ISSN 1807-1929
Revista Brasileira de Engenharia Agrícola e Ambiental
v.21, n.1, p.21-26, 2017
Campina Grande, PB, UAEA/UFCG – http://www.agriambi.com.br

DOI: http://dx.doi.org/10.1590/1807-1929/agriambi.v21n1p21-26

Response of eggplant crop fertigated with doses of nitrogen and potassium

Álvaro H. C. de Souza[1], Roberto Rezende[1], Marcelo Z. Lorenzoni[1], Cássio de C. Seron[1], Tiago L. Hachmann[1] & Cláudia S. Lozano[1]

[1] Universidade Estadual de Maringá/Departamento de Agronomia/Centro Técnico de Irrigação. Maringá, PR. E-mail: alvarohcs@hotmail.com (Corresponding author); rrezende@uem.br; marcelorenzoni@hotmail.com; cassioseron@msn.com; tiagohach@gmail.com; claulozano93@gmail.com

Key words:
vegetables
yield
greenhouse
Solanum melongena L.

ABSTRACT
The objective of the present study was to evaluate the response of eggplant, cv. 'Ciça', with respect to yield, number of fruits and dry matter (root and stem), when grown in a greenhouse and conducted under fertigation with nitrogen and potassium. The experiment was conducted in the Irrigation Technical Center of the State University of Maringá, between the months of February and August 2015. Four nitrogen doses (0.0; 6.43; 12.86 and 25.72 g of N plant^{-1}) and four potassium doses (0.0; 5.18; 10.36 and 20.73 g of K plant^{-1}) were tested, totaling 16 treatments in a 4 x 4 factorial scheme, arranged in a completely randomized design with four replicates, in a Red Latosol with sandy texture. The highest number of fruits per plant and yield were found in the range of 14-17 g of N plant^{-1} (145-177 kg N ha^{-1}). Single doses of potassium did not statistically influence yield and root dry matter.

Palavras-chave:
hortaliças
produtividade
ambiente protegido
Solanum melongena L.

Resposta da cultura da berinjela fertirrigada com doses de nitrogênio e potássio

RESUMO
Objetivou-se, no presente estudo, avaliar a resposta da cultura da berinjela, cultivar Ciça, com relação à produtividade, número de frutos e massa seca (raiz e caule), quando cultivada em ambiente protegido e conduzida sob fertirrigação com nitrogênio e potássio. O experimento foi conduzido no Centro Técnico de Irrigação da Universidade Estadual de Maringá, entre os meses de fevereiro e agosto de 2015. Foram testadas quatro doses de nitrogênio (0,0; 6,43; 12,86 e 25,72 g de N planta^{-1}) e quatro doses de potássio (0,0; 5,18; 10,36 e 20,73 g de K planta^{-1}), perfazendo 16 tratamentos em esquema fatorial 4 x 4, dispostos em delineamento inteiramente casualizado com quatro repetições, em Latossolo vermelho distrófico, de textura arenosa. O maior número de frutos por planta e produtividade foi obtido na dose entre 14-17 g de N planta^{-1} (145-177 kg ha^{-1}). Doses isoladas de potássio não influenciaram estatisticamente a produtividade nem a massa seca de raiz.

Ref. 051-2016 – Received 14 Apr, 2016 • Accepted 24 Oct, 2016 • Published 23 Nov, 2016

Introduction

The adequate management of fertilizers is one of the main factors that affect the cultivation of eggplant (*Solanum melongena* L.), to meet the requirements of the crop. An incorrect fertilization management leads to contamination of underground water and it is not possible to attenuate the salinization of the soils (Oliveira et al., 2014).

The nutrients most used in fertigation are those with high mobility in the soil, such as potassium and nitrogen (Lopes et al., 2010). Nitrogen stands out among the main nutrients related to the increase in yield and for playing a fundamental role in crop yield and growth (Aminifard et al., 2010).

Nitrogen is responsible for structural functions and participates in various organic compounds that are vital for the plant, such as proteins, proline and amino acids (Parida & Das, 2005). Amiri et al. (2012) observed that the eggplant crop responds up to the dose of 120 kg of N ha^{-1}, while Trani (2014) recommends up to 200 kg of N ha^{-1} for cultivation in protected environments.

