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Economic viability of muskmelon cultivation in different planting spacing in Brazil central region

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Viabilidad económica del cultivo de melón Cantaloupe en diferentes espaciamientos de plantación

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ABSTRACT

Keywords:
Cucumis melo L.
Economic indicators
Production costs
Financial return
Noble melon

Production diversification is one way to avoid losses due to market variations. Melons are among the species used for this purpose, however, little information is a limiting factor to production stimulation. The objective of this study was to estimate and evaluate the economic indicators of muskmelon (*Cucumis melo* L.) cultivation, defining the most appropriate plant spacing in the planting line. A randomized complete block design was used, with four replications of five treatments corresponding to planting spacing of 15, 25, 35, 45 and 55 cm. From the production data of each treatment, economic indicators related to costs and returns obtained with the melon crop were estimated. For the production of melons in a protected area of 300 m^2, a total operating cost of $ 440.02 per production cycle was obtained. This amount was constituted by investments in manual operations, inputs, other expenses and interest of cost, which had a participation of 60.60%, 31.78%, 4.62% and 3.00%. The highest values of the economic indicators and the lower equilibrium and productivity prices were obtained for melons spaced 55 cm. The cultivation of muskmelons spaced 55 cm in the planting lines provides greater economic gains for this culture. This species can be used by farmers as an alternative to crops commonly grown in systems protected environment, but continuing studies should be performed to allow greater financial performance by optimizing the production system.

RESUMEN

Palabras clave:
Cucumis melo L.
Iindicadores económicos
Costos de producción
Rendimiento financiero
Melón

La diversificación de la producción es una manera de evitar las pérdidas debido a las variaciones del mercado. Los melones se encuentran entre las especies utilizadas para este propósito, sin embargo, la poca información es un factor limitante para la estimulación de la producción. El objetivo de este estudio fue estimar y evaluar los indicadores económicos del cultivo del melón Cantaloupe (*Cucumis melo* L.), definiendo el espaciamiento más apropiado de la planta en la línea de plantación. Se utilizó un diseño de bloques completos al azar, con cuatro repeticiones de cinco tratamientos correspondientes a un espaciamiento de plantación de 15, 25, 35, 45 y 55 cm. A partir de los datos de producción de cada tratamiento, se estimaron los indicadores económicos relacionados con los costos y los retornos obtenidos con el cultivo de melón. Para la producción de melones en un área protegida de 300 m^2, se obtuvo un costo total de operación de $ 440.02 por ciclo de producción. Este monto fue constituido por inversiones en operaciones manuales, insumos, otros gastos e intereses de costo, que tuvieron una participación de 60,60%, 31,78%, 4,62% y 3,00%. Los valores más altos de los indicadores económicos y el menor precio de equilibrio y productividad se obtuvieron para los melones espaciados 55 cm. El cultivo de melones Cantaloupe espaciados 55 cm en las líneas de plantación proporciona mayores ganancias económicas para este cultivo. Esta especie puede ser utilizada por los agricultores como una alternativa a los cultivos que se cultivan comúnmente en sistemas de medio ambiente protegido, pero deben realizarse estudios continuos para permitir un mayor rendimiento financiero optimizando el sistema de producción.

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The diversification of production in rural properties can be an important tool to alleviate losses caused by the fluctuation of prices paid to producers. In this sense, the production of melons has been pointed out as an alternative to the commonly used crops (Silva *et al*., 2014). In addition, the great diversity of marketable melon species makes possible the most appropriate choice according to the characteristics of each property and preferences of the consumer market.

The search for fruits with superior organoleptic characteristics has aroused interest in the production of fruits known as "nobles", popularly known as Japanese melon or Cantaloupe, which belong to the group of muskmelons (*Cucumis melo* var. *Reticulatus* Naud., Group Cantaloupensis). The attraction of the market is due to the marked aroma characteristics, pulp with differentiated coloration and higher soluble solids content compared to traditional melons (Medeiros *et al*., 2007).

