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IMPACT OF BIO-CHEMICAL PHOSPHORUS FERTILIZATION AND LITHOVIT REGIMES ON SOME QUALITATIVE TRAITS OF VARIOUS BERSEEM VARIETIES

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ABSTRACT: A field experiment was conducted at the Agric. Res. Station, Fac. Agric., Zagazig Univ., Sharkia Governorate, Egypt, during the winter seasons of 2019/2020 and 2020/2021. The investigation aimed at studying the impact of ten bio-chemical phosphorus fertilization and lithovit regimes on some qualitative traits of forage for 1st and 3rd cuts of six Egyptian clover varieties (Berseem, *Trifolium alexandrinum* L.) *q.e.* Helaly, Sakha 4, Gemmeiza 1, Giza 6, Serw 1, and local variety. The ten bio-chemical phosphorus fertilization and lithovit regimes were F_1, control; F_2, chemical phosphorus, 15.5 Kg P_2O_5 /fad., F_3, bio-phosphorus fertilizer “Phosphorien”; F_4, 50% of F_2 + phosphorien; 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 + lithovit; F_{10}, sole lithovit. Results disclosed varietal differences in each of phosphorus content (P%), digestible energy (DE Kcal/g dry matter), protein yield (Kg/fad.), as well as carbohydrate and fiber yields (Kg/fad.) in both the 1st and the 3rd cuts. The ten bio-chemical phosphorus fertilization and lithovit regimes resulted in a significant impact on the above cited traits in both the 1st and the 3rd cuts.

Key words: Egyptian clover, bio-chemical fertilization, phosphorus, lithovit, qualitative traits.

INTRODUCTION

Leguminosae family includes many genuses, Trifolium genus ranked at the top with about 240 species. Egyptian clover (T. *alexandrinum* L.), Red clover (T. *pratense* L.), White clover (T. *repen*), and alsike clover (T. *hybridum* L.) are the most important species **(Zayed *et al.*, 2012; Ibrahim *et al.*, 2022).** Egyptian clover is a great moment forage crop cultivated as a winter annual forage crop in many Asian, European, and Mediterranean countries. The distinction of the Egyptian clover is ascribed to its multi-cut nature, high yield with long duration of green fodder availability, more and above its good quality, palatability, and digestibility **(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 plants fixes atmospheric ‘N’ in the soil which amounted as much as 33-66 Kg N/ ha for the following crops **(Williams *et al.*, 1990; Govindasamy *et al.*, 2021)**. Berseem is the Arabic and Coptic word, it grows in Egypt since 6000 years BC **(Tarrad and Zayed, 2009; Zayed, 2013).**

Berseem forage quality is determined mainly by its content of various nutrients like minerals, crude protein, and fiber content, *etc.* 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.*, 2011 b).**

Raising phosphorus fertilizer level tended to lessen berseem contents of dry matter and nitrogen free extract (NFE%) otherwise, phosphorus content, crude protein (CP), protein yield, crude fiber content (CF), fiber yield, and

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net energy were increased ascribed to increasing phosphorus fertilizer levels **(Mohsen *et al.*, 2011a; Seif and Saad, 2014; Ansari and Ghadimi, 2015; Chaichi *et al.*, 2015; Ansari and Ghadimi, 2017; Arif *et al.*, 2022). Roy *et al.* (2015)** quoted that raising phosphorus fertilizer level from 40 to 80 Kg P_2O_5/ha gradually increased each of dry matter (%), crude protein content, protein yield, and nitrogen free extract.

Phosphorus is the second major nutrient deficient in Egyptian soils. Phosphorus is of a great moment in photosynthesis, synthesis of nucleic acids, proteins, and lipids **(Ayub *et al.*, 2013; Khattab *et al.*, 2019).** Phosphorus displays a dogmatic role in legume seedling establishment its shoots and roots **(Fathy, 2014).** Phosphatic fertilization is more important for leguminous field crops than nitrogenic fertilization. Movement of the nutrients within the plant as well as the transportation of energy and transfer of genetic characters to the following generation are controlled by phosphorus **(Abdelsalam and El-Sanatawy, 2022).** The recapture efficacy of phosphorus is less than 20% of the supplied phosphorus fertilizers to the soil globally **(Qureshi *et al.*, 2012)**. Withal, **Sharma *et al.* (2013)** propagated that phosphorus fertilizer utilization is less than 30% because soluble P is rapidly fixed in the soil due to reacting with free Al^{3+}, Ca^{2+}, and Fe^{3+}. Soil microorganisms play a vital role in P availability to the plants supplied with organic and/ or inorganic P sources **(Wani *et al.*, 2007).** Phosphorus solubilizing bacteria (PSB) plays an important role in enhancing P efficiency of natural and applied P and improving field crop's productivity **(Khan *et al.*, 2009)**. Phosphate solubilizing bacteria inoculation decrease or may minimize the supply with chemical P fertilizers up to 100% depending on soil and climatic conditions **(Fazlullah *et al.*, 2018; Khattab, 2019).** Phosphate solubilizing bacteria (PSB) produces some organic acids in the soil that reduce the pH and thus solubilize calcium phosphate complexes.

Lithovit (manufactured by Zeovita-GmbH, Berlin, Germany) and quantitatively was analyzed by **Wichmann and Basler (2006)** as well as **Wedad Kasim *et al.* (2020).** It is the first CO_2 foliar nano-fertilizer that can be applied successfully in bare fields and under glass. Lithovit consists of calcium carbonate [($CaCO_3$), 80%] supplemented by many momenta micro-nutrients. Most particles are very small (< 10 µm) that they can be absorbed directly through the stomata of plant's foliage. Calcium carbonate decomposes in leaves stomata to calcium oxide (CaO) and carbon dioxide (CO_2), which promote the photosynthesis process and increase carbon uptake and assimilation, thereby improving plant growth and productivity **(Carmen *et al.*, 2014; Abdelkader *et al.*, 2018; Mostafa, 2019; Ibrahim *et al.*, 2022).**

The study aims at investigating the interactive impacts of ten biochemical phosphorus fertilization and lithovit regimes on some forage quality of six Egyptian clover (Berseem) varieties.

MATERIALS AND METHODS

Field experiment was carried out at the Agricultural Experimental Farm, Faculty of Agric. Zagazig Univ., Zagazig District, Sharkia Governorate, Egypt (Lat. 30°34'59.3" N, long 31°31'03.3" E, 9 m above the sea level) during the winter growing seasons of 2019/2020, and 2020/2021 to study the influence of ten biochemical phosphorus fertilization and lithovit regimes on some forage quality traits of six Egyptian clover varieties (Berseem, *Trifolium alexandrinum* L.). Certified seeds of the studied berseem varieties *q.e.* Helaly, Gemmeiza 1, Sakha 4, Serw 1, and Giza 6 were kindly obtained from the production unit, Agriculture Research Center (ARC), Giza, Egypt. A local multi-cut berseem variety commonly planted by farmers was also investigated. Mixture of *Rhizobium trifolii* with sand was broadcasted and incorporated with the field soil prior to planting for promoting N fixation. Seeds were broadcasted in 2×5 m plots (10 m^2) with 20 Kg/ faddan seeding rate (faddan or fad= 4200 m^2). The ten biochemical phosphorus fertilization and lithovit regimes (F_1…to F_{10}) were as follows: F_1, control; F_2, chemical phosphorus, 15.5 Kg P_2O_5/fad., F_3, bio- phosphorus fertilizer "Phosphorien"; F_4, 50% of F_2 + phosphorien; 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 + lithovit; F_{10}, sole lithovit.