Potassium is the nutrient most required by fruit vegetables and performs various functions in the plant, such as: activation of enzymes involved in respiration, regulation of cell turgor and it has direct effect on CO_2 assimilation rate, through the control of stomatal opening and closure (Faquin & Andrade, 2004). Fawzy et al. (2007) recommend the dose of 290 kg of K ha^{-1} and Trani (2014) the dose of 220 kg of K ha^{-1}.

Based on the above, this study aimed to evaluate the response of the eggplant crop, cv. 'Ciça', with respect to yield, number of fruits and dry matter (root and stem), cultivated in protected environment and conducted under fertigation with nitrogen and potassium.

Material and Methods

The study was conducted from February to August 2015 in a protected environment, at the Irrigation Technical Center (CTI) of the State University of Maringá (UEM), in the municipality of Maringá-PR, Brazil (23° 25' 57" S; 51° 57' 08" W; 542 m). The climate of the region, according to Köppen's classification, is Cfa, humid mesothermal, characterized by abundant rainfalls in the summer and dry winters. The mean annual rainfall is around 1500 mm. The means of monthly minimum and maximum temperatures are 17 and 26 °C, respectively (Caviglione et al., 2000).

The study was conducted in a protected environment, with an arched cover coated with low-density polyethylene film (150-μ thick) and laterals protected with anti-aphid screen.

The experimental design was completely randomized, in a 4 x 4 factorial scheme with four replicates, totaling 64 experimental plots. Four doses of nitrogen (0; 6.43; 12.86 and 25.72 g of N $plant^{-1}$) and potassium (0; 5.18; 10.36 and 20.73 g of K $plant^{-1}$) were tested, using urea as the N source and potassium chloride as the K source.

The seedlings were produced in protected environment using trays with 64 cells. The hybrid eggplant cultivar 'Ciça' was used, for being resistant to Anthracnose and Phomopsis fruit rot, which are relevant fungal diseases in eggplant cultivation. Transplantation occurred when the seedlings had five to six true leaves, and one seedling was transplanted to each pot. The pots (volume of 25 L) were filled with 25 kg of dry soil. The soil used in the experiment, classified as dystrophic Red Latosol with sandy texture was characterized (EMBRAPA, 1997), corrected and fertilized according to the physical and chemical analyses (Table 1).

Soil correction was performed by applying 32 g of dolomitic limestone per pot (RNV = 86%). Basal fertilization consisted in the application of 30 g of P_2O_5 (single superphosphate), 10.06 g of K_2O (potassium chloride) and 500 g of organic compost, per pot.

The plants were irrigated using drip micro-irrigation system with emitters spaced by 0.8 m, which comprehended the spacing between plants. The lateral rows were spaced by 1.2 m, which comprehended the spacing between rows.

Irrigation management was performed by weighing the pots on a precision scale (± 2 g) with capacity for 50 kg. Irrigation was applied when the soil was close to the gravimetric water content of 0.08 g g^{-1}, equivalent to the critical tension for the eggplant crop of -15 kPa (Bilibio et al., 2010). The soil was irrigated until reaching the gravimetric water content of 0.2 g g^{-1}, equivalent to the moisture at pot capacity, according to the methodology proposed by Casaroli & Lier (2008). The time of irrigation was calculated for each experimental plot, based on the mean flow rate of the drippers (3.9 L h^{-1}) and actual moisture of the soil of each plot.

The doses referring to the treatments were diluted in a graduated cylinder with 1 L of water and weekly applied in each experimental plot following the absorption curve of the eggplant crop (Trani et al., 2011). The first fertigation was performed at seven days after transplantation (DAT) (April 16, 2015). In the 1st and 2nd weeks, a dose corresponding to 6.90% of the total (3.45% per week) was applied. Between the 3rd and 4th weeks, 10.34% of the total (5.17% per week) was applied. Between the 5th and 10th weeks, 51.72% of the total (8.62% per week) was applied. Between the 11th and 16th weeks, 31.02% (5.17% per week) was applied.

