Scientific J. Flowers & Ornamental Plants
www.ssfop.com/journal
ISSN: 2356-7864 **doi: 10.21608/sjfop.2021.214143**

EFFECT OF MINERAL FERTILIZATION AND CUTTING NUMBERS ON GROWTH AND PRODUCTIVITY OF GUAR PLANT
I. EFFECT ON VEGETATIVE GROWTH PARAMETERS

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Scientific J. Flowers & Ornamental Plants, 8(4):461-469 (2021).

Received:
5/12/2021
Accepted:
24/12/2021

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ABSTRACT: This work was carried out during the two successive growing seasons of 2019 and 2020 at the farm of Animal Industrial Feeding Factory at Shosha Village, Production Sector, Agricultural Research Centre, Ministry of Agriculture, and Laboratory of Floriculture, Faculty of Agriculture, Minia University, to study the effect of mineral fertilization and number of cuts on the vegetative growth of guar (*Cyamopsis tetragonoloba*, (L.) Taub.) plants. Data revealed that increasing mineral NPK level led to a significant increase in plant height, number of branches and herb fresh and dry weights as compared with control. While, without cut treatment (control) was superior to other cutting treatments (one, two and three cuts) on increasing all studied previous parameters except number of branches. It can be noticed that the highest level of NPK mineral fertilization (500 kg/fed comprised of 200 kg ammonium sulfate + 200 kg calcium supper phosphate + 100 kg potassium sulfate) in combination with applying three cuts led to the greatest branch number.

Key words: *Cyamopsis tetragonoloba*, fertilization, NPK, number of cuts, vegetative growth.

INTRODUCTION

Guar, *Cyamopsis tetragonoloba* (L.) Taub. belongs to Family Fabaceae (Leguminosae) (Gillet, 1958), is a summer legume traditionally grown in the semi-arid regions of India and Pakistan as a vegetable, forage and grain crop. At the present time, guar is noticeable as one of the most important sources of mucilage, which makes a special type of gum, used in industry and pharmaceutical preparation. Guar seeds contain about 34% protein, 23% gum and 40% fixed oil (Kamel, 2009). There is still, however, a lack of a complete nutritive profile of guar cultivated in Egypt as summer forage legume and cut at a different time to get good branches, good yields and biomass quality and quantity are available.

Chemical nutrients, particularly N, P and K are most important for plants, as they play a vital role in the plant structure of several compounds i.e. hormones, protein, amino acids, nucleic acids and fats, and regulation of water relationship. However, using intense chemical fertilizers lead to serious problems on human health due to contamination of the environment (air, soil and drainage water). Supplying guar plants with N, P and K fertilization led to an increase in plant height, number of branches and herb fresh and dry weights (Sortino and Gresta, 2007; Kamel, 2009; Ayub *et al*., 2011 and Abo El-Ezz, 2019).

Cutting number had a positive impact on the growth of different plants (Omer *et al*., 1993 on guar; Akash and Saoub, 2000 on sudangrass; Simon *et al*., 2003 on white clover; Moniruzzaman *et al*., 2008 on kangkong plant; Abd El-Azim and Waleed, 2016 and Singh *et al*., 2017 on coriander; Nayak and Maji, 2018 on palak; Ansa and Garjila, 2019 on elephant grass).

Therefore, the aim of this study was to add more information concerning the effect of mineral fertilization and cutting frequency on the growth of guar plants (*Cyamopsis tetragonoloba* (L.) Taub.).

MATERIALS AND METHODS

This work was carried out during the two successive growing seasons of 2019 and 2020 at the farm of Animal Industrial Feeding Factory, Shosha Village, which belongs to the Production Sector, Agricultural Research Centre, Ministry of Agriculture, and laboratory of Floriculture, Faculty of Agriculture, Minia University, to study the effect of mineral fertilization and number of cuts on the vegetative growth of guar (*Cyamopsis tetragonoloba*, (L.) Taub.) plants.

Plant materials and proceedings:

The seeds of guar plant were obtained from Ornamental Nursery, Faculty of Agriculture, Minia University. The seeds were sown in sandy calcareous soil on the first day of March in both seasons. The experimental unit (plot) was 4.8 m^2 (2.0 × 2.4 meters) and contained 3.0 rows, 50 cm apart, and seeds were sown in hills, 30 cm apart on one side of the row, therefore, each plot contained 21 hills and plants were thinned to one plant per hill after three weeks from sowing date.

