisetum typhoides* and *Sorghum bicolor*) for the first and second seasons, where the high rate of cut (0.57&0.61 ton/fed.) and the third cut (0.47&0.60 ton/fed.) compared to the control plants in the first cut (0.47 & 0.51 ton/fed.), the second cut (0.54&0.65 ton/fed.) and the third cut (0.43&0.56 ton/fed.) in the first and second seasons (2018/2019&2019/2020) respectively.

In addition to the results in table (7) showed that, plants (*Hordeum vulgare* grown after *Cyamopsis tetragonolobe* and *Vigna sinensis,*as well as *Trifolium alexandrinum* grown after *Pennisetum typhoides* and *Sorghum bicolor*) and fertilized at a high compound fertilization rates (90:60:30 kg NPK/fed.) significantly increased the dry weight of the grass as the *Hordeum vulgare* plant grown after *Vigna sinensis* gave a significant increase in the first cut (0.75 & 0.80 ton/fed.), the second cut (0.82&0.87 ton/fed.) and the third cut (0.65&0.87 ton/fed.) in both seasons, while *Trifolium alexandrinum* was given Sowed after *Pennisetum typhoides* and fertilized with low rate of fertilization in the first cut (0.38 & 0.42 ton/fed.), second cut (0.42 & 0.48 ton/fed.) and third cut (0.37&0.47 ton/fed.) in the first and second seasons respectively, compared to plants unfertilized control in both seasons (2018/2019&2019/2020), this trend was true in the three cuts in the two seasons, the other treatments occupied on intermediate position between the abovementioned treatments in the two seasons. These results were in agreement with **Awasthi and Suraj (1983)** on barley**, Dwivedi *et.al.*, (2021)** on barley and **Muhammad *et.al.*, (2021)** on clover.

Crude protein content (%):

Table (7): Potentiality assessment of fertilization rates on dry yield (ton/fed) of winter forage grasses plants during the two seasons (2018/2019 & 2019/2020).

Seasons / Treatments	First season (2018/2019) H.v After C.t	H.v After V.s	T.a After P.t	T.a After S.b	Mean	Second season (2019/2020) H.v After C.t	H.v After V.s	T.a After P.t	T.a After S.b	Mean
					First cut					
F.0 (0.0)	0.58	0.59	0.34	0.38	0.47	0.60	0.64	0.40	0.42	0.51
F.1 (L.)	0.64	0.65	0.38	0.40	0.52	0.65	0.70	0.42	0.44	0.55
F.2 (M.)	0.69	0.70	0.46	0.48	0.58	0.70	0.76	0.51	0.53	0.62
F.3 (H.)	0.76	0.75	0.49	0.51	0.63	0.76	0.80	0.53	0.54	0.66
Mean	0.67	0.68	0.42	0.44	===	0.68	0.73	0.47	0.48	===
LS D. at 5% for	A=0.01 ,	B=0.01 ,	AxB=0.01			A=0.01 ,	B=0.01 ,	AxB=0.01		
					Second cut					
F.0 (0.0)	0.65	0.65	0.38	0.49	0.54	0.66	0.60	.42	0.47	0.56
F.1 (L.)	0.69	0.73	0.42	0.44	0.57	0.70	0.78	0.48	0.49	0.61
F.2 (M.)	0.74	0.76	0.50	0.53	0.63	0.75	0.83	0.53	0.57	0.67
F.3 (H.)	0.82	0.82	0.54	0.55	0.68	0.82	0.87	0.58	0.59	0.71
Mean	0.72	0.74	0.46	0.50	===	0.73	0.79	0.50	0.53	===
LS D. at 5% for	A=0.01 ,	B=0.01 ,	AxB=0.01			A=0.01 ,	B=0.01 ,	AxB=0.01		
					Third cut					
F.0 (0.0)	0.52	0.50	0.33	0.36	0.43	0.65	0.69	0.43	0.47	0.56
F.1 (L.)	0.56	0.54	0.37	0.39	0.47	0.69	0.75	0.47	0.49	0.60
F.2 (M.)	0.61	0.59	0.43	0.44	0.52	0.74	0.82	0.55	0.57	0.67
F.3 (H.)	0.68	0.65	0.47	0.49	0.57	0.82	0.87	0.58	0.60	0.72
Mean	0.59	0.57	0.40	0.42	===	0.73	0.78	0.51	0.53	===
LS D. at 5% for	A=0.01 ,	B=0.01 ,	AxB=0.01			A=0.01 ,	B=0.01 ,	AxB=0.01		

