Full Length Research Paper

Productivity and quality of watermelon as function of phosphorus doses and variety

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Although watermelon is one of the major vegetable-fruit crop, management fertilization still lacks information for increased productivity, quality and profitability, and to lower environmental impact. An experiment was conducted in Mossoró, Brasilian city of Rio Grande do Norte, from August to October 2012, to evaluate the effects of doses of phosphorus (P) (0, 45, 90, 135, 180 and 225 kg ha^{-1} P$_2$O$_5$) in productivity, quality and profitability of two cultivars of watermelon cultivation (Top Gun and Olympia), in a randomized blocks in a factorial 6 × 2, with four replications. Larger number of commercial fruits (1.70 per plant) and commercial yield (74.39 t ha^{-1}) were obtained with 54.8 and 49.4 kg ha^{-1} P$_2$O$_5$, respectively. Attributes of quality of watermelon fruit were not influenced by P. Dose between cultivars differences were found, and 'Olympia' had higher fruit mass and skin thickness than the 'Top Gun'. However, the soluble solids content of the 'Top Gun' was 4.9% higher than the Olympia. The maximum economic return was achieved with a dose of 49.37 kg ha^{-1} of P$_2$O$_5$.

Key words: *Citrullus lanatus*, phosphate fertilizer, production cost.

INTRODUCTION

Watermelon (*Citrullus lanatus* L.) has stood out among the main horticultural products in Brazil. In the past years, there has been an increase in the area planted with the crop, especially in the brazilian states from the north and northeast. From 2001 to 2014, the area planted with watermelon in Rio Grande do Norte had a 310% increase, going from 1,655 to 5,133 hectares, while in the same period there was 13% reduction in the productivity

Table 1. Physical and chemical characteristics of the soil to a depth 0-20 cm, sampled prior to the experiment.

Parameter	Values
pH (water)	5.9
P (mg dm^{-3})	6.4
K (cmol$_c$ dm^{-3})	0.16
Na (Cmol$_c$ dm^{-3})	0.02
Ca (Cmol$_c$ dm^{-3})	1.21
Mg (Cmol$_c$ dm^{-3})	0.11
Al (Cmol$_c$ dm^{-3})	0.05
H + Al (Cmol$_c$ dm^{-3})	3.22
OM (%)	0.24
CEC (Cmol$_c$ dm^{-3})	4.72
V (%)	32
sand (g kg^{-1})	820
silt (g kg^{-1})	40
clay (g kg^{-1})	140

(0.0125 mol L^{-1} H2SO4 and 0.050 mol L^{-1} HCl at a soil: extractant 1:10); Ca, Mg and Al = (KCl 1 mol L^{-1} in soil: 1:10 extractor); (H + Al) = (calcium acetate 0.5 mol L^{-1} in soil: 1:15 extractor); sand, silt and clay = pipette method; CEC = cation exchange capacity; OM = organic matter; V = base saturation.

(PAM, 2014). Along with the increase in the producers' interests for growing watermelon, there is also growth in the use of watermelon hybrids, mainly due to its productive potential. However, productivity has declined in recent years (PAM, 2014), demonstrating that this is a characteristic of low heritability (Ferreira et al., 2003) and strong environmental influence, it becomes then necessary to review the management currently adopted for this crop. Among the several production factors, fertilization is one of the factors that most lack information in the watermelon crop. Many producers, despite using hybrids, use old information for crop fertilization (Trani et al., 1997; CFSEMG, 1999; Cavalcanti et al., 2008), based on cultivars of open pollination and smaller productive potentials and, consequently, demand of nutrients. Among the nutrients, we can highlight phosphorus (P), which, despite being absorbed in small amounts by the watermelon plant (Grangeiro and Cecílio Filho, 2004; Nogueira et al., 2014), is key to obtain high productivity and quality of watermelon fruits. P is a component of nucleic acids (e.g. DNA), phospholipids, enzymes and molecules such as ATP (where the plant stores metabolic energy); it is present in the structures of the cellular membrane and participates in the synthesis of proteins and vitamins. Phosphorus also has an important function in the energy transfer system inside the plant, taking part in processes such as photosynthesis and respiration (Hawkesford et al., 2012). The use of this nutrient in the appropriate dose and time, favors growth of the roots, flowering and fruit set, besides accelerating their ripening and improving the sugar content (Molina, 2006). Most