Harvest started at 100 DAT and extended to 137 DAT. After counting the number of fruits per plant (NFP), the fruits were weighed to determine yield (Y), measured in grams of eggplant per plant. The fruits were harvested when they showed a shiny dark purple color, evaluating only fruits longer than 14 cm, a length defined as commercial standard (Luengo et al., 1999). At the end of the experiment, roots and stems were dried in a forced-air oven at 65 °C to obtain root dry matter (RDM) and stem dry matter (SDM) per plant.

Table 1. Chemical and physical characteristics of the soil used in the experiment

Chemical attributes								Physical-hydraulic attributes				
pH	P	Na^+	K^+	Ca^{+2}	Mg^{+2}	Al^{+3}	H^+	Granulometric fraction (g kg^{-1})			Moisture (g g^{-1})	
	(mg dm^{-3})		($cmol_c$ dm^{-3})					Sand	Silt	Clay	PCM	CM
4.8	8.63	2.10	0.07	1.56	0.38	0.70	2.48	780	30	190	0.20	0.08

PCM - Pot capacity moisture for ψm = -5.8 kPa; CM - Critical moisture for eggplant for ψm = -15 kPa

The data were subjected to analysis of variance and, when there was significance by the F test at 0.05 probability level, regression analysis was applied. Polynomial models were fitted to the data to verify the effect of the treatments. For significant interactions, a follow-up analysis was performed using the statistical program Sisvar (Ferreira, 2008).

Results and Discussion

The values of minimum and maximum temperature recorded inside the protected environment were 6.4 and 39.4 °C, respectively (data not shown). The mean daily air temperature varied from 13.3 to 31.2 °C, with mean of 21.9 °C. In eggplant cultivation, the ideal daytime temperature is between 25 and 35 °C and nighttime temperature between 20 and 27 °C (Ribeiro, 2007). During the cycle, there were temperatures lower than the minimum temperatures indicated for the crop, causing early fall of some leaves. The mean value of relative air humidity was 62.5%.

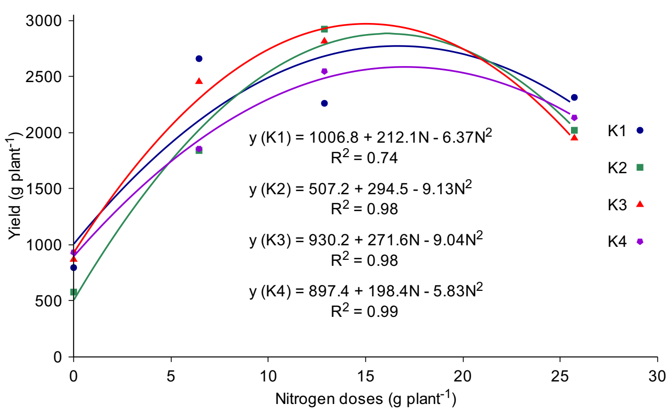
Based on the analysis of variance (Table 2), there was interaction between the doses of nitrogen and potassium for the yield, which allowed to fit individual regression equations to each dose of nitrogen at each level of potassium (Figure 1).

The data fitted best to the quadratic equation, showing the same tendency of increase in yield until the maximum value (K1 = 16.64; K2 = 16.12; K3 = 15.03; K4 = 17.01 g of N plant^{-1}), followed by a reduction. Hence, the tested doses of nitrogen were adequate because they allowed to identify the point of maximum yield.

Table 2. Summary of the analysis of variance for yield (Y), number of fruits per plant (NFP), root dry matter (RDM) and stem dry matter (SDM) in eggplant cultivation in protected environment

SV	DF	Mean squares			
		Y	NFP	RDM	SDM
N	3	10101158.6*	834.6**	28581.2**	20377.0**
K	3	149207.8ns	62.3**	5068.8ns	1294.0**
N x K	9	365053.6**	29.6**	3741.3ns	447.5*
Error	48	69994.8	7.7	2991.3	214.6
CV (%)		13.7	21.7	44.6	16.6
Mean		1933.9	12.8	122.7	88.3

** significant at 0.01 probability level; *significant at 0.05 probability level; ns not significant ($p > 0.05$), by F test



Doses (g of K plant^{-1}): K1 = 0; K2 = 5.18; K3 = 10.36; K4 = 20.73

Figure 1. Eggplant yield as a function of nitrogen doses in plants subjected to different potassium doses, cultivated in protected environment

The positive effect of nitrogen on eggplant yield was probably due to the stimulating effect of the element on the growth characteristics that form the base of flowering and fruiting (Aminifard et al., 2010).