Experimental layout:

This experiment was laid out as a split-plot arrangement in a randomized complete block design (RCBD) with three replicates. The main plot (A) comprised four levels of NPK mineral fertilization [$N_0P_0K_0$ (control), $N_1P_1K_1$ (125 kg/fed), $N_2P_2K_2$ (250 kg/fed) and $N_3P_3K_3$ (500 kg/fed)]. While four treatments of number of cuts [NC_0 (without cut), NC_1 (one cut), NC_2 (two cuts) and NC_3 (three cuts)] occupied the sub-plots. Therefore, the experiment consists of 16 treatments. The soil analysis was carried out according to the procedure of Jackson (1973) and the obtained data were shown in Table (a).

Mineral fertilization treatments:

Ammonium sulfate (20.6% N), calcium supper phosphate (15.5% P_2O_5) and potassium sulfate (48.0% K_2O) as a sources of nitrogen, phosphorus and potassium, respectively, were used to prepare the following mineral fertilizer formulations:

- $N_0P_0K_0$ (control): without fertilization.
- $N_1P_1K_1$ (125 kg/fed): Comprised of 50 kg ammonium sulfate + 50 kg calcium supper phosphate + 25 kg potassium sulphate.
- $N_2P_2K_2$ (250 kg/fed): Comprised of 100 kg ammonium sulphate + 100 kg calcium supper phosphate + 50 kg potassium sulphate.
- $N_3P_3K_3$: (500 kg/fed): Comprised of 200 kg ammonium sulphate + 200 kg calcium supper phosphate + 100 kg potassium sulphate.

The amount of P was added during the preparation of the soil for cultivation. The amount of NK was divided into three equal

Table a. Physical and chemical analysis of the used soil during the two seasons of 2019 and 2020.

Soil character	Values		Soil Character	Values	
	2019	2020		2019	2020
Physical properties			**Soluble cations (mg/100 g soil)**		
Sand (%)	91.0	92.0	**Ca^{++}**	8.43	8.61
Silt (%)	6.60	5.80	**Mg^{++}**	1.49	1.57
Clay (%)	2.40	2.20	**Na^{+}**	0.92	1.01
Soil type	sandy	sandy	**K^{+}**	0.82	0.89
Chemical properties			**DTPA-Extractable nutrients**		
pH (1:2.5)	8.19	8.29	**Fe (ppm)**	1.07	1.12
E.C. (dS/m)	1.03	1.14	**Cu (ppm)**	0.39	0.42
O.M. (%)	0.05	0.05	**Zn (ppm)**	0.31	0.34
$CaCO_3$ (%)	13.67	13.98	**Mn (ppm)**	0.53	0.59

doses, the first one was done on April, 1st, the second one was done on April, 15th and the last one was done on April, 30th.

Cuttings treatments:

- NC_0: The plants were left without cutting but they were harvested at the end of the experiment (in the first week of October) in both seasons.
- NC_1: The plants were cut one time on May, 15th and they were harvested in the first week of October in both seasons.
- NC_2: The plants were cut two times on May, 15th and July, 1st and they were harvested in the first week of October in both seasons.
- NC_3: The plants were cut three times on May, 15th, July, 1st and August, 15th and they were harvested in the 1st week of October in both seasons.

Data recorded:

In the first week of October of both seasons the following vegetative growth traits were collected: plant height (cm), number of branches/plant, herb fresh and dry weights/plant (g).

Statistical analysis:

The obtained results were tabulated and statistically analyzed by using MSTAT–C (1986) software. While L.S.D. test at 5% was followed to compare the means of treatments.

RESULTS AND DISCUSSION

Plant height (cm):

Data presented in Table (1) showed that mineral fertilization treatments significantly increased plant height (cm) of guar (*Cyamopsis tetragonoloba,* (L.) Taub.) compared to control plants in both seasons. The increase in plant height over the control was 10.01, 21.0 and 33.10% due to $N_1P_1K_1$, $N_2P_2K_2$ and $N_3P_3K_3$ during the first season. The same trend was observed in the second season. So, the tallest plants (97.91 and 97.28 cm in both seasons, respectively) were obtained by the highest level of NPK (500 kg/fed).