Melon fruits have a growing acceptance in markets around the world. In twenty years, production has practically doubled, from 15.1 to 29.6 million t between 1994 and 2014, with China holding 50% of the total production (FAO, 2017). In Latin America about one million tons of melons are produced, of which approximately 50% are grown in an area equivalent to 22,000 ha in Brazil (FAO, 2017). In addition, the melon market is an important job generator for communities in productive areas, raising the quality of life of local people (Crisóstomo *et al*., 2008).

With an approximate production of 560,000 t, the Northeast region is the largest producer of melons in Brazil, corresponding to 95% of the national production (IBGE, 2016), although the crop is capable of production practically throughout the national territory. In order to meet national and international demand, there has been a significant increase in the production of melons in the last decade, from 350,000 t produced in 2003 to 590,000 t annually in 2014 (IBGE, 2016).

Despite the potential use of melon as an alternative to monoculture in rural properties throughout the country, research focuses on areas already explored with the species. The lack of technical information is a discouraging factor for producers from other regions, due to the lack of preparation of professionals who work in the field.

Obtaining economic indicators for the crop is another essential action, for which it is possible to pass to the producer information related to the investments and returns associated with the cultivation of a particular species. Through a set of information it is possible to plan the actions to be taken before, during and after the productive cycle. This information must be obtained through specific studies, which envisage the improvement of the productive technique together with the observation of the operational costs, since these factors are intrinsically connected.

Thus, the objective of this study was to estimate and evaluate the economic indicators of muskmelon cultivation, defining the planting spacing in the planting line that presents greater economic advantages.

MATERIALS AND METHODS

Plant material and growing conditions

The study was conducted in the city of Goiânia, State of Goiás, Brazil. The municipality is located in the central region of the Country, 16°40'S, 49°15'W and altitude of 750 m. It presents as average climatic indicators: annual precipitation of 1.575 mm and average monthly temperature of 22.9 °C, predominance of Aw climate, characterized by tropical climate with rainy season of October/April and a period with rainfall less than 100 mm monthly between May/September.

The soil present in the experimental area is classified as an Latossolo Vermelho (Santos *et al*., 2013) and presents the following chemical characteristics: O.M. = 0.7%; pH = 4.6; P (Mehlich) = 3.5 mg dm^{-3}; K = 131.0 mg dm^{-3}; Ca = 2.0 $cmol_c$ dm^{-3}; Mg = 0.81 $cmol_c$ dm^{-3}; H + Al = 2.5 $cmol_c$ dm^{-3}; Al = 0.0 $cmol_c$ dm^{-3}; CTC = 5.6 $cmol_c$ dm^{-3}; m = 0.0%; V = 55.7%.

The experiment was designed in randomized blocks with five treatments corresponding to five planting spacing (15, 25, 35, 45, 55 cm), with four replications. Each plot consisted of a line of 3.5 m in length and 0.7 m in width. To obtain the useful plot, the first and last plants of each plot were eliminated.

The climatic records of the temperature and humidity of the air that occurred during the conduction of the experiment were obtained from a climatic station located at the Agronomy School of the Federal University of Goiás, Goiânia, Brazil (Figure 1).