The nitrogen dose of 15.03 g of N plant^{-1} promoted the highest yield at the dose K3, producing 2970.20 g of eggplant plant^{-1}. Considering the spacing adopted in the present study (0.8 x 1.2 m) corresponding to 10,416 plants ha^{-1}, the dose and the obtained yield are equivalent to approximately 157 kg of N ha^{-1} and 30.9 t ha^{-1}, respectively. The value is below the highest dose (200 kg of N ha^{-1}) recommended by Trani (2014) for eggplant cultivation in protected environment. However, different values are found in the literature. Amiri et al. (2012) obtained, in a sandy soil, yield of 27.6 t ha^{-1} with the application of the dose of 120 kg of N ha^{-1}. Moraditochaee et al. (2011) produced 35.03 t ha^{-1} with the application of 75 kg of N ha^{-1} and Bozorgi (2012) obtained 34.63 t ha^{-1} with 60 kg of N ha^{-1}.

According to Pereira & Machado (1987), the higher plant growth is due to the increase in leaf area and to the relationship between photosynthesis and leaf area, because crop yield becomes higher, the faster the plant reaches maximum leaf area index and the longer the duration of this period of source. In turn, nitrogen has direct effect on plant growth, acting in different physiological processes (Taiz & Zeiger, 2009). Therefore, in vegetables in which the organ of interest is a fruit, as the eggplant, adequate doses of nitrogen allow a rapid increment in leaf area, enabling the plant to reach the maximum leaf area index earlier.

In addition, the highest doses of nitrogen did not promote the highest yield in eggplant (Figure 1). The results agree with those found by Aminifard et al. (2010), Amiri et al. (2012) and Bozorgui (2012).

According to Sat & Saimbhi (2003), nitrogen in excess may delay flowering and increase the number of days necessary for fruit setting, and it may also cause oxidative damages that harm important cell components, such as lipids, proteins, DNA and RNA, reducing growth, number of fruits and, eventually, plant yield (Wei et al., 2009; Oliveira et al., 2014). Cabello et al. (2009) observed a reduction of 15% in melon yield when the nitrogen doses were excessive (390 kg of N ha^{-1}). According to Ruiz & Romero (1999), the reduction in the commercial yield is associated with the reduction of the nitrate reductase enzyme in the leaves and, consequently, a reduction in the exportation of amino acids to the fruits.

Regarding the doses of potassium, only the applications at the doses N2 and N3 showed significant differences, which in turn did not fit to the polynomial model.

The individual effect of potassium application was not significant (Table 2) on yield. This can be due to the low doses selected to be tested under the conditions of the present study. Thus, for future experiments it is suggested to consider a greater range of potassium doses. Hochmuth et al. (1993) tested potassium doses and observed that the yield can be described by a linear plateau model, in which there was an increase in yield up to 94 kg of K ha^{-1}, and after this value there was no increase in production. According to Michalojc & Buczkowska (2009), fruits with higher commercial quality were obtained with the highest doses of potassium, but the nutrient had small effect on yield. Still according to these authors, potassium at the doses of 0, 8, 16 and 24 g of K plant^{-1} in the form of potassium nitrate and potassium sulfate did not have effect on yield.

For the number of fruits per plant, the analysis of variance showed significant interaction between the doses of nitrogen and potassium (Table 2). The four follow-up analyses of N at K doses were subjected to regression analysis and explained with the quadratic model (Figure 2).

The highest number of fruits plant^{-1} (24.52) occurred at the dose of 18.75 g of N plant^{-1} (195 kg ha^{-1}), at the dose K4. Mirdad (2011) obtained 26.24 fruits plant^{-1} with the dose of 300 kg N ha^{-1}. Pal et al. (2002) obtained 14.4 fruits plant^{-1} with the dose of 187.5 kg ha^{-1} and Moraditochaee et al. (2011) produced 6.34 fruits plant^{-1} with 75 kg ha^{-1}.