Similar results on guar plant were noted by Razin (1991), Meawad *et al*. (1991), Salah El-Deen (1997), Omar (2005), Sortino and Gresta (2007), Salama and Nawar (2016), Seerangan *et al*. (2019) and Pimonov *et al*. (2021).

As can be seen from data presented in Table (1), without cut treatment (NC_0) significantly increased plant height than all other treatments [one cut (NC_1), two cuts (NC_2) or three cuts (NC_3)] in both seasons, whereas, the shortest plants were obtained from plants grazed three times (NC_3).

Our results are in agreement with those reported by Omer *et al*. (1993) on guar plant; Giambalvo *et al*. (2011) and Tufail *et al*. (2020) on berseem clover; Rana *et al*. (2015) on fenugreek plant; Abd El-Azim and Waleed (2016), Singh *et al*. (2017) and Bhapkar *et al*. (2019) on coriander; Ibrahim (2017) on *Moringa oleifera* and Ansa and Garjila (2019) on elephant grass.

The interaction between the main and sub-plot treatments (A × B) was significant for plant height in both seasons. The tallest plants were recorded with the plants fertilized with $N_3P_3K_3$ without cut (122.72 and 122.84 cm in both seasons, respectively) or fertilized with $N_2P_2K_2$ without cut (111.56 and 112.16 cm in both seasons, respectively).

Number of branches/plant:

Data presented in Table (1) proved that all used mineral fertilization treatments led to a significant increase in the number of branches/plant as compared to control plants in both seasons. The increase was parallel to the increase of mineral fertilization level. Therefore, the application of NPK (500 kg/fed) gave the highest value of branches number (17.19 in the first season and 15.84 branches in the second one) compared with control which recorded only 11.76 and 10.43 in the first and second seasons, respectively.

Table 1. Effect of mineral fertilization, number of cuts and their interactions on plant height (cm) and number of branches of guar plants during the first and second seasons.

Number of cuts treatments (B)	NPK levels (kg/fed) (A)									
	0.0	125	250	500	Mean (B)	0.0	125	250	500	Mean (B)
	The 1st season (2019)					The 2nd season (2020)				
	Plant height (cm)									
Control (Without cut)	92.20	101.42	111.56	122.72	106.98	93.50	102.40	112.16	122.84	107.73
One cut	82.98	91.28	100.41	110.45	96.28	83.68	91.65	100.38	109.94	96.41
Two cuts	68.04	74.85	82.33	90.57	78.95	68.20	74.70	81.81	89.60	78.58
Three cuts	51.03	56.14	61.75	67.92	59.21	50.81	55.65	60.95	66.75	58.54
Mean (A)	73.56	80.92	89.01	97.91		74.05	81.10	88.82	97.28	
L.S.D. at 5%	A: 7.01		B: 6.66		AB: 13.32	A: 7.15		B: 6.45		AB: 12.90
	Number of branches/plant									
Control (Without cut)	8.10	12.00	12.30	12.70	11.28	8.20	12.50	13.10	13.40	11.80
One cut	11.22	15.29	15.62	15.84	14.49	10.12	14.19	14.52	15.07	13.48
Two cuts	13.46	18.17	18.52	18.98	17.28	11.16	15.87	16.45	16.91	15.09
Three cuts	14.28	19.08	20.64	21.24	18.81	12.24	17.04	17.52	18.00	16.20
Mean (A)	11.76	16.14	16.77	17.19		10.43	14.90	15.40	15.84	
L.S.D. at 5%	A: 0.62		B: 0.20		AB: 0.40	A: 0.42		B: 0.23		AB: 0.46

The stimulating effects of NPK fertilization on increasing branches number/plant were emphasized on guar by Ali (1990), Sortino and Gresta (2007), Kamel (2009), Mohamed (2009), Ayub *et al*. (2011), Gendy *et al*. (2013), Mahdy and El-Said (2017) and Pimonov *et al*. (2021).

Regarding the impact of number of cuts on the number of branches/plant, data presented in Table (1) indicated that number of cuts had a positive significant effect on branches number/plant in both seasons. It could be observed that increasing number of cuts from NC_0 to NC_1, NC_2 and NC_3 led to a significant increase in the number of branches/plant. The greatest number of branches/plant was recorded with the three cutting treatments. Such increase over the control reached 28.46, 53.19 and 66.76% due to NC_1, NC_2 and NC_3, respectively in the first season. The same trend was noted in the second season.

