SUST
Journal of Agricultural and Veterinary Sciences
Journal homepage:
http:// journals.sustech.edu

Effect of Seed Rate and Stage of Cutting on Growth, Yield and Quality of Forage Guar (*Cyamopsis tetragonoloba*. L) at Soba, Khartoum, Sudan

Mohammed Ibrahim Abdelsalam*, H. M. H. Adar

College of Forestry and Range Science, Sudan University of Science and Technology
*Corresponding author: fdailmohammed@yahoo.com, mohamedibrahim@sustech.edu
Article history: Recieved: April 2019
Accepted: May 2019

Abstract
The study was conducted at the experimental farm of the College of Forestry and Range Science, in Soba, Khartoum State which was located between longitude 32º 52′98″ E and latitude 15º 60′ 40″ N. The study aimed at identifying the effect of seed rate and growth stages on growth, yield and nutritive value of guar forage. Treatments were three seed rates, S_1, S_2 and S_3 (1.2, 2.4 and 3.6kg/ha) and three stages of cuttings, flowering, pod and maturity stages. Treatments were laid on a randomized complete block design (RCBD), with three replicates. Growth parameter measurements were taken every 15 days during the course of the experiment, while the production parameter readings were taken three times at the three stages, flowering, pod and maturity stage. The data were statistically analyzed using the SAS software program. The study found that stem diameter decreased with increased seed rate. There was a significant difference between the growth stage in terms of dry matter yield, where the seed stage recorded the highest dry matter compared to the flowering and pod stages. The study concluded that seed rate and growth stages had affected both growth parameters and dry matter yield of guar. Increased seed rate will result in high quality fodder and high forage production for livestock feeding.

Keyword: Growth stages, stem diameter, leaf number, dry matter.

Introduction
The nutrition factor is considered one of the most important components to support animal production, and in order to reach the minimum production efficiency of the animal. Nutrition by major role by driving the functional efficacy, efficiency and production systems of livestock, (Ramteke *et al*., 2019). The nutritive value of plant species and forage production is more important for range management, (Temel et al., 2015). Forages are an essential part of ruminant's and other grazing animal's diets and are an important part of a profitable livestock enterprise, (Singh *et al*, 2012). Green fodders are cheaper and suitable for feeding range animals, compared to concentrated fodders. Legumes plays a key

role in the economics of arid and semi-arid regions, as they are a most important source of protein, (Ali *et al*, 2015). Guar or cluster bean (*Cyamopsis tetragonoloba*) is a source of the essential nutrients of the animal and a source of fiber in the mixtures to improve the amount consumed and reduce the economic cost of the purchase of concentrated feeds and thus lead to the sustainability of livestock production. Guar is a drought and salt tolerant summer annual legume**,** (Singla *et al*, 2016)**,** it is native to India. It has been used traditionally as a vegetable, cattle food and as a green manure crop in agriculture, multi-purpose legume crop; it grows easily in semi-arid regions, (Durgesh, 2015). The economic importance of the guar is attributed to the distinctive production of the forage, whether it is green fodder or hay. The forage quality information at different growth stages (phonological stages) could help range managers to determine suitable grazing time to achieve higher animal performance, (Abtahi and Esfahan, 2017). Several studies have examined the effect of seed rate on quantity and quality of forage yield. Increasing seed rates resulted in an increase in plant density, green forage yield, dry matter yield and crude protein, (Mevlut *et al*, 2011). The aim of the study was to determine the effect of the seed rate and the different cutting stages on the productivity and nutritive value of the guar fodder.

Material and Methods

Study Area

The study was conducted at the College of Forestry and Range Science Experimental Farm, Soba West, which was located in Khartoum State, between longitude 32º 52′98″ E and latitude 15º 60′ 40″ N, (www.alhelalia.com, 2018), about 15 km from the center of the capital Khartoum.

Experimental Design:

The experiment was laid in a randomized complete block design (RCBD) on an area of about 0.5 ha in three replicates and two treatments: seed rate and cutting stages.

Treatments:

Three seed rates used were 1.2, 2.4 and 3.6 kg/ha (S_1, S_2 and S_3. The cutting stages were at flowering stage, pod stage and seed maturity stage.

