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Substrates of *Mauritia flexuosa* and wastewater from pig farming on growth and quality in seedlings *of Acacia mangium*[1]

Substratos de *Mauritia flexuosa* e água residuária da suinocultura no crescimento e qualidade de mudas de *Acacia mangium*

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ABSTRACT - Sustainable alternatives should be adopted to minimise the negative environmental impacts of agricultural activities. The use of wastewater as well as organic waste, from agricultural activities or found naturally, such as the decomposed stems of the Buriti palm (*Mauritia flexuosa*), can be a sustainable alternative in the production of seedlings for the reforestation of areas in the process of degradation or desertification, common in the State of Piauí, Brazil. The aim of this study was to evaluate growth and quality in seedlings of *Acacia mangium* Willd grown in substrates with different proportions of decomposed stems of *Mauritia flexuosa* (DSB), and irrigated with wastewater from pig farming (WPF). The experimental design was completely randomised, arranged in a 5 x 2 factorial scheme, corresponding to five proportions of DSB and soil (v/v,% - 0:100, 20:80, 40:60, 60:40, 80:20), and two sources of irrigation water (well water and WPF), with four replications. At 100 days after sowing (DAS), the seedlings were collected to measure the variables related to growth, quality and nodulation. Height, root collar diameter, shoot dry weight, leaf area and nitrogen accumulation in the shoots were significantly influenced ($p \leq 0.05$) by the interaction between substrate and source of irrigation water. The WPF had no significant influence on the growth or quality of the *Acacia mangium* Willd seedlings. The best ratio between DSB substrate and soil was 46:54, considered the most suitable for seedling production in *Acacia mangium Willd*.

Key words: Seedling propagation. Organic waste. Natural nodulation.

RESUMO - Alternativas sustentáveis devem ser adotadas para minimizar os impactos ambientais negativos das atividades agrícolas. A utilização de águas residuárias assim como de resíduos orgânicos oriundos das atividades agrícolas ou encontrados naturalmente como o caule decomposto do buritizeiro, podem constituir uma alternativa sustentável para a produção de mudas para fins de reflorestamento de áreas em processos de degradação e desertificação, comuns no Piauí, Brasil. Objetivou-se neste trabalho, avaliar o crescimento e qualidade de mudas de *Acacia mangium* Willd cultivadas em substratos com diferentes proporções de caule decomposto de *Mauritia flexuosa* (CDB) e irrigado com água residuária da suinocultura (ARS). O delineamento experimental foi inteiramente casualizado, disposto em esquema fatorial 5 x 2, referentes a cinco proporções de CDB e solo (v/v, %: 0:100; 20:80; 40:60; 60:40; 80:20) e duas origens de água de irrigação (água de poço e ARS), com quatro repetições. Aos 100 dias após semeadura (DAS), as mudas foram coletadas para mensuração das variáveis relacionadas ao crescimento, qualidade e nodulação. A altura, o diâmetro do coleto, a massa seca da parte aérea, a área foliar e o acúmulo de nitrogênio na parte aérea, foram influenciados significativamente ($p \leq 0{,}05$) pela interação entre os substratos e a origem da água de irrigação. A ARS não influenciou significativamente o crescimento e qualidade das mudas de *Acacia mangium* Willd. A melhor relação entre o substrato CDB:solo foi a proporção 46:54, considerada a mais adequada à produção de mudas de *Acacia mangium* Willd.

Palavras-chave: Propagação de mudas. Resíduos orgânicos. Nodulação natural.

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INTRODUCTION

The water supply is of great relevance in the production of quality seedlings. In a nursery for the production of medium-sized native seedlings, which produces 100,000 seedlings per year, approximately 10,000 litres of water are needed per day (MACEDO, 1993). Because of a progressive lack of water, together with problems of quality, one alternative is the planned use of wastewater. Wastewater from pig farming (WPF) is a valuable resource due to the large volume generated and because it is a source of nutrients for agricultural crops. However, technical and biological information on the use of this effluent is still basic and scarce in forest production.

For growing *Eucalyptus grandis*, Pelissari *et al*. (2009) reported that the use of WPF anticipates seedling production from 90 to 60 days. Batista *et al*. (2014) concluded that a 50% ratio of WPF resulted in the best morphological and nutritional characteristics in seedlings of *Eucalyptus urophylla*.

