

GROWTH AND YIELD OF PEANUT WITH DIFERENT IRRIGATION LEVELS APPLIED BY DRIP IRRIGATION

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1 ABSTRACT

The peanut crop, being drought-tolerant, is an important alternative for the irrigated agriculture in northeastern Brazil. Considering this, the present work was aimed at evaluating the growth and productivity of the peanut crop under irrigation levels applied with a drip irrigation system. The experiment was conducted in the field, on an Alfissol, in Fortaleza, Ceará. The experimental design employed was randomized blocks, with five treatments (irrigation levels) and five blocks. The treatments consisted in irrigation levels of 25, 50, 75, 100 and 150% of the crop evapotranspiration (ET_o, mm day⁻¹) estimated by the Penman-Monteith reference evapotranspiration methodology (PMET_o). At 60 days after sowing (DAS) samples were collected for destructive analysis of growth in leaf number, plant height, stem diameter, and shoot dry matter. At 90 days after sowing, five plants of the planted area of each plot were harvested. The increase of the irrigation depths from 25% to 150% of the Penman-Monteith reference evapotranspiration (PMET_o) applied by drip irrigation cause linear increase of the number of leaves and of the shoot dry matter of peanut plants, being the 150% PMET_o (522.17 mm of irrigation depth) the level which provided the best response; the irrigation level corresponding to 146.5% PMET_o provided the highest plant height (40.31 cm). The irrigation level of 116.22% PMET_o provided the highest yield (1746.97 kg ha⁻¹) observed on peanut plants.

Keywords: *Arachis hypogaea* L., Penman-Monteith, Evapotranspiration.

**SOUSA, G. G.; AZEVEDO, B. M.; LIMA, R. H.; SILVA, J. E. S.; PEREIRA, VIANA,
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**CRESCIMENTO E PRODUTIVIDADE DO AMENDOINZEIRO COM DIFERENTES
LÂMINAS DE IRRIGAÇÃO APLICADAS COM IRRIGAÇÃO POR
GOTEJAMENTO**

2 RESUMO

A cultura do amendoim é uma importante alternativa para a agricultura irrigada da região Nordeste por ser bastante resistente à seca. Nesse sentido, objetivou-se avaliar o crescimento e a produtividade da cultura do amendoim sob diferentes lâminas de irrigação aplicadas com irrigação por gotejamento. O experimento foi conduzido em campo, em Argissolo Vermelho Amarelo, em Fortaleza, Ceará. O delineamento experimental foi em blocos ao acaso, composto de cinco tratamentos (lâminas de irrigação) e cinco blocos. Os tratamentos corresponderam às lâminas de irrigação de: 25, 50, 75, 100 e 150% da evapotranspiração da cultura (ET_o mm dia⁻¹) estimada através da evapotranspiração de referência obtida pela metodologia de Penman-Monteith (ET_{oPM}). Aos 60 dias após a semeadura (DAS) foram coletadas amostras destrutivas de plantas para análise de crescimento em número de folhas, altura de plantas, diâmetro do caule e matéria seca da parte aérea. Aos 90 DAS, foram colhidas cinco plantas da área útil de cada parcela, sendo analisadas as seguintes variáveis: número de frutos por planta, massa de vagem, massa de 100 sementes e produtividade. O aumento das lâminas de irrigação de 25% a 150% da evapotranspiração de referência de Penman-Monteith (ET_{oPM}) aplicada por irrigação por gotejamento causa aumento linear no número de folhas (NL) e na matéria seca da parte aérea (ADE) de plantas de amendoim, sendo ET_{oPM} 150% (522,17 milímetros de lâmina de irrigação), a lâmina que proporcionou a melhor resposta; a lâmina de irrigação correspondente a 146,5% ET_{oPM} promoveu a maior altura de planta (40,31 centímetros). A lâmina de irrigação correspondente a 123,2% da ET_{oPM} proporcionou a maior produtividade (1.739,3 kg ha⁻¹) do amendoim.

Palavras-Chave: *Arachis hypogaea* L., Penman-Monteith, Evapotranspiração.

3 INTRODUCTION

The peanut plant is a dicot, family Leguminosae, subfamily Papilionoidae, genus *Arachis*. Among the many known species, the common varieties belong to the species *Arachis hypogaea* L. (TASSO JÚNIOR et al., 2004), with the most economic interest (VEIGA et al., 2001). The plant is not sensitive to photoperiod and grows well in environments with average daytime temperatures between 22°C and 28°C. If, during the growth phase, the prevalent average temperature is lower than 18°C or higher than 33°C, production can be significantly affected.