Cultural Operations

Soil was first disc-plowed leveled and ridged up at 70 cm. The seeds were hand planted at the top of the ridge at a depth of 5 cm. The crop was irrigated at an interval of five days at the earliest stages of growth for three consecutive irrigations, then at 15 days till the maturity of the crop. Weed control was practiced manually, whenever necessary.

Plant Measurements

Plant measurements were carried out after two weeks from sowing and repeated four times for growth parameters (number of leaves, plant length and stems diameter), while the yield parameters were taken at flowering, pods and maturity stages.

Organic Matter Analysis

The plant material was dried at a temperature of 105 Cº for 24 hours (Abdelsalam and Elsaer, 2017), and then ground and analyzed by using Near Infra Red spectrometer (NIR), to determine the organic matter or nutritive value of the guar fodder.

Statistical Analysis

The statistical analysis program, SAS was used. Mean separation was carried out using the Duncan multiple range test method at Alpha 0.05.

Results and Discussion

Growth Parameters:

The results on Table (1) indicated that there was a significant difference in mean stem diameter, reflecting the effect of seed rate on stem diameter thickness. The number of leaves and plant height were not affected by the seed rate. This result agreed with Ayub *et al* (2011), who found that the plant height was not significantly affected by the seed rate. The highest seed rate resulted in a thinner stem thickness of about 5.5 mm, this is a preferable characteristic of fodder, where the lower stem diameter means the higher fodder quality, and it may increase the intake and digestibility. Increasing the seed rate definitely leads to increased plant density, and the higher the plant density leads to decrease stem diameter. This result agrees with Mohammed Nour, (2004), who stated that the plant density increased with the increased seed rate, while stem diameter decreased with the increase in seed rate. Gondal *et al*, (2017) and Snider *et al*, (2012), also found that the stem diameter decreased with an increase in the seed rate. This result explains the effect of plant density on stem diameter, where the increase in seed rate increases the plant density which accordingly, led to decreased stem diameter. Mohamed, (2008) stated that stem diameter increased with increasing the spacing. Increasing the distance between plants reduces plant density and thus reduces the effect of plant competition, allowing for increased stems diameter. It can be concluded that to obtain more palatable and digested fodder of guar forage, seed rate and plant density should be increased to produce high quality fodder.

Table (1). Effect of Seed Rate on Growth Parameters of Guar Forage.

Seed Rate	Growth Parameters		
	Stem diameter (mm)	Leaf number /plant	Plant height (cm)
S_1	6.83b	11a	41.58a
S_2	6.91a	9a	39.83a
S_3	5.5b	8b	41.63a

Means with the same letter are not significantly different at alpha 0.05

Leaf and Stem Dry Weight and leaf/stem Ratio

According to the results represented on Table (2), the dry weight of leaves and stems per plant of guar was not significantly affected by seed rate, neither leaf/stem ratio. The study found that there is a slight difference between these parameters, where the lower seed rate (S_1) recorded less weight for the average weight of the stems and leaves. The leaf to stem ratio is almost near the same for the different seed rates, this feature is important in determining the forage quality. Stavarache *et al* (2015), reported that the leaves/stems ratio is an important indicator for assessing forage quality. However, it is observed that S_3 was better in terms of leaf/stem ratio, 1.11:1

compared to 1.13:1 and 1.22:1 for seed rate S_2 and S_1 respectively. According to Abdel-Rahman and Abu Suwar (2012), the seed rate had little effect on the leaves. Generally increasing seed rate leads to increased plant density, which leads to increased leaf ratio. Therefore, it is better to increase the seed rate when guar is grown for forage production.

Table (2). Effect of Seed Rate on Leaves and Stem Dry Weight of Guar.

