

A fertilização com nitrogênio e potássio afeta a produção de banana
Nitrogen and potassium fertilization affects banana production
La fertilización con nitrógeno y potasio afecta la producción de banana

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Resumo

A bananeira apresenta crescimento rápido e alta produção de frutas, exigindo intensa fertilização, sendo o nitrogênio e o potássio os nutrientes mais destacados. No entanto, a produtividade nacional ainda é baixa, indicando a necessidade de estudos para melhorar o desempenho desse fruto. Assim, o objetivo deste trabalho foi avaliar a produtividade e as características dos frutos da banana Thap Maeo, segundo ciclo, sob adubação nitrogenada e potássica. As plantas da cultivar Thap Maeo foram utilizadas em espaçamento de 2,5 m x 2,5 m. O delineamento experimental foi em blocos casualizados, em esquema fatorial 2 x 4, com três repetições. A combinação de presença (400 kg ha⁻¹) ou ausência de nitrogênio e quatro doses de potássio (0, 300, 600 e 900 kg de K₂O ha⁻¹) formaram os tratamentos. Observou-se que a aplicação de K₂O nas melhores doses proporcionou ganhos de 8,5; 5,9; 16,3; 50,2; 20,0 e 27,6%, respectivamente, para as pencas por cacho, frutos por penca, frutos por cacho, diâmetro e comprimento do fruto e produtividade do fruto, quando comparados a testemunha. O uso de nitrogênio associado ao K₂O influencia isoladamente o número de pencas por cacho e frutos por cacho, aumentando seus valores. As variáveis pencas por cacho, frutos por penca, frutos por cacho, diâmetro do fruto, comprimento e produtividade foram beneficiadas pela aplicação de K₂O, e as melhores doses foram de 502,7 a 658,0 kg ha⁻¹.

Palavras-chave: Qualidade de frutas; *Musa sp.*; Manejo de nutrientes.

Abstract

Banana crop presents rapid growth and high fruit production, demanding intense fertilization, with nitrogen and potassium being the most outstanding nutrients. However, national productivity is still low, indicating the need for studies to improve the performance of this fruit. Thus, the objective of this work was to evaluate the productivity and fruit characteristics of Thap Maeo banana, second cycle, under nitrogen and potassium fertilization. Plants of the cultivar Thap Maeo were used in spacing of 2.5 m x 2.5 m. The experimental design was in randomized blocks in a 2 x 4 factorial scheme with three replicates. The combination of presence (400 kg ha⁻¹) or absence of nitrogen and four doses of potassium (0, 300, 600 and 900 kg of K₂O ha⁻¹) composed the treatments. It was observed that the application of K₂O at the best doses gave gains of 8.5; 5.9; 16.3; 50.2; 20.0 and 27.6%, respectively, for the hands per bunch, fruits per hand, fruits per bunch, fruit diameter and fruit length, and fruit yield, when compared to the control. It was concluded that the use of nitrogen in association with K₂O influences in isolation the number of hands per bunch and fruits per bunch, increasing their values. The variables hands per bunch, fruits per hand, fruits per bunch, fruit diameter,

length and yield were benefited by the application of K_2O , and the best doses were in the range of 502.7 to 658.0 $kg\ ha^{-1}$.

Keywords: Fruit quality; *Musa sp.*; Nutrient management.

Resumen

El plátano tiene un rápido crecimiento y una alta producción de fruta, lo que requiere una fertilización intensa, siendo el nitrógeno y el potasio los nutrientes más importantes. Sin embargo, la productividad nacional sigue siendo baja, lo que indica la necesidad de estudios para mejorar el rendimiento de esta fruta. Por lo tanto, el objetivo de este trabajo fue evaluar la productividad y las características de las frutas de banano Thap Maeo, segundo ciclo, bajo fertilización con nitrógeno y potasio. Las plantas del cultivar Thap Maeo se usaron en espacios de 2.5 mx 2.5 m. El diseño experimental fue en bloques aleatorizados, en un esquema factorial 2 x 4, con tres repeticiones. La combinación de presencia ($400\ kg\ ha^{-1}$) o ausencia de nitrógeno y cuatro dosis de potasio (0, 300, 600 y $900\ kg\ de\ K_2O\ ha^{-1}$) formaron los tratamientos. Se observó que la aplicación de K_2O en las mejores dosis proporcionó ganancias de 8.5; 5.9; 16.3; 50.2; 20.0 y 27.6%, respectivamente, para pencas por racimo, frutos por penca, frutos por racimo, diámetro y longitud del fruto y productividad del fruto, en comparación con el control. El uso de nitrógeno asociado con K_2O solo influye en el número de pencas por racimo y frutas por racimo, aumentando sus valores. Las variables pencas por racimo, frutos por penca, frutos por racimo, diámetro del fruto, longitud y productividad se beneficiaron con la aplicación de K_2O , y las mejores dosis fueron de 502.7 a $658.0\ kg\ ha^{-1}$.