In addition to the water, the substrate has a direct influence on the production of quality seedlings. The use of stalks or the decomposed stems of the Buriti palm (*Mauritia flexuosa* LF) as substrate is a potential alternative for the production of seedlings of tree species, of low cost, and still widely available in the southwest of the State of Piauí (ALBANO; MARQUES; CAVALCANTE, 2012; SILVA, 2012). Sousa *et al*. (2013) concluded that a ratio of 48:52 (DSB to Soil) promoted better seedling quality in *Enterolobium contortisiliquum*.

Popularly known in Brazil as the Australian Acacia, or simply Acacia, *Acacia mangium* Willd is a commercially versatile exotic legume tree, with a significant capacity for adaptation to the soil and climate conditions of Brazil (SMIDERLE; MOURÃO JÚNIOR; SOUSA, 2005). The species can be used in plantations destined for the production of energy, cellulose pulp, furniture, panels, adhesives, and honey (intercropped with other legumes), to the recovery of degraded soils, and in reforestation programs as carbon stock, characterising a species with multiple uses (ATTIAS; SIQUEIRA; BERGALLO, 2014).

With the increasing and disorderly exploitation of farming in the cerrado region of Piauí, and the decline in forest resources, studies are needed to evaluate the adaptability of wood species, as well as suitable and accessible methods of multiplication (LUSTOSA FILHO *et al*., 2015). This work was therefore carried out with the aim of evaluating growth and quality in seedlings of *Acacia mangium* Willd in different substrates and irrigated with wastewater from pig farming.

MATERIAL AND METHODS

The experiment was carried out from August to November 2014 in a gable shade house of 50% sombrite, in the forestry nursery of the Federal University of Piauí, Professor Cinobelina Elvas Campus, (UFPI/CPCE), Bom Jesus, Piauí.

The town of Bom Jesus is inserted in the microregion of the Upper Mid Gurguéia, in the south west of the State of Piauí, at 09º04’ S and 44º21’ W and an average altitude of 277 m. The climate in the region is type Aw, hot and semi-humid (KÖPPEN, 1948). An average maximum temperature of 34.8 °C and a minimum of 17.91 °C were seen during the experimental period, with an average air humidity of 43.98% and accumulated rainfall of 297 mm, recorded at the Bom Jesus conventional weather station (INMET, 2015).

Seeds of *Acacia mangium* Willd were commercially acquired from a specialised company. Perforated polyethylene bags, 15 cm x 25 cm, were used as containers for producing the seedlings.

The substrates used were different proportions of a mixture of soil and the decomposed stems of the Buriti palm (DSB). The soil used was a typic dystrophic yellow Latosol of a sandy-loam texture, collected on the UFPI/CPCE Campus and sampled in the subsurface layer (>0.50 cm). The soil characteristics were: pH in $CaCl_2$ = 3.9; P (Mehlich 1) = 5.3 mg dm^{-3}; K = 20.0 mg dm^{-3}; Ca^{2+} + Mg^{2+} = 0.5 cmol$_c$ dm^{-3}; Al^{3+} = 1.8 cmol$_c$ dm^{-3}; H + Al = 3.2 cmol$_c$ dm^{-3}; organic matter = 7.0 g dm^{-3}; sand = 673 g kg^{-1}; silt = 52 g kg^{-1} and clay = 275 g kg^{-1}, following a methodology described by Donagema *et al*. (2011). The DSB originated naturally from the decomposition of a stem of the Buriti palm (*Mauritia flexuosa*), obtained from the town of Palmeira do Piauí, whose chemical characteristics were: N = 18.4 g kg^{-1}; P = 2.4 g kg^{-1}; K = 8.1 g kg^{-1}; Ca = 10.7 g kg^{-1}; Mg = 2.9 g kg^{-1}; S = 2.1 g kg^{-1}; B = 25.6 g kg^{-1}; Cu = 5.8 g kg^{-1}; Mn = 769.6 g kg^{-1}; Fe = 5.9 g kg^{-1}, as per Silva (2009).

The experiment was carried out in a completely randomised design arranged in a 5 x 2 factorial scheme, corresponding to five substrates (100% soil, 20% DSB + 80% soil, 40% DSB + 60% soil, 60% DSB + 40% soil, and 80% DSB and 20% soil v/v) and two types of irrigation water (wastewater from pig farming and well water), with four replications and one seedling per plot, giving a total of 40 seedlings.

