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Stevia (Stevia rebaudiana Bertoni) responds to different levels of nitrogen and potassium fertilizers in loamy sand soil

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Abstract

A study was conducted in Al-Seba Reserve / Basra Governorate to study the effect of nitrogen and potassium fertilization on growth of stevia plants during 2018-2019 agricultural season, in pots. A sandy mixture of soil was used and two factors were studied: the first factor was urea fertilizer with five levels of nitrogen (N_0 0, $N_1$100, $N_2$150, N_3 200, and N_4 250 kg / ha) and the second factor was potassium sulfate with three levels of potassium (K_0 0, K_1 75 and $K_3$150 kg /h) . The experiment was experimental factor using a complete randomized design (C.R.D) with three replications. The results showed a significant effect of adding nitrogen and potassium fertilizers and there interaction on: plant height, number of branches, leaf area index, and the treatment N_3K_2 gave the highest yield reached (1.27 tons. h^{-1}), and N_4K_2 recorded a highest content of Rebaudioside A (53.26 ppm).

***Part of Ph.D. thesis of the first author**

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أستجابة الاستيفيا (*Stevia Rebaudiana Bertoni*) لمستويات مختلفة من السماد النتروجيني والبوتاسي في تربة مزيجية رملية.

***خولة داود كاطع هيثم عبدالسلام علي كريم حنون محسن**
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أجريت دراسة في محمية السيبة / محافظة البصرة لدراسة تأثير التسميد النتروجيني والبوتاسي على نمو محصول الاستيفيا خلال الموسم الزراعي 2018-2019, داخل أصص . استخدمت تربة مزيجيه رملية وأجريت دراسة عاملين :العامل الأول سماد اليوريا بخمس مستويات من النيتروجين (0 , 100, 150 , 200, 250 كغم/هكتار) والعامل الثاني سلفات البوتاسيوم بثلاث مستويات من البوتاسيوم (0, 75, 150 كغم/هكتار) صممت التجربة عاملية وباستخدام التصميم العشوائي الكامل (C.R.D) بثلاث مكررات. اظهرت النتائج التأثير المعنوي لإضافة السماد النتروجيني والبوتاسي والتداخل فيما بينهما على كل من: ارتفاع النبات, عدد الافرع بالنبات, دليل المساحة الورقية, واعطت المعاملة العاملية N3K2 اعلى حاصل بلغ (1.27 طن.هـ$^{-1}$), كما سجلت المعاملة العاملية N4K2 اعلى محتوى من Rebaudioside A بلغ (53.26 جزء بالمليون).

***البحث مستل من رسالة الدكتوراه للباحث الأول**

Introduction:

Stevia rebaudiana Bertoni, which originated from South America, is a bushy branched plant of the Asteraceae family (Gisieine et al., 2006). It is one of the 154 members of the genus Stevia and one of only two that produce sweet Steviol glycosides which has been being used in food items as a sweetener material (Soejarto et al., 1982). The sweetness of stevia comes from compounds known as diterpene glycosides (Brandle et al., 1992; Geuns, 2003). Among 10 sweet glycosides in stevia, two are the most important, namely stevioside and rebaudioside A (SGs) which are found to be the maximum immediately before flowering (Singh and Rao, 2005). Unlike many other sources of artificial or natural sweeteners, Rebaudioside-A has the most desirable flavor profile and in comparison, to other sources of artificial and natural sweeteners, stevia-based sweeteners do not have aftertaste bitterness (Yadav, 2011). Stevia is grown as a crop in

height of 10 cm. after that seedling transplanted, the vigorous seedlings were uprooted carefully from the pots so that roots were at minimal damage and then transplanted into the pots (permanent place) on 15-12-2018 and 1-1-2019. At the age of six weeks, two seedlings were transplanted at the center of each pot. The transplanted seedlings were established 15 days after transplantation and then the weaker seedling was removed keeping the more vigorous one in the pot. Nitrogen fertilizer (urea) was applied in two equal splits; the first one was 14 days after seedling transplantation and the second one was 30 days after the application of the first dose. Potassium was added to the soil in one dose along with the first split of nitrogen fertilizer. The full dose of phosphorous fertilizer was applied to the soil before seedling transplanting (Aladakatti, 2011). All plants received normal agricultural practices during the growing season such as irrigation, weed control, deflowering, and plant protection measures particularly protecting the crop from Fusarium and whitefly.