The exploration of the peanut crop is a viable alternative for the Brazilian Northeast as it is the second largest consuming region (of peanuts and their products) in Brazil. The national production obtained, in the range of 11,000 tons, is insufficient to meet the regional demand (that exceeds 50,000 tons), although the climate conditions of the several micro-regions are favorable to the development and establishment of peanut crops (IBGE, 2011).

One way to improve growth and yield of peanut, and meet the demand, would be the use of irrigation. Bilibio et al. (2010) emphasized that in irrigated agriculture, special attention should be given to water management, determining precisely the crop water requirements as well as determining the most appropriate time to irrigate, thus maximizing the efficiency of water use. Usually, irrigation brings unquestionable advantages for crops, favoring the maximum expression of their productive potential.

Dependendo do clima, suas necessidades hídricas variam de 500 a 700 mm por ciclo para obtenção de boas colheitas (DOORENBOS & KASSAM, 1979). The peanut crop requires about 508 to 635 mm of water throughout the cycle to express their maximum productivity (BALDWIN & HARRISON, 1996), while Silva & Beltrão (2000) obtained

higher yields when applied 700 mm water during the crop cycle. However, there are few studies testing the use of different irrigation water to better meet the water requirement and improve the productivity of the peanut plant. Correia & Nogueira (2004) ascertained that a water deficit of 35 days after sowing resulted in a plant weight decrease.

Tests with different irrigation levels are a very practical way of estimating the water need of a specie, so that the can be given crop the best conditions to grow and produce. (AZEVEDO & BEZERRA, 2008). Some researchers have been studying and recording the positive aspects of testing many crops with different irrigation levels. Azevedo et al. (2005) tested different irrigation levels in the pepper crop, Freitas et al. (2010) tested them in castor bean growing at Pentecoste, Ceará.

This work aimed to evaluate the growth and yield of peanut under different irrigation levels applied with a drip irrigation system.

4 MATERIAL AND METHODS

The study was conducted at the experimental station of Agrometeorology, Department of Agricultural Engineering, Federal University of Ceará, UFC, Pici Campus, Fortaleza, Ceará, Brazil, located at the geographic coordinates of 3°44'45''S and 38°34'55''W and 19.5 m above sea level from September to December (2010). The climate is classified according to Köppen method as Aw, that is, tropical wet, very hot, with most rain in the summer and autumn seasons. The soil is classified as Alfissol (EMBRAPA, 2006), whose physical characteristics of soil textural class presented a loamy sand, soil bulk density of 1.54 kg dm⁻³, density of particles of 2.59 kg dm⁻³, 0.131 m³ m⁻³ at field capacity, soil permanent wilting point of 0.077m³ m⁻³, porosity of 40% and saturated water of 0,054 m³ m⁻³. The mean climate values collected during the experiment were wind speed of 3.9 m s⁻¹, temperature of 28.67°C, 66% relative humidity, 12.5 mm of rainfall, 12345.025 mb of barometric pressure and 1025.1 hours of sunshine.

The peanut cultivar PI-165317 was sown manually on September 21, 2010, with a spacing of 1.0 m between plant rows, in open pits, with an average of four seeds per pit (spaced 0.20 m on the row). At 6 days after sowing, there was a 100% germination. The thinning was manually performed, with the plants being uprooted near the soil surface, leaving only one plant per pit. All treatments were started at 21 days after sowing (DAS). The required phytosanitary treatments were also conducted, on the first appearance of signs of pests or diseases.

The experiential design used in the experiment was that of randomized blocks with five treatments (irrigation levels) corresponding to the levels of irrigation: L1 = 25, L2 = 50, L3 = 75, L4 = 100 and L5 = 150% of the evapotranspiration (PMET_o, mm day⁻¹) Penman-Monteith reference. The irrigation management calculation was carried out based on the estimated reference evaporation calculated through the Penman-Monteith method, proposed by FAO 56 (ALLEN et al., 2006), in which data from the UFC weather station was used.