Fertilizers Used

The chemical phosphorus fertilizer *q.e.* calcium superphosphate (15.5% P_2O_5) was applied 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 (PDB) "*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/fad., to detect the fertilization regimes F_3, F_4, F_5, F_7, F_8, and F_9. Inoculation with phosphorien was done by mixing with berseem seeds using Arabic gum 5% as adhesive substance, just before sowing. Berseem plants were sprayed with the aqueous solution of the nano-fertilizer Lithovit (100 g/ 20 L tap water) using hand operated compressed air sprayer. Welting agent Kinzo (100 cm^3/ 20 L tap water) was supplied with the spraying solution. Lithovit application was done in the fertilization regimes F_6, F_7, F_8, F_9, and F_{10}. Lithovit supply was applied as foliar spray 30 days after sowing, then after 15 days follows to each cut with the same rate. It is worthy noting that, the weather was not rainy for many days after lithovit foliar spray application. Rains in Egypt is drizzling during winter season.

The study was designed in a split-plot system with three replicates in both seasons. The Egyptian clover varieties were assigned to the main plot, and the ten biochemical phosphorus fertilization and lithovit regimes were allotted to the sub-plots. The soil texture of the experimental site was sandy loam. Fodder maize was the preceding summer crop in the two seasons. Berseem varieties were sown on 4^{th} and 7^{th} November in the first and second seasons, respectively. Surface flood irrigation system was used.

Four cuts were obtained for each season, the 1^{st} cut was achieved 65 days post sowing date, the 2^{nd} cut was done 50 days later, the 3^{rd} cut was obtained 40 days after the 2^{nd} one, finely the 4^{th} cut was conducted 30 days later to the 3^{rd} cut. A representative subsample of about 0.5 Kg of the whole plant material per plot in both the 1^{st} and 3^{rd} cuts in the two growing seasons were oven dried at 70°C for 72 hr. The dried subsamples were ground, bagged, and stored until analyzing and determining the following quality traits, phosphorus (%), digestible energy (DE) Kcal/g dry matter, protein yield (Kg/ fad), carbohydrate yield (Kg/fad.), and fiber yield (Kg/fad.). Phosphorus content (%) was analyzed and determined according to the **AOAC (2012)**, digestible energy (DE, Kcal/ g dry matter) was calculated from the formula, DE= 0.546+0.055 TDN, where TDN is the total digestible nutrients (TDN= 74.43+ 0.35 CP%- 0.73 CF%), protein yield, carbohydrate yield, and fiber yield were calculated by multiplying crude protein (CP%), nitrogen free extract content (NFE%), and crude fiber (CF%) by dry forage yield/ fad, in the same respective order. Chemical analyses were conducted and presented on dry matter basis. Data were analyzed by analysis of variance based on split-plot design regarding to the procedures outlined by **Snedecor and Cochran (1990)**. Homogeneity of variance between the two seasons was tested using bartellet's test **(Steel *et al.*, 1997)** which revealed insignificant variation for all studied traits, so data of the two seasons were presented and discussed in the combined analysis. Comparing means was conducted using the least significant differences (LSD) at 1 and 5% probability levels according to **Duncan (1995)**. In the interaction tables, capital and small alphabet were used for mean comparison in rows and columns, respectively.

RESULTS AND DISCUSSION

It is of great moment to note 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 six berseem varieties were analyzed and presented on dry matter basis.

Phosphorus Content (P%)

Results displayed in Table 1 disclose varietal differences in phosphorus content (P%) in the 1^{st} and 3^{rd} cuts. Allusion to the descending ranking order, P (%) in the 1^{st} cut amounted as much as 0.563, 0.547, 0.526, 0.518, 0.507, and 0.500% for the berseem varieties Helaly, local variety, Serw 1, Giza 6, Sakha 4, and Gemmeiza 1, respectively.

Table 1. Varietal differences as well as bio-chemical phosphorus fertilization and lithovit regimes effect on phosphorus content (P%), digestible energy DE (Kcal/ g dry matter) and Protein yield (Kg fad.) of Egyptian clover varieties

Main effects and interaction	Phosphorus (%)		DE (Kcal/ g dry matter)		Protein yield (Kg/fad.)	
	Combined		Combined		Combined	
	1st cut	3rd cut	1st cut	3rd cut	1st cut	3rd cut
Egyptian clover variety (V)						
Helaly	0.563 a	0.410 b	3.967 f	3.924 e	224.95 d	275.04 b
Gemmeiza 1	0.500 f	0.409 c	4.122 a	3.979 c	172.06 e	263.37 c
Sakha 4	0.507 e	0.417 a	4.077 c	3.957 d	216.28 d	289.86 a
Serw 1	0.526 c	0.398 d	4.064 d	3.878 f	253.35 b	230.11 e
Giza 6	0.518 d	0.395 e	4.079 b	4.063 a	269.87 a	250.08 d
Local	0.547 b	0.417 a	4.063 e	4.012 b	237.63 c	195.30 f
F-test	**	**	**	**	**	**
Bio-chemical phosphorus fertilization and lithovit regime (F)						
F_1	0.549 c	0.369 j	4.033 g	3.947 h	232.39 cd	228.01 ef
F_2	0.531 d	0.410 e	4.030 h	3.966 f	226.12 cd	236.84 e
F_3	0.571 b	0.400 i	3.962 i	3.975 d	236.20 c	248.56 d
F_4	0.588 a	0.424 b	4.033 g	4.018 b	213.90 ef	263.25 c
F_5	0.526 e	0.416 d	4.045 f	3.916 i	208.39 f	280.76 a
F_6	0.474 i	0.401 h	4.110 c	3.881 j	248.67 b	219.24 f
F_7	0.525 e	0.403 g	4.084 d	3.974 e	221.13 de	251.32 d
F_8	0.512 f	0.421 c	4.065 e	3.964 g	210.82 ef	266.28 bc
F_9	0.505 g	0.426 a	4.130 a	4.032 a	230.36 cd	275.20 ab
F_{10}	0.486 h	0.406 f	4.127 b	4.015 c	262.27 a	236.78 e
F-test	**	**	**	**	**	**
Interaction						
V×F	**	**	**	**	**	**

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

There was diverse ranking order regarding to the varietal differences in their P contentment in the 3rd cut as follow; 0.417, 0.417, 0.410, 0.409, 0.398, and 0.395% for the berseem varieties Sakha 4, the local variety, Helaly, Gemmeiza 1, Serw 1, and Giza 6, consecutively. In the 1st cut, Helaly variety had the highest phosphorus content (0.563%) while, Gemmeiza 1 had the lowest (0.500%). In the 3rd cut, superiority in phosphorus content (0.417%) was reported by both the local variety and Sakha 4 variety, whereas Giza 6 variety ranked the last. The 1st cut of berseem was relatively higher than the 3rd cut in phosphorus content in each of the six Egyptian clover varieties. Varietal differences in phosphorus content of Egyptian clover were also elaborated by **Seif and Saad (2014).** The varietal differences in P% may be ascribed to the slight differences in the specific genetical makeup of the investigated berseem varieties and their response to the environment.