Table (1) Some chemical and physical characteristics of experimental soil of Al-Zubair location

Characters	value	Unit
Soil PH	7.8	
Soil E.C. (1:1)	4.70	$Des.m^{-1}$
N available (NH4+ + NO3-)	75	
Phosphor	3.30	$Mg.kg^{-1}$
potassium	0.127	
Organic matter	0.15	%
clay	20.13	
silt	21.54	%
Sand	58.33	
Texture	Loamy sand	

Growth parameters studied:

Plant height (cm):

Plant height was measured by measuring tape from the soil surface to the fully opened leaf at the top and expressed in centimeters.

Number of leaves plant^{-1}:

The number of fully opened leaves was recorded before harvesting the crop, that after collecting the branches.

Leaf area index:

Leaf area index was calculated using the equation of Watson (1952) as follows;

$$LAI = \frac{\text{Leaf area per plant } (cm^2)}{\text{Land area occupied by each plant } (cm^2)}$$

Leaf area per plant (cm^2) = Number of leaves × leave area

Leaf area was calculated by taking an average area of three leaves per plant using the Image J program.

Numbers of branches plant^{-1}:

cell division and elongation. Such happens through an ideal occurring an ideal expansion of the cell wall that is essential for the division process, (Reddy et al. 2004 and Mengel and Kirkby, 2007). Results of this study agree well with those of previous workers (Maheshwar, 2005; Ahmed et al, 2011; Hassanain et al, 2016).

The significant interaction effect of nitrogen and potassium levels was also noticed in respect of plant height Fig (1) The impact of interaction revealed that combination treatment N4K1 had the highest plant height (55.33 cm) which was 81.7% more than the lower plant height values of the control treatment N0K0 (27.00 cm).