The drip irrigation was used throughout the entire crop cycle, using a self-compensating dripper for each plant, with irrigation every two days. Soil moisture monitoring was conducted with tensiometers that were installed at a depth of 0.30 m in the planting row, with a distance of 20 cm from the plant in each treatment. For the calculus of the PMET_o it was taken into account the data on climatic variables, calculated in accordance with the standards proposed by the FAO (Allen et al., 2006), due to its wide acceptance.

The mean values of the readings of the tensiometers were converted into matrix potential, with values of -21.8 kPa for the treatment 25% PMET_o, -9.2 kPa for the treatment

50% PMETo, -9.0 kPa for the treatment 75% PMETo, -8.2 kPa for the treatment 100% PMETo and -6.4 kPa for the treatment 150% PMETo. The average discharge of the emitters was 2.0 L h^{-1} , with a pressure of $1,0 \text{ kgf cm}^{-2}$.

Up to the 21st day after sowing, the irrigation level PMETo 100% was applied in all treatments, every two days, during one hour of water application time, in order to establish a uniform stand. The total irrigation depth applied in that period was 72.5 mm. After the 21st day after sowing, the irrigation depths began to be applied according to the treatments, in the following values: $L_1 = 170.47 \text{ mm}$; $L_2 = 243.71 \text{ mm}$; $L_3 = 302.9 \text{ mm}$; $L_4 = 387.29 \text{ mm}$ and $L_5 = 522.17 \text{ mm}$, corresponding to the 25, 50, 75, 100 and 150% of PMETo treatments, respectively.

The fertilization was performed with 13.33 g of urea, 294.11 g of superphosphate and 80 g of potassium chloride per pit, corresponding to doses of 15.0, 62.5 and 50 kg ha^{-1} of N, P_2O_5 and K_2O , respectively, as recommended by Fernandes (1993). The doses of potassium chloride were split in two applications: the first application was made on the sowing day and the second application was performed in the 25th DAS. The superphosphate was applied in a single dose on the sowing day.

At the 60th DAS, plants were collected to determine the initial growth characteristics: number of leaves (NL), plant height – PH (cm), stem diameter – SD (mm) and shoot dry matter (g plant^{-1}). The harvest was performed at the 90th DAS, taking five plants at random from the center line of each treatment, in each block. The plants were separated by treatment and placed in screened greenhouse for three days, in order to dry the pods. The agronomic variables evaluated in this study were: number of fruits per plant (NFP), pod weight – PW (g), 100 seeds weight – 100SW (g) and grain yield (kg ha^{-1}). The results were subjected to analysis of variance and regression using the computer program SAEG/UFV (RIBEIRO JÚNIOR, 2001).

5 RESULTS AND DISCUSSION

According to the analysis of variance presented in Table 1, except for the stem diameter, (SD) the different irrigation depth influenced significantly the number of leaves (NL), plant height (PH), shoot dry weight (SDW), number of fruits per plant (NFP), pod weight (PW), 100 seed weight (100SW) and grain yield in the significance level of 1% by F test.

Table 1. Summary of analysis of variance for the of number of leaves ,in plant height , stem diameter, the shoot dry matter, the number of fruit per plant, pod weight,100 seed weight and grain yield. Fortaleza, CE, 2011.

FV	Treatments	Blocks	Residue	VC (%)
GL	4	4	16	
Variables	Mean Squares			
Number of leaves	3762,42*	645,25 ^{ns}	1033,62	30,63
Plant height	2629**	279,48 ^{ns}	18,39	15,07
Stem diameter	2,08 ^{ns}	0,42 ^{ns}	1,11	17,96
Shoot dry matter	3762,42*	645,25 ^{ns}	10033,6	30,63
Number of fruit per plant	991,42**	19,08*	201,59	31,74
Pod weight	18968,6**	623,71 ^{ns}	2964,66	33,26
100 seeds weight	167,62**	10,01 ^{ns}	16,59	9,96
Grain yield	1251064**	61865,7 ^{ns}	107796	36,62

FV= variation factor; GL = Degree of freedom; VC= variation coefficient; ** = significant at 1 % level by the test F, * = significant at 5 % level by the test F and ns = Not significant

Considering the NL (Figure 1A), the linear function was the one that best adjusted to the data with the increase of the level of irrigation with a coefficient of determination (R^2) 0.98. The depth that provided the greatest increase was the one of 150% PMETo (522.17 mm) which was not possible, thus maximizing the number of peanut leaves with the treatments studied, at 60 DAS.