Palabras clave: Calidad de la fruta; *Musa sp.*; Manejo de nutrientes.

1. Introduction

Banana (*Musa sp.*) is one of the fruit species with the highest demand for nutrients, mainly due to the large amount of fruit exported by the harvest (Ganeshamurthy et al., 2011). The success of the cultivation of this species is related to the proper management, including the nutrients supply through the fertilizer's application. However, changes in the growing environment, including climatic, edaphic and technological characteristics, significantly alter the demand for nutrients (Mustaffa & Kumar, 2012), and it is necessary to carry out studies aimed at quantification and fertilization.

Among the nutrients demanded by the crop, stand out the potassium and the nitrogen. In this sense, potassium is the element with the greatest demand during the stages of

development and production of banana. This is due to the export of this nutrient by fruits harvesting, which have their quality affected by the availability of potassium (Nomura et al., 2017). In addition to composing the fruits, potassium exerts physiological functions in the plant, participating in the processes of photoassimilate production and translocation (Taiz et al., 2017).

In this sense, it was observed that the application of potassium sulphate in banana crop resulted in an increase of all the studied variables, of vegetative growth, biometric and productive parameters of fruits, besides the post-harvest quality (Kumar & Kumar, 2007). Similar responses were also verified in a study with increasing doses of potassium from different sources, in which an increase of about 400 kg ha⁻¹ year⁻¹ was obtained at the maximum estimated doses of the different sources used (Ganeshamurthy et al., 2011).

In addition to potassium, nitrogen has a physiological function, acting effectively on photosynthesis processes and on the distribution of photoassimilates to the various plants organs, resulting in the accumulation of dry matter, plant and fruit development (Taiz et al., 2017). For banana, it is observed that nitrogen, applied in commercial crops, results in a decrease in the productive cycle and improvement of the physical and chemical fruit qualities (Nomura et al., 2016; Nomura et al., 2017). It also provide greater financial return to the rural producers, an essential fact, since the Brazilian production is realized in large part in small and medium family farms.

Despite the importance of nitrogen in the plants physiological activities, there are controversial results in the literature about its application in banana cultivation and its effects on the fruits development and production. In this sense, it was observed that banana seedlings fertilized with increasing doses of nitrogen had a decrease in height and dry matter accumulation in the aerial part (Silva et al., 2013), while the application of nitrogen in the second and third production cycles resulted in lower fruit yield (Silva et al., 2012). On the other hand, other studies have shown that the elevation of nitrogen rates results in an increase in the production variables (Nomura et al., 2016).

In view of the possibility of changes to the nutrient demand in different environments and the conflicting information in the literature, the aim of this study was to evaluate the productivity and fruit characteristics of Thap Maeo banana, during the production second cycle, under nitrogen and potassium fertilization.

2. Methodology

The experiment was carried out in the field, conducted for one year. It was of qualitative and quantitative nature and applied statistical methods for the evaluation of the collected data (Pereira et al., 2018).

The experiment was conducted in the municipality of Chapadão do Sul, located at coordinates 18° 46' 17.8 "south latitude, 52° 37' 27.7" west longitude and with an elevation of 813 m. The soil in the area was classified as Latossolo Vermelho Distrófico. The typical climate of the region is tropical humid type (Aw) with rainy season in the summer and dry in winter and average annual precipitation of 1,850 mm (Cunha et al., 2013).