Brazilian soils (91%) have a low content (<9 mg dm^{-3}) or middle (9 to 12 mg dm^{-}3) P (Lopes, 1998; Anghinoni, 2004) then being considered phosphorus poor, owing to their source material and high determination of this element, causing low P content available, especially in soils where there is a predominance of minerals sesquioxides (Novais and Smyth, 1999; Raij, 2011), for which there is often shortage of element in plants resulting in low productivity (Leon et al., 2008; Maluki et al., 2015.). However, excess phosphorus fertilization can also be harmful to the plant, especially the antagonistic effect on zinc absorption (Souza et al., 2011a), as well as to the environment due to eutrophication of water sources (Bennett et al., 2001). The present paper aimed at assessing the effect of doses of phosphorus upon productivity, quality and profitability of the watermelon crop.

MATERIALS AND METHODS

Site location and characterization

The experiment was done from August to October 2012, in Mossoró, RN, with geographic coordinates 5° 03' 37" S and 37° 23' 50" W and altitude of 72 meters. During the experiment period, the average temperature and the average relative humidity were 26.7°C and 56.8%, respectively, without rain. The soil of the experimental area was classified as Red Yellow Argisol (EMBRAPA, 2006), whose physico-chemical characteristics of the layer 0-20 cm are presented as in Table 1.

Treatments and experimental design

The experimental design was randomized complete blocks, with four replications. The treatments were arranged in a 6 × 2 factorial design, composed by six doses of phosphorus (0, 45, 90, 135, 180 and 225 kg ha^{-1} of P_2O_5) and two watermelon (*Citrullus lanatus*) cultivars ('Top Gun' and 'Olímpia'). Each experimental unit was composed by three rows of eight plants, with a space of 2.5 m between the rows and 0.8 m among the plants, the total area was 48 m^2, and the plants used were the eight plants from the central row from each parcel as useful area.

Field establishment

Soil preparation consisted of plowing and harrowing, followed by thrown distribution of limestone (Relative Neutralization Total Power of 95%), in total area, and incorporation with grid, in order to elevate base saturation to 70%. Irrigations by sprinklers were done for 20 days, using a 5 mm daily slide. After this period, the next step was furrowing, with approximately 10 cm deep, and fertilization of planting with triple superphosphate (43% P_2O_5), in the dose corresponding to each treatment. Right after that, the sites were raised and drip irrigation was employed, with one hose per site, with issuers with 0.40 m in space between each other and 1.5 L h^{-1} of flow. The sites were covered with black plastic, and holes of approximately 4 cm in diameter were made in it, with a 0.80 m space between each other. The seedlings were produced in polyethylene trays with 200 cells, and transplanted when they presented one permanent leaf. After that, the plants from each site were covered with white polypropylene tissue, weighting 15 g m^{-2},

forming a tunnel in order to avoid the attack of leafminer (*Liriomyza trifolli*) and the whitefly (*Bemisia tabaci*), so the cover remains for 15 days. Topdressing was done daily through irrigation water, beginning right after transplanting, and the total following amounts were applied 98.63; 198.53; 32.88; 6.26; 2.04 and 7.8 kg ha^{-1} of N, K_2O, Ca, Mg, B and Zn, respectively. The fertilizers used were urea, potassium nitrate, potassium chloride, calcium nitrate, magnesium sulfate, boric acid and zinc sulfate and 1.16 L ha^{-1} of Root$^{®}$ (amino acid based product used to improve rooting of seedlings). Irrigation was done daily according to the need of the crop, with a total slide in the cycle of 286.4 mm.

Harvesting and parameters evaluated

The harvests of fruits were done in the useful area of the experimental unit, at 56 and 63 days after transplantation, and an evaluation was made of:

a) Total and commercial productivity (t ha^{-1}): total productivity corresponded to the sum of the masses of healthy fruits (from all classes), while for the commercial productivity (t ha^{-1}) fruits with mass ≥ 5.0 kg were considered;
b) Number of fruits per plant, total and commercial (fruits plant^{-1}): obtained by dividing the number of total or commercial fruits by the number of plants;
c) Mass of the fruits and commercial fruits (kg): corresponded to the result of the division of total or commercial productivity by the number of total or commercial fruits, in 1 hectare;
d) Content of solid soluble (ºBrix): portions of the pulp were removed from close to the flower scar, central and close to the fruit peduncle, which were homogenized by extracting juice, and the readings were determined in a digital refractometer;
e) Titratable acidity (g citric acid per 100 mL of juice): at 1 mL of the pulp juice, used to evaluate the content of soluble solids, 49 mL of distilled water and 2 drops of phenolphthalein 1% were added. Titration was done until the turning point with NaOH solution (0.1 N), previously standardized;
f) Peel thickness (mm): determined with the employment of caliper rule in the median region of the fruit; Pulp firmness (N): obtained by the average of three readings in the pulp, one in the distal end, one in the center, and another close to the peduncle, with the help of a manual penetrometer with an 8 mm diameter door;
g) Content of phosphorus on the leaf: was removed from the fifth leaf from the main branch in the early fruiting (35 days) (Trani and Raij, 1997) and P contents were determined by the method of phospho-molybdic complex in reducing environment, according to EMBRAPA (2006).
h) Content of phosphorus in the soil after harvest: phosphorus content in the soil after harvest: after harvesting the fruit and eliminated the shoots of each plot were taken at random two samples of soil in the row and phosphorus extracted by Mehlich-1 (HCl 0.05 mol L^{-1} H_2SO_4 + 0.0125 mol L^{-1}) in a soil extractor ratio 1:10 (5 cm³ of TFSA and 50 mL of extraction solution) and analyzed by flame photometry. Based on the adjusted equation for commercial productivity, an economic analysis of the experiment was carried out. Costs with fertilizers, increase in productivity, cost-effective factors and economic return were calculated. Increase in productivity was calculated by the difference between the productivity obtained by the dose used and the productivity of the treatment without phosphorus. The cost-effective relation resulted in the division between the increase in production and the cost of the phosphatic fertilizer. The economic return was obtained by multiplying the value of the cost-effective relation by the price of 1 t of commercial watermelon (R$ 180,00) or R$ 0,18 kg^{-1}, which corresponded to the average price of sales of the fruits intended for the domestic market. To calculate the costs with fertilizers, the cost of a unit of P_2O_5 (R$ kg^{-1}) was used, and a bag of 25 kg of triple

superphosphate was acquired at the cost of R$ 50,95. The fixed cost, which corresponds to the sum of production and management costs, was not considered, because it is the same for all treatments. The data was submitted to a variance analysis (F test), using the statistics software SAS (SAS System, version 9.0). The regression equations were obtained by the table curve (Jandel Scientific, 1991), except for the total and commercial productivity, where the SAEG 9.0 (SAEG, 2005) software was used, due to the specificity of the equations.

RESULTS AND DISCUSSION

Content of phosphorus in the soil after harvest

The content of phosphorus (P) in the soil, assessed after the harvest of fruits was only influenced by the factor dose of phosphorus ($p < 0.01$) (Table 2), and as a higher dose was applied, the greater availability of P for watermelon was observed (Figure 1). Sandy textured soils have a better balance between content and P availability to plants, not being affected by the mounting process due to its lower content of clay, iron and aluminum oxides and calcium (Corrêa et al., 2011).

Content of phosphorus in the leaf

Differently from the P content in the soil, greater doses of P did not influence the leaf content of phosphorus ($p > 0.6$), which was affected only by the cultivar factor ($p < 0.01$) (Table 2). 'Top Gun' presented an average of 5.7 g kg^{-1} of P, which was 26.7% higher than the leaf content observed in 'Olímpia' (4.5 g kg^{-1}). However, both contents are within the range from 3 to 7 g kg^{-1} considered appropriate for the watermelon, according to Trani and Raij (1997). The increase in production provided by higher phosphorus availability in soil, resulted in a greater dilution of the phosphorus in the leaf tissue which contributed to the maintenance of its concentration (Larcher, 2004). The leaf contents of phosphorus range from 4.6 to 7.2 g kg^{-1}, for treatments with doses of 0 and 180 kg ha^{-1} of P_2O_5, respectively. Even plants that did not receive the application of phosphorus had a leaf content within the range considered appropriate for the watermelon (Trani and Raij, 1997). Maluki et al. (2015), who evaluated doses of nitrogen and phosphorus in the cultivar Sugar baby during flowering and beginning of fructification, did not observe an increase in the leaf content of P in relation to the increase of phosphate fertilization either.

Number of fruits per plant, total and commercial

Both number of fruits (NF) as to commercial fruit (NFC) per plant was not verified interaction between P doses and cultivars ($p > 0.49$ and $p > 0.95$ respectively). NF and NFC were influenced only by the dose of P (both with p

Table 2. Content of phosphorus in the soil (PS) and in the leaf (PF), fruits mass (MF), commercial fruits mass (MFC), number of fruits (NF), number of commercial fruits (NFC), total productivity (PT) and commercial productivity (PC) of the watermelon in relation to the doses of phosphorus and their respective averages for each cultivar.