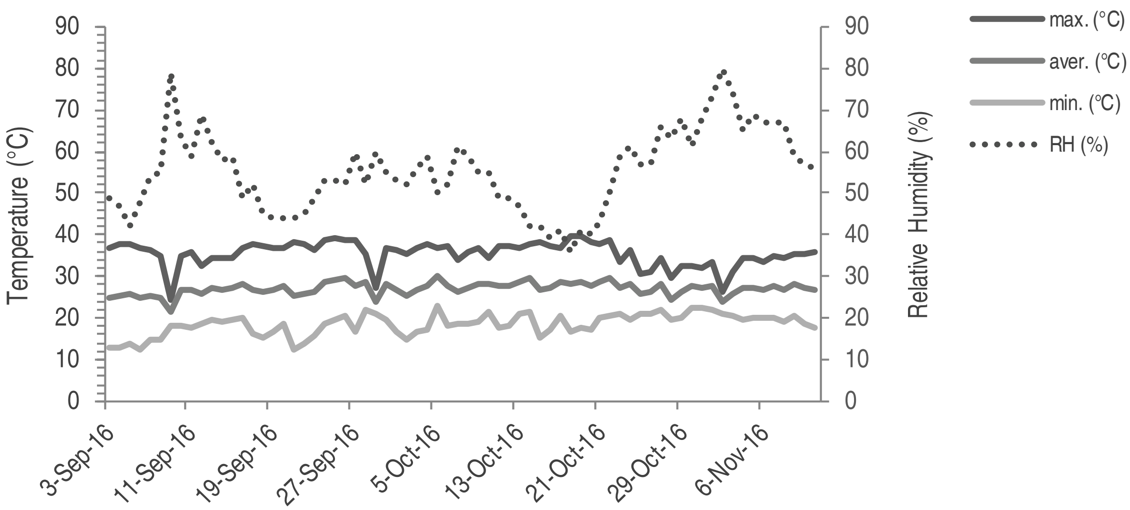

Figure 1. Summary of climatic conditions of relative air humidity and maximum, average and minimum temperature during the period of conduction of the study.

Ninety days before the installation of the experiment, the soil was corrected by applying a dose equivalent to 500 kg ha^{-1} of 100% ECCE dolomitic limestone ($CaCO_3$) in a haul distribution, followed by irrigation.

Plots were prepared with 50 cm wide than were fertilized, according to the recommendation in Bulletin 100 for the melon cultivation, and stirred for incorporation of the fertilizers. On the plots were distributed tapes suitable for irrigation, with drippers spaced 20 cm apart and "mulching" black and white in order to avoid the growth of spontaneous plants and excess water losses by evaporation. The irrigation was started soon after the assembly of the plots to allow the reaction of the elements incorporated into the soil.

The seedlings were obtained by sowing, on commercial substrate (Bioplant®) and earthworm humus (3:1), Cantaloupe melon seeds, Trinity cultivar. Thirty-five days after sowing, the seedlings were transplanted in the previously prepared plots. The conduction was vertically made by using plastic string attached to a 2.5 m high tensioned wire on the lines of planting.

Cover fertilization was carried out via fertigation at 33 and 54 days after transplanting, following the recommendations for the crop based on soil analysis. A control of whitefly and aphid with the use of insecticide based on thiamethoxam (250 g kg^{-1} of a.i.) was carried out, being applied at 14 and another at 52 days after transplanting of the seedlings. There was no need to apply fungicides or herbicides during cultivation.

The appearance of the crack in the insertion of the peduncle next to the fruit was defined as the harvesting point. The harvest was started at 63 days after transplanting and extended for six days until the fruits were harvested.

Economical analysis

In order to determine the production cost of a muskmelon production cycle, the total operational cost (TOC) structure proposed by Martin *et al.* (1998) was obtained by the sum of the expenses with interest of cost, depreciation, other expenses and the effective operating cost (EOC), which in turn is composed of the expenses of the operations and inputs used.

The economic analysis was made considering the different treatments as commercial crops. Considering the existence of structural elements such as greenhouse, irrigation system and other elements used by more than one productive cycle in the area of cultivation, in the present study the costs paid for the implantation of the same were disregarded.

In order to obtain the average prices received by the producers, the data contained in the website of the Center for Advanced Studies in Applied Economics (CEPEA, 2016) were taken into account. The average price of Cantaloupe melon received by producers in the period from January to May 2016 was $9.03 per 10 kg box, for calculation purposes, the same was used in the present work.

Labor costs were calculated through the index generated by the need for manual operations for each operation, obtained in men/day (MD), then multiplied by the average value of labor force in the region in the year 2016 ($23.83). For inputs, the cost was calculated based on the average value of the product in the region and the amount of material used. A rate of 5% of total EOC expenses was considered for other expenses, while costing interest is assumed to be 6.5% per year over 50% of OEC (Martin *et al*., 1998).