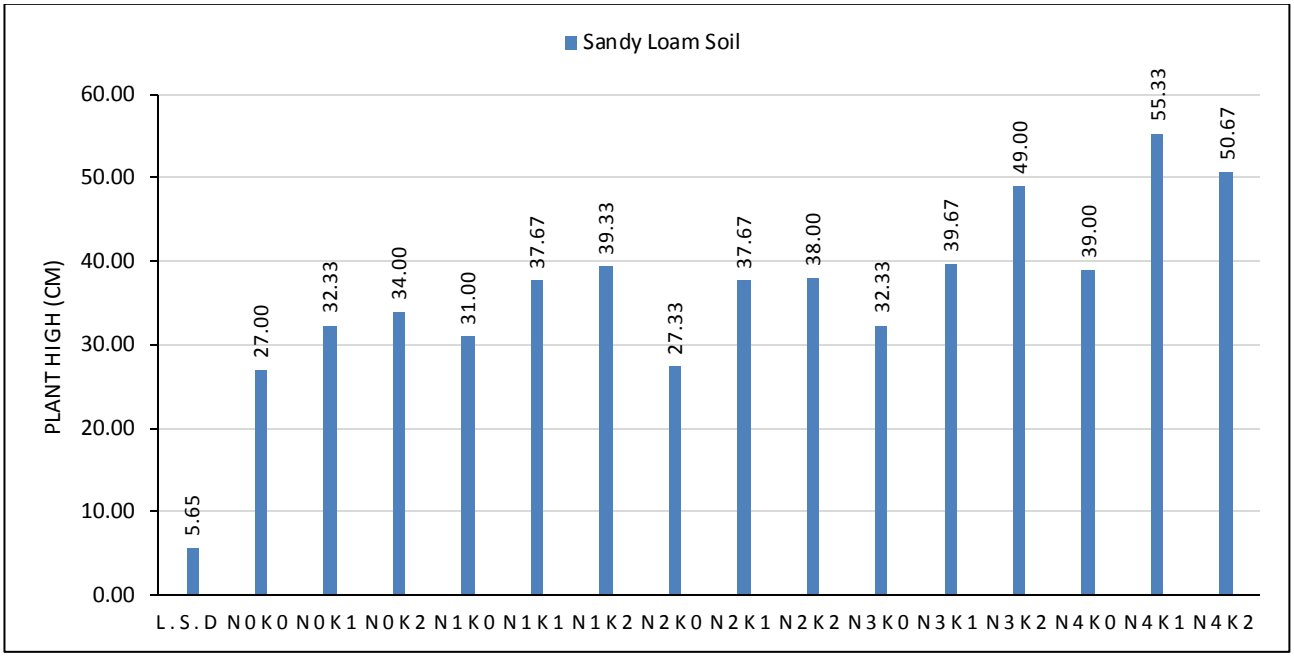

Figure 1 **- Interaction Effect for different levels of (N & K) fertilizers on plant height (cm) of Stevia in Sandy Loam Soil**

Numbers of branches plant^{-1} :

Different nitrogen and potassium levels influence positively the number of branches per plant (Table 2). Treatment N3 showed the highest number of branches 6.46 compare with other treatment, control treatment recorded the smaller number of branches 2.20. The availability of nitrogen at the beginning of plant growth encourages the growth and emergence of primary and secondary branches by supporting the growth buds and extending the duration of their production (Akbari *et al,* 2018). These results are in agreement with the finding of (Aladakatti et al., 2012). They stated that increasing N levels increased the number of branches per plant.

potassium fertilizer levels, results indicated the significant effect of increased potassium levels on the number of branches soil treatment K2 recorded the highest number of branches (4.43) without significant differences with K1 which recorded (3.92),(Table 2) while these two treatments recorded the highest rate for this trait compared to the control treatment. This may be due to the positive effect in increasing the height of the plant and the number of nodes of the stem by encouraging it to grow the tissue and improve the absorption of nutrients, as this was reflected in the increase in the number of vegetative

plant tissues which are reflected on leaf area per plant and then influence on leaf area index. (Inugraha, 2014). These results are following the finding of (Khanom, 2007).

The interaction between nitrogen and potassium on the leaf area index was significant in (Table 3) and (Fig. 2) results indicated the superiority of combination treatment N3 K2 (2.25) compared with other combination treatments. Control combination treatments the lowest leaf area index (0.31). These results are not consistent with (Inugraha *et al*, 2014 and Aladakatti, 2012) They indicated that there were no significant differences between nitrogen and potassium interaction.

Table 2 - Means of Plant Hight (cm), Number of Branches.Plant^{-1}, Number of leaves of Stevia Rebaudiana as influenced by different levels of Nitrogen and Potassium and their interaction

	Plant High (cm)			
	K (kg/ha)			
N (kg/ha)	0 kg/ha	75 kg/ha	150 kg/ha	Mean
control 0 kg/ha	27.00	32.33	34.00	31.11
100 kg/ha	31.00	37.67	39.33	36.00
150 kg/ha	27.33	37.67	38.00	34.33
200 kg/ha	32.33	39.67	49.00	40.33
250 kg/ha	39.00	55.33	50.67	48.33
Mean	31.33	40.53	42.20	
L.S.D (%5)	A	B	AB	
	3.260	2.525	5.646	
	Number of Branches per Plant			
	0 kg/ha	75 kg/ha	150 kg/ha	Mean
control 0 kg/ha	1.68	2.24	2.68	2.20
100 kg/ha	2.51	2.78	3.90	3.07
150 kg/ha	3.01	4.46	5.00	4.16
200 kg/ha	5.47	6.24	7.68	6.46
250 kg/ha	4.35	3.90	2.89	3.71
Mean	3.40	3.92	4.43	
L.S.D (%5)	A	B	AB	
	1.042	0.807	ns	
	Number of leaves			
	0 kg/ha	75 kg/ha	150 kg/ha	Mean
control 0 kg/ha	19.00	24.33	29.67	24.33
100 kg/ha	27.67	31.33	42.67	33.89
150 kg/ha	33.67	47.33	51.67	44.22
200 kg/ha	48.33	53.33	56.00	52.56
250 kg/ha	44.67	44.67	33.33	40.89
Mean	34.67	40.20	42.67	
L.S.D (%5)	A	B	AB	
	7.374	5.712	ns	