The ten bio-chemical phosphorus fertilization and lithovit regimes resulted in effective and significant impact on phosphorus content in both 1st and 3rd cuts. Referring to the 1st cut, the uttermost P (%) value (0.588%) was achieved due to application of the F_4 fertilization regime (50% chemical P+the biofertilizer phosphorien). Sole application of the foliar nano-fertilizer 'lithovit' resulted the lowermost P (%) value (0.486%). In the 3rd cut, the highest P (%) value (0.426%) in berseem plants was attained due to the application of F_9 fertilization regime (25% chemical P+ phosphorien+ lithovit). The lowest P content (0.369%) was recorded under phosphorus deficiency in control treatment. Phosphorus content of Egyptian clover distinctly diverse between the 1st and 3rd cuts wherein early cut has higher P (%) than the later one with an average value 0.527% and 0.408% in the same respective order. In this respect, **Seif and Saad (2014)** in Egypt propagated that, over five Egyptian varieties, combined analysis displayed significant increment in P content of berseem leaves due to increasing P level from zero to 22.5 and then up to 45 Kg P_2O_5/fad. They added that the 2nd cut was relatively higher in P content than the 4th one in the five berseem varieties investigated. Phosphorus content of Egyptian clover foliage was impacted by the interaction of bacterial strains '*Pseudomonas putidas*' and phosphorus fertilizer level, wherein the highest P (%) of berseem foliage was the resultant of using the bacterial strain M_5 + 150 Kg/ha from the phosphate fertilizer (triple superphosphate), that were the findings postulated by **Ansari and Ghadimi (2017)** in Iran.

The interaction effect between berseem varieties and the phosphorus fertilization and lithovit regimes on forage P content was significant in the combined analysis in the 1st and 3rd cuts. Allusion to the 1st cut (Table 1-A), P (%) of each berseem variety varied significantly under the ten fertilization regimes. Under each of F_1, F_2, and F_8 fertilization regimes, Helaly berseem variety has the uppermost P (%) and amounted as much as 0.627, 0.628 and 0.617%, respectively. Under F_3 and F_6 fertilization regimes, the local variety was superior in P (%) and valued 0.661 and 0.534%, in the same order, while under each of F_4, $F_{5,}$ and F_7 fertilization regimes, Sakha 4 berseem variety has the highest P (%) amounted as 0.693, 0.618 and 0.602%, consecutively. Under F_9 and F_{10} fertilization regimes, berseem variety Gemmeiza 1 (0.542%) and Serw 1 (0.528%) ranked first allusion to P (%). In the other direction, the highest P (%) was achieved under each of the following interactions, Helaly × F_1 and/or F_2, Gemmeiza 1× F_3 and/or F_4, Sakha 4×F_4, Serw 1×F_1, Giza 6×F_1 as well as the local variety × F_8. The uttermost P (%) valued 0.693% was the resultant of the F_4 × Sakha 4 interaction, while the lowermost P (%) value (0.414%) was achieved under either F_6 × Sakha 4 or F_{10} × Gemmeiza 1 interaction.

Referring to the 3rd cut (Table 1-B) under each of F_1, $F_{5,}$ and F_{10}, Gemmeiza 1 berseem variety surpassed the other five berseem varieties in P content and recorded 0.394, 0445, and 0.424%, successively. Meanwhile, when fertilization regimes F_2, F_3, $F_{4,}$ and F_{10} were applied, the local variety has the highest P (%) and valued as 0.469, 0.507, 0.487, and 0.426%, orderly. Gemmeiza 1 berseem variety has the highest P (%) under the application each of F_5 and F_{10} (0.418, 0.422%). In case of F_6 fertilization regime, Sakha 4 berseem variety has the highest P (%) value (0.447%), moreover under F_7 and F_8 fertilization regimes, Helaly variety has the highest P (%) with values 0.507 and 0.500%, respectively. Finely, under F_9 fertilization regime, Serw 1 produced the highest P content. The uppermost value of P (%) *i.e.*, 0.507% was achieved under either F_3 × the local variety or F_7 × Helaly variety interaction. Otherwise, the lowermost value of P content (0.316%) was the resultant of the interaction impact between F_1 × Serw1.

Digestible Energy (DE, Kcal/g dry matter)

The heat produced from the complete combustion of foods is expressed as gross energy (GE). The GE is not completely utilized by the animal since some of the feed leaves the body as faeces. The GE minus the energy lost in the faeces is called digestible energy (DE) **(Batterham, 1990 a and b; de Souza *et al.*, 2018).**

Digestible energy (DE) of the six Egyptian clover varieties as affected by the biochemical phosphorus fertilization and lithovit regimes is presented in Table 1. The varietal differences in digestible energy were highly significant in both the 1st and 3rd cuts. Referring to the 1st cut, Gemmeiza 1 berseem variety has the highest DE (4.12 Kcal/g dry matter) while Helaly berseem variety has the lowest DE (3.97 Kcal/g dry matter). Meanwhile, in the 3rd cut Giza 6 berseem variety was the superior in DE (4.06 Kcal/g dry matter), while Serw 1 berseem variety was the inferior in digestible energy. Since high dietary fiber levels can reduce the DE,

Table 1-A. Interaction effect between Egyptian clover varieties and bio-chemical phosphorus fertilization and lithovit regimes on phosphorus content (P%) 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	A 0.627 a	A 0.628 a	B 0.620 b	E 0.591 d	I 0.480 f	H 0.514 c	G 0.533 c	B 0.617 a	F 0.540 b	I 0.483 d
Gemmeiza 1	F 0.445 f	GH 0.416 b	A 0.599 c	AB 0.599 c	D 0.493 e	G 0.418 e	B 0.595 b	E 0.480 d	C 0.542 a	H 0.414 f
Sakha 4	D 0.526 d	E 0.478 e	G 0.427 f	A 0.693 a	B 0.618 a	I 0.414 f	C 0.602 a	H 0.422 f	G 0.430 f	F 0.459 e
Serw 1	A 0.596 c	C 0.530 d	B 0.581 d	F 0.504 f	D 0.523 c	C 0.531 b	G 0.492 d	I 0.457 e	E 0.514 d	C 0.528 a
Giza 6	A 0.609 b	B 0.601 b	C 0.539 e	D 0.526 e	F 0.502 d	I 0.434 d	H 0.442 f	E 0.515 c	G 0.483 e	D 0.526 b
Local	H 0.492 e	E 0.533 c	A 0.661 a	B 0.619 b	D 0.538 b	E 0.534 a	I 0.484 e	C 0.582 b	F 0.520 c	G 0.505 c

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

Table 1-B. Interaction effect between Egyptian clover varieties and bio-chemical phosphorus fertilization and lithovit regimes on phosphorus content (P%) 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	G 0.383 c	D 0.407 c	H 0.356 e	C 0.423 b	F 0.392 f	I 0.350 f	A 0.507 a	B 0.500 a	E 0.404 d	G 0.382 e
Gemmeiza 1	G 0.394 a	H 0.377 f	F 0.409 c	D 0.418 c	A 0.445 a	B 0.432 b	F 0.407 c	I 0.372 e	E 0.412 c	C 0.424 a
Sakha 4	J 0.357 e	C 0.434 b	E 0.423 b	I 0.381 e	H 0.397 e	B 0.447 a	D 0.428 b	A 0.481 b	G 0.404 d	F 0.415 b
Serw 1	I 0.316 f	E 0.389 d	G 0.371 d	C 0.424 b	B 0.435 b	F 0.381 e	H 0.357 e	B 0.434 c	A 0.474 a	D 0.397 c
Giza 6	E 0.391 b	F 0.382 e	H 0.333 f	C 0.414 d	B 0.420 c	D 0.405 c	G 0.363 d	C 0.417 d	A 0.431 b	E 0.392 d
Local	H 0.377 d	C 0.469 a	A 0.507 a	B 0.487 a	F 0.405 d	G 0.393 d	I 0.354 f	J 0.323 f	D 0.431 b	E 0.426 a

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

so Gemmeiza 1 berseem variety which has the lowermost crude fiber (24.59) in the 1st cut, has also the highest DE. Withal, Helaly berseem variety has the lowest DE because of it's high content of crude fiber in the 1st cut. Referring to the 3rd cut, the berseem variety Giza 6 has the lowest crude fiber content (CF%) so, it was the superior in DE, however Serw 1 berseem variety was the inferior in DE because of it's high content of crude fiber which was 28.66% **(Ibrahim *et al.*, 2022).**

Forage crop of the 1st cut has relatively higher DE (4.06 Kcal/ g dry matter) as the average of the six Egyptian clovers, than the 3rd cut (3.97 Kcal/ g dry matter) that was expetant trend since fiber content of the 1st berseem cut is relatively lower than the 3rd cut.