The experimental design used was a randomized block in a 2 x 4 factorial scheme, with nitrogen and potassium applied. For the N, the levels with and without urea application were considered at the dose of 889 kg ha⁻¹ (400 kg N ha⁻¹) and for potassium the doses of 0, 500, 1000 and 1500 kg KCl ha⁻¹ (0, 300, 600 and 900 kg K₂O ha⁻¹). The applications of these fertilizers were also divided equally in four times, during the period of the waters, from October to March. Each plot was formed by 12 plants, and the four central plants formed the useful plot.

The experiment consisted of 200 plants, 96 plants useful and the others serving as a border, in a second productive banana cycle. Plants of the cultivar Thap Maeo were used, with plant spacing of 2.5 m between plants and 2.5 m between rows, totaling 6.25 m² per plant.

Tillers management was performed at intervals of 45 to 60 days, avoiding the competition with the mother plant by water and nutrients. The elimination of the heart, which consists of the terminal portion of the rachis, when it reaches between 20 and 25 cm away from the last hand, was performed in order to improve fruit sanity by insect control. In addition, the application of herbicide was made punctually, avoiding the proliferation of spontaneous plants. Fungicides and insecticides were not used during the conduction of the experiment.

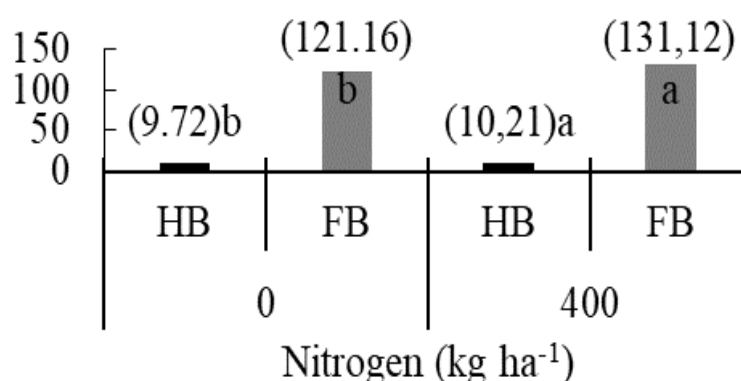
After harvesting, the following parameters were evaluated: number of hands per bunch, number of fruits per hand, number of fruits per bunch, average fruit weight, fruit weight per hand, diameter and length of the medium fruit of the second hand and fruit yield.

The data were submitted to analysis of variance and the means of the treatments were analyzed through regression to the potassium doses factor and the Tukey test at 5% probability for the nitrogen presence factor.

3. Results and Discussion

There was no interaction between the N and K factors, observing an increase in the production of hands per bunch and the number of fruits per bunch when the highest dose of N tested was used, corresponding to 400 kg ha⁻¹, when compared to the treatment without addition of N (Figure 1).

Figure 1. Number of hands per bunch (HB) and fruits per bunch (FB) for Thap Maeo banana plants fertilized with different doses of nitrogen.



Source: Authors.

