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Qualitative traits of various Egyptian clover varieties under efficiency of bio-chemical phosphorus fertilization and lithovit regimes

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Abstract. This investigation was performed at the Agriculture Research Station, Faculty of Agric. Zagazig Univ., Sharkia Governorate, Egypt, throughout the winter seasons of 2019/2020 and 2020/2021. The study aimed to evaluate the influence of ten bio-chemical fertilization and lithovit regimes on forage quality of 1st and 3rd cuts of various Egyptian clover varieties (Berseem, *Trifolium alexandrinum* L.) q.e. Helaly, Gemmeza 1, Sakha 4, Serw 1, Giza 6 and local variety. The ten fertilization regimes were F_1, control; F_2, chemical phosphorus 15.5 P_2O_5 kg fad^{-1}; F_3, bio-phosphorus fertilizer 'phosphorein'; F_4, 50% of F_2 + phosphorein; F_5, 25% of F_2 + phosphorien; F_6, F_2 + lithovit; F_7, F_3 + lithovit; F_8, F_4 + lithovit; F_9, F_5 + lihtovit; F_{10}, sole lithovit. Giza 6 Egyptian berseem variety ranked first in forage quality because of its high content of each CP (%), NFE (%), TDN (%), and DP (%) in the 3rd cut. The local berseem variety ranked the least over the six Egyptian clover varieties with the highest ash (%) in the 1st cut. Other varieties were in between. Allusion to the bio-chemical phosphorus fertilization and lithovit regimes, application of any phosphorus fertilization regimes surpassed the control treatment in most nutritive values. Application of F_9 fertilization regime (25% chemical P + bio-fertilizer 'phosphorien' + nano-fertilizer 'lithovit') tended to produce high forage quality with high content of CP (%) in the 1st cut, TDN (%) in both 1st and 3rd cuts as well as DP (%) in the 1st cut.

Key words: Egyptian clover, fertilizer, phosphorus, lithovit, quality.

List of abbreviations: CP (%) is crude protein content, CF (%) is crude fiber content, EE (%) is ether extract content, NFE (%) is nitrogen free extract content, TDN (%) is total digestible nutrients, and DP (%) is digestible protein.

INTRODUCTION

Genus *Trifolium* belongs to the Leguminosae family, it contains about 240 species. White clover (*T. repen*), Red clover (*T. pratense* L.), Alsike clover (*T. hybridum* L.), and Egyptian clover (*T. alexandrinum* L.) are the most important species (Zayed et al., 2012).

Egyptian clover is of great moment forage crop, and inshore is cultivated as a winter annual forage crop in many countries e.g., Egypt, India, Pakistan, Turkey, and Mediterranean countries. The distinction of the crop ascribed to its multi-cut nature, long duration of green fodder availability, and above all its high yield as well as good quality, palatability, and digestibility (Malaviya et al., 2005; Roy et al., 2005; Zayed et al., 2011).

Egyptian clover 'Berseem' is the main widely cultivated multi-cut winter leguminous forage crop in Egypt. Berseem is the main added value in the Egyptian economy, the cycle of berseem capital equals tens billions of American dollars. More and above berseem crop is the guard on Egyptian soil fertility. Berseem is the Arabic and Coptic word, it grows since 6,000 years BC in Egypt (Tarrad & Zayed, 2009; Zayed, 2013). Berseem is a multi-cut leguminous fodder crop and fixes atmospheric 'N' in the soil which is valued as much as (33–66 N ha^{-1}) for the following crops (Knight, 1985; Williams et al., 1990; Govindasamy et al., 2021).

Forage quality is determined pointedly by its content of various nutrients such as minerals, Protein components, Crude fiber, etc. Forage content of mineral and nutritional components varied respecting various and many factors such as fertilization regimes (Türk et al., 2007; Seif & Saad, 2014), Soil properties, and different environmental variables (Kulik, 2009). Berseem is highly nutritive forage crop, contains 14.9–28.3% crude fiber (CF), 15.8–26.7% crude protein (CP), 1.4–3.0% ether extract (EE), 1.4–2.58% calcium and 2.22–2.46% phosphorus (Mohsen et al., 2011b).

Raising levels of phosphorus fertilizers tended to decrease berseem contents of both dry matter (DM) and Nitrogen Free Extract (NFE), while crude protein (CP), crude fiber (CF), ether extract (EE), ash, and Phosphorus content (P) were increased due to increasing phosphorus fertilizer levels (Mohsen et al., 2011a; Seif & Saad, 2014). Roy et al. (2015) attested that increasing phosphorus level from 40 to 80 kg P_2O_5 ha^{-1} gradually increased crude protein (%), crude protein yield, dry matter (%), ether extract, and nitrogen free extract (NFE).

Phosphorus (P) after nitrogen, is the second major nutrient deficient in Egyptian soils. Phosphorus displays a dogmatic role in photosynthesis, as well phosphorus is of great moment in the synthesis of proteins, lipids, nucleic acids, and various important compounds (Ayub et al., 2013; Khattab et al., 2019). Phosphorus fertilization is more important for leguminous field crops than nitrogenous fertilization, nutrient movement within the plant and energy transport as well as the transfer of genetic characters to the following generation are controlled by phosphorus (Abdelsalam & El-Sanatawy, 2022). Phosphorus displays a dogmatic role in legume seedling establishing its roots and shoots (Fathy, 2014).

Phosphorus in soil solution is the immediate source of plant-available P (Holford, 1989), but Phosphorus solubility is inhibited due to the existence of alumunium and iron in acidic soils and calcium in alkaline and neutral soils (Ponmurugan & Gopi, 2006). According to Hamid & Sarwar (1977), the crop uses only about 15–33% of the supplied chemical phosphorus.

The usage of bio-fertilizers is a critical component to crop production in sustainable farming systems (Canbolat et al., 2006). Bio-fertilizers include many types of free-living microorganisms that convert nutrients from unavailable forms through some biological processes which enhance plant growth, development, and productivity (Chaichi et al., 2015). There is a noteworthy and momentary trend to replace chemical fertilizers with eco-friendly biofertilizers. The practice of microbial inoculation became popular and of great moment globally ascribed to being simple to use and safe for the environment. Phosphorus unavailability is the imperative factor limiting crop yield. Phosphorus availability increase through the usage of phosphate solubilizing bacteria (PSB), and it may enhance berseem forage yield and quality (Roy et al., 2015). Phosphate solubilizing bacteria (PSB) produce some organic acids such as succinate, oxalate, lactate, citrate, etc., in the soil that decrease the pH and thus solubilize calcium phosphate complexes. Because of these organic acids, PO_4^{-2} is exchanged by acid anion or is chelated and becomes dissolved and available mineral phosphate (Bajpal & Rao, 1971).

Lithovit (manufactured by Zeovita- GmbH, Berlin, Germany) and quantitatively analyzed by Wichmann & Basler (2006), Wedad Kasim et al. (2020), is the first CO_2 foliar nano-fertilizer that can be used successfully outdoors as well as under glass. It consists of calcium carbonate [($CaCO_3$), 80%] supplemented by numerous important micro-nutrients. Most lithovit particles are so small (< 10 µm) that they can be absorbed directly through the stomata of the plant's foliage. In leaves stomata, calcium carbonate decomposes to calcium oxide (CaO) and carbon dioxide (CO_2), this CO_2 increases the photosynthesis process causing an increase in carbon uptake and assimilation, thereby promoting plant growth and productivity (Carmen et al., 2014; Abdelkader et al., 2018; Mostafa, 2019).

The aim of the study

The study aims to investigate the interactive impacts of bio-chemical phosphorus fertilization and lithovit regimes on the forage quality of some Egyptian clover (Berseem) varieties.

MATERIALS AND METHODS

The study was conducted in a bare field at the Agricultural Research Farm, Faculty of Agriculture, Zagazig University, Zagazig District, Sharkia Governorate, Egypt (Lat. 30°34'59.3" N, long 31°31'03.3" E, 9 m above the sea level) during two consecutive winter growing seasons(2019/2020; 2020/2021) to investigate the impact of bio-chemical phosphorus fertilization and lithovit regimes on forage quality of various Egyptian clover varieties (Berseem, *Trifolium alexandrinum* L.). Certified seeds of the investigated varieties q.e. Helaly, Gemmeza 1, Sakha 4, Serw 1, and Giza 6 were obtained kindly from the production unit, Agriculture Research Center, Giza, Egypt. Mixture of *Rhizobium trifolii* with sand was broadcasted and incorporated with the field soil before planting for promoting N fixation. A local variety commonly planted by farmers was also studied. Seeds were broadcasted in 2×5 m plots (10 m^2) with a seeding rate of 20 kg fad^{-1} (fad. = 4,200 m^2).

Bio-chemical phosphorus fertilization and lithovit treatments included sole chemical phosphorus fertilization and sole biological fertilization (Phosphorien) as well as bio-chemical fertilization in addition to lithovit foliar application. The ten fertilization regimes were (F_1–F_{10}) as follows:

F_1, control; F_2, chemical phosphorus, 15.5 kg P_2O_5 fad^{-1}; F_3, bio- phosphorus fertilizer 'Phosphorien'; F_4, 50% of F_2 + Phosphorien; F_5, 25% of F_2 + Phophorien; F_6, F_2 + litovit; F_7, F_3 + litovit; F_8, F_4 + lithovit; F_9, F_5 + lithovit; F_{10}, sole lithovit.