Our results are in the line with those studied by Omer *et al*. (1993) on guar plant, Akash and Saoub (2000) on sudangrass, Simon *et al*. (2003) on white clover, Moniruzzaman *et al*. (2008) on kangkong plant, Ventroni *et al*. (2010) on alfalfa, Giambalvo *et al*. (2011) and Tufail *et al*. (2020) on berseem clover, Sowiński and Szydełko (2011) on sorghum-sudangrass hybrid, Lawal *et al.* (2015) and Ibrahim (2017) on *Moringa oleifera*, Rana *et al*. (2015) on fenugreek plant; Abd El-Azim and Waleed (2016) and Singh *et al*. (2017) on coriander.

The interaction between mineral fertilization and number of cuts (A × B) was significant for number of branches/plant in both experimental seasons. The highest number of branches/plant was produced from plants received the highest level of mineral fertilization ($N_3P_3K_3$) in addition to three time cuts in both seasons (21.24 and 18.00 branches/plant in both seasons, respectively).

Herb fresh and dry weights/plant (g):

Data presented in Table (2) stated that the influence of mineral fertilization treatments on herb fresh and dry weights/plant was significant in both seasons. Fertilizing plants with $N_1P_1K_1$, $N_2P_2K_2$ and $N_3P_3K_3$ increased herb fresh and dry weights/plant as compared to unfertilized plants. The heaviest herb fresh and dry weights/plant were produced as a result to applying $N_3P_3K_3$ (500 kg/fed) mineral treatment, followed by $N_2P_2K_2$ (250 kg/fed),

Table 2. Effect of mineral fertilization, number of cuts and their interactions on herb fresh and dry weights/plant of guar plants during the first and second seasons.

Number of cuts treatments (B)	NPK levels (kg/fed) (A)									
	0.0	125	250	500	Mean (B)	0.0	125	250	500	Mean (B)
	The 1st season (2019)					The 2nd season (2020)				
	Herb fresh weight/plant									
Control (Without cut)	352.13	720.03	746.46	850.16	667.20	354.13	729.60	756.00	859.20	674.73
One cut	327.48	669.63	694.21	790.65	620.49	329.34	678.53	703.08	799.06	627.50
Two cuts	301.28	616.06	638.67	727.40	570.85	302.99	624.25	646.83	735.13	577.30
Three cuts	265.13	542.13	562.03	640.11	502.35	266.63	549.34	569.21	646.92	508.02
Mean (A)	311.51	636.96	660.34	752.08		313.27	645.43	668.78	760.08	
L.S.D at 5%	A: 20.38		B: 10.11		AB: 20.22	A: 21.55		B: 12.33		AB: 24.66
	Herb dry weight/plant									
Control (Without cut)	82.43	110.10	178.50	186.06	139.27	85.50	187.96	191.10	197.30	165.47
One cut	76.25	101.84	165.11	172.11	128.83	79.09	173.86	176.77	182.50	153.06
Two cuts	69.77	93.19	151.08	157.48	117.88	72.37	159.08	161.74	166.99	140.05
Three cuts	61.05	81.54	132.19	137.79	103.14	63.32	139.20	141.52	146.12	122.54
Mean (A)	72.37	96.67	156.72	163.36		75.07	165.03	167.78	173.23	
L.S.D at 5%	A: 3.64		B: 2.11		AB: 4.22	A: 4.01		B: 2.32		AB: 4.64

while $N_1P_1K_1$ (125 kg/fed) came in the third class in both seasons. These three levels of mineral fertilization increased fresh weight over control treatment by 104.48, 145.52 and 141.43% in the first season and by 106.03, 113.48 and 142.63% in the second one, respectively. Also, these three mineral fertilization treatments significantly increased herb dry weight as compared to control in both seasons. The heaviest dry weights were obtained by the highest level of $N_3P_3K_3$ as recorded 163.36 and 173.23 in the first and second seasons, respectively.

In harmony with our results were those noted on guar by El–Barkouky *et al.* (1980), Meawad *et al*. (1991), Tewfike (2000), Abo El-Ezz (2019) and Abd Allah *et al*. (2020).

Concerning the effect of number of cuts on herb fresh and dry weights/plant, it could be observed that both herb fresh and dry weights/plant were significantly decreased by increasing number of cuts in both seasons compared with uncut plants.