To determine the profitability of each treatment, a) gross revenue, obtained between the quantity produced (10 kg boxes) and the average price received by the producer in the period from January to May of 2016, were calculated (Martin *et al*., 1998); B) operating profit, such as the difference between gross revenue and total operating cost; C) Profitability index, understood as the proportion of gross revenue that represents the final amount after covering the total operational cost of production; (D) Equilibrium price given at a given level of total operational cost of production as the minimum price required to be covered to cover the TOC, taking into account the average productivity obtained by the producer; E) Equilibrium productivity, given at a given level of total operational cost of production, as the minimum productivity required to cover the TOC. The amounts, when related to monetary amounts, were expressed in US dollars.

RESULTS AND DISCUSSION

For the production of muskmelons in a protected area of 300 m^2, a total operating cost of $440.02 was obtained per production cycle. This amount was comprised of investments in manual operations, inputs, other expenses and costing interest, which had a participation of 60.60%, 31.78%, 4.62% and 3.00%.

Expenditure on plant management, including mentoring, shedding lateral branches and fruit stewardship contributed most of the expenses related to the operations and also to the total operational cost (Table 1). The group of actions that compose this activity had a 67.19% share between the manual operations and 40.72% over the total operating cost.

Table 1. Estimated total operational cost for a muskmelon crop, spaced 55 cm between plants in a protected area of 300 m^2.

Description	Specification	Qty.	U.C. ($)	Cost ($)
A- Manual operations				
Soil prepare	Man/day	0.2	23.83	4.17
Seedling transplant	Man/day	0.8	23.83	16.67
Plant conduction	Man/day	8.6	23.83	179.17
Fertirrigation	Man/day	1.2	23.83	25.00
Pulverization	Man/day	0.2	23.83	4.17
Harvest	Man/day	1.8	23.83	37.50
Subtotal A ($)				266.67
B- Inputs				
B1 - Polietilen mulch				
Polietilen mulch	Coil (500 m)	0.32	130.95	41.91
B2 – Fertilizers				
Limestone	t	0.014	26.79	0.37
Single superphosphate (18% P_2O_5)	kg	2.40	0.39	0.96
KCl	kg	3.60	0.60	2.14
P fertilizer + micronutrients	kg	2.40	0.57	1.36
Ureia (45% N)	kg	2.40	0.61	1.46
B3 – Seeds				
Trinity cultivar	1000 seeds package	0.58	133.93	77.40
B4 – Pesticides				
Insecticide (2x)	100 g	1.68	8.46	14.21
Subtotal B ($)				139.82
Effective Operational Cost (A+B) ($)				406.49
C – Other expenses ($)				20.32
D - Costing Interest per year ($)				13.21
Total Operating Cost (A+B+C) ($)				440.02

Qty = Quantity; U.C = Unit Cost.

Among the inputs, the one that most charged the production of muskmelons in protected environment was the hybrid seed. The input stopped most of the expenses related to the preparation and maintenance for the correct development of the crop, with participation of 55.33%. In relation to the total operational cost, the acquisition of seeds represented a fraction of 17.59% of the final amount.

The different planting spacing of the muskmelon alter the total operational cost, mainly through the demand for labor to attend the activities of tutoring, pruning, among others, included in the item of plant management. Higher amounts of seeds, used to obtain larger plant stands, were the second factor to burden the activity due to the high value of the hybrid seeds.

There was a 265.12% increase in the need for labor and 267.24% in the number of seeds used for the treatment of smaller planting spacing between plants (Table 2). These increases in expenses culminated in a monetary difference of $1027.47 between treatments.

Table 2. Participation of the cost variation factors over the total operating cost for muskmelon cultivation in different planting spacing between plants in a protected area of 300 m^2.