The biochemical phosphorus fertilization and lithovit regimes had intrinsically impacts on the digestible energy of the 1st and 3rd cuts of the six berseem varieties investigated. The highest DE value in each of the 1st cut (4.13 Kcal/ g dry matter) and the 3rd cut (4.03 Kcal/ g dry matter) was the resultant of the fertilization regimes F_9 *i.e.* under the combination of 25% chemical P + the biofertilizer 'phosphorien' + nano CO_2 fertilizer 'lithovit'. The sole biofertilizer 'phosphorien' *i.e.* F_3 fertilization regime, as well as the duality application of 25% chemical P + the biofertilizer 'phosphorien' *i.e.* F_5 fertilization regime lessen digestible energy of berseem to 3.96 and 3.92 Kcal/g dry matter in 1st and 3rd cuts, respectively.

The interaction between the ten biochemical phosphorus fertilization and lithovit regimes and the six berseem varieties was influential on the digestible energy of both 1st and 3rd cuts (Tables 1-C and 1-D). In the 1st cut and under each of F_1, F_5, F_6, F_8, and F_9 fertilization regimes, Sakha 4 berseem variety surpassed the other varieties in the digestible energy. The highest DE was also achieved by Giza 6 berseem variety under F_2 fertilization regime, while under F_3 and F_7 fertilization regimes, Gemmeiza 1 berseem variety ranked first over the other varieties. Withal, under F_4 and F_{10} Serw 1 and Helaly exhibited the highest DE values. In the other direction, Helaly berseem variety was supreme in DE (4.21 Kcal/g dry matter) under F_{10} fertilization regime. However, Gemmeiza 1 outrank the other berseem varieties under F_2 fertilization regime. As well, Sakha 4 under F_9, Serw 1 under F_4, Giza 6 under F_2 as well as the local variety under F_7 fertilization regimes, each has the highest DE value. The uppermost digestible energy (4.29 Kcal/ g dry matter) has been recorded under the interaction impact between Sakha 4 berseem variety and F_9 fertilization regime. The lowermost DE value (3.70 Kcal/g dry matter) was achieved under the interaction of F_5 fertilization regime and the Helaly berseem variety.

Allusive to the 3rd cut results (Table 1-D), F_1 fertilization regime produced the highest DE value (4.16 Kcal/g dry matter) for Serw 1 berseem variety. Eke, fertilization regime F_5 was superior in DE when applied to Gemmeiza 1 berseem variety. Whereas, F_7 fertilization regime exhibited the highest DE value when supplied to Giza 6 berseem variety. Fertilization regime F_9 was superior in DE when supplied to either Sakha 4 or the local berseem varieties. Finley, F_{10} fertilization regime produced the highest DE when applied to the Helaly berseem variety. In the other direction, Giza 6 berseem variety represents superiority in digestible energy under five out of the ten fertilization regimes (F_3, F_5, F_6, F_7, and F_8), while the local berseem variety represents superiority in DE under fertilization regimes F_4 and F_9. Gemmeiza 1 × F_2, Giza 6 × F_3, and Helaly × F_{10} were also superior in DE. The uppermost DE (4.21) was the resultant of the interaction between F_7 fertilization regime and Giza 6 berseem variety. Otherwise, the lowest DE (3.62) was the resultant of F_5 × the local variety interaction.

Protein Yield (Kg/fad.)

Results compiled in Table 1 testify the effect of six Egyptian clover varieties and ten biochemical phosphorus fertilization and lithovit regimes on protein yield of the 1st and 3rd cuts.

Operative varietal differences in protein yield of Egyptian clover were noteworthy in both the 1st and 3rd cuts. Giza 6 berseem variety has the highest protein yield (269.87 Kg/fad.) in the first cut. It is a great moment to note that Giza 6 berseem variety has also the highest dry forage yield (1122.15 Kg/fad.) in the first cut. Gemmeiza 1 berseem variety has the lowest protein yield in

Table 1-C. Interaction effect between Egyptian clover varieties and bio-chemical phosphorus fertilization and lithovit regimes on digestible energy (DE, Kcal/ g dry matter) 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 3.96 e	F 3.97 d	E 3.99 d	I 3.87 e	J 3.70 f	B 4.04 e	H 3.92 f	D 4.00 d	C 4.03 e	A 4.21 a
Gemmeiza 1	J 3.97 d	A 4.21 b	D 4.16 a	C 4.19 b	I 4.05 d	H 4.07 d	E 4.15 a	F 4.14 b	B 4.20 b	G 4.09 e
Sakha 4	G 4.12 a	I 3.79 f	J 3.72 f	H 3.81 f	C 4.25 a	D 4.24 a	F 4.13 d	B 4.27 a	A 4.29 a	E 4.16 b
Serw 1	F 4.05 b	I 3.86 e	J 3.72 e	A 4.26 a	C 4.20 b	B 4.21 b	H 4.02 e	G 4.04 c	D 4.17 c	E 4.10 d
Giza 6	J 3.98 c	A 4.25 a	F 4.07 c	B 4.17 c	C 4.14 c	G 4.01 f	D 4.14 c	I 3.98 e	H 3.99 f	E 4.08 f
Local	C 4.12 a	G 4.10 c	D 4.12 b	J 3.91 d	I 3.94 e	E 4.11 c	A 4.14 b	H 3.95 f	F 4.11 d	B 4.13 c

F_1 control, **F_2** chemical P 15.5 kg P_2O_5/ fad, **F_3** bio-fertilizer phosphorien, **F_4** 50% of chemical P + bio (phosphorien), **F_5** 25% of chemical p + bio (phosphorien), **F_6** chemical P 15.5 kg P_2O_5/ fad + lithovit, **F_7** Phosphorien + lithovit, **F_8** 50% of chemical P + bio (phosphorien) + lithovit, **F_9** 25% of 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 digestible energy (DE, Kcal/g dry matter) 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 3.85 e	G 3.85 f	J 3.78 f	E 3.94 e	I 3.83 e	F 3.88 d	D 3.96 d	C 3.97 d	B 4.05 d	A 4.12 a
Gemmeiza 1	E 3.98 c	B 4.06 a	C 4.04 b	I 3.91 f	A 4.08 b	G 3.96 b	D 3.98 c	J 3.87 e	H 3.93 e	F 3.97 e
Sakha 4	J 3.89 d	D 3.97 d	F 3.95 e	E 3.96 c	I 3.89 c	G 3.94 c	H 3.90 e	B 4.01 c	A 4.09 c	C 3.98 d
Serw 1	A 4.16 a	C 3.99 b	D 3.96 d	E 3.95 d	F 3.88 d	H 3.66 f	J 3.64 f	I 3.65 f	G 3.82 f	B 4.08 b
Giza 6	J 3.75 f	I 3.94 e	F 4.09 a	D 4.15 b	B 4.20 a	G 4.02 a	A 4.21 a	C 4.16 a	E 4.11 b	H 4.00 c
Local	E 4.05 b	G 3.99 c	F 4.02 c	B 4.20 a	J 3.62 f	I 3.82 e	C 4.16 b	D 4.13 b	A 4.20 a	H 3.93 f

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

the 1st cut (172.06 Kg/fad.), as well it has the lowest dry forage yield (702.49 Kg/fad.) in the 1st cut **(Ibrahim *et al.*, 2022)**. Referring to the 3rd cut, Sakha 4 and the local variety produced the highest and the lowest protein yield (289.86, 195.30 Kg/fad.) in the same respective order. The average protein yield of the six berseem varieties in the 3rd cut was relatively higher (250.63 Kg fad.) than that in the 1st cut (229.02 Kg/fad.). Superiority of the 3rd cut over the 1st one in protein yield could be ascribed to the flush growth of berseem plants which produced the 3rd cut.