components of stevia plants Aladakatti et al., (2012) Interaction between nitrogen and potassium fertilizer has a positive effect on growth parameters and yield. (Inugraha *et al.*, 2014). The present study finding conforms to the finding of (Wiedenhoeft, 2006 and Rashid 2019). Were indicated to the significant effect of interaction between nitrogen and potassium on yield.

Table 3 - Means of Leaf Area Index (LAI) and Crop Yield t.ha^{-1} of Stevia Rebaudiana as influenced by different levels of Nitrogen and Potassium and their interaction

	Leaf Area Index (LAI)			
	K (kg/ha)			
N (kg/ha)	0 kg/ha	75 kg/ha	150 kg/ha	Mean
control 0 kg/ha	0.31	0.56	0.88	0.58
100 kg/ha	0.46	0.80	1.31	0.86
150 kg/ha	0.78	1.46	1.96	1.40
200 kg/ha	1.45	1.87	2.25	1.86
250 kg/ha	1.57	1.28	0.88	1.24
Mean	0.91	1.19	1.46	
L.S.D (%5)	A	B	AB	
	0.293	0.227	0.508	
	Crop Yield t/ha			
	0 kg/ha	75 kg/ha	150 kg/ha	Mean
control 0 kg/ha	0.22	0.47	0.73	0.47
100 kg/ha	0.31	0.60	0.80	0.57
150 kg/ha	0.51	0.81	1.10	0.80
200 kg/ha	0.80	1.02	1.27	1.03
250 kg/ha	0.92	0.70	0.58	0.73
Mean	0.55	0.72	0.90	
L.S.D (%5)	A	B	AB	
	0.18	0.14	0.32	