The wastewater used was from a growing and finishing pig farm of the Animal Science Department at UFPI/CPCE. The water was treated on an experimental scale in an anaerobic sequencing batch reactor treatment system, operated in 24-hour cycles. The system was constructed from PVC tubing with a diameter of 300 mm and a volume of 180 litres, as per recommendations established by Chernicharo (2007). The treated effluent was stored in a 100-litre reservoir. The chemical characterisation (Table 1) of the pig-farm wastewater used in the experiment was carried out following methods compiled and described in Alcarde (2009). The other source for irrigating the seedlings was well water, collected from an artesian well at CPCE/UFPI.

Before sowing, the seeds were immersed in water at 100 ºC for one minute, and then left in water at room temperature for 12 hours to overcome integument dormancy (SMIDERLE; MOURÃO JÚNIOR; SOUSA, 2005). Sowing was carried out manually using three seeds per container.

After sowing, the containers were placed in the shade house and irrigated twice a day with well water (08:00 and 16:00). This was due to the preliminary data from this study, where it was seen that the use of WPF after sowing adversely affects the emergence process, with a mean reduction of 79.7% in the emergence percentage of *Acacia mangium* Willd seedlings compared to the treatments receiving well water.

Thinning was performed 20 days after sowing, leaving the most vigorous or central plant per container. At 21 days, wastewater application was begun in the corresponding treatment, with extra irrigations (well water and wastewater) whenever there were visual symptoms of water deficit in the plants. The volume established was 100 mL of well water and wastewater per container for each irrigation interval, applied to the substrate.

At 100 DAS measurements were taken of the root collar diameter (CD) with a digital calliper, height (H) determined from the surface of the substrate to the apical meristem of the seedling with the aid of a millimetre rule, leaf chlorophyll (LC) by chlorophyll meter, leaf area (LA) using a model LI-3100C® area meter, the number of nodules of nitrogen fixing bacteria in the roots (NN) by visual counting, and nodule fresh weight (NFW) on an analytical balance. In addition, substrate samples were collected at the end of the experiment for chemical characterisation (Table 2) using a methodology described by Silva (2009).

To obtain the values for shoot dry weight (SDW) and root dry weight (RDW), the root system was separated from the substrate by washing under running water. The shoots and roots were then packed separately into paper bags and placed in a forced air circulation oven at 65 °C to constant weight.

After weighing, the shoots were ground in a Willey-type mill to determine the nitrogen content, following the Kjeldahl methodology. The accumulated nitrogen in the shoots (ANS) was calculated by multiplying the SDW by the nitrogen content. From the values of the

Table 1 - Mean values for pH, electrical conductivity and chemical elements present in the wastewater from pig farming used in the experiment

pH	Electrical Conductivity	N	P	K	Ca	Mg	S	
	$mS\ cm^{-1}$	$g\ kg^{-1}$						
7.25	4.15	0.37	0.06	0.28	0.07	0.06	0.03	
Co	Cu	Mn	Zn	Fe	Mo	Pb	Cd	Na
$mg\ kg^{-1}$								
0.01	0.01	0.52	0.30	3.07	0.01	0.01	0.02	2200.0

Table 2 - Characterisation of the substrates at CDB to soil ratios of 0:100 and 80:20, irrigated with well water (DSB and Water) and with WPF (DSB and WPF), at the end of the experiment

Treatment		pH	N	P	K	Ca	Mg	Organic matter %	C/N Ratio	EC* $mS\ cm^{-1}$
		H_2O	$g\ kg^{-1}$							
DSB/ Water	0:100	4.76	2.60	3.10	1.50	1.10	0.30	4.50	10.10	0.03
	80:20	5.67	8.10	1.20	0.80	2.40	0.50	19.20	13.80	0.10
DSB/WPF	0:100	5.27	2.30	1.00	1.20	0.80	0.20	4.20	10.70	0.07
	80:20	5.83	8.20	1.30	1.00	2.00	0.60	17.50	12.40	0.24

*Electrical Conductivity

morphological variables, the leaf area ratio (LAR) was determined by LA/TDW, and the Dickson Quality Index (DQI) calculated with the formula TDW/(H/DC + SDW/RDW) (DICKSON; LEAF; HOSNER, 1960).