Fertilizers used

Calcium superphosphate (15.5% P_2O_5) as a chemical phosphorus fertilizer was supplied at sowing, the amounts of the commercial fertilizer were calculated according to each phosphorus level in the fertilization regimes F_2, F_4, F_5, F_6, F_8, and F_9. The biofertilizer 'phosphorien' is phosphate dissolving bacteria (*Bacillus megatherium* var. *phosphaticum*) commercially produced by the General Organization for the Agricultural Equalization Fund (GOAEF), Ministry of Agriculture, Egypt. Phosphorien was used at the rate of 600 g seeds per fad. to detect the fertilization regimes F_3, F_4, F_5, F_7, F_8, and F_9. Inoculation by phosphorien was done by mixing with berseem seeds using Arabic gum 5% as an adhesive substance, just before sowing. Berseem plants were sprayed with the aqueous solution of the nano-fertilizer Lithovit (100 g L^{-1} tap water) using hand operated compress air sprayer. Welting agent Kinzo (100 cm^3 20 L^{-1} tap water) was applied with the spraying solution. Lithovit application was done in the fertilization regimes F_6, F_7, F_8, F_9, and F_{10}. Lithovit foliar spray was applied 30 days after sowing, then after 15 days from each cut at the same rate. It is worth noting that, the weather was not rainy for many days after lithovit foliar spray application. Rains in Egypt is drizzling during the winter season.

The experiment included three replicates in a split-plot design in both seasons. Berseem varieties were allotted to the main plots, the ten regimes of bio-chemical phosphorus fertilization and lithovit were assigned to the sub-plots. A composite soil sample up to 30 cm depth was used for physical and chemical analyses. The soil texture of the experimental site was sandy loam. Fodder maize was the preceding summer crop in both seasons. Egyptian clover varieties were sown on 4th and 7th November in the first and second seasons, respectively, surface flood irrigation system was used.

Four cuts were taken each season, the first cut was attained 65 days post planting date, 50 days later, the second cut was achieved, the third cut was done 40 days after the second one, finely the fourth cut was obtained 30 days later to the third one. A representative subsample of approximately 0.5 kg of the whole plant material per plot in the 1st and 3rd cuts of the two seasons were oven dried at 70 °C for 72 hr. The dried subsamples were ground, bagged, and stored until analyzing and determining quality parameters. Crude protein (CP), crude fiber (CF), ether extract (EE), and ash were determined according to the Association of the Official Analytical Chemist (AOAC, 1995). Nitrogen free extract (NFE) was calculated as follows, NFE = 100 - (CP% + CF% + EE% + Ash%), total digestible nutrients (TDN) was calculated according to Adams et al. (1964) using the equation, TDN = 74.43 + 0.35 CP% - 0.73 CF%, digestible protein (DP) content was calculated according to the following equation, DP (%) = 0.9596 CP - 3.55 (Bredon et al., 1963). Chemical analyses were conducted and presented on a dry matter basis. Data were analyzed by analysis of variance based on split plot design according to the procedures outlined by Snedecor & Cochran (1990). Homogeneity of variance between the two growing seasons was tested using bartellet's test (Steel et al., 1997) which revealed insignificant variation, for all investigated traits; thus data of the two seasons were presented and discussed in a combined analysis. Mean comparing was done using the least significant differences (LSD) at 1 and 5% probability levels according to Duncan (1955). In the interaction tables, capital and small alphabet were used for mean comparison in rows and columns, respectively.

RESULTS AND DISCUSSION

Worthy to be noted that chemical analyses were conducted for the first and third cuts in both growing seasons. Withal, the chemical constituents for the whole plant material of the various berseem varieties were analyzed and presented on a dry matter basis.

Crude Protein Content (CP, %)

Results outlined in Table (1) clear that crude protein content (CP, %) recorded significant variation among the Egyptian clover varieties in both the 1st and 3rd cuts. According to the descending ranking order, CP (%) in the 1st cut valued as much as 25.54, 24.76, 24.60, 24.41, 24.25, and 22.72%, for Sakha 4, Helaly, Serw 1, Gemmeza 1, Giza 6 and the local variety, respectively. In the 3rd cut, there was diverse ranking order concerning the varietal content of CP as follows; 21.71, 21.65, 21.13, 20.97, 20.67, and 20.22% for Egyptian clover varieties Giza 6, local, Gemmeza 1, Sakha 4, Helaly and Serw 1, in respective order. In the 1st cut, Sakha 4 had the highest CP content with a slight significant magnitude. Diverse results were noted in the 3rd cut, wherein, Giza 6 clover variety recorded the highest content of crude protein while the lowest content of CP was recorded by serw 1 clover variety. Varietal differences in the crude protein content of Egyptian clover were also corroborated by Lannucci (2001), De Santis et al. (2004), Mohsen et al. (2011a; 2011b), Seif & Saad (2014) and Salama et al. (2020). The variation in CP content among the tested varieties may be ascribed to the slight differences in their specific genetical makeup and their response to the environment.

Allusion to the crude protein content of berseem varieties for the earlier than the later cuts results in Table (1) asserted that the 1st cut has a relatively high CP content than the 3rd cut for all Egyptian clover varieties under study. The average value of CP over the 6 varieties in the 1st cut was 24.38% vs 21.06 in the 3rd cut. This suggestion matched well with that of Mohsen et al. (2011b), Seif & Saad (2014), Bakhoum et al. (2016). Such findings are more appropriate along more leafy plants alongside shorter stems of higher biophysiological activities forming more crude protein for earlier than the later cuts. More and above, the later cuts are accompanied by a relatively warmer environment and its limited assimilation rate causing decreases in CP content.

Effective and significant impact of the bio-chemical phosphorus fertilization and lithovit regimes on CP (%) was appreciable in 1st and 3rd cuts (Table 1). In the first cut, the highest CP (%) was achieved when the F_9 regime was applied. Fertilization regime F_9 comprised bio P-fertilizer phosphorien and the nano-fertilizer lithovit in addition to 25% of the recommended chemical P fertilizer. In the 3rd cut, the highest CP (%) in Egyptian clover was attained due to the application of the F_5 regime which included duality of 25% of the recommended P chemical fertilizer and the bio-fertilizer 'phosphorien' (Phosphorus solubilizing bacteria, PSB). In both cuts, application of either sole chemical P with the recommended level (15.5 kg P_2O_5 fad^{-1}) i.e. F_2 regime, or application of sole chemical P (recommended level) accompanied with foliar spray of the nano-fertilizer lithovit (F_6) resulted in the lowest CP content (23.28, 22.98 in the first cut; 19.86, 20.03 in the 3rd cut) in the same respective order. Crude protein is distinctly diverse between the 1st and 3rd cuts, wherein the early cut has higher CP (%) than the latter one. Seif & Saad (2014) purported that increasing phosphorus levels from the control to 22.5 and 45 kg P_2O_5 fad^{-1} caused a significant increase in leaves CP content (over 5 Egyptian clover varieties). Roy et al. (2015) avowed that Phosphate Solubilizing Bacteria (PSB) inoculation increased CP (%) of berseem compared to uninoculated treatment. They also added that raising the chemical P fertilizer level from 40 kg P_2O_5 ha^{-1} to 80 kg ha^{-1}, gradually increased the crude protein content of berseem. Obtained results go along with those of Türk et al. (2007), Mohsen et al. (2011a), and Chaichi et al. (2015) on Egyptian clover.

Table 1. Varietal differences as well as bio-chemical phosphorus fertilization and lithovit regimes effect on crud protein (CP, %), Crude fiber (CF, %) and ether extract (EE, %) of Egyptian clover varieties

Main effects and interaction	CP (%)		CF (%)		EE (%)	
	Combined		Combined		Combined	
	1st cut	3rd cut	1st cut	3rd cut	1st cut	3rd cut
	Egyptian clover variety (V)					
Helaly	24.76 b	20.67 e	28.61 a	27.72 b	1.46 f	2.87 d
Gemmeza 1	24.41 d	21.13 c	24.59 f	26.58 d	2.29 b	3.13 a
Sakha 4	25.54 a	20.97 d	26.26 b	27.04 c	1.69 c	2.93 c
Serw 1	24.60 c	20.22 f	26.13 c	28.66 a	2.32 a	1.97 f
Giza 6	24.25 e	21.71 a	25.58 d	24.78 f	1.57 e	2.53 e
Local	22.72 f	21.65 b	25.25 e	26.00 e	1.64 d	3.01 b
F-test	**	**	**	**	**	**
	Bio-chemical phosphorus fertilization and lithovit regime (F)					
F_1	25.10 c	20.14 h	27.13 b	26.90 d	2.46 a	2.93 c
F_2	23.28 i	19.86 j	26.34 d	26.28 g	1.77 d	2.56 g
F_3	24.75 d	20.97 g	28.74 a	26.60 f	1.71 f	2.71 e
F_4	23.48 h	21.33 e	26.36 c	25.69 i	1.60 i	2.49 h
F_5	23.58 g	22.38 a	26.11 e	28.75 a	2.03 b	2.58 f
F_6	22.98 j	20.03 i	24.19 j	28.50 b	1.87 c	2.96 b
F_7	24.07 f	21.18 f	25.38 h	26.72 e	1.71 g	2.80 d
F_8	24.22 e	21.52 c	25.92 f	27.14 c	1.70 h	2.96 b
F_9	27.17 a	21.44 d	25.72 g	25.41 j	1.73 e	2.34 i
F_{10}	25.16 b	21.72 b	24.81 i	25.98 h	1.71 g	3.04 a
F-test	**	**	**	**	**	**
Interaction						
V×F	**	**	**	**	**	**

F_1 control; F_2 chemical P 15.5 kg P_2O_5 fad^{-1}; F_3 bio-fertilizer phosphorien; F_4 50% chemical P + bio (phosphorien); F_5 25% chemical p + bio (phosphorien); F_6 chemical P 15.5 kg P_2O_5 fad^{-1} + lithovit; F_7 Phosphorien + lithovit; F_8 50% chemical P + bio (phosphorien) + lithovit; F_9 25% chemical P + bio (phosphorien) + lithovit; F_{10} Lithovit (foliar).