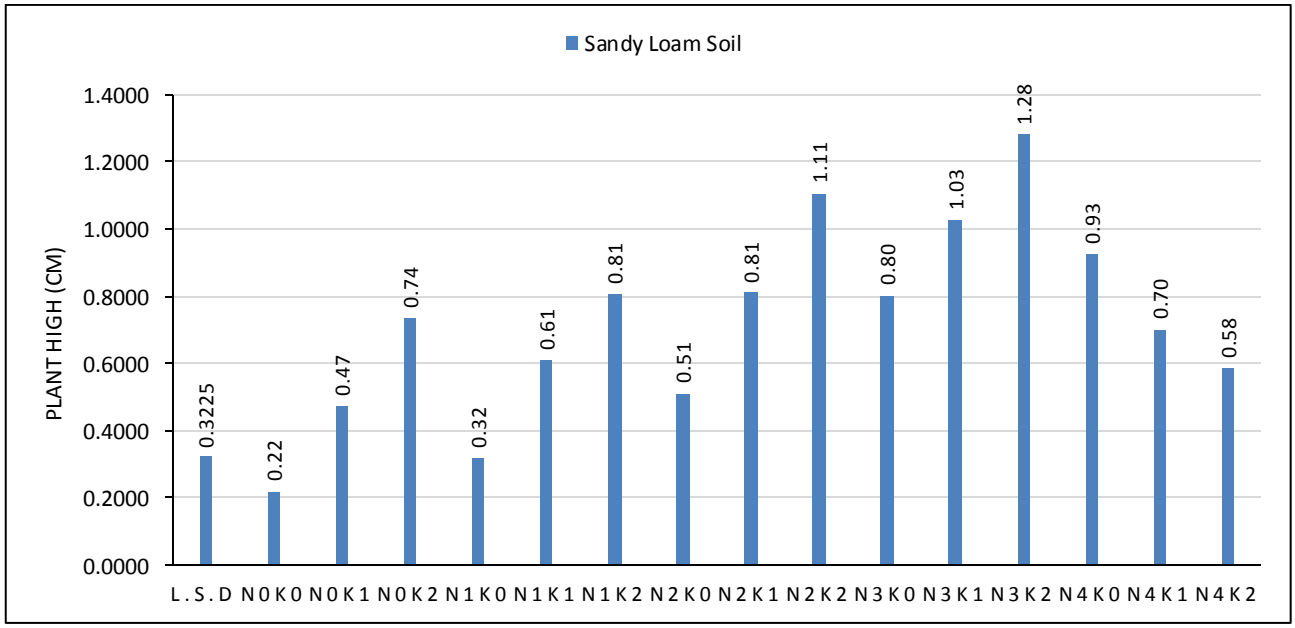

Figure 3 **- Interaction Effect for different levels of (N & K) fertilizers on Crop Yield t/ha of Stevia in Sandy Loam Soil**

(Maniruzzaman *et al.*, 2016). The results above are in agreement with the findings of Maniruzzaman *et al.*, (2016) Benhmimou *et al.*, (2018) refer to the increased potassium concentration according to increasing potassium levels. There was no significant interaction between Nitrogen and Potassium levels on potassium concentration in dry leaves of stevia (Table 4). There are numerical differences between the combination treatments; control combination treatment recorded the lowest value (3.46%).

Table 4 - Means of Nitrogen percentage %N, Potassium percentage %K, Rebaudioside A (ppm) of stevia rebaudiana as influenced by different levels of Nitrogen and Potassium and their interaction

		Nitrogen percentage %N		
		K (kg/ha)		
N (kg/ha)	0 kg/ha	75 kg/ha	150 kg/ha	Mean
control 0 kg/ha	3.73	4.20	4.39	4.11
100 kg/ha	4.36	4.62	4.67	4.55
150 kg/ha	4.57	4.60	4.71	4.63
200 kg/ha	4.76	4.90	4.99	4.88
250 kg/ha	5.23	5.51	6.44	5.72
Mean	4.53	4.76	5.04	
L.S.D (%5)	A	B	AB	
	0.470	0.364	ns	
		Potassium percentage %K		
N (kg/ha)	0 kg/ha	75 kg/ha	150 kg/ha	Mean
control 0 kg/ha	3.46	3.88	4.13	3.82
100 kg/ha	4.21	4.81	5.22	4.75
150 kg/ha	3.87	4.40	4.84	4.37
200 kg/ha	4.06	4.36	5.33	4.58
250 kg/ha	3.69	4.21	5.11	4.33
Mean	3.86	4.33	4.93	
L.S.D (%5)	A	B	AB	
	ns	0.530	ns	
		Rebaudioside A, ppm		
N (kg/ha)	0 kg/ha	75 kg/ha	150 kg/ha	Mean
control 0 kg/ha	6.97	7.02	7.21	7.07
100 kg/ha	6.50	14.32	21.36	14.06
150 kg/ha	16.80	19.99	20.05	18.95
200 kg/ha	20.64	38.84	39.13	32.87
250 kg/ha	27.83	33.33	53.26	38.14
Mean	15.75	22.70	28.20	
L.S.D (%5)	A	B	AB	
	2.611	2.023	4.523	

Effect of nitrogen and potassium fertilization and their interaction on Rebaudioside content:

Rebaudioside increases gradually because of increasing fertilizer levels (nitrogen and potassium). Results indicated the significant

References:

Ahmed B, Hossain M, Islam R, Saha A.k. and Mandal, A. (2011). A review on natural sweetener plant – Stevia having medicinal and commercial importance. *Agron Glas* 1: 75-92.

Akbari, F., Arminian, A., Kahrizi, D., Fazeli, A., and Ghaheri, M. (2018). Effect of nitrogen sources on gene expression of Stevia rebaudiana (Bertoni) under in vitro conditions. Cellular and Molecular Biology, 64(2), 11-16.