Seed Rate	Average Weights (g)		
	Stems	Leaves	Stem/leaf ratio
S_1	11.6a	9.5a	1.22:1
S_2	13.8a	12.19a	1.13:1
S_3	13.8a	12.48a	1.11:1

Means with the same letter are not significantly different at alpha 0.05

Yield Parameters

Results on the Table (3), showed no significant differences between the yield of green forage at the different growth stages, but the seed stage recorded higher weight of green forage about (8.58 kg/m²), compared to the other stages. As for dry matter, there were significant differences between the different treatment, where the seed stage gave the high productivity of the dry matter (2.53 kg/m²), compared to the 1.82 kg/m² and 1.01 kg/m² for pod and flowering stages respectively. This may be due to the low moisture content in the forage as the plants progress in age. This result confirmed by Mahala *et al* (2012), who stated that dry matter increased with maturity. Ayub *et al*, (2011), found that the dry matter was significantly affected by seed rate. Also Abdel-Rahman and Abu Suwar (2012), reported that the higher seed rate resulted in high forage production. This result reflects the significant effect of plant maturity on dry matter production. To obtain the highest yield of dry matter from the guar forage, the harvest should be delayed to the maturity stage, because the delay of harvest leads to increased dry matter of the forage. The study found that the average weight of the dry matter produced from the guar forage was about 1.8 tons dry matter / ha. This result reflects the high efficiency of guar fodder production and makes it a promising plant to produce fodder for livestock.

Table (3) Effect of Growth Stages on Fresh and Dry Weight of Guar Forage.

Growth Stages	Average Weight (kg/m^2)	
	Green forage	Dry weight forage
Flowering Stage	5.9a	1.01c
Pod Stage	8.04a	1.82b
Seed Stage	8.58a	2.53a

Means with the same letter are not significantly different at alpha 0.05

The Nutritive Value of Guar Forage at Different Cutting Stages

Based on the results shown on Table (4), the highest percentage of fiber was guar observed with increased plant life. The flowering stage was less fiber percentage recorded in terms of ADF 23, CF17.74 and NDF 30.49, while the seed stage recorded high percentage of these components, which are 30.20, 25.91 and 56.17 for ADF, CF and NDF respectively. This result agreed with Stavarache *et al* (2015), who stated that the ADF and NDF influenced positively the plant age. On the other hand the percentage of CP, FAT and sugar decreased with the increasing of the guar life. The results showed that in the seed stage recorded less CP 19.49, sugar 1.03 and FAT 4.68 compared with the flowering stage, CP 29.14, sugar 5.39 and 5.21. This result illustrated the effect of age on the quality of forage produced from guar plant, where, when the plant age increased, fiber content increased and protein decreased. Naseri *et al*, (2017) found that the ADF, NDF and CF were increased with the increase of plant age. Temel *et al* (2015) stated that the CP decreased in the maturity stage of the plant. In the late maturing stage, the nutritional value of the feed is generally reduced as a result of the transformation of most nutrients into seed production. However, in the case of Guar fodder, fodder remains rich in crude protein CP and minerals and thus reduces the negative effect of age on the plant. Through the analysis of the organic matter of the plant, it is observed that the guar has a high content of crude protein until the seed stage, therefor the Guar forage considered a rich in crude protein content in all of it is growth stage.

Table (4) Organic matter, content % of Guar forage at Different Cutting Stages

Organic matter	Growth Stages		
	Flowering stage	Bud stage	Seed stage
ADF	23	30.24	35.20
Ash	11.08	11.52	10.56
Fat	5.21	4.61	4.68
CF	17.74	19.33	25.91
Moisture	9.96	9.05	7.31
NDF	30.49	37.14	56.17
CP	29.14	22.58	19.49
Sugar	5.39	5.54	1.03

ADF: Acid Detergent Fiber, NDF: Neutral Detergent Fiber, CF: Crude Fiber, CP: Crude Protein

Conclusion

The study concluded that the seed rate had a clear effect on the number of leaves and stem diameter of the guar forage. The cutting stage also had an effect on forage productivity, especially dry matter. The nutritive value of guar forage reduced with the maturity of the plant. It is recommended that, the seed rate is to be increased to obtain high forage production from the guar.

Acknowledgement

The authors would like to thank the College of Forestry and Range Science at the Sudan University of Science and Technology for facilitating the field work of the research. They also extend thanks to the graduates Abrar Elamin Abdelrahman, Hafssa Ahmed Mohamed-nour and Safia Ali Abdalla for helping in gathering most of the information.