F.0=Control
F.1=Fertilization low
F.2=Fertilization medium
F.3=Fertilization high

C.t. =Cyamopsis tetragonolobe
V.s. =Vigna sinensis
P.t. =Pennisetum typhoides
S.b. =Sorghum bicolor
H.v. =Hordeum vulgare
T.a. =Trifolium alexandrinum

A= Winter forage grasses
B= Fertilization levels
A×B = Winter forage × Fertilization levels

Results in table (8) showed that, the cultivation of *Hordeum vulgare* after *Vigna sinensis* gave a significant increase in the percentage of crude protein content, as it was given in the first cut (2.57 & 2.92 %), in the second cut (2.59 & 2.94 %) and the third cut (2.41 & 2.98 %) compared to the *Hordeum vulgare* grown after *Cyamopsis tetragonolobe*, which was given in the first cut (2.48 & 2.69 %), in the second cut (2.51 & 2.72 %) and in the third cut (2.25 & 2.78 %) during the two study seasons (2018/2019 & 2019/2020) respectively, while the *Trifolium alexandrinum* grown after Sorghum bicolor recorded the highest significant increase in the percentage of crude protein content, as it was given in the first cut (19.69 & 20.92 %), in the second cut (19.71&21.17 %) and in the third cut (19.04&21.42 %) compared to *Trifolium alexandrinum* grown after *Pennisetum typhoides*, which was given in the first cut (19.53&20.29 %), in the second cut (19.58&20.75 %) and in the third cut (18.79 & 20.83 %) during the two study seasons (2018/2019 & 2019/2020) respectively.

Table 8. Potentiality assessment of fertilization rates on crude protein content (%) of winter forage grasses plants during the first and second seasons (2018/2019 & 2019/2020).

Seasons	First season (2018/2019)					Second season (2019/2020)				
Treatments	H.v After C.t	H.v After V.s	T.a After P.t	T.a After S.b	Mean	H.v After C.t	H.v After V.s	T.a After P.t	T.a After S.b	Mean
					First cut					
F.0 (0.0)	2.37	2.43	19.33	19.50	10.91	2.43	2.57	19.67	20.00	11.17
F.1 (L.)	2.47	2.57	19.50	19.70	11.06	2.60	2.77	20.00	20.67	11.51
F.2 (M.)	2.53	2.60	19.57	19.73	11.11	2.83	2.90	20.50	21.33	11.89
F.3 (H.)	2.57	2.67	19.73	19.83	11.20	2.90	3.43	21.00	21.67	12.25
Mean	2.48	2.57	19.53	19.69	-----	2.69	2.92	20.29	20.92	-----
LS D. at 5% for	A=0.06	B=0.05	AxB=0.1			A=0.33	B=0.28	AxB=0.55		
					Second cut					
F.0 (0.0)	2.39	2.45	19.38	19.52	10.94	2.47	2.57	20.00	20.33	11.34
F.1 (L.)	2.47	2.60	19.59	19.72	11.09	2.63	2.77	20.67	21.00	11.77
F.2 (M.)	2.55	2.63	19.62	19.75	11.14	2.87	2.97	21.00	21.67	12.13
F.3 (H.)	2.61	2.69	19.72	19.85	11.22	2.90	3.47	21.33	21.67	12.34
Mean	2.51	2.59	19.58	19.71	-----	2.72	2.94	20.75	21.17	-----
LS D. at 5% for	A=0.01	B=0.01	AxB=0.01			A=0.27	B=0.37	AxB=0.74		
					Third cut					
F.0 (0.0)	2.12	2.34	18.23	18.67	10.34	2.50	2.63	20.33	20.67	11.53
F.1 (L.)	2.23	2.39	18.23	18.93	10.56	2.67	2.77	20.67	21.33	11.86
F.2 (M.)	2.30	2.41	18.97	19.13	10.70	2.93	3.00	21.00	21.67	12.15
F.3 (H.)	2.37	2.48	19.27	19.43	10.89	3.00	3.50	21.33	22.00	12.46
Mean	2.25	2.41	18.79	19.04	-----	2.78	2.98	20.83	21.42	-----
LS D. at 5% for	A=0.09	B=0.10	AxB=0.21			A=0.79	B=0.41	AxB=0.82		