The data were tested for normality (Shapiro Wilk) and homocedasticity (Bartlett). Transformation of the data for SDW, RDW, TDW, DQI and ANS was necessary, using the function $Y = log (x + 1)$, as they originally did not present a normal distribution. The data were then submitted to analysis of variance (ANAVA), and when finding significant differences by F-test at 5% probability, Tukey's test was applied to the mean values at 5% probability. The mean values for the quantitative factor were submitted to polynomial regression analysis and the optimal proportion of each variable was calculated by the partial derivative of the β0 and β1 estimators. The equations were selected based on the significance of the models and their biological significance. The analyses were carried out using the R Development Core Team software (2011), version 3.2.0.

RESULTS AND DISCUSSION

From the results of the analysis of variance (Table 3), it was seen that the seedlings of *Acacia mangium* Willd were tolerant to irrigation with wastewater, there being no statistical evidence of this effluent on the growth variables in relation to the treatments irrigated with well water. There was a significant effect ($p \leq 0.05$) from the interaction between the substrates and the source of the irrigation water on the variables H, CD, SDW, LA and ANS.

For seedling height in *Acacia mangium* Willd, it was found that the substrate at the estimated DSB to soil ratio of 48.5:51.5 associated with well water for irrigation, provided a maximum H of 65.79 cm plant^{-1} (Table 3). The application of wastewater gave a maximum H of 58.94 cm plant^{-1} at the estimated DSB to soil ratio of 41.4:58.9, with a quadratic trend whether irrigated with well water or wastewater (Figure 1a).

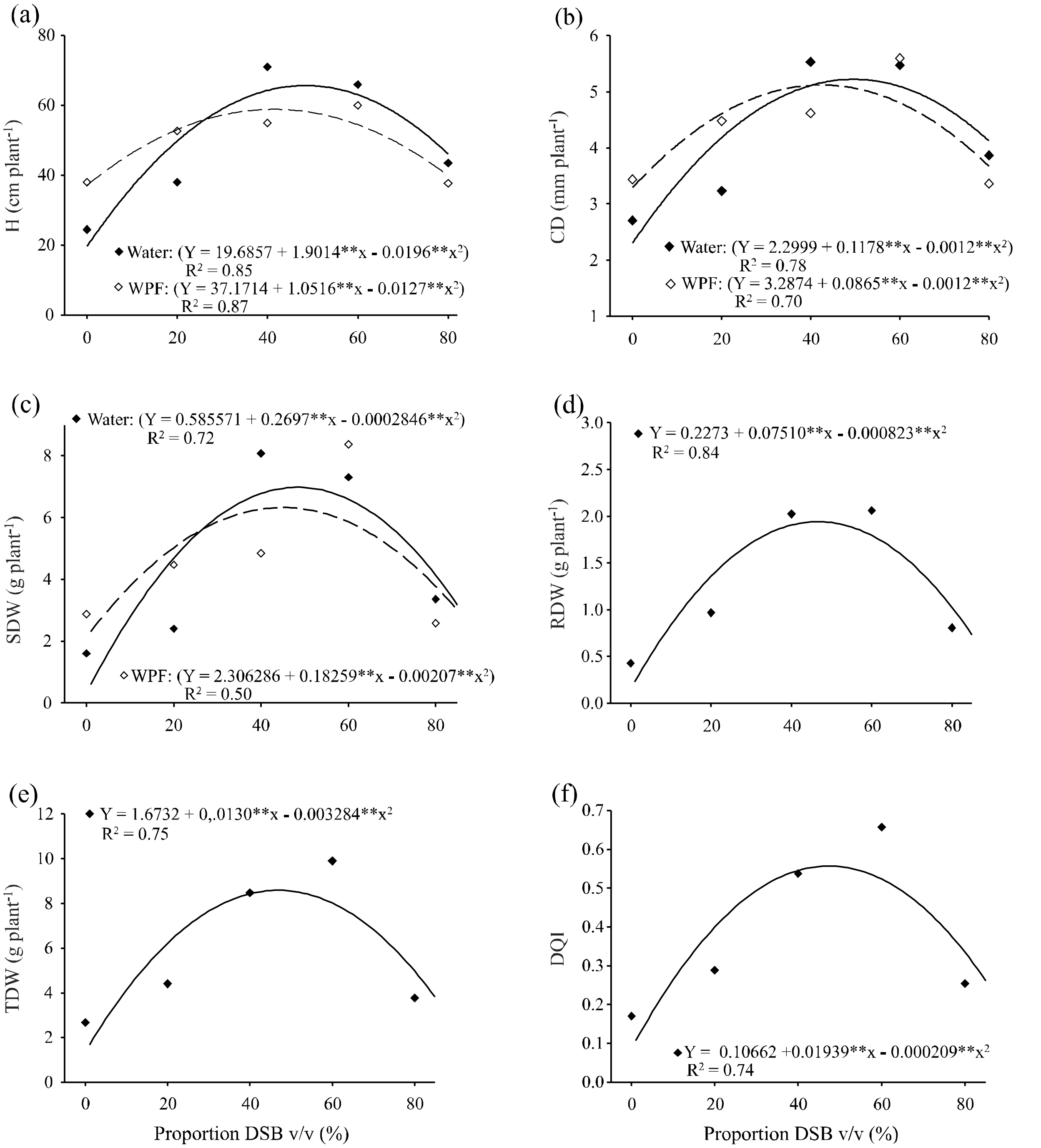
For CD in the *Acacia mangium* seedlings, those submitted to irrigation with drinking water obtained a