Doses of P$_2$O$_5$ (kg ha^{-1})	PS (mg dm^{-3})	PF (g kg^{-1})	MF (kg)	MFC (kg)	NF (fruits plant^{-1})	NFC	PT (kg ha^{-1})	PC (kg ha^{-1})
0	9.8	4.46	8.01	8.32	1.22	1.13	48891.8	46967.3
45	30.0	5.09	8.78	9.10	1.72	1.60	74793.0	71968.9
90	42.3	5.52	7.90	8.76	2.07	1.66	79891.3	71586.0
135	63.0	5.03	8.34	8.98	1.91	1.66	78881.4	74402.6
180	95.9	5.20	8.14	8.65	2.02	1.79	81573.9	76964.6
225	116.3	5.35	8.20	8.89	1.99	1.69	80228.3	74624.7
Cultivars								
Top Gun	61.50	5.67	7.92	8.42	1.82	1.58	71352.0	66464.5
Olímpia	56.35	4.54	8.54	9.15	1.82	1.59	76734.6	72373.6
Values of F								
P$_2$O$_5$ (P)	13.42**	0.71^{ns}	1.26^{ns}	1.34^{ns}	6.30**	4.71*	8.92**	7.09**
Cultivars (C)	0.65^{ns}	10.34*	7.75*	14.06**	0.00^{ns}	0.01^{ns}	2.47^{ns}	2.97^{ns}
P x C		1.56^{ns}	1.48^{ns}	0.47^{ns}	0.89^{ns}	0.22^{ns}	0.6^{ns}	0.46^{ns}
SD	22.14	1.22	0.78	0.67	0.35	0.30	11.872.81	11.870.38
CV	37.58	24.02	9.48	7.73	19.65	19.18	16.03	17.10

^{ns} - non-significant; * - Significant ($p < 0.05$); ** - Significant ($p < 0.01$).
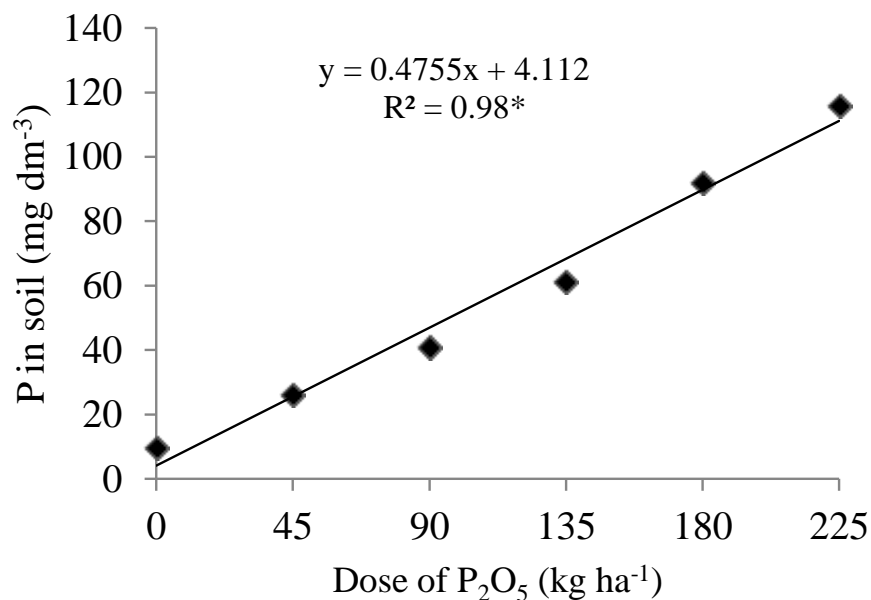

$$y = 0.4755x + 4.112$$
$$R^2 = 0.98*$$

Figure 1. Content of phosphorus in the soil, assessed after the harvest of fruits, of both cultivars, in relation to the dose of phosphorus. Mossoró-RN, 2012.