F.0=Control	***C.t.* =*Cyamopsis tetragonolobe***	***A= Winter forage grasses***
F.1=Fertilization low	***V.s.* =*Vigna sinensis***	***B= Fertilization levels***
F.2=Fertilization medium	***P.t.* =*Pennisetum typhoides***	***A×B = Winter forage × Fertilization levels***
F.3=Fertilization high	***S.b.* =*Sorghum bicolor*** ***H.v.* =*Hordeum vulgare*** ***T.a.* =*Trifolium alexandrinum***	

Data in table (8) showed that, all rates of NPK fertilization were high compound fertilization rates (90:60:30 kg NPK/fed.), medium compound fertilization rates (60:40:20 kg NPK/fed.) and low compound fertilization rates (30:20:10 kg NPK/fed.) a significant increase in the percentage of crude protein content, as the high rate of fertilization gave a significant increase in the percentage of crude protein content, as it was given in the first cut (11.20 & 12.25 %), in the second cut (11.25 & 12.34 %) and in the third cut (10.89 & 12.46 %) followed by the medium rate of fertilization, which was given in the first cut (11.11 & 11.89 %), in the second cut (11.14 & 12.13 %) and in the third cut (10.70 & 12.15 %) then the low rate of fertilization in the first cut (11.06 & 11.51 %), in the second cut (11.09 & 11.77 %) and in the third cut (10.56 & 11.86 %) compared to the unfertilized control plants, which gave in the first cut (10.91 & 11.17 %), in the second cut (10.94 & 11.34 %) and in the third cut (10.34 & 11.53 %) in both seasons study (2018/2019 & 2019/2020) respectively.

In addition to the results in table (8) showed that, the plants (*Trifolium alexandrinum* grown after *Sorghum bicolor*) and fertilized at a high compound fertilization rates (90:60:30 kg NPK/fed.) had a significant increase in the percentage of crude protein content as it was given in the first cut (19.83 & 21.67 %), in the second cut (19.85 & 21.67 %) and in the third cut (19.43 & 22.00 %). The least significant increase in the percentage of crude protein content was the cultivation of *Hordeum vulgare* after *Cyamopsis tetragonolobe*, which was given in the first cut (2.47 &2.60 %), in the second cut (2.47&2.63 %) and in the third cut (2.23&2.67 %) compared to the unfertilized control plants in both seasons (2018/2019 & 2019/2020), this trend was true in the three cuts in the two seasons, the other treatments occupied on intermediate position between the abovementioned treatments in the two seasons. These results were in agreement with **Awasthi and Suraj (1983)** on barley**, Dwivedi *et.al.*, (2021)** on barley and **Muhammad *et.al.*, (2021)** on clover.

Carbohydrates content (%):

The results in table (9) showed that, the cultivation of *Hordeum vulgare* after *Vigna sinensis* gave the highest significant increase in the percentage of total carbohydrate content as it was given in the first cut (13.25 & 13.91 %), the second cut (13.25 & 13.91 %) and the third cut (13.25 & 13.91 %) followed by the *Hordeum vulgare* grown after *Cyamopsis tetragonolobe*, which was given in the first cut (13.25 & 13.91 %), the second cut (13.25 & 13.91 %) and the third cut (13.25&13.91 %). The least significant of them was the significant increase of *Trifolium alexandrinum* grown after *Sorghum bicolor* as it was given in the first cut (13.25 & 13.91 %), the second cut (13.25 & 13.91 %) and the third cut (13.25 & 13.91 %) during the two growing seasons (2018/2019 & 2019/2020) respectively.