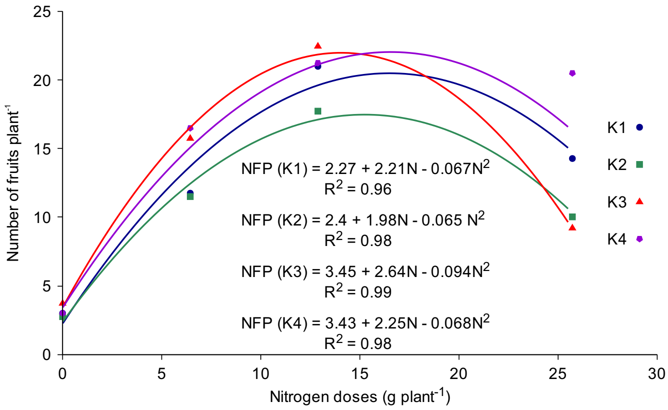
According to Ngetich et al. (2013), the function of nitrogen in the plant is to increase the number of male flowers and the highest number of fruits is obtained with the maximum doses.

Nitrogen influences the processes involved in plant growth and development, altering the source-sink relationship and, consequently, the distribution of assimilates between vegetative and reproductive organs (Pôrto et al., 2014). Kano et al. (2010) claim that, during the process of cell differentiation, nitrogen stimulates the production of flower buds. However, excessive doses of nitrogen in the flowering stage of vegetable crops favor the abortion of female flowers (Ngetich et al., 2013).

In the follow-up analysis of K doses at the N doses (Figure 3), there were significant differences only for the doses N2 and N4.

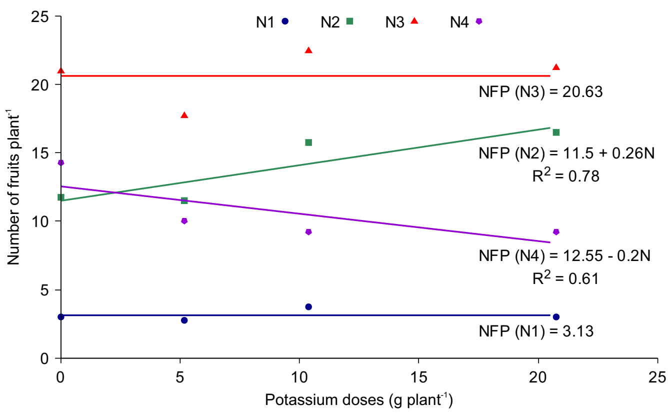
The non-significant effect and the amount of only 3.13 NFP at the dose N1 may have occurred due to the restriction of growth by the nitrogen. The result corroborates that one of Moraditochaee et al. (2011), who obtained 4.34 eggplant fruits plant^{-1}, without nitrogen application.

There was significant interaction between the doses of nitrogen and potassium for stem dry matter (Figure 4A; Figure 4B), with significant differences for the N doses at each dose of K, allowing the fit to the quadratic model.