The interaction between Egyptian clover varieties and fertilization regimes acted significantly on crude protein content (CP, %) of the first and third cuts (Tables 1-A; 1-B), respectively. Allusion to the 1st cut, each of Helaly and the local variety of Egyptian clover produced the highest CP (%) under sole bio-fertilizer 'phosphorien' i.e. the under F_3 fertilization regime. Berseem variety 'Serw 1' has the highest CP (%) under F_4 fertilization regime (50% chemical P + phoaphorien). Each of Gemmeza 1, Sakha 4 and Giza 6 Egyptian clover varieties produced the highest CP (%) under fertilization regime F_9 which included 25% of the recommended P level + bio-fertilizer 'phosphorein' + the nano fertilizer foliar spray 'lithovit'. The highest CP (%) content (29.7%) was the resultant of the interaction effect between Giza 6 berseem variety and fertilization regime F_9. The lowest value of CP (%) (19.31%) was obtained under the interaction between Giza 6 berseem variety and fertilization regime F_6 (chemical P 15.5 kg P_2O_5 fad^{-1} + lithovit). In respect to the third cut, each of the following highest CP (%) 24.61, 26.48, 22.95, 23.31, 24.72, and 23.38% was the resultant of the following interactions, Helaly × F_{10}, Gemmeza 1 × F_5, Sakha 4 × F_2, Serw 1 × F_{10}, Giza 6 × F_9 and local variety × F_6, in the same order. The highest (26.48%) and the lowest CP (%) (14.39%) were obtained under the interaction effect of Gemmeza 1 berseem variety × F_5, and Serw 1 × F_2, respectively. Seif & Saad (2014) reported the interaction effect for berseem varieties and the supplied phosphorus fertilizer levels on CP (%) of leaves, were significant. They added that the highest leaf CP content (19.45%) was the resultant of the interaction effect between berseem variety Gemmeza 1 and phosphorus level 45 kg P_2O_5 fad^{-1}, while Giza 6 variety produced the lowest CP content (10.94%) under phosphorus deficiency in the control treatment. Analogues findings were noted by Roy et al. (2015) as well as Ismail & Hassanen (2019).

Table 1-A. Interaction effect between Egyptian clover varieties and bio-chemical phosphorus fertilization and lithovit regimes on crude protein content (CP, %) of the first cut

	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}
Helaly	F	I	E	B	C	J	H	D	G	A
	20.66 c	19.46 d	20.84 d	22.15 b	21.47 d	16.01 f	19.99 e	21.00 e	20.47 e	24.61 a
Gemmeza 1	J	B	I	C	A	H	F	D	E	G
	17.97 e	22.72 b	18.97 f	22.44 a	26.48 a	19.98 d	20.73 d	21.05 d	20.80 d	20.14 e
Sakha 4	I	A	B	H	F	C	E	B	G	D
	17.33 f	22.95 a	21.77 a	20.04 f	21.22 e	21.53 c	21.28 c	21.77 c	20.31 f	21.50 d
Serw 1	G	J	E	C	F	B	I	H	D	A
	20.32 d	14.39 f	20.78 e	21.11 d	20.53 f	21.54 b	19.01 f	20.11 f	21.06 c	23.34 b
Giza 6	G	I	E	H	D	J	B	C	A	F
	21.37b	19.25 e	21.76 b	20.99 e	22.45 b	17.75 e	23.76 a	23.37 a	24.72 a	21.69 c
Local	B	I	F	H	D	A	C	E	G	J
	23.16 a	20.41 c	21.72 c	21.27 c	22.12 c	23.38 a	22.27 b	21.81 b	21.30 b	19.01 f

F_1 control; F_2 chemical P 15.5 kg P_2O_5 fad^{-1}; F_3 bio-fertilizer phosphorien; F_4 50% chemical P + bio (phosphorien); F_5 25% chemical p + bio (phosphorien); F_6 chemical P 15.5 kg P_2O_5 fad^{-1} + lithovit; F_7 Phosphorien + lithovit; F_8 50% chemical P + bio (phosphorien) + lithovit; F_9 25% chemical P + bio (phosphorien) + lithovit; F_{10} Lithovit (foliar).

Crude fiber content (CF, %)

The Egyptian clover (berseem) varieties under study displayed significant variation in their crude fiber content (CF, %) in first and third cuts as compiled in Table (1). In the 1st cut, Helaly variety has the highest content of crude fiber (28.61) followed by Sakha 4 berseem variety, while Gemmeza 1 variety was the lowest (24.59). Conflicting results were observed in the 3rd cut, wherein Serw 1 berseem variety ranked first in CF (%) and valued about 28.66%, Helaly placed in the second rank (27.72) with an operative difference. The berseem variety Giza 6 has the lowest crude fiber content (24.78%). The average value of crude fiber content tended to increase slightly from 1st to 3rd cut (26.07 to 26.80) Bakhoum et al. (2016) alluded to the gradual increase of crude fiber content from 1st cut to 3rd cut of the Egyptian clover. Seif & Saad (2014) highlighted that crude fiber content varied significantly among five Egyptian clover varieties. They added that CF (%) of the fourth cut was relatively higher than the second cut. Varietal variation in crude fiber content may be ascribed to the slight differences in their genetic specific and/ or their interaction with the environmental seasonal condition.

Table 1-B. Interaction effect between Egyptian clover varieties and bio-chemical phosphorus fertilization and lithovit regimes on crude protein content (CP, %) of the third cut

	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}
Helaly	B 26.27 a	I 23.03 e	A 27.34 a	E 24.80 b	G 24.07 c	J 22.28 e	F 24.62 b	H 23.34 e	D 25.79 d	C 26.10 c
Gemmeza 1	D 24.80 d	E 24.63 a	C 25.05 c	I 23.26 d	J 20.22 f	G 23.76 c	H 23.57 d	B 25.22b	A 29.34 b	F 24.18 d
Sakha 4	E 25.94 c	H 23.26 c	G 24.17 d	J 20.52 f	C 27.87 a	F 25.76 a	I 22.92 f	B 28.80 a	A 29.24 c	D 26.95 b
Serw 1	B 26.18 b	E 24.57 b	J 22.65 f	A 27.17 a	F 24.15 b	H 23.81 b	D 24.59 c	I 23.55 d	C 25.26 e	G 24.01 e
Giza 6	G 23.21 f	H 23.06 d	F 23.22 e	E 23.98 c	I 22.75 d	J 19.31 f	C 25.47 a	D 24.58 c	A 29.47 a	B 27.45 a
Local	B 24.18 e	I 21.11 f	A 26.07 b	H 21.16 e	F 22.42 e	E 22.93 d	D 23.25 e	J 19.81 f	C 23.94 f	G 22.28 f

F_1 control; F_2 chemical P 15.5 kg P_2O_5 fad^{-1}; F_3 bio-fertilizer phosphorien; F_4 50% chemical P + bio (phosphorien); F_5 25% chemical p + bio (phosphorien); F_6 chemical P 15.5 kg P_2O_5 fad^{-1} + lithovit; F_7 Phosphorien + lithovit; F_8 50% chemical P + bio (phosphorien) + lithovit; F_9 25% chemical P + bio (phosphorien) + lithovit; F_{10} Lithovit (foliar).

The bio-chemical phosphorus fertilization and lithovit regimes influenced significantly the crude fiber content of the 1st and 3rd cuts of the Egyptian clover variety. The highest CF (%) in the 1st cut (28.74%) was the resultant of the fertilization regime F_3 i.e. under sole phosphorus bio-fertilizer 'phosphorien'. The fertilization regime F_{10} comprised a sole foliar spray of nano-fertilizer lithovit lessen crude fiber content to the lowest value (24.81%). Regarding the 3rd cut, crude fiber content ranged between 25.41% to 28.75%. Seif & Saad (2014) in Egypt deposed that increasing levels of phosphorus fertilizer applied caused a slight nidgin increase in the crude fiber content of five Egyptian clover varieties. Fertilization treatment comprised dual application of PSD and 80 kg P_2O_5 ha produced the lowest crude fiber (20.08) as ratified by Roy et al. (2015) who worked on Egyptian clover in India.

The crude fiber content (CF, %) of the first cut was significantly influenced by the interaction between the fertilization regimes and the Egyptian clover varieties (Table 1-C). Each of the following interactions has the highest CF (%); Helaly variety × F_5, Gemmeza 1 × F_1, Sakha 4 × F_3, Serw 1 × F_3, Giza 6 × F_9, and the local variety × F_4. Under five out of the ten fertilization regimes i.e., F_1, F_4, F_5, F_6, and F_7; Helaly berseem variety was superior in CF (%). Sakha 4 outclassed the other varieties under fertilization regimes F_2 and F_3, Giza 6 berseem variety produced the highest CF (%) under each of F_8, F_9, and F_{10} fertilization regimes. The uppermost crude fiber content (34.98%) has been observed under the interaction effect between berseem variety 'Helaly' and F_5 fertilization regime, whereas the lowermost CF (%) amounted to 20.80% was the resultant of the interaction between Giza 6 berseem variety and the sole chemical P fertilization (15.5 kg P_2O_5 fad^{-1}).