References:

Abdel-Rahman, EL-f. M and Abu Suwar, A. O, (2012). Effect of seeding rate on growth and yield of two alfalfa (Medicago sativa L.) cultivars. International Journal of Sudan Research 2 (2) 1-14.

Abdelsalam, M. I and Elsaer, A. A, (2017). The Effect of Some Range Site Characteristics on Rangeland Vegetation Attributes at Altadamon Locality- South Kordofan State, Sudan. University of Bakht Alruda Scientific Journal, Issue No. 22. 192-204.

Ali, Z, Ashraf, M. AL-Qurainy, F Khan, S, and Akram N. A, (2015). Field Screening of Guar [*Cyamopsis tetragonoloba* (L.) TAUB.] Accessions for Enhanced Forage Production on Hot Drylands. Pak. J. Bot., 47(4): 1429-1437, 2015.

Ayub, M, Khalid, M, Tariq, M, Nadeem, M. A, and Naeem, M, (2011). Effect of different seeding densities and nitrogen levels on growth, forage yield and quality attributes of Cluster bean (*Cyamoposis tetragonoloba*

Tuab.). Journal of Agricultural Technology. 7(5): 1409-1416.

Durgesh, K. R. (2015). Trends and Economic Dynamics of Guar in India, Working Paper. *INDIAN COUNCIL FOR RESEARCH ON INTERNATIONAL ECONOMIC RELATIONS.*

Gondal M. R., Hussain A., Yasin, S., Musa M and Rehman H. S, (2017). Effect of Seed Rate and Row Spacing on Grain Yield of Sorghum. SAARC J. Agri., 15(2): 81-91 (2017) DOI: h ttp://dx.doi.org/10.3329/sja.v15i2.35154

http://www.helalia.com/vb/showthread.php?t=4973#ixzz5Uf45FnGy 22/10/2018 14:15

Mahala, A. G, Amasiab, S. O, Monera .A. Yousif and Elsadig, A, (2012). Effect of Plant age on Dry Matter yield and nutritive value of some leguminous plants (*Cyamopsis tetragonoloba*, *Lablab purpureus* and Clitoria (*Clitoria ternatea*). International Research Journal of Agricultural Science and Soil Science. 2(12). 502- 508.

Mohamed, A. A, (2008). Effect of Spacing on Growth and Forage Yield of Guar (*Cyamopsis tetragonoloba* L.Tayp). M.Sc. thesis. University of Khartoum, Sudan.

Mohammed Nour, H. H, (2004). Effect of Seed Rate and Sowing Method on Growth, Yield and Quality of Forage Maize (*Zea mays* L.). M. Sc Dissertation. Department of Agronomy, Faculty of Agriculture, Khartoum University. Khartoum, Sudan.

Naseri. S, Adibi, M, A and Kia Kianian, M (2017). Forage Quality of Endangered Species of *Astragalus fridae* Rech. F. in Semnan Province, Iran. Journal of Rangeland, 7 (4). 387-399.

Ramteke, R, Doneria, R and Gendley, MK, (2019). Antinutritional Factors in Feed and Fodder used for Livestock and Poultry Feeding. Acta Scientific Nutritional Health 3.5 (2019): 39-48.

Satvarache, M., Samuil, C., Popovic, C. I., Tarcau, D and Vintu, V. (2015). The Productivity and Quality of Alfalfa (*Medicago sativa* L.) in Romanian Forest Steppe. Not Bot Horti Agrobo, 43(1). 179-185

Singla, S; Grover, K; Angadi, S. V; Begna, S. H; Schutte, B and Leeuwen, D. V. (2016). Growth and Yield of Guar (*Cyamopsis tetragonoloba* L.) Genotypes under Different Planting Dates in the Semi-Arid Southern High Plains. American Journal of Plant Sciences,(**7)1246-1258.**http://www.scirp.org/journal/ajps http://dx.doi.org/10.4236/ajps.2016.78120.