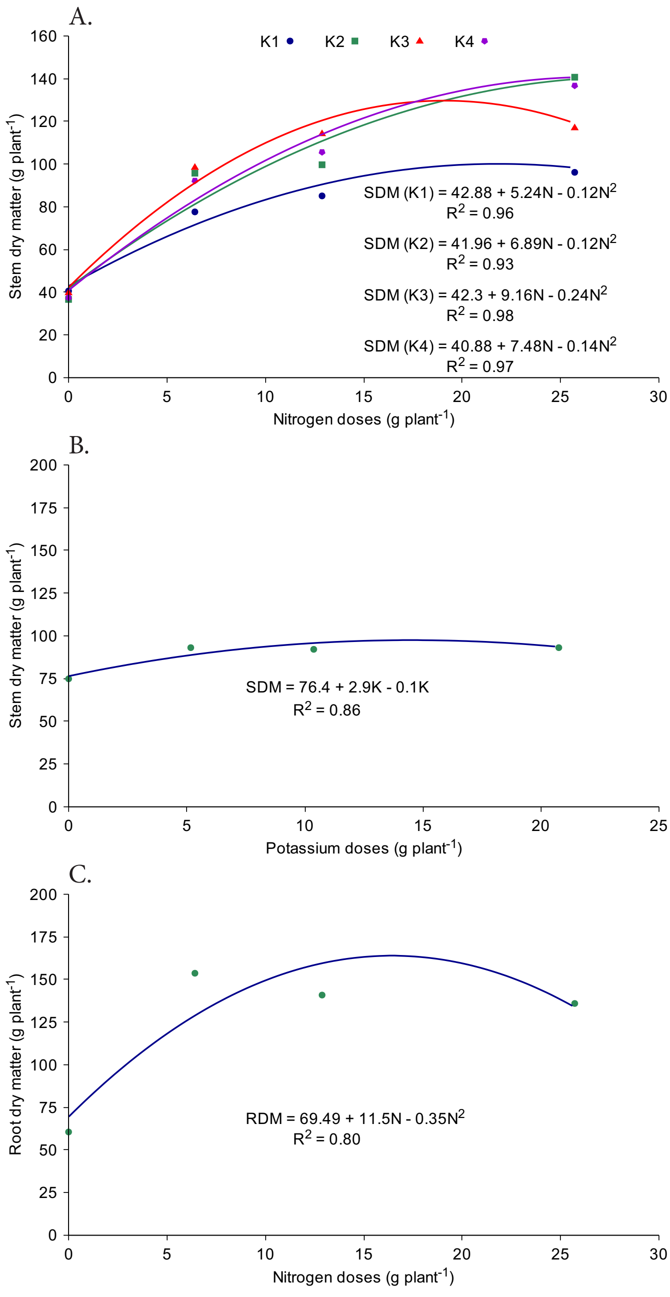
Doses (g of K plant^{-1}): K1 = 0; K2 = 5.18; K3 = 10.36; K4 = 20.73

Figure 2. Number of fruits per plant of eggplant as a function of nitrogen doses in plants subjected to different potassium doses cultivated in protected environment



Doses (g of N plant^{-1}): N1 = 0; N2 = 6.43; N3 = 12.86; N4 = 25.72

Figure 3. Number of fruits per plant of eggplant as a function of potassium doses in plants subjected to different nitrogen doses cultivated in protected environment



Doses (g of K plant^{-1}): K1 = 0; K2 = 5.18; K3 = 10.36; K4 = 20.73

Figure 4. Dry matter obtained in the experiment conducted in protected environment: (A) Eggplant stem as a function of nitrogen doses in plants subjected to different potassium doses; (B) Eggplant stem as a function of the potassium doses; (C) Eggplant root as a function of the nitrogen doses

The dose of 25.72 g of N plant^{-1} promoted higher value of stem dry matter (140.6 g plant^{-1}), via fertigation, at the dose K4.

There was an increment in stem dry matter at all doses of K, varying from 133 to 243% in relation to the initial value, for the doses K1 and K4, respectively. For the potassium doses, there were significant differences at the doses N3 and N4, but it was not possible to fit a polynomial model. The overall effect of potassium on stem dry matter can be described by a quadratic model (Figure 4B).

The analysis of variance indicated no significant difference in the interaction between doses of nitrogen and potassium for root dry matter. There was significant difference only for the application of nitrogen, individually (Figure 4C).

At the dose of 0 g N plant^{-1}, root dry matter was equal to 69.49 g plant^{-1}. The highest dose of nitrogen (25.73 g N plant^{-1}) promoted 133.67 g of RDM plant^{-1} and the highest value observed (163.95 g of RDM plant^{-1}) was obtained with 16.42 g of N plant^{-1}.

Conclusions

1. The maximum number of fruits plant^{-1} and yield were obtained between 14.0 and 17.0 g of N plant^{-1} (145 to 177 kg of N ha^{-1}).

2. Nitrogen doses higher than 15.03 and 14.04 g plant^{-1} can reduce yield and number of fruits plant^{-1}, respectively.