<0.01) (Table 2), and there was adjustment in the linear plateau model of regression to the means of the characteristics in function of the dose of P. Maximums of NF (2 per plant) and NFC (1.7 per plant) were obtained with 77.22 and 54.75 kg ha^{-1} of P$_2$O$_5$, respectively (Figure 2A and B). These results were 58.9 and 50.69% superior to the NF and NFC when there was no application of phosphorus. Leão et al. (2008), when evaluating the levels of chemical and organic fertilization in cultivar

Crimson Sweet, found no interaction between these factors and obtained a maximum of 1.5 fruit per plant. This difference is because the current hybrids of watermelon are more productive than the cultivars of open pollination, being the NF one of the factors that contributes to that (Leão et al., 2008). The lack of response from NF and NFC above the doses of 77.22 and 54.75 kg ha^{-1} of P$_2$O$_5$, respectively, can be an indication of maximum efficiency of the cultivar regarding
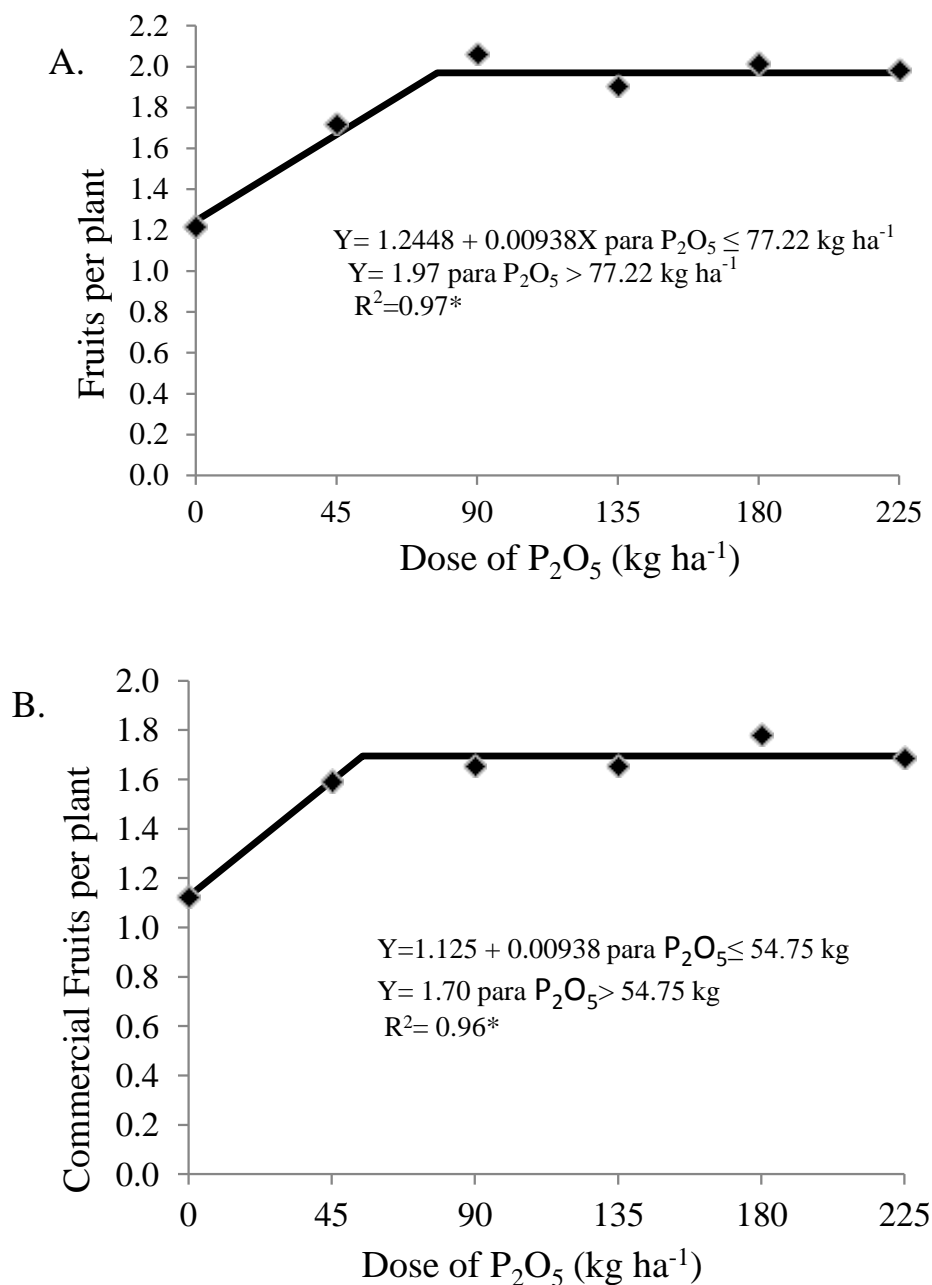
Figure 2. Number of fruits (A) and commercial fruits (B) per plant of both watermelon cultivars, in relation to the dose of phosphorus. Mossoró-RN, 2012.

absorption and/or use of this nutrient (Meng et al., 2014). Similar results were also found by Freitas Júnior et al. (2008).