Table 3 - Summary of the analysis of variance and test of mean values for the variables of *Acacia mangium* Willd, submitted to substrates in increasing proportions of DSB and to the application of well water and WPF for irrigation

SV	DF	Mean Square					
		H	CD	SDW	RDW	TDW	DQI
Water (W)	1	0.10^{ns}	0.18^{ns}	0.014^{ns}	0.007^{ns}	0.020^{ns}	0.001^{ns}
Substrate (S)	4	1579.46*	8.58*	0.296**	0.167**	0.345**	0.031**
W x S	4	362.41*	1.55*	0.054*	0.004^{ns}	0.040^{ns}	0.002^{ns}
Residual	30	46.98	0.40	0.016	0.006	0.016	0.001
CV%		14.09	14.99	18.22	25.27	16.39	30.65
Mean Water		cm plant^{-1}	mm plant^{-1}	------------- g planta^{-1}--------------			
		48.6 a	4.16 a	4.54 a	1.32 a	5.73 a	0.36 a
Mean WPF		48.7 a	4.29 a	4.62 a	1.18 a	5.95 a	0.39 a
SV	DF	Mean Square					
		LC	LA	LAR	NN	NFW	ANS
Water (W)	1	76.17^{ns}	756.90^{ns}	116.99^{ns}	133.44**	0.096**	0.162*
Substrate (S)	4	566.50**	254057.66*	3745.87**	3.42^{ns}	0.006^{ns}	0.516**
W x S	4	117.50^{ns}	100038.84*	290.42^{ns}	3.42^{ns}	0.006^{ns}	0.149**
Residual	30	54.85	29192.25	205.45	4.41	0.010	0.034
CV%		13.85	33.85	14.91	82.91	13.40	8.58
Mean Water		ug cm^{-2}	cm^2 plant^{-1}	cm^2 g^{-1}	Unit	mg nodule^{-1}	mg plant^{-1}
		54.85 a	500.3 a	97.83 a	26.5 a	170.0 a	175.64 b
Mean WPF		52.09 a	509.0 a	94.41 a	0.0 b	0.0 b	195.22 a

SV: source of variation; DF: degrees of freedom; CV%: coefficient of variation; H: shoot height; CD: root collar diameter: SDW, shoot dry weight; RDW: root dry weight; TDW: total dry weight; DQI: Díckson Quality Index; LC: leaf chlorophyll; LA: leaf area; LAR: leaf area ratio; NN: number of nodules; NFW: nodule fresh weight; ANS: accumulated nitrogen in the shoots; * and ** significant at 5% and 1% probability by F-test respectively; ^{ns} not significant at 5% probability

Figure 1 - Height (a), root collar diameter (b), shoot dry weight (c), root dry weight (d), total dry weight (e) and Díckson Quality Index (f) in seedlings of *Acacia mangium* Willd, grown in different proportions of DSB and soil, for the application of WPF. * and ** significant at 1% and 5% probability respectively



maximum mean value of 5.19 mm plant^{-1} at the DSB to soil ratio of 49.0:51.0 (Table 3). The seedlings that received the wastewater had a maximum of 5.15 mm plant^{-1}, obtained at the estimated DSB to soil ratio of 43.3:56.7, (Figure 1b).