3. The isolated application of potassium doses (0 to 20.73 g of K plant^{-1}) did not cause significant differences in yield or root dry matter.

Literature Cited

Aminifard, M. H.; Aroiee, H.; Fatemi, H.; Ameri, A.; Karimpour, S. Responses of eggplant (*Solanum melongena* L.) to different rates of nitrogen under field conditions. Journal Central European Agriculture, v.11, p.453-458, 2010. http://dx.doi.org/10.5513/JCEA01/11.4.863

Amiri, E.; Gohari, A. A.; Esmailian, Y. Effect of irrigation and nitrogen on yield, yield componentes and water use efficiency of eggplant. African Journal of Biotechnology, v.11, p.3070-3079, 2012.

Bilibio, C.; Carvalho, J. A.; Martins, M. A.; Rezende, F. C.; Silva, W. G.; Gomes, L. A. G. Função de produção da berinjela irrigada em ambiente protegido. Irriga, v.15, p.10-22, 2010. http://dx.doi.org/10.15809/irriga.2010v15n1p10

Bozorgi, H. R. Study effects of nitrogen fertilizer management under nano iron chelate foliar spraying on yield and yield components of eggplant (*Solanum melongena* L.). ARPJ Journal of Agricultural and Biological Science, v.7, p.233-237, 2012.

Cabello, M. J.; Castellanos, M. T.; Romojaro, F.; Martínez-Madrid, C.; Ribas, F. Yield and quality of melon grown under different irrigation and nitrogen rates. Agricultural Water Management, v.92, p. 866-874, 2009. http://dx.doi.org/10.1016/j.agwat.2008.11.006

Casaroli, D.; Lier, Q. J. V. Critérios para determinação da capacidade de vaso. Revista Brasileira de Ciência do Solo, v.7. p.59-66, 2008. http://dx.doi.org/10.1590/S0100-06832008000100007

Caviglione, J. H.; Kiihl, L. R. B.; Caramori, P. H.; Oliveira, D. Cartas climáticas do Paraná. Londrina: IAPAR, 2000. CD Rom

EMBRAPA - Empresa Brasileira de Pesquisa Agropecuária. Manual de métodos de análise de solo. 2.ed. Rio de Janeiro: Embrapa CNPS, 1997. 212p.

Faquin, V.; Andrade, A. T. Nutrição mineral e diagnose do estado nutricional das hortaliças. Lavras: FAEPE-UFLA, 2004. 88p.

Fawzy, Z. F.; El-nemr, M. A.; Saleh, S. A. Influence of levels and methods of potassium fertilizer application on growth and yield of eggplant. Journal of Applied Sciences Research, v.3, p.42-49, 2007.

Ferreira, D. F. Sisvar: Um programa para análises e ensino de estatística. Revista Científica Symposium, v.6, p.36-41, 2008.

Hochmuth, G. J.; Hochmuth, R. C.; Donley, M. E.; Hanlon, E. A. Eggplant yield in response to potassium fertilization on sandy soil. HortScience, v.28, p.1002-1005, 1993.

Kano, C.; Cardoso, A. I. I.; Villas-Boas, R. L. Influência de doses de potássio nos teores de macronutrientes em plantas e sementes de alface. Horticultura Brasileira, v.28, p.287-291, 2010. http://dx.doi.org/10.1590/S0102-05362010000300008

Lopes, L. N.; Souza, C. F.; Santoro, B. L. Utilização da TDR para monitoramento da solução de nitrato de potássio em Latossolo Vermelho-Amarelo. Engenharia Agrícola, v.30, p. 932-947, 2010. http://dx.doi.org/10.1590/S0100-69162010000500015

Luengo, R. F. A.; Calbo, A. G.; Lana, M. M.; Moretti, C. L.; Henz, G. P. Classificação de hortaliças. Brasília: Embrapa Hortaliças, 1999. 63p.