Data in table (9) showed that, all levels of NPK fertilization were high compound fertilization rates (90:60:30 kg NPK/fed.), medium compound fertilization rates (60:40:20 kg NPK/fed.) and low compound fertilization levels (30:20:10 kg NPK/fed.), there was no significant increase in the percentage of total carbohydrate content compared to the control plants that were not fertilized in both seasons (2018/2019 & 2019/2020).

Table 9. Potentiality assessment of fertilization rates on carbohydrates content (%) of winter forage grasses plants during the first and second seasons (2018/2019&2019/2020).

Seasons	First season (2018/2019)					Second season (2019/2020)				
Treatments	H.v After C.t	H.v After V.s	T.a After P.t	T.a After S.b	Mean	H.v After C.t	H.v After V.s	T.a After P.t	T.a After S.b	Mean
					First cut					
F.0 (0.0)	62.17	64.39	48.11	46.98	55.41	60.47	60.80	44.14	43.42	52.21
F.1 (L.)	58.78	61.95	43.79	42.58	51.80	60.66	60.60	44.00	42.93	52.05
F.2 (M.)	58.40	60.09	43.36	42.19	51.01	60.87	61.00	43.50	42.00	51.82
F.3 (H.)	58.31	59.71	42.29	41.91	50.56	61.05	60.37	43.17	42.30	51.72
Mean	59.42	61.56	44.39	43.41	-----	60.79	60.69	43.70	42.64	-----
LS D. at 5% for	A=0.48 ,	B=0.59 ,	AxB=1.18			A=0.89 ,	B=0. 36 ,	AxB=0.72		
					Second cut					
F.0 (0.0)	61.24	62.01	46.47	45.75	53.87	60.10	60.36	43.09	42.36	51.48
F.1 (L.)	57.93	60.55	42.44	41.15	50.52	60.17	60.13	42.30	42.08	51.17
F.2 (M.)	57.34	58.61	42.05	40.99	49.75	60.17	60.24	42.22	41.41	51.01
F.3 (H.)	56.83	58.95	41.09	40.71	49.42	60.39	60.09	41.98	41.57	51.01
Mean	58.34	60.06	43.01	42.15	-----	60.21	60.21	42.40	41.85	-----
LS D. at 5% for	A=0.16 ,	B=0.13 ,	AxB=0.27			A=0.43 ,	B=0.40 ,	AxB=0.80		
					Third cut					
F.0 (0.0)	60.15	61.35	46.45	45.46	53.35	59.84	60.16	42.51	41.92	51.11
F.1 (L.)	56.87	59.84	41.99	40.70	49.85	59.68	60.07	42.05	41.92	50.77
F.2 (M.)	56.03	57.98	41.41	40.35	48.94	59.53	59.77	41.66	40.95	50.48
F.3 (H.)	55.60	57.66	40.24	39.91	48.36	59.52	59.39	41.58	40.60	50.27
Mean	57.16	59.21	42.53	41.60	-----	59.65	59.85	41.95	41.19	-----
LS D. at 5% for	A=0.19 ,	B=0.19 ,	AxB=0.37			A=0.53 ,	B=0.45 ,	AxB=0.90		

F.0=Control — ***C.t. =Cyamopsis tetragonolobe*** — ***A= Winter forage grasses***
F.1=Fertilization low — ***V.s. =Vigna sinensis*** — ***B= Fertilization levels***
F.2=Fertilization medium — ***P.t. =Pennisetum typhoides*** — ***A×B = Winter forage × Fertilization levels***
F.3=Fertilization high — ***S.b. =Sorghum bicolor***
H.v. =Hordeum vulgare
T.a. =Trifolium alexandrinum

In addition to the results in table (9) showed that, the plants (*Hordeum vulgare* grown after *Cyamopsis tetragonolobe* and *Vigna sinensis* as well as *Trifolium alexandrinum* grown after *Pennisetum typhoides* and *Sorghum bicolor*) and fertilized at the three rates under study. There was no increase in the percentage of total carbohydrate content compared to control during the two study seasons (2018/2019 & 2019/2020), this trend was true in the three cuts in the two seasons, the other treatments occupied on intermediate position between the abovementioned treatments in the two seasons. These results were in agreement with **Awasthi and Suraj (1983)** on barley**, Dwivedi *et.al.*, (2021)** on barley and **Muhammad *et.al.*, (2021)** on clover.