Working in greenhouse conditions with water deficit in the soil, Távora & Melo (1991) and Correia & Nogueira (2004) verified a decrease in the number of leaves in the peanut crop at 35 and 90 DAS, respectively. According to last authors mentioned, the intensity of damage caused by the water stress depends on the duration, intensity, frequency and time of its occurrence.

Similar to the NL, a linear model was adjusted to the data obtained from SDW that increases as the level of irrigation rises (Figure 1B). Results close to these were reported in peanut plants by Silva & Beltrão (2000) with irrigation levels of 700 mm applied during the crop cycle, under the environmental conditions of Rodelas, BA, Brazil. Alexandre Júnior et al. (2010) investigated the growth of the peanut plant under different irrigation levels at 90 DAS, showing the same trend in a study about this variable.

Unlike the NL and the SDW, the PH (Figure 1C) presented fit in a quadratic polynomial model with a determination coefficient of 0.74 as a function of the different irrigation levels applied from 21th to 60th DAS. The irrigation level increasing to 146.5% PMETo (475.25 mm) resulted in reaching a maximum plant height (PH) of 40.31 cm. Alexandre Júnior et al. (2010) working with the peanut crop in the typical climatic conditions of Barbalha, CE, Brazil, concluded that the irrigation depth corresponding to 125% of PMETo (821 mm) was the one that provided the greatest increase in plant height. Nageswara Rao et al. (1988) had smaller gains in plant height in the peanut crop when they applied smaller irrigation depths while Araújo & Ferreira (1997) found a drop in peanut plant height, caused by deficiency of soil moisture.