Snider J. L., Raper R. L and Schwab E. B, (2012). The effect of row spacing and seeding rate on biomass production and plant stand characteristics of non-irrigated photoperiod-sensitive sorghum (*Sorghum bicolor*(L.) Moench). University of Nebraska - Lincoln DigitalCommons@University of Nebraska – Lincoln. Publications from USDA-ARS / UNL Faculty. 876.

Abtahi M and Esfahan Z. E (2017). Effects of phenological stage on forage quality of halophyte species *Salsola arbuscula*. In the central desert of Iran. Applied Ecology and Environmental Research 15(3): 901-909.

Mevlut T, Sebahattin A and Osman Y (2011). Effect of Seeding Rate on the Forage Yield and Quality in *Pea* Cultivars of Differing leaf Types. Turkish Journal of Field Crops, 16(2): 137-141.

http://digitalcommons.unl.edu/usdaarsfacpub/876.

Temel S., Surmen and Tan. M, (2015). The Effect of Growth Stages on the Nutritive Value of Spesific Halophyte Species in Saline Grasslands. J. Anim. Plant Sci. 25(5) 1419-1428.

Singh, K.M, Meena, M.S and Kumar, A (2012). An Economic View to Forage and Fodder Production in Eastern India. Electronic Journal, 10.2139. pp 1-29. ww.researchgate.net

تأثير معدلات البذور ومراحل القطع على نمو انتاجية ونوعية علف القوار (*Cyamopsis tetragonoloba*. L) في منطقة سوبا، الخرطوم، السودان

محمد ابراهيم عبدالسلام *وحسين محي الدين حسين عدار

جامعة السودان للعلوم والتكنولوجيا– كلية علوم الغابات والمراعي

المستخلص

أجريت الدراسة في مزرعة كلية علوم الغابات والمراعي التعليمية، جامعة السودان للعلوم والتكنولوجيا، بسوبا بولاية الخرطوم التي تقع بين خط طول ″52′98 °32 شرقا و خط عرض ″40 ′60 °15 شمالاً. والتي تبعد حوالي 15كم عن مركز العاصمة. هدفت الدراسة للتعرف على تأثير معدل البذور ومراحل القطع المختلفة على الإنتاجية والقيمة الغذائية للعلف المنتج من نبات القوار (***Cyamopsis tetragonoloba***. L) . تمت التجربة على ثلاثة معدلات للبذور 1.2 و2.4 و3.6 كجم/هكتار، تم حصاد العلف على ثلاث مراحل، مرحلة الإزهار ومرحلة تكوين القرون ومرحلة إنتاج البذور. تم تصميم التجربة على نظام القطاعات العشوائية الكاملة في ثلاثة مكررات. أخذت قراءات مؤشرات النمو كل 15 يوماً وتكررت أربع مرات خلال فترة التجربة، كما أخذت قراءات مؤشرات الإنتاجية ثلاث مرات في مرحلة الإزهار ومرحلة تكوين القرون ومرحلة إنتاج البذور. تم تجفيف المادة الجافة في فرن كهربائي على درجة حرارة 105 درجة مئوية لمدة 24 ساعة للحصول على المادة الجافة، وتم وضعها في جهاز الأشعة تحت الحمراء لمعرفة مكوناتها العضوية. تم تحليل النتائج التي توصلت اليها الدراسة بواسطة البرنامج الإحصائي SAS بطريقة Duncan . وجدت الدراسة أن قطر الساق يتناقص مع زيادة معدل البذور، كما توصلت الدراسة الى أن هنالك فروقات معنوية في انتاجية المادة الجافة خلال مراحل القطع الثلاث، حيث سجلت مرحلة إنتاج البذور أعلى انتاجية من المادة الجافة بالمقارنة مع المرحلتي الإزهار وتكوين القرون. خلصت الدراسة الى أن معدلات البذور ومراحل القطع المختلفة لها تأثير واضح على الإنتاجية والقيمة الغذائية للعلف المنتج من محصول القوار. زيادة معدل البذور وبالتالي الكثافة النباتية تنتج علف عالي القيمة الغذائية للحيوانات. توصي الدراسة بزيادة معدل البذور للحصول على انتاجية عالية من علف القوار.