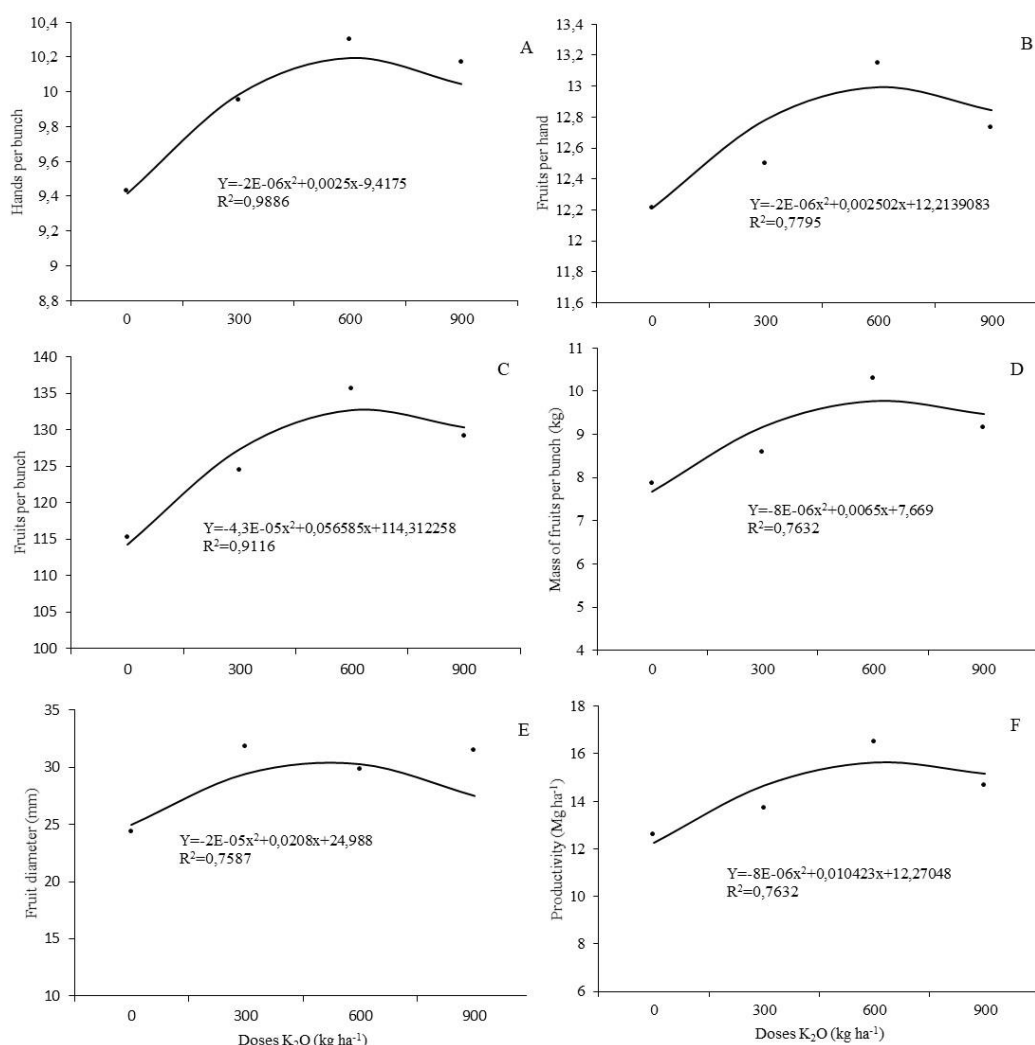
The increase in the K₂O doses resulted in an increment in the number of hands per bunch (Figure 2A) up to the estimated maximum value of 625 kg K₂O ha⁻¹, culminating in production of 10.2 units. In this dose, a gain of 8.5% of hands per bunch was obtained when compared to the treatment without application of K₂O. At the same time, it was observed that after the maximum estimated dose there was decrease of the variable up to the maximum dose used in the experiment.

The evaluated parameters increase of hands per bunch and fruits per bunch (Figure 1), in treatments where nitrogen was applied, is related to the participation of this element in the metabolism and in the physiological processes that comprise the production and distribution of photoassimilates (Taiz et al., 2017). The increase of N available to the banana trees results in a higher leaf area, greater photosynthetic activity and, consequently, a greater accumulation of photoassimilates, which are transferred to the fruits during the filling stage (Melo et al., 2010; Nomura et al., 2016).

In studies on the fertilization of banana plants with nitrogen, different results can be observed, which may be related to environmental effects, fertilizer sources, management form, genomic group, among others. In relation to the initial development, it was verified that the application of increasing concentrations of potassium nitrate positively influenced the biometric characteristics of Prata-anã and Nanicão banana seedlings, as well as the relative levels of chlorophyll, negatively affecting only the length of roots. In this same study it was verified that the application of urea was significantly superior to potassium nitrate, resulting in better quality seedlings (Siqueira et al., 2013). There are studies that point to a negative effect of the application of nitrogen on banana plants of the Prata-anã type, in which there was a significant decrease of the biometric characteristics in seedlings (Silva et al., 2013) and productivity with plants in second and third cycles of production (Silva et al., 2012).

These results reaffirm the importance of this line of research, aiming at the generation of solid and reproducible information by the producers. It is also observed that fertilizers make up a significant part of the total operational costs of a banana (Furlaneto et al., 2011). Thus, assertive decisions must be made as to the choice of the nutritional source, how it should be applied and in what quantity, so that the banana grows and produces correctly without any damage to the producer.

Figure 2. Production components of Thap Maeo banana fruits, due to doses of K₂O.



Source: Authors.