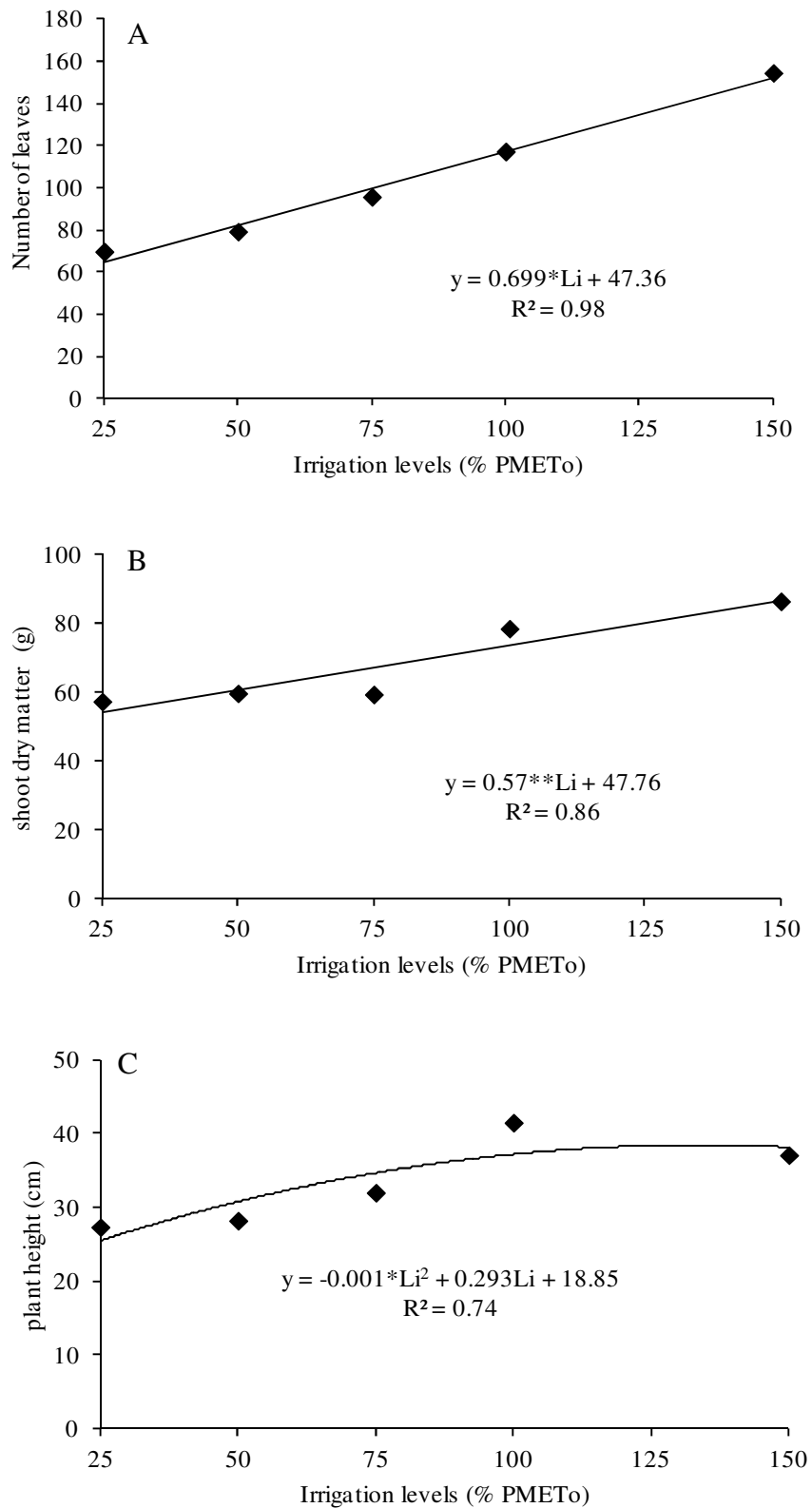


Figure 1. Number of leaves (A), shoot dry matter (B) and plant height(C) of peanut crops due to irrigation levels. Fortaleza, CE, 2011.

The regression analysis showed that the NFP, relatively to the different irrigation levels, could be adjusted to a quadratic polynomial model with determination coefficient of 0.82 (Figure 2A). The increasing of irrigation amount resulted in a maximum number of fruits per plant equal to 64, obtained with irrigation level of 111.75% of PMETo (428.7 mm). Távora & Melo (1991) working with the peanut crop in greenhouse conditions, observed similar results to this study for this variable. It should be noted that the occurrence of a water deficit in a peanut crop, during the growth and development phases of the gynophores and pods, causes a decrease in the number of pods (TÁVORA et al., 1985).

It can be seen in Figure 2B there was a quadratic response of PW with increased irrigation levels. The model estimates an optimum PW of 207.86 g for the irrigation level of 131.4% of PMETo (463.46 mm), in other words, the PW would increase from the treatment in 25% for an irrigation depth 131.4% higher than the PMETo. And from this level on the NPP would start to decrease. In pepper crop, Azevedo et al. (2005), testing different irrigation levels, although based on water evaporation in Class "A" tank, they observed that increasing irrigation levels influence significantly the average fruit weight (PW).

For the variable weight of a hundred seeds (100SW, shown in Figure 2C), the regression analysis that best fit was the quadratic polynomial (with $R^2 = 0.76$). From this result, it was calculated that 100SW reached a maximum (45.50 g) at the irrigation level of 104.75% PMETo (336.33 mm). Corroborating with this study, Araújo & Ferreira (1997) showed a 100SW of 45.25 g for the peanut crop grown without water stress. On the other hand, Silva et al. (1998) obtained opposite results for this study. According to the authors, the irrigation depths applied measuring (300, 500 to 700 mm) by furrow irrigation, did not significantly influence this variable in the peanut crop.

The productivity of grain in the peanut crop was influenced by the increase in the amount of water applied, obtaining a quadratic polynomial model, with a determination coefficient of 0.90 (Figure 2D). This model estimates a maximum grain yield value of 1746.97 kg ha⁻¹ which corresponds to an irrigation level of 116.22% of PMETo (449.7 mm). The yield obtained with this irrigation level is above the average grain yield values of 1151.6 kg ha⁻¹ in Ceará (IPCE, 2010) and below the average productivity values of 2225 kg ha⁻¹ in Brazil (IBGE, 2011).

Under field conditions, the irrigation depth of 700 mm provided a peanut yield of 2026 kg ha⁻¹ (SILVA et al., 1998). On the other hand, Silva & Beltrão (2000) found a grain yield of 1671 kg ha⁻¹ with the peanut crop being irrigated with a 500 mm of irrigation depth.