The addition of DSB together with irrigation using well water gave the maximum productivity for SDW of 7.08 g plant^{-1} at the estimated DSB to soil ratio of 48.2:51.8, showing quadratic growth (Figure 1c). The same trend as shown by the seedlings irrigated with wastewater, with a maximum value of 6.27 g plant^{-1} at the DSB to soil ratio of 43.5:56.5 (Figure 1c).

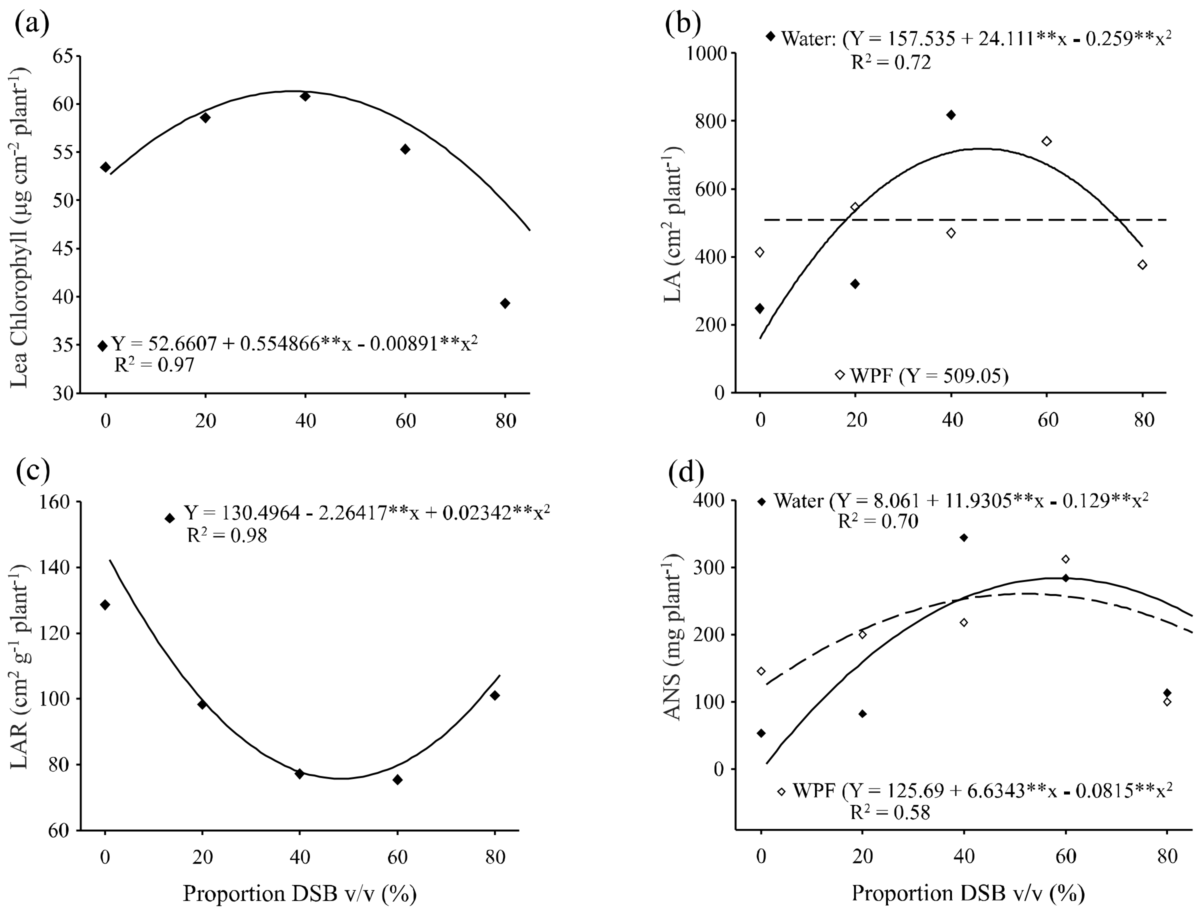
With RDW and TDW, there was a significant effect ($p \leq 0.05$) from the proportions of DSB only (Table 3). The highest mean value for RDW (1.94 g plant^{-1}) was reached at the estimated DSB to soil ratio of 45.7:54.3 (Figure 1d). For TDW, the DSB to soil ratio of 45.9:54.1 gave the maximum productivity of 8.58 g plant^{-1} (Figure 1e).