For the number of fruits per hand, it was verified the variable increase as the K₂O doses increased (Figure 2B), and the maximum number of fruits, 12, 92, was obtained with the maximum estimated dose of 625.5 kg ha⁻¹, decreasing after this. At this maximum dose, an increase of 5.9% was obtained, compared to plants not fertilized with K₂O.

The maximum fruit number per bunch (Figure 2C) was obtained with the maximum calculated dose of 657.96 K₂O ha⁻¹, which culminated in 132.9 fruits per cluster. At this dose, the estimated gain was 16.3%, compared to the control treatment, but there was a decrease in fruit production from this dose.

For the fruit weight per bunch it was observed that the highest value was estimated at 11.68 kg bunch⁻¹, obtained with the calculated dose of 650 kg of K₂O ha⁻¹ (Figure 2D). At this moment, there was an increase of 48.57% in relation to treatment without application of K₂O.

The increase in K₂O doses resulted in an increase in the fruit diameter (Figure 2E), and the dose of 628.3 kg of K₂O ha⁻¹ resulted in gains of 50.2% in the diameter of the banana fruits, culminating in a maximum diameter of 33.04 mm.

The highest productivity of Thap Maeo banana fruits was obtained with the estimated dose of 651.4 kg ha⁻¹ of K₂O, reaching 15.7 Mg ha⁻¹, which represents a gain of 27.6% in relation to the control treatment (Figure 2F).

Although some studies have addressed nitrogen and potassium fertilization together (Ratke et al., 2012), the interaction between the two fertilizers was not observed in the present study, corroborating a similar study in which fertilizer application was carried out separately in banana pioneer cultivar (AAAB) (Brasil et al., 2000). Thus, in addition to the before mentioned effects on nitrogen fertilization, the use of increasing doses of potassium provided positive responses (Figure 2) for the parameters evaluated.

The positive effects of increasing K₂O doses applied may be related to the participation of this element in several processes, as photosynthesis, protein production, amino acids, among others, being also part of the process of translocation of photoassimilates (Taiz et al., 2017). This last process is essential to the maintenance of fruit quality, since this species exports a large amount of nutrients during harvesting (Ganeshamurthy et al., 2011), with emphasis on potassium itself (Nomura et al., 2017).

The application of adequate doses of K₂O results in maintenance of this nutrient in the soil (Teixeira et al., 2001) and plant tissues (Barroso et al., 2011). This favors the banana productivity during future productive cycles due to the greater availability of K in the soil, resulting in larger fruits and increasing productivity (Martins et al., 2011). On the other hand, when in excess, K may interfere negatively in the absorption of other nutrients, such as Mg, for example (Silva et al., 2008), impairing fruit production and, potentially, explaining the observed drop for the variables after the maximum points of the doses of K₂O used in the present study (Figure 2).

4. Final Considerations

The nitrogen fertilization increases hands and banana fruit numbers.

The K₂O utilization in doses varying between 502,7 a 658,0 kg ha⁻¹ positively affects the productive components of Thap Maeo banana.

It is observed that the banana Thap Maeo responds to nitrogen and potassium fertilization, however, there are still many questions to be resolved for this crop. We therefore

suggest that more research work be carried out, considering the assessment of nutrient concentrations in the plant and fruits, the study with other cultivars and the evaluation in an irrigated system.

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References

Barroso, AAF, Viana, TVA, Marinho, AB, Costa, SC & Azevedo, BM. (2011). Teores de macronutrientes em folhas de bananeira cv. Pacovan Apodi, sob lâminas de irrigação e doses de potássio. *Engenharia Agrícola*, 31(3), 529-538.

Brasil, EC, Oeiras, AHL, Menezes, AD & Veloso, CAC. (2000). Desenvolvimento e produção de frutos de bananeira em resposta à adubação nitrogenada e potássica. *Pesquisa Agropecuária Brasileira*, 35(12), 2407-2414.

Cunha, FF, Magalhães, FF & Castro, MA. (2013). Métodos para estimativa da evapotranspiração de referência para Chapadão do Sul-MS. *Revista Engenharia na Agricultura*, 21(2), 159-172.

Furlaneto, FPB, Martins, AN & Esperancini, MST. (2011). Viabilidade econômica de manejos nutricionais na cultura de banana. *Pesquisa Agropecuária Tropical*, 41(2), 205-212.