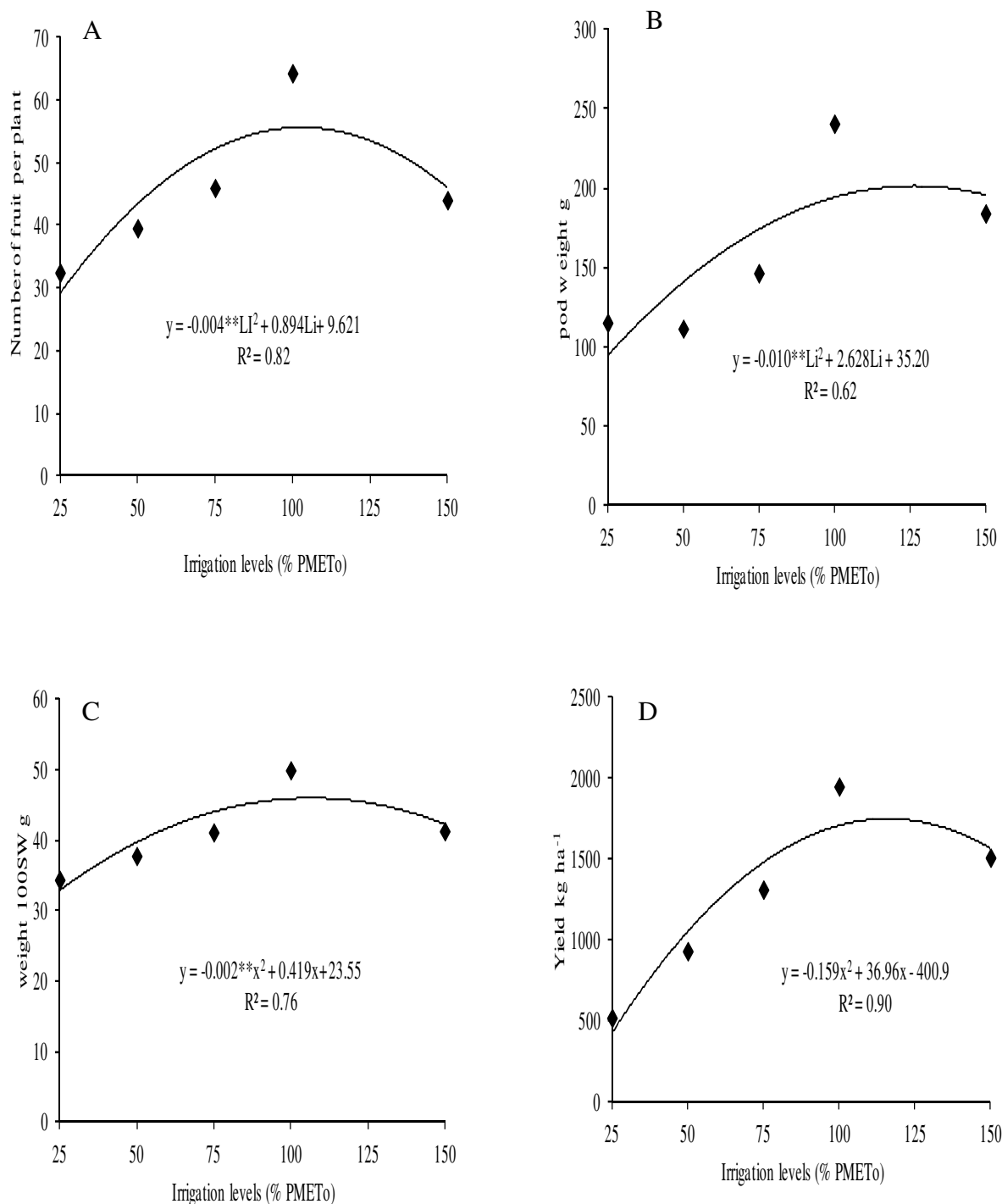


Figure 2. Number of fruit per plant (A), pod weight (B), weight 100SW (C) and yield (D) in peanut plants according to irrigation levels. Fortaleza, CE, 2011.

6 CONCLUSIONS

The increase of the irrigation depths from 25% to 150% of the Penman-Monteith reference evapotranspiration (PMETo) applied by drip irrigation cause linear increase of the

number of leaves (NL) and of the shoot dry matter (SDW) of peanut plants, being the 150% PMETo (522.17 mm of irrigation depth) the level which provided the best response; the irrigation level corresponding to 146.5% PMETo provided the highest plant height (40.31 cm).

The irrigation levels 111.75%; 131.4% and 104.75% of PMETo, provided the highest number of fruits per plant (64), pod weight (207.86 g) and weight of 100 seeds (45, 50 g), respectively.

The irrigation level of 116.22% PMETo provided the highest yield (1746.97 kg ha⁻¹) observed on peanut plants.

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