Conclusion

Results showed, a clear superiority of the applied treatment with a high levels of combined fertilizer (90:60:30 kg NPK/fed.) for all summer and winter forage grasses in the characteristics of the contents of fresh and dry forage crop ton/fed. during the two growing seasons with some minor differences, the increase was significant with successive leguminous forage grasses after forage grasses compared to cultivation of forage grasses after leguminous forage crops with the use of a high rate of complete fertilizer of (N:P:K).

Results also showed the superiority of the same treatment in the parameters of the chemical content of the forage (the percentage of protein and carbohydrate content).

Results were in agreement with **Awasthi and Suraj (1983)** on barley, **Lal and Shaik (2000)** on sudan grass, **Abd El-Aziz (2002)** on pearl millet, **Ammaji and Suryamarayoma (2003)** on sudan grass, **Ronald and Robert (2005)** on sudan grass, **Ayub et.al., (2009)** on pearl millet, **Sajid et.al., (2009)** on guar, **Obeng *et.al.*, (2012)** on pearl millet and **Hamdan and Fezaa (2017)** on sudan grass, **Zaghloul *et.al.*, (2017)** on cowpea, **Dwivedi *et.al.*, (2021)** on barley and **Muhammad *et.al.*, (2021)** on berseem.

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التقييم الكمي والنوعي لمحاصيل العلف الحولية المتعاقبة في جميع الأنماط لبعض العشبيات العلفية الصيفية والشتوية مع مستويات التسميد المختلفة

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أقيمت تجربة بحثيه بمزرعة البحوث والتجارب الزراعية بكلية الزراعة بمشتهر – جامعة بنها – محافظة القليوبية – مصر لدراسة نظام تعاقب بعض العشبيات العلفية الصيفية والشتوية وكذلك تركيزات من السماد الكامل (N:P:K) وتأثير ذلك علي المحصول والمحتوي الكيماوي وذلك خلال موسمي الزراعة (2020/2019&2019/2018).

شملت الدراسة نباتات العلف الصيفية التالية (الجوار – لوبيا العلف – الدخن – حشيشة السودان) ونباتات العلف الشتوية التالية (البرسيم المصري – الشعير) كما شملت علي أربع مستويات من السماد الكامل (بدون تسميد (كنترول) – مستوي منخفض (30:20:10 كجم NPK/فدان) – مستوي متوسط (60:40:20 كجم NPK/فدان) – مستوي مرتفع (90:60:30 كجم NPK/فدان)) في تصميم قطعه منشقة مره واحدة بحيث وزعت العشبيات العلفية الصيفية والشتوية في القطع الرئيسية ووزعت معاملات التسميد الكامل في القطع الفرعية في ثلاث مكررات.

أظهرت النتائج:

تفوق واضح للمعاملة بمستوي التسميد الكامل المرتفع (90:60:30 كجم NPK/فدان) لجميع العشبيات العلفية الصيفية والشتوية في صفات كمية المحصول العلفي الطازج والجاف طن/فدان خلال موسمي الزراعة مع بعض الفروق البسيطة وكانت الزيادة معنويه مع العشبيات العلفية البقولية المتعاقبة بعد العشبيات العلفية النجيلية بالمقارنة بزراعة العشبيات العلفية النجيلية بعد المحاصيل العلفية البقولية مع إستخدام المستوي المرتفع من التسميد الكامل من (N:P:K).

كما أظهرت النتائج تفوق نفس المعاملة في قراءات المحتوي الكيماوي للعلف (نسبة محتوي البروتين والكربوهيدرات) الناتج من العشبيات تحت الدراسة مقارنة بالكنترول ولم ترقي هذه الزيادات إلي مستوي المعنوية في محتوي النباتات من الكربوهيدرات.

خلصت النتائج إلي التوصية بزراعة المحاصيل العلفية البقولية بعد المحاصيل العلفية النجيلية مع إستخدام مستوي تسميد كامل مرتفع (90:60:30 كجم NPK/فدان) وذلك للحصول علي أعلي إنتاجية ومحتوي كيماوي للعشبيات العلفية وتعظيم الإستفاده منها كأعلاف حيوانية لتقليل الفجوه العلفية.