Total and commercial productivity

The total (PT) and commercial (PC) productivity of fruits were influenced only by the dose of phosphorus (Table 2). There were adjustments in the linear plateau model of regression for these characteristics (Figure 3A and B). PT (80.14 t ha^{-1}) and PC (74.39 t ha^{-1}) maximums were obtained with 54.3 and 49.4 kg ha^{-1}, respectively. These doses provided increase of 63.9 and 63.1%, respectively, in the PT and PC treatment that did not receive phosphate fertilization. The dose that provided greater PC was close to the one that provided greater NFC per plant. These results are in accordance with the ones obtained by Hochmuth et al. (1993), who saw that the linear plateau model better represents the response to
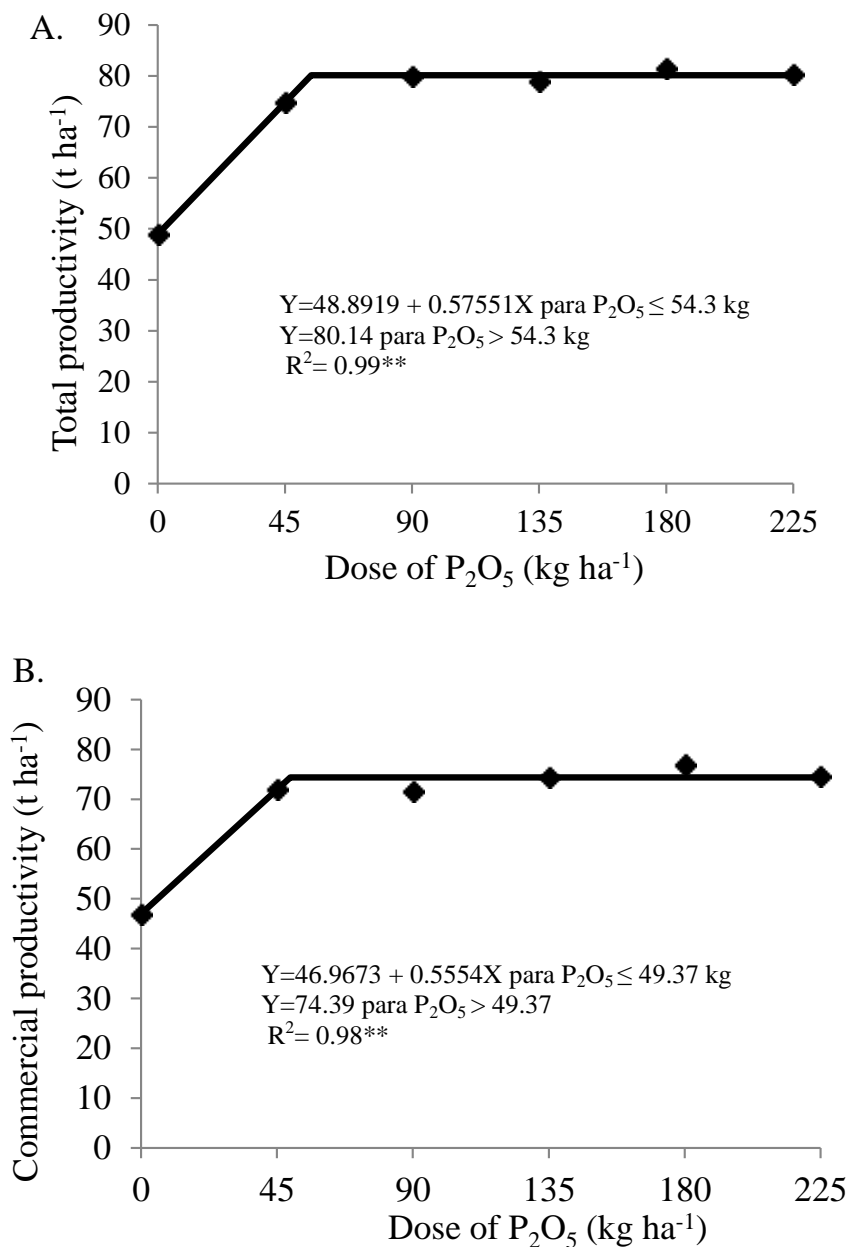
A.