Table 1-C. Interaction effect between Egyptian clover varieties and bio-chemical phosphorus fertilization and lithovit regimes on crude fiber content (CF, %) of the first cut

	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}
Helaly	C 29.53 b	D 28.91 a	A 31.31 a	E 27.98 b	B 30.53 b	G 26.48 d	H 26.43 c	F 26.78 c	J 24.56 d	I 24.68 f
Gemmeza 1	I 25.07 e	H 25.33 e	J 23.95 f	B 28.91 a	D 26.65 e	E 26.44 e	F 26.27 d	A 29.28 b	C 27.70 b	G 26.22 d
Sakha 4	F 27.04 c	C 27.72 b	E 27.51 b	H 26.52 d	A 28.82 c	D 27.65 c	B 28.75 b	I 26.21 d	J 23.46 e	G 26.73 b
Serw 1	J 21.62 f	I 23.04 f	G 27.00 c	F 27.28 c	E 28.80 d	A 34.80 a	C 34.07 a	B 34.35 a	D 30.57 a	H 25.06 e
Giza 6	A 32.41 a	B 26.66 c	E 24.08 e	H 22.24 e	J 21.77 f	F 23.91 f	I 22.17 f	G 23.12 e	D 25.08 c	C 26.36 c
Local	F 25.70 d	D 26.03 d	E 25.78 d	I 21.23 f	A 35.92 a	B 31.71 b	H 22.63 e	G 23.10 f	J 21.12 f	C 26.81 a

F_1 control; F_2 chemical P 15.5 kg P_2O_5 fad^{-1}; F_3 bio-fertilizer phosphorien; F_4 50% chemical P + bio (phosphorien); F_5 25% chemical p + bio (phosphorien); F_6 chemical P 15.5 kg P_2O_5 fad^{-1} + lithovit; F_7 Phosphorien + lithovit; F_8 50% chemical P + bio (phosphorien) + lithovit; F_9 25% chemical P + bio (phosphorien) + lithovit; F_{10} Lithovit (foliar).

Table 1-D. Interaction effect between Egyptian clover varieties and bio-chemical phosphorus fertilization and lithovit regimes on crude fiber content (CF, %) of the third cut

	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}
Helaly	D 29.47 a	F 27.68 c	E 29.33 c	B 31.16 a	A 34.98 a	I 25.72 a	C 29.83 a	H 27.06 b	G 27.59 b	J 23.31 e
Gemmeza 1	A 28.57 b	I 22.57 e	G 24.03 f	22.30 f	F 24.38 c	B 25.65 b	H 23.40 f	E 24.51 e	D 25.09 c	C 25.37 b
Sakha 4	D 25.36 e	B 32.30 a	A 34.49 a	C 30.62 b	G 23.14 e	J 22.35 e	F 23.65 d	H 23.08 f	I 22.71 f	E 24.88 c
Serw 1	C 27.33 d	B 31.15 b	A 33.68b	I 22.51 e	H 22.57 f	J 22.13 f	D 27.16 b	E 26.11 d	G 23.82 e	F 24.86 d
Giza 6	C 27.56 c	J 20.80 f	E 25.40 e	I 23.20 d	H 23.40 d	F 25.06 c	G 24.73 c	B 28.12 a	A 30.36 a	D 27.15 a
Local	F 24.51 f	H 23.53 d	D 25.50 d	A 28.40 c	B 28.17 b	G 24.21 d	I 23.51 e	C 26.65 c	E 24.75 d	J 23.29 f

F_1 control; F_2 chemical P 15.5 kg P_2O_5 fad^{-1}; F_3 bio-fertilizer phosphorien; F_4 50% chemical P + bio (phosphorien); F_5 25% chemical p + bio (phosphorien); F_6 chemical P 15.5 kg P_2O_5 fad^{-1} + lithovit; F_7 Phosphorien + lithovit; F_8 50% chemical P + bio (phosphorien) + lithovit; F_9 25% chemical P + bio (phosphorien) + lithovit; F_{10} Lithovit (foliar).

The crude fiber content of the 3rd cut was affected significantly by the interaction between Egyptian clover varieties and the fertilization regimes of both bio-chemical phosphorus and lithovit (Table 1-D). Under F_1 fertilization regime, Giza 6 berseem variety ranked first in CF (%); under each of F_2 and F_3 fertilization regimes, Helaly berseem variety has the highest CF (%); under F_4 fertilization regime, Gemmeza 1 variety ranked first in CF (%), under each of F_5 and F_{10}, the highest CF (%) was obtained by the local berseem variety; while under each of F_6, F_7, F_8, and F_9 fertilization regimes, Serw 1 berseem variety has the ultra most value of crude fiber content. The uppermost value of crude fiber content (35.92%) was the resultant of the interaction of F_5 fertilization regime and the local berseem variety, while the lowest value of crude fiber content (21.12%) was achieved under the interaction of F_9 fertilization regime and the local berseem variety. Seif & Saad (2014) corroborated the significant interaction impact of the berseem varieties × phosphorus levels, their results indicated that each of the berseem varieties was differently affected by the phosphorus application level. They added that the berseem variety Sakha 4 produced the highest leaf CF content (32.35%) when fertilized with 45 kg P_2O_5 fad^{-1}.

Ether extract content (EE, %)

Varietal differences among the six Egyptian clover varieties concerning ether extract content were verified in both 1st and 3rd cuts (Table 1). Ether extract content recorded the highermost value (2.32%) in the 1st cut for the berseem variety 'Serw 1' while the lowermost EE, % (1.46%) was reported for the berseem variety 'Helaly' in the 1st cut. Diverse varietal differences in EE (%) of the 3rd cut were disclosed. The highest ether extract content value (3.13%) was observed in the berseem variety 'Gemmeza 1', while the lowest one (1.97%) was recorded in berseem variety 'Serw 1'. The average EE (%) value over the six berseem varieties increased from 1.83% in the 1st cut to 2.74% in the 3rd cut. These results resemble those ratified by Seif & Saad (2014), who pointed out that the highest EE content was for Helaly berseem variety, whereas the lowermost EE (%) was for Giza 6 berseem variety. They added that the 2nd cut was relatively higher in EE content than the 4th cut in each of the five Egyptian clover varieties studied. Bakhoum et al. (2016) deduced that ether extract content of 'Meskawy' Egyptian clover variety relatively decreased from 1st cut to the third one.

Application of various bio-chemical phosphorus fertilization and lithovit regimes caused significant variation in ether extract content of berseem (all over the six varieties) in the 1st and 3rd cuts as elucidated in Table 1. Ether extract was differently affected in 1st cut than the 3rd one by the bio-chemical phosphorus fertilization and lithovit regimes, wherein in the 1st cut the highest EE content (2.46) was obtained under control treatment, while the lowest EE content (1.60) was the resultant of application F_4 fertilization regime (50% chemical P + bio-fertilizer 'phosphorien'). Results of EE content in 3rd cut were differ from those of the 1st cut, wherein, the fertilization regime F_{10} (sole foliar application with lithovit) produced the highest content of EE content (3.04) and the fertilization regime F_9 (25% chemical P + bio-fertilizer 'phosphorien' + lithovit) produced the lowest EE content (2.34%). The increment of ether extract content of the 3rd cut over the 1st one was noted under each fertilization regime studied. Increasing EE content of Egyptian clover due to raising chemical phosphorus fertilizer levels was in place as previously confirmed by results of Mohsen et al. (2011a), Seif & Saad (2014), and Roy et al. (2015).

The interaction between the Egyptian clover varieties and the bio-chemical phosphorus fertilization and lithovit regimes was influential on EE content of both 1st and 3rd cuts (Tables 1-E; 1-F). In the 1st cut and under the control fertilization regime (F_1), the highest EE content was recorded for each of Gemmeza 1, Sakha 4, Serw 1, and the local berseem varieties. The highest EE content was also achieved under F_2 fertilization regime by Helaly berseem variety while under F_5 fertilization regime, Giza 6 berseem variety has the highest EE content. In the other direction, Gemmeza 1 berseem variety was supreme in EE content under each of F_1, F_2, F_6, and F_7 fertilization regimes. Withal, Serw 1 berseem variety outrank the other varieties in EE content under each of F_3, F_4, F_5, F_8, F_9, and F_{10} fertilization regimes. The utmost EE content value (3.05%) was obtained under the interaction impact of F_1 fertilization regime × Gemmeza 1 berseem variety. The lowermost EE content value (0.81%) was achieved under the impact of the interaction between F_4 fertilization regime and Giza 6 berseem variety. Oscillatory results were observed in the 3rd cut, wherein under the fertilization regimes F_1, F_2, F_3, F_4, F_6, and F_8, the highest EE content was achieved from Gemmeza 1, Serw 1, Helaly, Sakha 4, Giza 6 and the local variety, in the same respective order. In the other direction, Helaly berseem variety was superior in EE content under each of F_2 and F_3 fertilization regimes. Likely, Gemmeza 1 variety content of EE (%), surpassed the other varieties under F_1 and F_9 fertilization regimes, while Sakha 4 has the highest EE content under each of F_4, F_5, F_7, and F_{10} fertilization regimes. Giza 6 under F_6 as well as the local variety under F_8 fertilization regimes produced the highest EE content.