The variation in the bromatological traits of the studied varieties may be explained by the genotypic characteristics of each variety and their response to the environment.

The biochemical phosphorus fertilization regimes displayed diverse influence on berseem protein yield in the 1st and 3rd cuts (Table 1). Allusive to the 1st cut, application of the sole nano fertilizer lithovit as foliar spray produced the highest protein yield (262.27 Kg/fad.). Otherwise, application of either F_5 or F_8 reduced the protein yield to the lowest values (208.39 and 210.82 Kg/fad.) orderly without significant value in-between. Diverse results were exhibited in the 3rd cut, wherein availability of phosphorus *via* either F_5 fertilization regime (25% chemical P + biofertilizer "phosphorien") or F_9 fertilization regime (25% chemical P + biofertilizer "phosphorien" + lithovit) produced the highest protein yield (280.76 and 275.20 Kg/fad.) successively. The lowest protein yield (219.24 Kg/fad.) in the 3rd cut was the resultant of F_6 application (chemical P 15.5 P_2O_5/fad. + lithovit). The existence of proper amount of available phosphorus enhanced plant growth and development as well as elevated protein yield **(Wang *et al.*, 2006)**. Results obtained by **Ansari and Ghadimi (2015)** developed that at a phosphorus fertilizer level of zero, the M_{21} phosphate solubilizing bacteria (PSB) produced the highest protein yield (1088 Kg/ha). They added that in case of supply 50 and 100 Kg/ha phosphorus, the M_{168} PSB strain produced a higher protein yield with an average of 1090 and 1164 Kg/ ha, in respective order. **Chaichi *et al.* (2015)** imparted that the highest protein yield of Egyptian clover grown in Iran was obtained by the dual application of nitrogen fixing bacteria and phosphorus solubilizing bacteria. **Arif *et al.* (2022)** noted that application of 120 Kg P_2O_5/ ha recorded the highest protein yield for Egyptian clover grown in India.

Impact of the interaction between berseem varieties and the ten biochemical phosphorus fertilization and lithovit regimes on protein yield of the 1st cut was operative as shown in Table 1-E**.** Helaly berseem variety was the supreme over the other berseem varieties in protein yield under each of F_6, F_8, F_9 and F_{10} fertilization regimes. Serw 1 berseem variety has the highest protein yield whichever F_2 and F_5 was applied. However, Giza 6 berseem variety ranked the first over the other varieties under each of F_4, F_6 and F_7 fertilization regimes. As well, the local variety of Egyptian clover has the highest protein yield under each of F_1, F_3 and F_9 fertilization regimes.

Allusion to the other direction of the interaction, F_{10} fertilization regime outbalanced the other fertilization regimes in protein yield when Helaly berseem variety was sown. However, fertilization regimes F_6 and F_9 resulted in significant excess in protein yield of the berseem variety Gemmeiza 1. More and above, F_2, F_5 and F_6 fertilization regimes were at par in protein yield of the berseem variety Sakha 4, tacking in acount that these fertilization regimes were the supreme over the others. In the same line each of the following interactions, F_2 × Serw 1, F_5 × Serw 1, F_4 × Giza 6, F_7 × Giza 6 as well as F_1 × the local variety and F_3 × the local variety produced the highest protein yield. In general, the uppermost protein yield value (405.30 Kg/fad.) was the outturn of the interaction between F_{10} fertilization regime (sole foliar application of the nano-fertilizer "lithovit") and Helaly berseem variety. The lowermost protein value (114.22 Kg/fad.) was the resultant of the interaction between F_5 fertilization regime (25% chemical P + biofertilizer "phosphorien") and the berseem variety Gemmeiza 1.

Referring to the 3rd cut, Helaly berseem variety outclassed the other berseem varieties in protein yield (Kg/fad.) under five out of the ten bio-chemical phosphorus fertilization and lithovit regimes *i.e.* F_1, F_2, F_3, F_4, and F_5 (Table 1-F). Withal, Gemmeiza 1 berseem variety has the highest protein yield under each of F_6, and F_{10} fertilization regimes. Also, Sakha 4 berseem variety outbraved the other berseem varieties under each of F_3, F_5, F_6, F_7, F_9 and F_{10} fertilization

Table 1-E. Interaction effect between Egyptian clover varieties and bio-chemical phosphorus fertilization and lithovit regimes on protein yield (Kg/fad.) 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	E	E	D	E	D	B	C	B	B	A
	132.57 e	121.84 e	181.31 d	148.34 C	177.79 c	284.01 a	240.92 b	277.25 a	280.19 a	405.30 a
Gemmeiza 1	BC	AB	C	DE	E	A	D	DE	AB	BC
	193.68 d	209.61 d	180.38 d	117.80 d	114.22 d	234.88 c	144.00 d	133.29 d	206.09 c	186.64 d
Sakha 4	C	A	C	BC	ABC	AB	E	E	C	BC
	217.37 c	255.88 b	212.54 c	223.13 b	237.81 b	249.88 bc	160.57 d	168.54 c	213.13 c	223.95 c
Serw 1	B	A	AB	D	A	CD	D	D	E	BC
	273.00 b	303.67 a	278.21 ab	223.67 b	302.50 a	243.63 c	228.93 b	225.47 b	203.89 c	250.56 c
Giza 6	CD	DEF	CDE	AB	G	C	A	EF	F	B
	269.15 b	241.72 bc	257.38 b	339.07 a	163.64 c	276.35 ab	360.83 a	235.35 b	223.62 bc	331.60 b
Local	A	C	A	BC	B	CD	D	C	B	D
	308.57 a	223.97 cd	307.37 a	231.40 b	254.37 b	203.25 d	191.52 c	225.00 b	255.23 a	175.59 d

F_1 control, **F_2** chemical P 15.5 kg P_2O_5/ fad, **F_3** bio-fertilizer phosphorien, **F_4** 50% of chemical P + bio (phosphorien), **F_5** 25% of chemical p + bio (phosphorien), **F_6** chemical P 15.5 kg P_2O_5/ fad + lithovit, **F_7** Phosphorien + lithovit, **F_8** 50% of chemical P + bio (phosphorien) + lithovit, **F_9** 25% of 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 protein yield (Kg/ fad) 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	C	ABC	ABC	AB	A	E	D	B	E	E
	302.43 a	315.40 a	311.93 a	329.24 a	334.87 a	205.78 b	249.99 c	308.12 b	190.90 e	201.80 d
Gemmeiza 1	G	BCD	EF	F	B	CD	E	D	A	BC
	166.99 d	283.51 b	228.94 b	209.57 e	308.12 b	280.78 a	240.06 cd	265.79 c	345.74 b	304.17 a
Sakha 4	G	DE	BC	BC	B	EF	BC	F	A	C
	204.47 c	272.08 b	307.13 a	312.54 b	321.09 ab	270.13 a	306.96 a	252.44 c	362.57 a	289.15 a
Serw 1	ABC	F	DE	A	CD	E	CD	C	AB	BC
	253.48 b	150.49 d	211.79 c	272.43 c	232.23 d	200.41 b	232.77 d	236.96 d	264.88 d	245.67 b
Giza 6	C	D	C	C	B	D	B	A	B	C
	240.20 b	195.27 c	243.63 b	242.41 d	280.23 c	174.32 c	281.73 b	332.52 a	290.21 c	220.25 c
Local	ABC	ABC	B	A	AB	CD	ABC	ABC	ABC	D
	200.49 c	204.30 c	187.96 d	213.31 e	208.03 e	184.06 c	196.43 e	201.86 e	196.90 e	159.64 e