Planting Spacing	Plant Conduction (Man/day)		Seed (1000 seeds package)		TOC increase (%)
	Quantity	($)	Quantity	($)	
15 cm	31.40	654.17	2.13	285.27	234.00
25 cm	25.80	537.50	1.28	171.43	181.00
35 cm	20.00	416.17	0.91	121.88	142.00
45 cm	14.20	295.83	0.64	85.71	110.00
55 cm	8.60	179.17	0.58	77.41	0.00

TOC = total operating cost.

The estimated gross revenues, considering the average price received by producers between January and June 2016 ($9.03 per 10 kg box), were positive for all evaluated treatments and varied in a decreasing $1769.17 to $872.12 for protected environment of 300 m^2 in the treatments with use of planting spacing of 15 to 55 cm, respectively. Despite the lower value of gross revenue found for the planting spacing of 55 cm, in this one was observed the highest operating profit (Table 3), corresponding to the net profit obtained by the producer. This is mainly due to lower labor and seed costs during the productive cycle combined with good productivity. At the same time, it is observed that the treatment provided higher profitability indices, following the trend of operating profit.

The lower operating profit and profitability index were obtained for the treatment of 45 cm between plants. In spite of the lower values of these indicators, obtained in

Table 3. Productivity and economic indicators obtained by cultivating the muskmelon in a protected environment of 300 m^2, as a function of planting spacing.

Planting spacing (cm)	Production (10 kg boxes)	Gross revenue	TOC	OP	PI (%)
			($)		
15	195.93	1769.17	1467.49	301.67	17.05
25	179.61	1621.85	1236.45	385.39	23.76
35	134.91	1218.24	1066.87	151.37	12.43
45	108.46	979.33	922.88	56.44	5.76
55	96.58	872.12	440.02	432.09	49.55

TOC = total operating cost; OP = operating profit; PI = profitability index.

the treatment with planting spacing of 45 cm, it is observed that all the treatments were able to profit after the payment of all the operational costs.

For species usually cultivated in protected environments, such as lettuce, it was observed that, even when operating profit was favored by the adoption of the intercropping system with cucumber (Silva *et al*., 2008) or tomato (Rezende *et al*., 2005), this economic indicator was much lower than that obtained in this work with melon cultivation. It was verified that all the treatments reached productivities greater than the equilibrium for the price received by the producer from January to May of 2016. However, the crop driving in planting spacing of 55 cm required less production to cover the total operating costs. In this way, the cultivation in planting spacing of 55 cm allows greater security to the producer against the variations in the prices paid for the product, since the equilibrium price obtained for this treatment was approximately 50% lower than the amount paid to the producers in the survey period ($9.03) (Table 4).

The cultivation of muskmelon presents good economic indicators, favoring the introduction of the crop in rotation with other species already exploited commercially. Compared to other cultivated species such as corn (Kaneko *et al*., 2016) and soybean (Vazquez *et al*., 2014), muskmelon cultivation generates an income of approximately 42 and 23 times higher, respectively, in a same productive area size.

Table 4. Production and equilibrium price obtained with the cultivation of muskmelon in a protected environment of 300 m^2, as a function of planting spacing.

Planting spacing	Equilibrium productivity (10 kg boxes)	Equilibrium price ($ per 10 kg boxes)
15 cm	162.52	7.49
25 cm	136.93	6.88
35 cm	118.93	7.91
45 cm	102.20	8.51
55 cm	48.73	4.56

The lack of interest of rural producers to seek new species options for inclusion in different production systems is a reflection of the low technical-scientific production in regions not recognized nationally or internationally as potential regions producing a given crop. In this context, the importance of the economic feasibility study, which determines the operational sustainability and the profitability for the rural worker, is inserted. Consequently, bringing solutions to increase productivity combined with lower operating costs in agriculture and reducing the risks of monetary loss in the face of market oscillations.

CONCLUSIONS

For the muskmelon crop, better economic indexes are obtained with a 55 cm planting spacing between plants, in the central region of Brazil. In addition, the cultivation of the melon in all the spacings studied generated positive economic indices. This species can be used by farmers as an alternative to crops commonly grown in protected environment systems but future studies should be done in order to enable a greater financial return by optimizing the melon production system.

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