Table 1-E. Interaction effect between Egyptian clover varieties and bio-chemical phosphorus fertilization and lithovit regimes on ether extract (%) of the first cut

	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}
Helaly	B	A	G	F	F	D	C	E	H	I
	2.08 e	2.10 b	0.99 f	1.24 c	1.23 f	1.69 d	1.81 b	1.65 c	0.92 f	0.86 f
Gemmeza 1	A	B	H	C	F	B	D	I	E	G
	3.05 a	2.65 a	1.68 e	2.50 b	2.21 c	2.66 a	2.44 a	1.30 d	2.26 b	2.13 b
Sakha 4	A	I	D	G	B	F	J	C	E	H
	2.64 c	1.00 f	1.92 c	1.23 d	2.50 b	1.47 e	0.92 f	2.48 b	1.66 d	1.08 e
Serw 1	A	H	G	D	C	I	J	E	F	B
	2.97b	1.94 c	1.98 a	2.54 a	2.68 a	1.80 c	1.74 c	2.50 a	2.33 a	2.72 a
Giza 6	CD	CD	B	I	A	G	F	H	E	C
	1.75 f	1.76 d	1.96 b	0.81 e	1.99 d	1.37 f	1.65 e	1.00 f	1.69 c	1.76 c
Local	A	G	C	F	E	B	D	F	E	D
	2.27 d	1.17 e	1.75 d	1.24 c	1.55 e	2.23 b	1.69 d	1.25 e	1.54 e	1.69 d

F_1 control; F_2 chemical P 15.5 kg P_2O_5 fad^{-1}; F_3 bio-fertilizer phosphorien; F_4 50% chemical P + bio (phosphorien); F_5 25% chemical p + bio (phosphorien); F_6 chemical P 15.5 kg P_2O_5 fad^{-1} + lithovit; F_7 Phosphorien + lithovit; F_8 50% chemical P + bio (phosphorien) + lithovit; F_9 25% chemical P + bio (phosphorien) + lithovit; F_{10} Lithovit (foliar).

Table 1-F. Interaction effect between Egyptian clover varieties and bio-chemical phosphorus fertilization and lithovit regimes on ether extract (%) of the third cut

	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}
Helaly	D	B	A	H	G	C	F	J	I	E
	3.11 b	3.44 a	3.76 a	2.25 d	2.75 b	3.40 b	2.88c	1.86 f	2.20 d	3.04 c
Gemmeza 1	A	J	C	I	H	E	B	D	G	F
	4.06 a	2.16 e	3.56 c	2.57 c	2.61 e	3.04 d	3.93 b	3.46 b	2.91 a	2.96 d
Sakha 4	F	G	J	A	D	I	C	E	H	B
	2.57 e	2.50 c	1.23 f	4.16 a	3.36 a	2.32 f	3.95a	2.60 d	2.44 b	4.15 a
Serw 1	D	A	H	G	J	C	I	B	E	F
	2.39 f	2.68 b	1.44 e	1.61 e	1.32 f	2.43 e	1.39 f	2.57 e	2.15 e	1.67 f
Giza 6	C	I	E	J	D	A	G	B	H	F
	2.84 c	2.12 f	2.55 d	1.40 f	2.75 c	3.48 a	2.33 d	3.14 c	2.29 c	2.36 e
Local	G	H	C	E	F	D	I	A	J	B
	2.64 d	2.48 d	3.69 b	2.96 b	2.71 d	3.08 c	2.31 e	4.14 a	2.03 f	4.05 b

F_1 control; F_2 chemical P 15.5 kg P_2O_5 fad^{-1}; F_3 bio-fertilizer phosphorien; F_4 50% chemical P + bio (phosphorien); F_5 25% chemical p + bio (phosphorien); F_6 chemical P 15.5 kg P_2O_5 fad^{-1} + lithovit; F_7 Phosphorien + lithovit; F_8 50% chemical P + bio (phosphorien) + lithovit; F_9 25% chemical P + bio (phosphorien) + lithovit; F_{10} Lithovit (foliar).

Nitrogen Free Extract (NFE, %)

Table (2) expose the varietal differences and the impact of bio-chemical phosphorus fertilization and lithovit regimes on nitrogen free extract (NFE%) of Egyptian clover (1st and 3rd cuts). Results of the first cut exhibited that NFE (%) value ranged between 27.77% for Helaly berseem variety and 33.46% for Giza 6 berseem variety. The same trend was reaffirmed in the third cut, wherein, the highest NFE content (39.11%) was recorded by Giza 6 berseem variety, while the lowest NFE (%) value (35.16) was for Helaly berseem variety. Combined results clarified that the 3rd cut has higher content of nitrogen free extract than the 1st cut. Obtained results go along with those of Kulik (2009) as well as Seif & Saad (2014).

Table 2. Varietal differences as well as the bio-chemical phosphorus fertilization and lithovit regimes effect on nitrogen free extract (NFE, %), ash (%), and total digestible nutrients (TDN, %) of Egyptian clover varieties

Main effects and interactions	NFE (%)		Ash (%)		TDN (%)	
	Combined		Combined		Combined	
	1st cut	3rd cut	1st cut	3rd cut	1st cut	3rd cut
	Egyptian clover variety (V)					
Helaly	27.77 f	35.16 f	17.39 b	13.58 a	62.21 f	61.43 e
Gemmeza 1	32.30 c	36.79 c	16.42 e	12.38 d	65.02 a	62.42 c
Sakha 4	29.87e	36.47 e	16.64 d	12.59 b	64.20 c	62.03 d
Serw 1	30.15 d	36.68 d	16.80 c	12.47 c	63.96 d	60.58 f
Giza 6	33.46 a	39.11 a	15.14 f	11.88 f	64.25 b	63.94 a
Local	32.73 b	37.09 b	17.67 a	12.25 e	63.95 e	63.02 b
F-test	**	**	**	**	**	**
	Bio-chemical phosphorus fertilization and lithovit regime (F)					
F_1	28.34 i	37.14 e	16.97 c	12.89 b	63.41 g	61.84 h
F_2	31.73 d	38.71 a	16.88 f	12.59 d	63.35 i	62.20 f
F_3	27.73 j	37.37 d	17.07 b	12.35 g	62.11 j	62.35 d
F_4	30.99 g	38.30 b	17.57 a	12.18 j	63.40 h	63.14 b
F_5	31.64 e	34.05 j	16.65 g	12.24 h	63.62 f	61.28 i
F_6	35.05 a	36.08 h	15.92 i	12.43 f	64.82 c	60.64 j
F_7	33.16 b	37.10 f	15.68 j	12.21 i	64.33 d	62.34 e
F_8	32.00 c	35.50 i	16.16 h	12.88 c	63.98 e	62.15 g
F_9	28.48 h	37.82 c	16.89 e	12.99 a	65.16 a	63.38 a
F_{10}	31.36 f	36.78 g	16.96 d	12.49 e	65.13 b	63.07 c
F-test	**	**	**	**	**	**
Interaction						
V×F	**	**	**	**	**	**

F_1 control; F_2 chemical P 15.5 kg P_2O_5 fad^{-1}; F_3 bio-fertilizer phosphorien; F_4 50% chemical P + bio (phosphorien); F_5 25% chemical p + bio (phosphorien); F_6 chemical P 15.5 kg P_2O_5 fad^{-1} + lithovit; F_7 Phosphorien + lithovit; F_8 50% chemical P + bio (phosphorien) + lithovit; F_9 25% chemical P + bio (phosphorien) + lithovit; F_{10} Lithovit (foliar).

Nitrogen free extract content which represents the carbohydrate content was significantly influenced by bio-chemical phosphorus fertilization and lithovit regimes in both 1st and 3rd cuts of Egyptian clover. It is worth mentioning that the duality application of chemical phosphorus (15.5 kg P_2O_5 fad^{-1}) and lithovit (F_6) increased NFE (%) of the first cut of Egyptian clover to the uttermost value (35.05). Availability of phosphorus through the application of sole chemical phosphorus fertilizer (15.5 kg P_2O_5 fad^{-1}) i.e. F_2 fertilization regime increased NFE content of the 3rd cut of berseem to the highermost value (38.71). Unfertilized berseem plants under control fertilization regime F_1 produced the lowest value of NFE content (28.34) in the 1st cut, whereas the lowest content of NFE (34.05) in the 3rd cut was the resultant of supplying the fertilization regime 25% chemical P + bio phosphorien (F_5). The present results resemble those noticed by Türk et al. (2007) on narbon vetch, Mohsen et al. (2011a) on berseem, Seif & Saad (2014) as well as Roy et al. (2015) on Egyptian clover. Bakhoum et al. (2016) imparted that, the highest content of NFE was obtained by applying the bio-organic + mineral phosphorus fertilization treatment.

The interaction between the two main studied factors affected significantly on NFE content of Egyptian clover in the 1st and 3rd cuts. Allusive to the first cut results (Table 2-A), F_2 fertilization regime produced the highest NFE content (36.23%) for the local berseem variety. Withal, fertilization regime F_6 was superior in NFE content when supplied to any of the following berseem varieties q.e., Helaly, Serw 1, and Giza 6. Whereas F_7 fertilization regime exhibited the uppermost NFE content when applied to either Gemmeza 1 or Sakha 4 berseem varieties. In the other direction, Giza 6 berseem variety represents superiority in NFE content under six out of ten phosphorus fertilization regimes (F_1, F_2, F_3, F_4, F_5, and F_6) while the local berseem variety represents superiority in NFE content under three out of ten fertilization regimes (F_8, $F_{,9}$ and F_{10}). Availability of phosphorus fertilizer in addition to the nano fertilizer ‘lithovit’ through the application of F_6 fertilization regime produced the uppermost NFE content for Giza 6 berseem variety (40.16%). But the same variety ‘Giza 6’ produced the lowest NFE content (22.10%) under the application of F_9 fertilization regime *i.e.,* under a limited mineral phosphorus fertilizer (25% chemical P of the recommended level).