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

regimes. Finely, Giza 6 berseem variety surpassed the other varieties in protein yield under F_8 fertilization regime. On the other direction, each of F_2, F_3, F_4 and F_5 has an odds in protein yield when Helaly berseem variety was sown. Moreover, F_9 × Gemmeiza 1 and F_9 × Sakha 4 produced high protein yields. Each of the following interaction F_1 × Serw 1, F_4 × Serw 1, F_9 × Serw 1, Giza 6 × F_8; each of F_1, F_2, F_4, F_5, F_7, F_8 and F_9 × the local berseem variety significantly increased protein yield of berseem forage in the 3rd cut.

The outmost protein yield (362.57 Kg/fad.) was the outturn of the interaction effect between F_9 fertilization regime and Sakha 4 berseem variety. Otherwise, the lowermost protein yield (150.49 Kg/fad.) was the resultant of the interaction impact between F_2 fertilization regime and Serw 1 berseem variety.

Carbohydrate Yield (Kg/fad.)

Carbohydrate yield (Kg/fad.) of the six Egyptian clover varieties under the ten biochemical phosphorus fertilization and lithovit regimes are publicized in Table 2. Egyptian clover varieties varied distinctly in their carbohydrate yield (Kg/ fad) in both 1st and 3rd cuts. Giza 6 berseem variety recorded the highest carbohydrate yield (380.65 Kg/fad.) in the 1st cut, while Gemmeiza 1 recorded the lowest carbohydrate yield (226.01 Kg/fad.) for the same cut. Diverse findings were noted in the 3rd cut wherein; Sakha 4 berseem variety was the highest in carbohydrate yield (505.83 Kg/fad). Otherwise, the local berseem variety yielded the lowest carbohydrate yield (336.26 Kg/ fad). Superiority of Giza 6 berseem variety in carbohydrate yield of the 1st cut is ascribed mainly to its superiority in nitrogen free extract (NFE%) content (33.46%) which represents the carbohydrate content as well as its superiority in the dry forage yield (1122.15 Kg/ fad) in the 1st cut. However, superiority of the berseem variety Sakha 4 in the 3rd cut pointedly attributed to its superiority in the dry forage yield of the 3rd cut (1383.50 Kg/fad.) **(Ibrahim *et al.*, 2022).**

Carbohydrate yield of berseem forage differed significantly due to various bio-chemical phosphorus fertilization and lithovit regimes in both 1st and 3rd cuts. In the 1st cut carbohydrate yield of berseem forage recorded the highest value (387.51 Kg/fad.) under F_6 fertilization regime (chemical 15.5 P_2O_5/fad. + lithovit). Otherwise, the lowermost carbohydrate yield (246.60 Kg/fad.) was the resultant of F_9 fertilization regime application (25% of the chemical P + bio-fertilizer "phosphorien" + lithovit foliar spray). Referring to the 3rd cut, reversed results were recorded for the abovenamed fertilization regimes wherein F_6 fertilization regime has the lowermost carbohydrate yield (406.33 Kg/fad.) while F_9 fertilization regime has the highest carbohydrate yield (484.41 Kg/ fad.). It is worth to mention that F_6 and F_{10} fertilization regimes were at par in their low carbohydrate yield while F_4 and F_9 fertilization regimes were at par in their high carbohydrate yield. Superiority or inferiority of the abovenamed fertilization regimes in carbohydrate yield could be ascribed to the close relation with both NFE (%) and the dry forage yield for the same fertilization treatments.

The operative and significant impact of the interaction between the biochemical phosphorus fertilization and lithovit regimes on a side, and the six berseem varieties on the other one was appreciable on carbohydrate yield (Kg/fad.) in the 1st and 3rd cuts. Allusion to the 1st cut (Table 2-A) and under each of F_1, F_2 and F_8 fertilization regimes, the local berseem variety has the highest carbohydrate yield. The highest carbohydrate yield (Kg/fad.) was also achieved under each of the following interactions, F_4 × Sakha 4; F_5 × Serw 1; F_6×Gemmeiza 1; F_6 × Giza 6 and F_{10} × Helaly berseem variety. Referring to the other direction, Giza 6 berseem variety outrank the other varieties in carbohydrate yield under each of F_1, F_2, F_3, F_4, F_6 and F_7 fertilization regimes. The local berseem variety has the highest carbohydrate yield under each of F_1, F_2, F_8 and F_9 fertilization regimes. Helaly berseem variety was supreme in carbohydrate yield under the treatment F_{10} (sole foliar spray with lithovit) fertilization regime. The utmost carbohydrate yield (574.68 Kg/fad.) was obtained under the interaction impact of F_6 fertilization regime (chemical P 15.5 Kg P_2O_5/ fad. + lithovit) × Giza 6 berseem variety. The lowermost carbohydrate yield (120.43 Kg/fad.) was achieved under the interaction influence of F_1 (control) × Helaly berseem variety. Oscillatory findings were observed in the 3rd cut (Table 2-B**)**, wherein under fertilization regimes

Table 2. Varietal differences as well as bio-chemical phosphorus fertilization and lithovit regimes effect on carbohydrate and fiber yields (Kg/fad.) of Egyptian clover varieties

Main effects and interactions	Carbohydrate yield (Kg/fad.)		Fiber yield (Kg/fad.)	
	Combined		Combined	
	1st cut	3rd cut	1st cut	3rd cut
Egyptian clover variety (V)				
Helaly	262.07 d	467.52 b	253.75 c	375.64 a
Gemmeiza 1	226.01 e	459.01 bc	173.68 e	331.97 b
Sakha 4	254.36 d	505.83 a	229.13 d	372.93 a
Serw 1	310.14 c	417.67 d	273.26 b	325.80 b
Giza 6	380.65 a	446.96 c	285.22 a	282.16 c
Local	339.70 b	336.26 e	265.17 bc	234.02d
F-test	**	**	**	**
Bio-chemical phosphorus fertilization and lithovit regime (F)				
F_1	270.74 f	420.44 de	250.30 cd	306.79 e
F_2	306.70 bc	453.78 b	257.75 bc	314.16 de
F_3	267.95 f	439.93 bc	277.79 a	318.96 cde
F_4	291.56 de	471.86 a	242.69 de	320.19 cd
F_5	276.56 ef	431.07 cd	227.37 fg	359.60 a
F_6	387.51 a	406.33 e	266.29 ab	311.23 de
F_7	299.39 cd	438.20 bcd	232.90 efg	321.48 cd
F_8	286.52 de	438.84 bc	234.69 ef	335.67 b
F_9	246.60 g	484.41 a	221.34 g	330.38 bc
F_{10}	321.36 b	403.89 e	255.90 bc	285.74 f
F-test	**	**	**	**
Interaction				
V×F	**	**	**	**