Aladakatti, Y. R., (2011) Response of Stevia (Stevia rebaudiana Bertoni.) to irrigation schedule, planting geometry and nutrient levels, doctoral diss., Univ of Agric Sci, Dept of Agron, Dharwad.

Aladakatti, Y. R., Palled, Y. B., Chetti, M. B., Halikatti, S. I., Alagundagi, S. C., Patil, P. L., and Janawade, A. D. (2012). Effect of nitrogen, phosphorus, and potassium levels on growth and yield of stevia (Stevia rebaudiana Bertoni). *Karnataka J. Agric. Sci*, 25(1), 25-29.

Amtmann, A., Troufflard, S., Armengaud, P. (2008). The effect of potassium nutrition on pest and disease resistance in plants Physiologia Plantarum. Aug; 133(4):682-691. And Self-Incompatibility Mechanism of Genus Stevia.

Benhmimou, A., Ibriz, M., Douaik, A., Lage, M., AlFaïz C., Chaouqi, S., Zouahri, A., (2018). Effect of NPK Fertilization on the Growth, Yield, Quality and Mineral Nutrition of New Sweet Plant in Morocco (Stevia rebaudiana Bertoni). *American Journal of Biology and Life Sciences*. Vol. 6, No. 3, pp. 36-43.

Black, C. A. (1965). Methods of Soil Analysis Part1And2. American Society of Agronomy, Inc.; USA.

Brandle, J. E., and Rosa, N. (1992). Heritability for yield, leaf: stem ratio, and stevioside content estimated from a landrace cultivar of Stevia rebaudiana. *Canadian Journal of Plant Science*, 72(4), 1263-1266.

Chakraborty, K., and Mistri, B. (2015). Soil Fertility and Its' Impact on Agricultural Productivity: A Study in Sapar Mouza, Burdwan-I CD Block, West Bengal. *International Journal of Humanities and Social Science Studies* (IJHSSS). 2(3), 196-206.

Geuns J. (2003). Stevioside. Phytochemistry, 64: 913–921.

Gisieine, E.C., H.A. Abdol, C.A. Caudio, A.F. Leticia, T.Gilson, H.T Mirian, Wilson E.F and B.B. Roberto. (2006). Investigation of the tolerability of oral Stevioside in Brazilian hyperlipidemic Patients.Brazilian Archives of Biol. and Tech., *An International*, 49(4):583-587.

Giuffré, L., Giardina, E., Ciarlo, E., Ríos, P., and Vella, L. (2015). A Study on the Effect of Soil Amendments and Environmental Conditions of Stevia Rebaudiana In Urban Soils of Buenos Aires, Argentina. *Current Agriculture Research Journal*, 3(1), 07-13. doi: http://dx.doi.org/10.12944/CARJ.3.1.02 .

Gomez, K. A., and Gomez, A. A. (1984). Statistical procedures for agricultural research. John Wiley & Sons.

Hashimoto, Y., Moriyasu, M., Nakamura, S., Ishiguro, S. and Komuro, M., (1978), High performance liquid chromatographic determination of Stevia components on a hydrophilic packed column. *J. Chromator*, 161: 403-405.

Hassanain, M & Osman, A. & Sewedan, E. and Kotb, Sh.. (2016). Effects of Nitrogen fertilizer, humic acid foliar spraying, and their interactions on stevia (stevia rebaudiana l.) under reclaimed soil conditions in Egypt. *J.Agric.and Env.Sci.Dam.Univ*., Egypt. 1515.

Havlin, J. L. (2005). Soil fertility and fertilizers: An introduction to nutrient management (7th ed.). Upper Saddle River, NJ: Pearson/Prentice Hall.

Helgi, O. and S. A. Rolfe, (2005). The Physiological of Flowering Plant. 4th Ed., Camb. Univ. Press, Camb. UK., 100-106.

Inugraha, M., Maghfoer, D., & Widaryanto, E. (2014). Response of Stevia (Stevia rebaudiana Bertoni M) to nitrogen and potassium Fertilization. *IOSR Journal of Agriculture and Veterinary Science* (IOSR-JAVS), 7(10), 47-55.