Table 2-A. Interaction effect between Egyptian clover varieties and bio-chemical phosphorus fertilization and lithovit regimes on nitrogen free extract (NFE, %) of the first cut

	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}
Helaly	J	D	H	G	I	A	E	C	F	B
	23.87 f	29.63 d	24.38 d	24.44 f	24.08 f	33.38 e	27.74 f	30.81 e	27.31 d	32.08 b
Gemmeza 1	I	E	G	D	B	C	A	F	J	H
	26.66 e	33.77 c	32.24 b	33.83 b	35.51 b	34.39 c	35.80 b	33.10 b	26.41 e	31.31 d
Sakha 4	H	I	J	E	G	B	A	F	D	C
	29.15 c	26.30 e	22.58 f	29.97 d	29.43 e	33.58 d	36.83 a	29.79 f	30.38 c	30.71 e
Serw 1	H	I	J	G	B	A	F	E	D	C
	27.45 d	24.98 f	24.25 e	29.67 e	33.84 c	36.34 b	30.44 e	31.47 d	31.48 b	31.58 c
Giza 6	G	B	E	D	C	A	F	H	J	I
	32.05 a	39.46 a	34.35 a	36.84 a	37.03 a	40.16 a	34.29 c	31.76 c	22.10 f	26.58 f
Local	H	A	J	G	I	F	D	C	E	B
	30.84 b	36.23 b	28.56 c	31.19 c	29.95 d	32.432 f	33.88 d	35.08 a	33.22 a	35.88 a

F_1 control; F_2 chemical P 15.5 kg P_2O_5 fad^{-1}; F_3 bio-fertilizer phosphorien; F_4 50% chemical P + bio (phosphorien); F_5 25% chemical p + bio (phosphorien); F_6 chemical P 15.5 kg P_2O_5 fad^{-1} + lithovit; F_7 Phosphorien + lithovit; F_8 50% chemical P + bio (phosphorien) + lithovit; F_9 25% chemical P + bio (phosphorien) + lithovit; F_{10} Lithovit (foliar).

Regarding the third cut (Table 2-B), the highest NFE content value was the resultant of the interaction effect of any of the following. F_1 ×Sakha 4, F_2 × Serw 1, F_3 × Gemmeza 1, F_4 × Giza 6, F_6 × Helaly, and F_9 × local variety. In the other direction, Serw 1 berseem variety was superior in NFE content under F_1, F_2, and F_{10} fertilization regimes, withal, the local berseem variety exhibited the highest NFE content under F_7, F_8, and F_9 fertilization regimes. The highest NFE content (47.72%) and the lowest NFE content (27.51%) were obtained under the interaction effect of F_2 × Serw 1 berseem variety and F_5 × the local berseem variety, consecutively. These results of the interaction are in harmony with those clarified by Seif & Saad (2014).

Table 2-B. Interaction effect between Egyptian clover varieties and bio-chemical phosphorus fertilization and lithovit regimes on nitrogen free extract (NFE, %) of the third cut

	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}
Helaly	H	E	J	G	I	A	C	D	B	F
	32.94 e	35.08 e	31.12 f	33.61 a	31.31 e	40.41 b	37.84 c	36.95 c	38.57 c	33.80 f
Gemmeza 1	B	E	A	H	J	C	F	I	G	D
	39.96 c	37.38 d	41.58 a	33.93 e	32.72 d	38.51 c	37.30 d	33.20 e	35.49 e	37.83 c
Sakha 4	A	J	D	C	G	E	I	F	B	H
	40.30 b	33.69 f	36.65 d	37.82 d	35.48 c	36.43 d	33.89 e	35.82 d	39.79 d	34.83 e
Serw 1	B	A	C	E	F	J	H	I	G	D
	42.89 a	47.72 a	38.55 c	38.26 c	36.29 b	28.40 f	33.39 f	29.53 f	33.45 f	38.38 a
Giza 6	J	D	E	A	C	B	F	G	I	H
	31.35 f	40.26 b	40.05 b	44.04 f	41.00 a	42.76 a	39.41 b	38.52 b	36.14 d	37.52 d
Local	H	F	G	B	J	I	C	D	A	E
	35.41 d	38.11 c	36.28 e	42.16 b	27.51 f	29.96 e	40.77 a	38.99 a	43.44 a	38.29 b

F_1 control; F_2 chemical P 15.5 kg P_2O_5 fad^{-1}; F_3 bio-fertilizer phosphorien; F_4 50% chemical P + bio (phosphorien); F_5 25% chemical p + bio (phosphorien); F_6 chemical P 15.5 kg P_2O_5 fad^{-1} + lithovit; F_7 Phosphorien + lithovit; F_8 50% chemical P + bio (phosphorien) + lithovit; F_9 25% chemical P + bio (phosphorien) + lithovit; F_{10} Lithovit (foliar).

Ash content (Ash, %)

Ash content exhibited significant differences among the six Egyptian clover varieties in 1st and 3rd cuts (Table 2). The local variety has the highest ash content (17.67%) in the first cut, while the uttermost ash content (13.58%) for the 3rd cut was obtained by Helaly berseem variety. Allusion to the lowest ash content for the 1st cut (15.14%), as well as for the 3rd cut (11.88%), it was achieved by berseem variety 'Giza 6'. The decrement of ash content for the third cut compared with the 1st cut was assured all over the six Egyptian clover varieties investigated. Ash content of different Egyptian clover varieties was of slight significant differences in both the 2nd and 4th cuts, that was the finding reported by Seif & Saad (2014) in Egypt. Bakhoum et al. (2016) postulated that ash (%) for berseem clover decreased gradually from 1st cut to the 3rd one.

The bio-chemical phosphorus fertilization and lithovit regimes exhibited operative impact on the ash content of berseem for 1st and 3rd cuts (Table 2). F_4 fertilization regime (50% chemical P + bio-fertilizer phosphorien) outstrips the other fertilization regimes allusive to ash content for the 1st cut (17.57%), the same fertilization regime (F_4) has the lowest ash content for the 3rd cut (12.18%). The highest ash content for the 3rd cut (12.99%) was obtained when F_9 (25% chemical P + bio-fertilizer phosphorien + lithovit) was applied. The effectual promoter impact of phosphorus on the ash content of forage was assured by each of Mohsen et al. (2011a), Seif & Saad (2014) as well as Bakhoum et al. (2016). Conversely, Roy et al. (2015) denoted that phosphorus application impact on the ash content of Egyptian clover was nonentity.

Table 2-C. Interaction effect between Egyptian clover varieties and bio-chemical phosphorus fertilization and lithovit regimes on ash (%) of the first cut

	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}
Helaly	C	F	D	B	J	H	I	G	A	E
	18.31 a	17.56 b	17.95 b	18.36 a	15.64 e	16.93 b	16.00 c	17.14 b	18.39 a	17.64 a
Gemmeza 1	D	F	C	A	B	I	H	G	E	C
	16.92 c	16.38 e	17.00 d	18.10 b	17.68 b	13.54 f	14.79 e	15.87 d	16.90 c	17.00 c
Sakha 4	D	B	E	A	C	E	I	H	G	F
	16.91 c	17.14 d	16.84 e	17.66 d	17.06 c	16.84 c	15.69 d	15.85 e	16.01 f	16.38 f
Serw 1	H	C	B	A	F	I	H	G	D	E
	16.06 d	17.35 c	17.44 c	18.10 b	16.76 d	15.92 d	16.07 b	16.36 c	17.10 b	16.84 e
Giza 6	C	F	E	D	G	I	J	H	B	A
	15.42 e	14.92 f	15.07 f	15.16 e	14.84 f	14.10 e	13.86 f	14.54 f	16.38 e	17.06 b
Local	A	E	C	D	F	B	G	H	J	I
	18.21 b	17.95 a	18.12 a	18.00 c	17.92 a	18.20 a	17.67 a	17.21 a	16.55 d	16.85 d

F_1 control; F_2 chemical P 15.5 kg P_2O_5 fad^{-1}; F_3 bio-fertilizer phosphorien; F_4 50% chemical P + bio (phosphorien); F_5 25% chemical p + bio (phosphorien); F_6 chemical P 15.5 kg P_2O_5 fad^{-1} + lithovit; F_7 Phosphorien + lithovit; F_8 50% chemical P + bio (phosphorien) + lithovit; F_9 25% chemical P + bio (phosphorien) + lithovit; F_{10} Lithovit (foliar).

The interaction between the ten phosphorus fertilization regimes and the six Egyptian clover varieties significantly impacted the ash content of 1^{st} and 3^{rd} berseem cuts. Regarding to the 1^{st} cut, Table (2-C). The control fertilization regime (F_1) surpassed other fertilization regimes in ash content (18.32%) when supplied to the local berseem variety. Application of F_4 (50% chemical P + bio-fertilizer phosphorien) caused supereminence each of Gemmeza 1, Sakha 4, and Serw 1 in ash content. F_9 × Helaly berseem variety and F_{10} × Giza 6 interaction had the highest ash content. In the other direction, Helaly berseem variety outbrave the other berseem varieties in ash content under each of F_1, F_4, F_9, and F_{10} fertilization regimes, while the local variety has the utmost ash content under each of F_2, F_3, F_5, F_6, F_7, and F_8 fertilization regimes. The interaction effect between F_9 fertilization regime and Helaly berseem variety produced the uppermost ash content (18.39%), while the lowermost ash content (13.54%) was the resultant of the interaction effect between F_6 (chemical P 15.5 P_2O_5 fad^{-1} + lithovit) and Gemmeza 1 berseem variety. As for the third cut, results in Table (2-D) exhibited that the control fertilization regime (F_1) surpassed other fertilization regimes in ash content (13.10%) when applied to the local berseem variety. F_7 × Giza 6 berseem variety as well as F_8 fertilization regime × Serw 1 berseem variety had the highest ash content. Supplementation of F_9 (25% chemical P + bio-fertilizer phosphorien + lithovit) fertilization regime caused supereminence in each of Helaly, Gemmeza 1, and Sakha 4 berseem varieties in ash content. In other direction, Helaly berseem variety ranked first in ash content compared with other berseem varieties under eight out of ten fertilization regimes (F_1, F_3, F_4, F_5, F_6, F_7, F_9, and F_{10}). Sakha 4 ranked first under F_2 and F_8 fertilization regimes. The uppermost ash content (14.19%) was the resultant of the interaction effect between F_9 (25% chemical P + bio-fertilizer phosphorien + lithovit) and Helaly berseem variety. The lowermost ash content (11.11%) was obtained due to the interaction impact of F_5 fertilization regime and Sakha 4 Egyptian clover variety.