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

Table 2-A. Interaction effect between Egyptian clover varieties and bio-chemical phosphorus fertilization and lithovit regimes on carbohydrate yield (Kg/ fad) 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 120.43 d	EF 156.73 c	E 161.69 e	EF 146.19 d	E 177.80 d	B 425.53 b	D 271.45 b	C 366.04 a	D 296.75 b	A 498.12 a
Gemmeiza 1	CDEF 208.20 c	B 287.34 b	CD 232.09 d	F 171.27 d	DEF 200.55 d	A 339.92 cd	CDE 218.67 c	F 174.89 c	EF 185.56 de	C 241.61 d
Sakha 4	C 244.36 c	AB 289.28 b	DE 198.47 de	A 325.86 b	C 250.98 c	A 325.65 d	BC 258.00 b	E 174.33 c	CD 221.45 cd	BC 255.18 cd
Serw 1	DE 286.23 b	CD 308.78 b	CD 297.95 c	F 244.23 c	A 423.99 a	B 371.81 c	DE 283.44 b	CD 301.30 b	EF 254.07 c	C 329.59 b
Giza 6	D 371.75 a	C 413.69 a	CD 380.82 a	B 520.82 a	F 266.32 c	A 574.68 a	B 485.70 a	E 304.10 b	G 167.68 e	E 320.98 b
Local	A 393.46 a	AB 384.38 a	C 336.66 b	C 340.98 b	C 339.74 b	D 287.47 e	D 279.06 b	A 398.46 a	BC 354.11a	D 282.72 c

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

Table 2-B. **Interaction effect between Egyptian clover varieties and bio-chemical phosphorus fertilization and lithovit regimes on carbohydrate yield (Kg/ fad) 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	CD	A	D	BCD	CD	BC	D	AB	E	F
	482.12 b	568.31 a	465.74 bc	499.46 b	488.18 b	519.46 a	473.02 ab	542.00 a	359.72d	277.19 e
Gemmeiza 1	G	CD	C	H	FG	B	DE	EF	A	AB
	371.30 c	466.31 b	501.75 ab	316.86 d	380.60 d	541.19 a	431.86 bc	419.05 b	589.95 b	571.28 a
Sakha 4	DE	G	CD	B	C	EF	DE	FG	A	E
	475.34 b	399.41 c	516.91 a	589.88 a	536.82 a	457.18 b	488.65 a	415.30 b	710.27 a	468.51 b
Serw 1	A	A	B	A	B	D	B	C	B	B
	535.06 a	498.99 b	392.86 d	493.63 b	410.36 cd	264.29 c	408.82 c	347.96 c	420.71 c	404.01 c
Giza 6	E	DE	CD	AB	A	DE	BC	A	CDE	E
	352.28 c	408.26 c	448.39 c	508.47 b	511.80 ab	420.00 b	467.29 ab	547.95 a	424.25 c	380.94 c
Local	D	AB	D	A	E	E	BC	BC	AB	CD
	306.53 d	381.39 c	313.96 e	422.87 c	258.68 e	235.84 c	359.60 d	360.77 c	401.55 cd	321.44 d

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

F_1, F_2, F_4, F_5, F_8, F_9 and F_{10}, the highest carbohydrate yield was achieved from Serw1; Helaly, Serw 1, the local variety; Serw 1, Giza 6, the local variety; Giza 6; Helaly, Giza 6; Gemmeiza 1, Sakha 4; and Gemmeiza 1 varieties, in the same order. Allusive to the other direction, Helaly berseem variety has the highest carbohydrate yield under each of F_6, F_7 and F_8 fertilization regimes. Withal, Gemmeiza 1 berseem variety carbohydrate yield outranks other berseem varieties under F_3, F_6 and F_{10} fertilization regimes. As well, Sakha 4 has the highest carbohydrate yield under each of F_3, F_4, F_5, F_7 and F_9 fertilization regimes. Serw 1 yielded the highest carbohydrate yield under the control fertilization regime (F_1). Giza 6 berseem variety produced the highest carbohydrate yield under each of F_5, F_7 and F_8 fertilization regimes. The uppermost carbohydrate yield (710.27 Kg/ fad) was the resultant of the interaction of F_9 fertilization regime × Sakha 4 berseem variety. The lowest carbohydrate yield (235.84 Kg/ fad) was obtained under the interaction influence of the local variety × F_6 fertilization regime.

Fiber Yield (Kg/fad.)

The results in Table 2 points to the effect of biochemical phosphorus fertilization and lithovit regimes on fiber yield (Kg/fad.) of Egyptian clover varieties in 1st and 3rd cuts.

Respecting to the 1st cut, fiber yield of the Egyptian clover varieties ranged between 173.68 Kg/fad., for Gemmeiza 1 berseem variety to 285.22 Kg/fad., for Giza 6 berseem variety. In the 3rd cut, both Helaly and Sakha 4 had the highest fiber yield which valued 375.64 and 372.93 Kg/fad., consecutively. The lowest fiber yield (234.02 Kg/fad.) was that of the local variety. All varietal differences in fiber yield were operative in both cuts. Fiber yield (Kg/ fad) of the third cut was in general higher than that yield in the 1st cut. That increase in fiber yield of most berseem varieties with cuts advanced could be explained appropriately to the affluence of both fiber content (CF%) and dry weight of berseem varieties in the 3rd cut over the 1st one.

The results on account fiber yield (Kg/fad.) of Egyptian clover (Table 2) revealed that different bio-chemical phosphorus fertilization and lithovit regimes had operatively influenced fiber yield (Kg/fad.). The maximum fiber yield (277.79 and 359.60 Kg/fad.) in the 1st and 3rd cuts, was observed with the F_3 and F_5 fertilization regimes, respectively *i.e.* under either sole application of the biofertilizer phosphorien (F_3) or dual application of 25% chemical P + the bio-fertilizer phosphorien (F_5). The fertilization regimes F_9 in the 1st cut and F_{10} in the 3rd cut recorded the minimum fiber yield (221.34 and 285.74 Kg/fad.) in the same respective order.

The interaction between the six berseem varieties and the ten bio-chemical phosphorus fertilization and lithovit treatments was effectual on fiber yield (Kg/fad.) of both 1st and 3rd cuts (Tables 2-C, 2-D). Referring to the 1st cut, under the control fertilization treatment (F_1), the highest fiber yield (Kg/fad.) was achieved by each of Gemmeiza 1 (223.16 Kg/fad.) and the local berseem variety (312.78 Kg/ fad.). F_2 and F_4 were at par, but both fertilization regimes surpassed the other fertilization regimes in fiber yield of Sakha 4 berseem variety. However, each of F_2 and F_3 fertilization regimes has the highest fiber yield when Serw 1 berseem variety was planted. As well each of F_4, F_6, F_7 and F_{10} fertilization regimes has at par fiber yield but they surpassed the other regimes when the berseem variety Giza 6 was sown. Likely, each of F_1, F_3, F_4, F_5 and F_8 has at par fiber yield, in the same time they surpassed the other fertilization regimes when the local berseem variety was planted. Respecting to the other direction, Helaly berseem variety has the highest fiber yield under each of F_8, F_9 and F_{10} fertilization regimes. Withal, Sakha 4 berseem variety was the supreme over the other varieties under each of F_2 and F_4 fertilization regimes. Serw 1 berseem variety ranked first compared to other varieties in fiber yield under whichever F_2 and F_3. Giza 6 berseem variety has the highest fiber yield when any of F_1, F_4, F_6 and F_7 fertilization regimes was applied. The local berseem variety was superior in fiber yield under each of F_4, F_5 and F_8 fertilization regimes. It's worthy to mention that the uttermost fiber yield (413.70 Kg/fad.) was the resultant of the interaction between Serw 1 berseem variety and F_3 fertilization regime (sole application of biofertilizer phosphorien). Meantime, the lowest fiber yield (112.91 Kg/fad.) was the outturn of the interaction between Gemmeiza 1 berseem variety and F_4 fertilization regime.