Michalojc, Z.; Buczkowska, H. Influence of varied potassium fertilization on eggplant yield and fruit quality in plastic tunnel cultivation. Folia Horticulturae, v.21, p.17-26, 2009. http://dx.doi.org/10.2478/fhort-2013-0122

Mirdad, Z. M. Vegetative growth yield and yield components of eggplant (*Solanum melongena* L.) as influenced by irrigation intervals and nitrogen levels. Journal of King Abdulaziz University: Meteorology, Environment and Arid Land Agriculture Sciences, v.22, p.31-49, 2011.

Moraditochaee, M.; Bozorgi, H. R.; Halajisani, N. Effects of vermicompost application and nitrogen fertilizer rates on fruit yield and several attributes of eggplant (*Solanum melongena* L.) in Iran. World Applied Sciences Journal, v.15, p.174-178, 2011.

Ngetich, O.; Niyokuri, A.; Rono, J.; Fashaho, A.; Ogweno, J. Effect of diferente rates of Nitrogen fertilizer on the growth and yield of Zucchini (*Curcubita pepo* cv. Diamant L.) Hibrid F1 in Rwandan high altitude zone. International Journal of Agriculture and Crop Sciences, v.5, p.54-62, 2013.

Oliveira, F. A.; Medeiros, J. F.; Alves, R. C.; Linhares, P. S. F.; Medeiros, A. M. A.; Oliveira, M. K. T. Interação entre salinidade da água de irrigação e adubação nitrogenada na cultura da berinjela. Revista Brasileira de Engenharia Agrícola e Ambiental, v.18, p.480-486, 2014. http://dx.doi.org/10.1590/S1415-43662014000500003

Pal, S.; Saimbiij, M. S.; Bal, S. S. Effect of nitrogen and phosphorus levels on growth and yield of brinjal hybrids (*Solanum melongena* L.). Journal of Vegetable Science, v.29, p.90-91, 2002.

Parida, A. K.; Das, A. B. Salt tolerance and salinity effects on plants: A review. Ecotoxicology and Environmental Safety, v.60, p.324-349, 2005. http://dx.doi.org/10.1016/j.ecoenv.2004.06.010

Pereira, A. R.; Machado, E. C. Análise quantitativa do crescimento de comunidades vegetais. Campinas: Instituto Agronômico, 1987. 33p.

Pôrto, M. L. A.; Puiatti, M.; Fontes, P. C. R.; Cecon, P. R.; Alves, J. C. Produtividade e acúmulo de nitrato nos frutos da abóbora "Tetsukabuto" em função da adubação nitrogenada. Horticultura Brasileira, v.32, p.280-285, 2014. http://dx.doi.org/10.1590/S0102-05362014000300007

Ribeiro, C. S. C. Berinjela (*Solanum melongena* L.). Brasília: Embrapa Hortaliças, Sistemas de Produção, 2007. Versão Eletrônica. <https://goo.gl/Z6Vrfn>. 14 Jan. 2016.

Ruiz, J. M.; Romero, L. Cucumber yield and nitrogen metabolismo in response to nitrogen supply. Scientia Horticulturae, v.82, p.309-316, 1999. http://dx.doi.org/10.1016/S0304-4238(99)00053-9

Sat, P.; Saimbhi, M. S. Effect of varying levels of nitrogen and phosphorus on earliness and yield of brinjal hybrids. Journal Soils Crops, v.4, p.217-222, 2003.

Taiz L.; Zeiger, E. Fisiologia vegetal. 4.ed. Porto Alegre: Artmed, 2009. 820p.

Trani, P. E. Calagem e adubação para hortaliças sob cultivo protegido. 1.ed. Campinas: Instituto Agronômico, 2014. 25p.

Trani, P. E.; Tivelli, S. W.; Carrijo, O. A. Fertirrigação em hortaliças. 2.ed. Campinas: Instituto Agronômico, 2011. 51p. Série Tecnologia APTA. Boletim Técnico IAC, 196

Wei, G. P.; Yang, L. F.; Zhu, Y. L.; Chen, G. Changes in oxidative damage, antioxidante enzyme activities and polyamine contents in leaves of grafted and non-grafted eggplant seedlings under stress by excess of calcium nitrate. Scientia Horticulturae, v.120, p.443-451, 2009. http://dx.doi.org/10.1016/j.scienta.2008.12.009