Our results were in the line with those observed by Omer *et al*. (1993) on guar plant; Tabacco *et al*. (2002) on lucerne; Moniruzzaman *et al*. (2008) on kangkong plant; Tehlan and Thakral (2008), Moniruzzaman and Rahman (2015), Abd El-Azim and Waleed (2016), Singh *et al*. (2017) and Bhapkar *et al*. (2019) on coriander; Foidl *et al.* (2011), Lawal *et al.* (2015) and Ibrahim (2017) on *Moringa oleifera*; Sarkar *et al*. (2014) on *Ipomoea reptans* and Narayan *et al*. (2018) on palak (*Beta vulgaris* var. Bangalensis) plant.

The interaction between main and sub-plot treatments (A × B) was significant for shoot fresh and dry weights/plant in both experimental seasons as clearly shown in Table (2). The heaviest weights were obtained by fertilizing guar plants by mineral fertilization treatment $N_3P_3K_3$ (500 kg/fed) without cut (NC_0) in both seasons (850.16 and 859.20 g, respectively for shoot fresh weight and 186.06 and 197.30 g, respectively for shoot dry weight.

DISCUSSION

Supplying plants with mineral fertilization formulations of $N_1P_1K_1$ (125 kg/fed), $N_2P_2K_2$ (250 kg/fed) and $N_3P_3K_3$ (500 kg/fed) led to an increase in all vegetative growth traits (plant height (cm), number of branches/plant, herb fresh and dry weights/plant (g)). These results reflected the enhancing role of NPK fertilization. Nitrogen is an indispensable elementary constituent of numerous organic compounds of general importance, amino acids, proteins, nucleic acids and compounds of secondary plant metabolism such as the alkaloids.

Higher plants are major contributors to the large amount of N which is continuously being converted from the inorganic to the organic form. The exact function of potassium in the energy conversion process is not yet totally understood. Although, it is documented that potassium is involved in metabolic reactions including those of energy (ATP), synthesis and energy transfer (Mengel and Kirkby, 2001). The improvement impact of NPK on plant growth and productivity may be due to the role of nitrogen on chlorophyll, enzymes and proteins synthesis; and the role of phosphorus on root growth development, phosphor-proteins and phospho-lipids formation as well as the role of potassium on promotion of enzymes activity and enhancing the translocation of assimilates (EL-Desuki *et al*., 2006).

From the previous physiological and biological studies, it might be concluded that NPK fertilizers had positive effects on vegetative growth. While increasing number of cuts led to good branches. The reduction of plant height might be due to the apical dominance which causes the development of lateral buds, ultimately increasing the number of shoots (Sarkar *et al*., 2014).

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تأثير التسميد المعدني وعدد مرات الحش علي نمو وإنتاجية نبات الجوار
١. التأثير علي صفات النمو الخضري

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تم إجراء هذه التجارب خلال موسمي النمو المتعاقبين ٢٠١٩ و٢٠٢٠ بمزرعة مصنع أعلاف شوشة، قطاع الإنتاج، مركز البحوث الزراعية، وزارة الزراعة، ومعمل شعبة نباتات الزينة، قسم البساتين، كلية الزراعة، جامعة المنيا بهدف دراسة تأثير التسميد المعدني وعدد مرات الحش على نمو نبات الجوار (*Cyamopsis tetragonoloba* (L.) Taub.). أشارت النتائج إلى أن زيادة مستوي التسميد المعدني (النيتروجين والفوسفور والبوتاسيوم) أدي إلي زيادة إرتفاع النبات، عدد الأفرع/نبات والوزن الطازج والجاف للنبات مقارنة بمعاملة الكنترول. في حين تفوقت المعاملة بدون حش (الكنترول) على باقي المعاملات (حشة واحدة، حشتين، ثلاث حشات) في كل الصفات المدروسة بإستثناء طول النبات. يمكن القول بأن التسميد المعدني بالمستوى الأعلى (٥٠٠ كجم/فدان يتكون من ٢٠٠ كجم سلفات الأمونيوم + ٢٠٠ كجم كالسيوم سوبر فوسفات + ١٠٠ كجم بوتاسيوم سلفات) مع الحش ثلاث مرات يعطي أكبر عدد من الأفرع لنبات الجوار.