Allusion to the 3rd cut, the interaction between the two main factors of the study was efficacious on fiber yield of the Egyptian clover varieties under study.

Fiber yield of berseem forage recorded the highest value under each of the following fertilization regimes *q.e.* F_2, F_3, and F_8 with values amounted 468.40, 468.63, and 476.18 Kg/fad., respectively, when the berseem variety Helaly was planted. Fertilization regime F_9 (25% of the recommended chemical phosphorus fertilizer + phosphorien + lithovit) enhanced the fiber yield of the berseem variety Gemmeiza 1 (460.33 Kg/fad.) over the other fertilization regime. Fertilization regimes F_4, F_5, F_7, and F_9 were at par in fiber yield of Sakha 4 berseem variety and each of them surpassed the other regimes of fertilization. Fertilization regimes F_7 and F_8 were the supreme in fiber yield of Serw 1 berseem variety (417.20 and 404.84 Kg/fad.) orderly. The control fertilization regime (F_1) ranked first in fiber yield of Giza 6 berseem variety (364.28 Kg/fad.). Fertilization regime F_5 resulted in the highest fiber yield (337.75 Kg/ fad.) of the local berseem variety. Referring to the other direction of the interaction, Helaly berseem variety surpassed the other varieties in fiber yield under each of F_1, F_2, F_3, F_4, F_5, F_6, and F_8 fertilization regimes and recorded values of 468.40, 469.63, 415.82, 476.18, 340.43 and 392.82 Kg/fad., in the same order. Gemmeiza 1 berseem variety was the supreme in fiber yield compared with the other varieties under F_6, F_9 and F_{10} fertilization regimes. As well, Sakha 4 berseem variety ranked first comparing to the other Egyptian clover varieties under F_4, F_6, and F_7 fertilization treatments in fiber yield which amounted as well as 413.50, 346.09 and 414.60 Kg/fad. Serw 1 variety came at the top in fiber yield (417.20 and 404.80 Kg/fad.) under F_7 and F_8 fertilization regimes orderly. The outmost fiber yield (476.18 Kg/fad.) was the resultant of the interaction effect between F_7 fertilization regime and berseem variety Helaly, while the lowermost fiber yield (195.28 Kg/fad.) was the outturn of the interaction impact between the local berseem variety and the F_9 fertilization regime.

Table 2-C. Interaction effect between Egyptian clover varieties and bio-chemical phosphorus fertilization and lithovit regimes on fiber yield (Kg/fad.) 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	F	E	E	D	B	C	BC	BC	A
	148.73 d	146.44 d	194.51 c	186.39 b	258.33 b	327.93 b	291.96 b	321.51 a	299.81 a	361.91 a
Gemmeiza 1	AB	C	CD	E	E	A	DE	E	C	BC
	223.16 c	192.03 c	172.99 c	112.91 c	137.71 d	253.52 c	142.95 e	129.53 c	176.21 d	195.84 d
Sakha 4	C	A	B	AB	C	C	D	D	D	C
	212.52 c	355.33 a	303.28 b	332.89 a	197.45 c	216.79 d	165.68 de	135.05 c	165.57 d	206.76 d
Serw 1	B	A	A	F	BC	E	CDE	D	F	BCD
	284.95 b	384.98 a	413.70 a	185.32 b	282.77 b	226.37 cd	252.86 c	249.99 b	192.25 d	259.43 c
Giza 6	B	D	C	AB	E	A	A	C	D	AB
	319.66 a	218.07 c	281.54 b	328.11 a	168.31 c	358.52 a	350.34 a	269.32 b	230.37 c	327.92 b
Local	A	B	A	A	A	C	CD	A	B	D
	312.78 ab	249.64 b	300.74 b	310.50 a	319.68 a	214.58 d	193.63 d	302.75 a	263.82 b	183.55 d

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

Table 2-D. Interaction effect between Egyptian clover varieties and bio-chemical phosphorus fertilization and lithovit regimes on fiber yield (Kg/fad.) 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	A	A	BC	A	D	D	E	E	E
	432.30 a	468.40 a	468.63 a	415.82 a	476.18 a	340.43 ab	330.44 b	392.82 a	229.04 e	202.40 d
Gemmeiza 1	E	C	CD	D	C	B	C	B	A	B
	232.92 e	316.08 b	289.03 c	269.98 c	310.05 c	371.62 a	304.16 c	369.63 b	460.33 a	395.88 a
Sakha 4	EF	EF	BC	A	A	DE	A	F	A	CD
	319.03 c	328.64 b	388.15 b	413.50 a	436.09 b	346.98 ab	414.60 a	303.96 c	418.73 b	359.57 b
Serw 1	EF	F	E	CD	D	D	A	AB	B	EF
	269.77 d	240.97 d	275.18 c	352.07 b	325.69 c	323.86 b	417.20 a	404.84 a	384.53 c	263.85 c
Giza 6	A	CD	CD	DE	CD	E	DE	B	C	CD
	364.28 b	270.36 d	269.68 c	256.84 c	271.84 d	234.81 c	262.84 d	329.00 c	294.37 d	267.61 c
Local	CD	B	CD	D	A	BC	D	D	D	CD
	222.46 e	260.54 d	223.09 d	212.91 d	337.75 c	249.64 c	199.62 e	213.79 d	195.28 f	225.12 d

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

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تأثير نظم التسميد الفوسفاتي البيوكيميائي والليثوفيت على بعض صفات الجودة لأصناف مختلفة من البرسيم

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أقيمت تجربة حقلية بمحطة البحوث الزراعية- كلية الزراعة- جامعة الزقازيق بمحافظة الشرقية- مصر خلال الموسمين الشتويين ٢٠٢٠/٢٠١٩، ٢٠٢١/٢٠٢٠. يهدف البحث الى دراسة تأثير ١٠ نظم للتسميد الفوسفاتي البيوكيميائي والليثوفيت على بعض صفات الجودة لمحصول العلف في الحشة الأولى والثالثة لستة أصناف من البرسيم المصري (*Trifolium alexandrinum* L.) هي: هلالي، سخا ٤، جميزة ١، جيزة ٦، سرو ١، وصنف محلي. نظم التسميد الفوسفاتي العشرة المستخدمة كانت على النحو التالي: كنترول **(F_1)**، سماد فوسفاتي كيماوي بمعدل ١٥.٥ كجم فو٢أ٥/ فدان **(F_2)**، سماد فوسفاتي بيوكيميائي "فوسفورين" **(F_3)**، ٥٠% من نظام التسميد F_2 + فوسفورين (F_4)، ٢٥% من نظام التسميد F_2 + فوسفورين (F_5)، نظام التسميد F_2 + الليثوفيت **(F_6)**، نظام التسميد F_3 + الليثوفيت (F_7)، نظام التسميد F_4 + الليثوفيت (F_8)، نظام التسميد F_5 + الليثوفيت (F_9)، وسماد الليثوفيت منفرداً (F_{10}). أظهرت النتائج وجود اختلافات صنفيه مؤكدة معنوياً في صفات نسبة الفوسفور في محصول العلف، الطاقة المهضومة، محصول كلا من البروتين، الكربوهيدرات والالياف في الحشتين الأولى والثالثة، أثرت نظم التسميد الفوسفاتي البيوكيميائي العشرة معنوياً على جميع صفات جودة محصول العلف سابقة الذكر في الحشتين الأولى والثالثة.

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