$Y=48.8919 + 0.57551X$ para $P_2O_5 \leq 54.3$ kg
$Y=80.14$ para $P_2O_5 > 54.3$ kg
$R^2= 0.99**$

(y-axis) Total productivity (t ha^{-1})
(x-axis) Dose of P_2O_5 (kg ha^{-1})

B.

$Y=46.9673 + 0.5554X$ para $P_2O_5 \leq 49.37$ kg
$Y=74.39$ para $P_2O_5 > 49.37$
$R^2= 0.98**$

(y-axis) Commercial productivity (t ha^{-1})
(x-axis) Dose of P_2O_5 (kg ha^{-1})

Figure 3. Total productivity (A) and commercial productivity (B) of both watermelon cultivars, in relation to the dose of phosphorus. Mossoró, 2012.

phosphate fertilization in soils with low content of phosphorus. These authors concluded that for two sites with low contents of phosphorus in the soil (between 5 and 6 mg kg^{-1} - the solution extracted 0.0125 mol L^{-1} H_2SO_4 and 0.050 mol L^{-1} HCl), with only 60 kg ha^{-1} of P_2O_5, 78.8% was obtained from the maximum production of 'Royal Jubilee' watermelon. However, the dose that maximized the PC differs from the one found by Leão et al. (2008), who obtained 22.5 t ha^{-1} with 360 kg ha^{-1} of P_2O_5, and also from Silva et al. (2014), whose maximum productivity was 23.84 t ha^{-1} with the dose of 218 kg ha^{-1}

of P_2O_5.

These differences can be attributed both to the genetic variability and the type of mathematical model chosen to determine the production behavior, seeing that the quadratic models tend to overrate the dose of fertilizers required to reach maximum production (Cerrato and Blackmer, 1990). The high PT and PC obtained in this investigations can be attributed to the optimum conditions during cultivation, both in handling and climate, aligned with low incidence of pests and diseases. These productivities confirm the productive potential of

Table 3. Content of soluble solids (SS), peel thickness (EC), titratable acidity (ATT) and pulp firmness (FP) of the watermelon in relation to the doses of phosphorus and their respective averages for each cultivar.

Doses of P_2O_5	SS	EC	ATT	FP
(kg ha^{-1})	(ºBrix)	(mm)	(%)	(N)
0	10.7	14.00	0.136	9.05
45	10.4	13.00	0.127	9.19
90	10.3	13.81	0.134	10.04
135	10.2	14.13	0.138	9.66
180	10.7	13.25	0.143	9.28
225	10.2	13.88	0.140	10.34
Cultivars				
Top Gun	10.7	13.25	0.137	9.76
Olímpia	10.2	14.10	0.136	9.43
Values of F				
P_2O_5 (P)	1.01^{ns}	1.00^{ns}	1.81^{ns}	1.32^{ns}
Cultivars (C)	7.30**	5.47*	0.12^{ns}	0.80^{ns}
P x C	0.46^{ns}	0.74^{ns}	1.54^{ns}	0.57^{ns}
SD	0.67	1.26	0.01	1.27
CV	6.51	9.25	8.34	13.26

^{ns} - non-significant; * - Significant ($p < 0.05$); ** - Significant ($p < 0.01$).

watermelon hybrids and their efficiency in the use of phosphorus, showing that the producers can be applying excessive amounts of phosphorus, especially in sandy soils. The dose (54.3 kg ha^{-1}) that resulted in the maximum productivity was below the reference value adopted in this paper (90 kg ha^{-1} of P_2O_5), which is the official recommendation of phosphorus for the state of Pernambuco, in the irrigated watermelon 'Crimson Sweet' crop, in soils with contents of phosphorus between 6 and 12 mg dm^{-3} of P. With the dose that maximized the PC, by the end of the experiment, considering the adjustment obtained on Figure 1, 30 mg dm^{-3} of P was still available for the plants, which can be considered an average content of P for the soil in which the experiment was done (CFSEMG, 1999).

Mass of the fruits and commercial fruits

The mass of fruits and commercial fruits (MFC) were solely influenced by the cultivar factor (Table 2). The Olímpia cultivar had greater MF and MFC compared to the 'Top Gun' (Table 2). For both cultivars, the average of MFC was superior to 7 kg, considered a higher commercial value. These results corroborate the ones found by Freitas Júnior et al. (2008) and Silva et al. (2014), which did not see influence of doses of P for the mass of fruits.