When analysing the DQI of the seedlings of *Acacia mangium* Willd (Table 3), similar behaviour was reported for the variables RDW and TDW (Table 3), where the DQI of the seedlings irrigated with wastewater did not differ ($p > 0.05$) from that of the seedlings irrigated with well water. However, there was an individual effect with a quadratic fit for the proportions of DSB. Use of the estimated DSB to soil ratio of 43.4:53.7 gave the highest value for DQI of 0.55 (Figure 1f). As a comparison, Caldeira *et al*. (2014), evaluating substrates based on sewage sludge associated with other materials in the production of *Acacia mangium* Willd seedlings, found that the combination of sewage sludge and organic compost at a ratio of 40:60 gave the maximum value for DQI of 0.34; an inferior performance to that found in this study, showing that seedlings of *Acacia mangium* Willd grown at the estimated proportion of DSB show satisfactory quality for planting.

For the variables related to photosynthesis, a significant effect ($p \leq 0.05$) from the substrate was seen on LC (Table 3), with the maximum value for this variable (68.86 ug cm^{-2}) occurring at the estimated DSB to soil ratio of 31.1:68.9 (Figure 2a).

However, LA in the seedlings of *Acacia mangium* was significantly influenced ($p \leq 0.05$) by the interaction of the substrate and the source of the irrigation water (Table 3). The seedlings submitted to irrigation with well water had a maximum value for LA of 718.67 cm^2 plant^{-1} (Figure 2b), achieved at the estimated DSB to soil ratio

Figure 2 - Leaf chlorophyll (a), Leaf area (b), leaf area ratio (c) and accumulated nitrogen in the shoots (d) in seedlings of *Acacia mangium* Willd, grown in different proportions of DSB and soil, for the application of WPF. * and ** significant at 1% and 5% probability respectively



of 46.5:53.5. No fit to the tested regression models was seen for LA with the seedlings in treatments that received wastewater, with a mean value of 509.05 plant^{-1} cm^2 (Figure 2b).

Lucena *et al*. (2007), working with seedlings of *Delonix regia* (Hook.) Raf. (flamboyant), also a leguminous forest species, found that the use of wastewater from sewage treatment resulted in greater growth in H, SDW, RDW and AF, compared to seedlings submitted to mineral and organic fertiliser in the substrate.

Different results were obtained by Augusto *et al*. (2007) using wastewater from biological sewage treatment systems in the fertigation of seedlings of *Eucalyptus grandis* Hill. Ex. Maiden. The authors found an inferior performance of 107.8, 120.1 and 38.6% for the variables AF, SDW, RDW in seedlings irrigated with wastewater compared to treatment with conventional fertigation.

The LAR is a morpho-physiological component that expresses the useful area for photosynthesis, which relates the LA responsible for the interception of light energy and CO_2 with the TDW, where the lower the LAR, the greater the efficiency of the plant in producing biomass (BENINCASA, 2003). Thus, it was found that the LAR of the *Acacia mangium* seedlings was influenced ($p \leq 0.05$) by the principle effect of the substrates (Table 3), with the estimated minimum value (75.74 cm^2 g^{-1}) occurring at the estimated ratio of 48.3:51.7 (DSB to soil), represented by a positive quadratic regression (Figure 2c).

The presence of nodules with diazotrophic bacteria was found in most of the roots of the *Acacia mangium* seedlings (26.5 nodules plant^{-1} with 170.0 mg nodule^{-1}), even with no inoculation procedure. This indicates that even though dealing with an exotic species, *Acacia mangium* displayed affinity with the indigenous communities of these microorganisms present in the samples of yellow Latosol used in making up the substrates. A significant main effect ($p \leq 0.05$) from the source of water was seen on NN and NFW (Table 3). Further, there was an inhibitory effect caused by WPF on natural seedling nodulation, since these treatments did not nodulate differently from the treatments with well water (Table 3).

In agreement with the results of the present study, Costa *et al*. (2012), in a study with seedlings of *Enterolobium contortisiliquum* (Vell.) Morong irrigated with different concentrations of wastewater from treated domestic sewage, found that treatments that received no wastewater, or wastewater at low concentrations, displayed a larger presence of nodules of nitrogen-fixing bacteria.