Ganeshamurthy, AN, Satisha, GC. & Patil, P. (2011). Potassium nutrition on yield and quality of fruit crops with special emphasis on banana and grapes. *Karnataka Journal of Agricultural Sciences*, 24(1), 29-38.

Kumar, AR. & Kumar, N. 2007. Sulfate of potash foliar spray effects on yield, quality, and post-harvest life of banana. *Better crops*, 91(2), 22-24.

Martins, AN, Teixeira, LA., Suguino, E, Hashimoto, JM & Narita, N. (2011). Irrigação e Adubação potássica via fertirrigação em bananeira ‘WILLIANS’, produção e qualidade de frutos. *Revista Brasileira de Fruticultura*, 33(1), 743-751.

Melo, AS, Fernandes, PD, Sobral, LF, Brito, MEB & Dantas, JDM. (2010). Crescimento, produção de biomassa e eficiência fotossintética da bananeira sob fertirrigação com nitrogênio e potássio. *Revista Ciência Agronômica*, 41(3), 417-426.

Mustaffa, MM & Kumar, V. (2012). Banana production and productivity enhancement through spatial, water and nutrient management. *Journal of Horticultural Science*, 7(1), 1-28.

Nomura, ES, Cuquel, FL, Damatto Jr, ER, Fuzitani, EJ & Borges, AL. (2017). Fertilization with nitrogen and potassium in banana cultivars ‘Grand Naine’, ‘FHIA 17’ and ‘Nanicão IAC 2001’ cultivated in Ribeira Valley, São Paulo State, Brazil. *Acta Scientiarum. Agronomy*, 39(4), 505-513.

Nomura, ES, Cuquel, FL, Damatto Jr, ER, Fuzitani, EJ, Borges, AL & Saes, LA. (2016). Nitrogen and potassium fertilization on ‘Caipira’ and ‘BRS Princesa’ bananas in the Ribeira Valley. *Revista Brasileira de Engenharia Agrícola e Ambiental*, 20(8), 702-708.

Pereira, AS, Shitsuka, DM, Parreira, FJ & Shitsuka, R. (2018). *Metodologia do trabalho científico*. [e-Book]. Santa Maria. Ed. UAB / NTE / UFSM. Accessed on: May, 5th, 2020. Available at:

https://repositorio.ufsm.br/bitstream/handle/1/15824/Lic_Computacao_Metodologia-Pesquisa-Cientifica.pdf?sequence=1.

Ratke, RF, Santos, SC, Pereira, HS, Souza, ED & Carneiro, MAC. (2012). Desenvolvimento e produção de bananeiras Thap Maeo e Prata-Anã com diferentes níveis de adubação nitrogenada e potássica. *Revista Brasileira de Fruticultura*, 34(1), 277-288.

Silva, I. P., Silva, J. T. A. & Carvalho, J. G. 2013. Nitrogênio e boro em mudas de bananeira Prata Anã cultivadas em casa de vegetação. *Agrarian*, 6(19), 51-59.

Silva, JTA, Silva, IP, Moura Neto, A. & Costa, EL. (2008). Aplicação de potássio, magnésio e calcário em mudas de bananeira 'Prata-anã' (AAB). *Revista Brasileira de Fruticultura*, 30(3), 782-786.

Silva, JT, Pereira, RD. & Rodrigues, MG. (2012). Adubação da bananeira 'Prata Anã' com diferentes doses e fontes de nitrogênio. *Revista Brasileira de Engenharia Agrícola e Ambiental*, 16(12), 1314-1320.

Siqueira, DL, Oliveira, MA, Alexandre, RS, Oliveira, JP, Schmildt, ER & Chagas, K. (2013). Fertilizantes nitrogenados no crescimento inicial ex vitro de cultivares de bananeira. *Revista Brasileira de Ciências Agrárias*, 8(3), 421-427.

Taiz, L, Zeiger, E, Moller, IM & Murphy, A, (2017). *Plant Physiology and Development*, sixth ed. Sinauer Associates, Sunderland.

Teixeira, LAJ, Natale, W & Ruggiero, C. (2001). Alterações em alguns atributos químicos do solo decorrentes da irrigação e adubação nitrogenada e potássica em bananeira após dois ciclos de cultivo. *Revista Brasileira de Fruticultura*, 23(3), 684-689.

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