Attributes of fruit quality

For the attributes of fruit quality, there was significant effect only of cultivars in the content of soluble solids and peel thickness (Table 3). In general, the attributes of fruit quality present little environmental influence and high heritability (Ferreira et al., 2003). This can explain the lack of response to phosphate fertilization, regarding the attributes of quality of both hybrids. 'Top Gun' presented SS (10.7 °Brix) superior to 'Olímpia' (10.2 °Brix) (Table 3). The results overcome the value of 8.7 °Brix seen by Lima Neto et al. (2010), in the Crimson Sweet cultivar. Freitas Júnior et al. (2008), assessing the response of the 'Congo' watermelon to doses of phosphorus, did not verify the effect on the content of soluble solids either. The soluble solids (SS) represent the content of sugar in the fruits, so it is one of the characteristics that most contribute to the quality of the watermelon. The averages of SS seen for both cultivars were superior to 10 °Brix and, therefore, above the minimum required for the commercialization in the most demanding markets (9 °Brix) (Table 3). Currently, the farmers have preferred hybrids with greater content of SS because they can be a differential factor in the conquest of new markets and better prices, since part of the population chooses a better quality product, even if they have to pay a little more for that (Filgueiras et al., 2000). The peel thickness and the pulp firmness have strong influence in the resistance of fruits to handling and mechanic damage, and since the internal market is usually done in bulk, the fruits with greater peel thickness tend to have fewer problems during transportation (Barros et al., 2012). 'Olímpia''s peel thickness was superior (14.10 mm) to 'Top Gun' (13.25 mm). Values lower to these were seen by Barros et al. (2012), in the Crimson Sweet cultivar (12.57 mm). However, Lima Neto et al. (2010) found 17.3 mm for Crimson Sweet peel thickness, which shows that for the same cultivar there is great variation caused by

Table 4. Commercial productivity (PC), cost with phosphate fertilizer (CFF), productivity increase (IP), cost-effective (C/B) and economic return in relation to the dose of phosphorus in watermelon

Doses of P_2O_5 (kg ha^{-1})	PC (t)	CFF (R$)	IP (t)	C/B t/R$	Return (b/a*180) (R$/R$)
0	46.97	0.00	-	-	-
45	71.96	199.35	24.99	0.125	22.50
49.37[1]	74.39	218.71	27.42	0.125	22.50
90	74.39	398.70	27.42	0.069	12.42
135	74.39	598.05	27.42	0.046	8.28
180	74.39	797.40	27.42	0.034	6.12
225	74.39	996.75	27.42	0.028	5.04

[1] Dose to maximize the productivity of commercial fruit.

the environment.

The average value of the titratable acidity of 0.137% (2.144 mmol H$^+$ 100 mL^{-1}) was lower to the ones obtained by Grangeiro and Cecílio Filho (2004), who found results in the interval of 0.247 to 0.256% of citric acid for the hybrid of watermelon Tide, as well as the ones seen by Lima Neto et al. (2010), which was 1.08% and Barros et al. (2012), who found 1.51%, both for Crimson Sweet. The pulp firmness, besides influencing the resistance to transportation and susceptibility to mechanic damage, also interferes in the post-harvest useful life. The average observed for pulp firmness was 9.59 N, a value lower to the one found by Barros et al. (2012), who found an average of 21.85 N for the Crimson Sweet watermelon.

Economic analysis

The dose responsible for the maximum PC (49.37 kg ha^{-1} P_2O_5) provided a return of R $ 22.50 for each real invested in fertilizer. Doses greater than 49.37 kg ha-1 P_2O_5 had significant decreases in economic returns, and the dose of 225 kg ha^{-1} P_2O_5 reached R $ 5.04 (Table 4). The phosphorus fertilization has brought positive results for both soil fertility and for the watermelon productivity, but did not influence the quality.

Conclusions

The response of cultivars of Olimpia and Top Gun watermelons to the increase in provision of P to the plants was similar, with maximum commercial productivity reached with 49.37 kg ha^{-1} of P_2O_5. The increase in the dose of phosphorus from 0 to 225 kg ha^{-1} of P_2O_5, in Red Yellow Argisol with 6.4 mg dm^{-3} of P, does not influence the quality of watermelon fruits. The maximum economic return for the crop of watermelon in Red Yellow Argisol with 6.4 mg dm^{-3} of P is reached with the dose of 49.37 kg ha^{-1} of P_2O_5.

Conflict of interests

The authors have not declared any conflict of interests.

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