The lack of nodulation possibly occurred due to the availability of nitrogen present in the WPF, which may have inhibited the symbiosis between plant and microorganism. Another inhibitory factor may have been the high electrical conductivity and sodium concentration. High levels of nitrogen promote a reduction in plant nodulation, due to a decrease in communication between host and symbiont, stimulated by the deficiency, which includes the exudation of flavonoids by the plant and the synthesis of Nod factors by the bacteria (HUNGRIA; VARGAS, 2000; MOREIRA; SIQUEIRA, 2006).

Another aspect considered one of the possible causes of nodulation inhibition is the high concentration of sodium present in the WPF, reflecting in an increase in the electrical conductivity of the substrates (Table 1 and 2). This statement is in line with several authors who report that salinity causes changes in the process of bacterial infection and the formation and function of root system nodules (FREIRE; RODRIGUES, 2009; FREITAS *et al*., 2007; MANCHANDA; GARG, 2008; TAVARES *et al*., 2012).

In relation to the NAS of the *Acacia mangium* seedlings, the maximum value (283.87 mg plant^{-1}) was seen at the estimated ratio of 46.3:53.7 (DSB to soil) for seedlings irrigated with well water (Figure 2d). Treatments that received wastewater had a maximum value of 260.68 mg plant^{-1} at the ratio of 40.6:59.4 (DSB to soil) (Figure 2d). Overall, the wastewater was more efficient in promoting N accumulation in the shoots of the *Acacia mangium* seedlings when compared to the treatments irrigated with well water, even in the presence of noduliferous nitrogen-fixing bacteria (Table 3).

Araújo *et al*. (2016), evaluating growth and nutritional balance in seedlings of *Enterolobium contortsiliquum* grown on different substrates and irrigated with WPF, found that increasing proportions of organic compounds based on carnauba straw and poultry litter contributed to better seedling growth and nutritional balance. However, irrigation with WPF promoted growth and nutritional quality inferior to those of seedlings produced with well water. This shows that each species has a different capacity for metabolising the elements contained in these effluents.

Except for nodulation, the growth and quality variables of the *Acacia mangium* Willd seedlings did not differ for the source of irrigation water (Table 3). These results indicate the technical viability of using treated wastewater from pig farming as a substitute for clean water in irrigating seedlings of this species. Evaluation of the sensitivity of other forest species, monitoring the salinity of this effluent, and developing reuse methodologies are suggested as a sustainable alternative to high water consumption in nurseries and the current scenario of water scarcity in certain regions.

According to the chemical analysis of the substrates shown in Table 2, the addition of DSB promoted an increase in nutrients (N, Ca and Mg) and organic matter in the substrate. Seedlings of *Acacia mangium* Willd grown in substrates containing DSB showed superior performance of the growth variables compared to seedlings grown in substrates containing only soil (0:100). On the other hand, a decrease in the values of the variables under analysis, starting with the optimal proportions, may have occurred due to an increase in the organic matter content of the substrates unbalancing the concentrations of available cations and anions (Table 2).

Sousa *et al*. (2013) also found that incorporating DSB into the growth substrate of seedlings of *Enterolobium contortisiliquum* (Vell.) Morong gave higher values for the growth variables under evaluation. The authors attributed this result to the chemical effect related to nutrient availability, as well as to the physical effects that the addition of this material has on the substrate, such as lower density, and greater porosity, aeration and water retention. The satisfactory performance of decomposed stems of the Buriti palm in substrates was also reported by Albano, Marques and Cavalcante (2014), when growing seedlings of *Carica papaya* L.; by Silva (2012), in seedlings of Passiflora edulis; and Beckmann-Cavalcante *et al*. (2013) in *Heliconia psittacorum* L.

CONCLUSIONS

1. Irrigation with wastewater from pig farming is suitable for the growth and quality of *Acacia mangium* Willd seedlings, proving to be a viable alternative for disposing of this effluent. However, the use of wastewater inhibits the natural nodulation of the seedlings;
2. The use of decomposed stems of the Buriti palm as a component of the growth substrate contributes to greater growth and higher quality in seedlings. Using TDW as reference, the ratio of 46:54 (CDB to soil) is the most suitable for maximising production in seedlings of *Acacia mangium* Willd.

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