Table 2-D. Interaction effect between Egyptian clover varieties and bio-chemical phosphorus fertilization and lithovit regimes on ash (%) of the third cut

	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}
Helaly	E 13.75 a	H 13.11 b	I 12.96 a	B 14.01 a	C 13.94 a	F 13.70 a	J 12.87 a	G 13.40 c	A 14.19 a	D 13.87 a
Gemmeza 1	C 12.94 c	E 12.41 d	H 11.94 e	F 12.16 c	J 11.54 e	G 12.03 e	I 11.77 f	B 13.01 d	A 13.10 c	D 12.85 b
Sakha 4	F 12.76 e	C 13.15 a	D 12.84 b	I 11.45 e	J 11.11 f	H 12.07 d	G 12.14 d	B 13.60 a	A 14.00 b	E 12.78 c
Serw 1	D 12.77 d	F 12.18 e	E 12.24 d	H 11.74 d	B 13.06 b	C 12.83 b	G 12.15 c	A 13.44 b	D 12.77 d	I 11.55 f
Giza 6	D 12.03 f	G 11.71 f	H 11.56 f	J 11.32 f	D 12.03 c	B 12.10 c	A 12.33 b	E 11.84 f	F 11.76 f	C 12.07 d
Local	A 13.10 b	B 12.97 c	C 12.54 c	D 12.39 b	J 11.74 d	H 11.87 f	F 12.01 e	G 11.96 e	E 12.11 e	I 11.83 e

F_1 control; F_2 chemical P 15.5 kg P_2O_5 fad^{-1}; F_3 bio-fertilizer phosphorien; F_4 50% chemical P + bio (phosphorien); F_5 25% chemical p + bio (phosphorien); F_6 chemical P 15.5 kg P_2O_5 fad^{-1} + lithovit; F_7 Phosphorien + lithovit; F_8 50% chemical P + bio (phosphorien) + lithovit; F_9 25% chemical P + bio (phosphorien) + lithovit; F_{10} Lithovit (foliar).

Results announced by Seif & Saad (2014) referred to a significant interaction effect between Egyptian clover varieties and phosphorus fertilization treatment on the ash content of berseem leaves.

Total Digestible Nutrient Content (TDN, %)

TDN is a calculated figure that represents the sum of all digestible organic nutrients in the feed (Torell et al., 2005). The results in Table (2) point to the influence of Egyptian clover varieties as well as bio-chemical phosphorus fertilization and lithovit regimes on total digestible nutrient content (TDN%). Despite the narrow range of TDN (%) between the highest forage content (62.05%) for Gemmeza 1 berseem variety and the lowest one (62.21%) for Helaly berseem variety in the 1st cut, the varietal differences in TDN (%) were significant. Withal, findings in the 3rd cut had analogous trend wherein, Giza 6 has the highest TDN content (63.94%) while Serw 1 berseem variety has the lowest TDN content (60.58%). It is worth mentioning that, as crude protein content and TDN (%) increase, forage quality also rises (Mohsen et al., 2011a). So, forage quality of the 1st cut tended to outclass that of the 3rd cut in the present study (Tables 1 and 2). Salama et al. (2020) purported that some berseem varieties and/ or cuts appeared to be of better quality than others because of the association between high CP (%) and TDN (%) and low NFE and fiber content. Varietal differences in TDN content were also reported by Seif & Saad (2014).

The bio-chemical phosphorus fertilization and lithovit regimes acted significantly on the digestible organic nutrients of Egyptian clover 1st and 3rd cuts. Application of F_9 fertilization regime (25% chemical P + bio-fertilizer 'phosphorien' + the nano-fertilizer 'lithovit') improved berseem quality *via* raising TDN (%) to the uppermost value in each of 1st and 3rd cuts (65.16 and 63.38%, respectively). The fertilization regime F_8 recorded

TDN (%) to the lowest value (62.11%) in the 1st cut of Egyptian clover. Whereas the lowest TDN (%) value (60.64%) in the 3rd cut was obtained under F_6 fertilization regime (chemical P 15.5 kg P_2O_5 fad^{-1} + lithovit). Mohsen et al. (2011a) divulged that as the percentages of CP and TDN increase berseem quality likely rises. They added that TDN (%) for both berseem 3rd and 4th cuts increased significantly with phosphorus fertilization. Seif & Saad (2014) discerned that the TDN content of berseem leaves (over 5 Egyptian varieties) increased as phosphorus level increased up to 45 kg P_2O_5 fad^{-1}. Bakhoum et al. (2016) evinced that the total digestible nutrient (%) of berseem clover forage increased consistently in the bio-organic mineral fertilization treatments of both phosphorus and nitrogen.

Table 2-E. Interaction effect between Egyptian clover varieties and bio-chemical phosphorus fertilization and lithovit regimes on total digestible nutrients (TDN%) of the first cut

	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}
Helaly	G	F	E	I	J	B	H	D	C	A
	62.11 e	62.28 d	62.59 d	60.36 e	57.32 f	63.45 e	61.27 f	62.84 d	63.31 e	66.55 a
Gemmeza 1	J	A	D	C	I	H	E	F	B	G
	62.25 d	66.58 b	65.66 a	66.30 b	63.71 d	64.02 d	65.60 a	65.36 b	66.39 b	64.37 e
Sakha 4	G	I	J	H	C	D	F	B	A	E
	65.00 a	58.99 f	57.71 f	59.26 f	67.29 a	67.13 a	65.19 d	67.66 a	68.08 a	65.70 b
Serw 1	F	I	J	A	C	B	H	G	D	E
	63.64 b	60.29 e	57.77 e	67.51 a	66.40 b	66.61 b	63.21 e	63.61 c	65.88 c	64.69 d
Giza 6	J	A	F	B	C	G	D	I	H	E
	62.43 c	67.31 a	64.02 c	65.88 c	65.31 c	62.90 f	65.29 c	62.50 e	62.58 f	64.22 f
Local	C	G	D	J	I	E	A	H	F	B
	65.00 a	64.64 c	64.94 b	61.11 d	61.71 e	64.78 c	65.41 b	61.91 f	64.74 d	65.23 c

F_1 control; F_2 chemical P 15.5 kg P_2O_5 fad^{-1}; F_3 bio-fertilizer phosphorien; F_4 50% chemical P + bio (phosphorien); F_5 25% chemical p + bio (phosphorien); F_6 chemical P 15.5 kg P_2O_5 fad^{-1} + lithovit; F_7 Phosphorien + lithovit; F_8 50% chemical P + bio (phosphorien) + lithovit; F_9 25% chemical P + bio (phosphorien) + lithovit; F_{10} Lithovit (foliar).

The effective and significant influence of the interaction between the bio-chemical phosphorus fertilization and lithovit on one side, and the Egyptian clover varieties on the other one was appreciable on TDN content in 1st and 3rd cuts (Tables 2-E; 2-F). Allusion to the 1st cut, and under F_2 fertilization regime (chemical P 15.5 kg P_2O_5 fad^{-1}), the highest TDN (%) was achieved by each of Gemmeza 1 and Giza 6 berseem varieties. The highest TDN (%) was also reported under each of the following interactions, F_4 × Serw 1; F_7 × Local variety; F_9 ×Sakha 4, and F_{10} × Helaly. Regarding the other direction, Helaly berseem variety was supreme in TDN (%) under F_{10} (sole foliar spray with lithovit) fertilization regime. Withal Gemmeza 1 berseem variety outrank the other varieties in TDN (%) under each of F_3 and F_7 fertilization regimes. Sakha 4 berseem variety has the highest TDN (%) value under each of F_1, F_5, F_6, F_8, and F_9 fertilization regimes. Each of Serw 1 × F_4; Giza 6 × F_2 and the local variety × F_1 has the highest TDN (%). The utmost TDN content value (68.08%) was achieved under the interaction influence of F_9 fertilization regime ×Sakha 4 berseem variety. The lowermost TDN (%) value (57.32) was obtained under the interaction effect between F_5 fertilization regime and Helaly berseem variety. Oscillatory results were noted in the 3rd cut, wherein under fertilization regimes F_1, F_5, F_7, F_9, F_{10}, the highest TDN (%) was obtained from Serw 1, Gemmeza 1, Giza 6, both Sakha 4 and the local variety as well as Helaly varieties, in the same order. Allusive to the other direction, Helaly berseem variety has the highest TDN (%) under F_{10} fertilization regime. Withal, Gemmeza1 variety content of TDN (%), outranks other berseem varieties under F_2 fertilization treatment, while berseem variety Serw 1 has the highest TDN (%) under F_1 fertilization regime. It's worth noting that Giza 6 berseem variety can produce high forage quality as TDN (%) was the highest under each of the following fertilization regimes i.e., F_3, F_5, F_6, F_7, and F_8. The local berseem variety has the highest TDN (%) under F_4 fertilization regime. The uppermost value of TDN content (66.46%) was the resultant of the interaction of F_9 fertilization regime and the local berseem variety, it is worth noting that the same interaction lower the crude fiber content to the lowest value (21.12%, Table 1-D) so the forage quality raise under this interaction effect. The lowest TDN content (55.95%) was obtained under the interaction effect of the local variety × F_5 which produced also the highest crude fiber content (35.92, Table 1-D) so, the forage quality was reduced under this interaction effect. Significant interaction influence of Egyptian clover varieties and phosphorus fertilization treatments on TDN content was also reported early by Seif & Saad (2014) in Egypt.

Table 2-F. Interaction effect between Egyptian clover varieties and bio-chemical phosphorus fertilization and lithovit regimes on total digestible nutrients (TDN%) of the third cut

	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}
Helaly	H	G	J	E	I	F	D	C	B	A
	60.10 e	60.14 f	58.87 f	61.76 e	59.66 e	60.70 d	62.14 d	62.23 d	63.66 d	65.03 a
Gemmeza 1	E	B	C	I	A	G	D	J	H	F
	62.42 c	63.89 a	63.59 b	61.18 f	64.25 b	62.12 b	62.51 c	60.43 e	61.49 e	62.34 e
Sakha 4	J	D	F	E	I	G	H	B	A	C
	60.76 d	62.23 d	61.97 e	62.09 c	60.82 c	61.78 c	60.89 e	62.91 c	64.42 c	62.44 d
Serw 1	A	C	D	E	F	H	J	I	G	B
	65.76 a	62.65 b	61.99 d	61.90 d	60.59 d	56.56 f	56.21 f	56.39 f	59.48 f	64.30 b
Giza 6	J	I	F	D	B	G	A	C	E	H
	58.25 f	61.71 e	64.46 a	65.54 b	66.39 a	63.19 a	66.56 a	65.73 a	64.78 b	62.78 c
Local	E	G	F	B	J	I	C	D	A	H
	63.78 b	62.57 c	63.21 c	66.38 a	55.95 f	59.47 e	65.70 b	65.20 b	66.46 a	61.51 f

F_1 control; F_2 chemical P 15.5 kg P_2O_5 fad^{-1}; F_3 bio-fertilizer phosphorien; F_4 50% chemical P + bio (phosphorien); F_5 25% chemical p + bio (phosphorien); F_6 chemical P 15.5 kg P_2O_5 fad^{-1} + lithovit; F_7 Phosphorien + lithovit; F_8 50% chemical P + bio (phosphorien) + lithovit; F_9 25% chemical P + bio (phosphorien) + lithovit; F_{10} Lithovit (foliar).

Digestible protein content (DP, %)

The results compiled in Table (3) clearly show that the Egyptian clover varietal differences in the content of digestible protein (DP, %) as well as the bio-chemical phosphorus fertilization and lithovit regime impact on digestible protein content were analogous to those of crude protein content previously shown in Table (1) and previously discussed. Also, results of the interaction effect between Egyptian clover varieties and fertilization regimes on DP (%) Tables (3-A; 3-B) behaved in a parallel trend almost like to crude protein content previously presented and discussed (Tables 1-A and 1-B). Analogous findings were ascertained by Seif & Saad (2014) as well as Bakhoum et al. (2016).

Table 3. Varietal differences as well as the bio-chemical phosphorus fertilization and lithovit regimes effect on digestible protein (DP%) of Egyptian clover varieties

Main effects and interactions	DP (%) Combined 1st cut	3rd cut
	Egyptian clover variety (V)	
Helaly	20.21 b	16.28 e
Gemmeza 1	19.87 d	16.73 c
Sakha 4	20.96 a	16.57 d
Serw 1	20.05 c	15.85 f
Giza 6	19.72 e	17.28 a
Local	18.25 f	17.22 b
F-test	**	**
	Bio-chemical phosphorus fertilization and lithovit regime (F)	
F_1	20.53 c	15.77 h
F_2	18.79 i	15.51 j
F_3	20.20 d	16.57 g
F_4	18.98 h	16.92 e
F_5	19.08 g	17.93 a
F_6	18.50 j	15.67 i
F_7	19.55 f	16.77 f
F_8	19.69 e	17.10 c
F_9	22.53 a	17.03d
F_{10}	20.60 b	17.29 b
F-test	**	**
Interaction		
V×F	**	**

F_1 control; F_2 chemical P 15.5 kg P_2O_5 fad^{-1}; F_3 bio-fertilizer phosphorien; F_4 50% chemical P + bio (phosphorien); F_5 25% chemical p + bio (phosphorien); F_6 chemical P 15.5 kg P_2O_5 fad^{-1} + lithovit; F_7 Phosphorien + lithovit; F_8 50% chemical P + bio (phosphorien) + lithovit; F_9 25% chemical P + bio (phosphorien) + lithovit; F_{10} Lithovit (foliar).

Table 3-A. Interaction effect between Egyptian clover varieties and bio-chemical phosphorus fertilization and lithovit regimes on digestible protein (DP %) of the first cut

	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}
Helaly	B	I	A	E	G	J	F	H	D	C
	21.66 a	18.55 e	22.69 a	20.25 b	19.55 c	17.83 e	20.07 b	18.84 e	21.20 d	21.50 c
Gemmeza 1	D	E	C	I	J	G	H	B	A	F
	20.25 d	20.09 a	20.49 c	18.77 d	15.86 f	19.25 c	19.07 d	20.65 b	24.61 b	19.66 d
Sakha 4	E	H	G	J	C	F	I	B	A	D
	21.34 c	18.77 c	19.65 d	16.14 f	23.20 a	21.17 a	18.44 f	24.09 a	24.51 c	22.31 b
Serw 1	B	E	J	A	F	H	D	I	C	G
	21.58 b	20.03 b	18.18 f	22.53 a	19.62 b	19.30 b	20.05 c	19.05 d	20.69 e	19.49 e
Giza 6	G	H	F	E	I	J	C	D	A	B
	18.72 f	18.58 d	18.73 e	19.46 c	18.28 d	14.98 f	20.89 a	20.03 c	24.73 a	22.79 a
Local	B	I	A	H	F	E	D	J	C	G
	19.65 e	16.71 f	21.46 b	16.76 e	17.96 e	18.45 d	18.76 e	15.46 f	19.43 f	17.83 f

F_1 control; F_2 chemical P 15.5 kg P_2O_5 fad^{-1}; F_3 bio-fertilizer phosphorien; F_4 50% chemical P + bio (phosphorien); F_5 25% chemical p + bio (phosphorien); F_6 chemical P 15.5 kg P_2O_5 fad^{-1} + lithovit; F_7 Phosphorien + lithovit; F_8 50% chemical P + bio (phosphorien) + lithovit; F_9 25% chemical P + bio (phosphorien) + lithovit; F_{10} Lithovit (foliar).

Table 3-B. Interaction effect between Egyptian clover varieties and bio-chemical phosphorus fertilization and lithovit regimes on digestible protein (DP %) of the third cut

	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}
Helaly	F	I	E	B	C	J	H	D	G	A
	16.28 c	15.13 d	16.45 d	17.71 b	17.05 d	11.81 f	15.64 e	16.60 e	16.10 e	20.07 a
Gemmeza 1	J	B	I	C	A	H	F	D	E	G
	13.70 e	18.25 b	14.65 f	17.98 a	21.86 a	15.62 d	16.34 d	16.65 d	16.41 d	15.78 e
Sakha 4	I	A	B	H	F	C	E	B	G	D
	13.08 f	18.47 a	17.34 a	15.68 f	16.81 e	17.11 c	16.87 c	17.34 c	15.94 f	17.08 d
Serw 1	G	J	E	C	F	B	I	H	D	A
	15.95 d	10.26 f	16.39 e	16.71 d	16.15 f	17.12 b	14.69 f	15.75 f	16.66 c	18.84 b
Giza 6	G	I	E	H	D	J	B	C	A	F
	16.96 b	14.93 e	17.33 b	16.59 e	17.99 b	13.48 e	19.25 a	18.88 a	20.17 a	17.27 c
Local	B	I	F	H	D	A	C	E	G	J
	18.67 a	16.04 c	17.29 c	16.86 c	17.68 c	18.88 a	17.82 b	17.38 b	16.89 b	14.69 f

F_1 control; F_2 chemical P 15.5 kg P_2O_5 fad^{-1}; F_3 bio-fertilizer phosphorien; F_4 50% chemical P + bio (phosphorien); F_5 25% chemical p + bio (phosphorien); F_6 chemical P 15.5 kg P_2O_5 fad^{-1} + lithovit; F_7 Phosphorien + lithovit; F_8 50% chemical P + bio (phosphorien) + lithovit; F_9 25% chemical P + bio (phosphorien) + lithovit; F_{10} Lithovit (foliar).

CONCLUSION

Giza 6 Egyptian berseem variety ranked first in forage quality because of its high content of each CP (%), NFE (%), TDN (%), and DP (%) in the 3rd cut. The local berseem variety ranked the least over the six Egyptian clover varieties with the highest ash (%) in the 1st cut. Other varieties were in between. Allusion to bio-chemical phosphorus fertilization and lithovit regimes, application of any phosphorus fertilization regimes surpassed the control treatment in most nutritive values. Application of F_9 fertilization regime (25% chemical P + bio-fertilizer 'phosphorien' + nano-fertilizer 'lithovit') tended to produce high forage quality with high content of CP (%) in the 1st cut, TDN (%) in both 1st and 3rd cuts as well as DP (%) in the 1st cut. It is worth mentioning that, as crude protein content and total digestible nutrient content (TDN %) increases, forage quality also rises, so, forage quality of the 1st cut tended to outclass that of the 3rd cut in the present study.

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