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Water demand and technical-economic viability of cowpea grown in different production scenarios

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ABSTRACT: Water demand and agronomic and economic efficiency of cowpea are strongly related to agricultural practices and climatic conditions. This study aimed to determine in which cropping season cowpea has the highest water demand and maximum agronomic and economic efficiency as a function of water stress under the edaphoclimatic conditions of the semi-arid region of northeastern Brazil. Cowpea was cultivated in two cropping seasons (rainy and dry) and subjected to five forms of water stress (without water stress, water suspension for 5, 10 and 15 days and rainfed cultivation) and four replicates, started in the flowering and grain filling stages, under no-tillage system. Agronomic (yield, biomass, harvest index and water use efficiency) and economic (gross revenue, net revenue, rate of return and profit margin) parameters were evaluated. The water demand of cowpea in the dry season was 20.2% higher than in the rainy season; consequently, the Kc values obtained were also higher in this period. The climatic conditions that occurred during the cropping seasons and water stress negatively influenced the agronomic performance and financial profitability of cowpea, being more evident in the rainfed cultivation. For the edaphoclimatic conditions of the study, cowpea can be grown without significant losses of yield and profitability in both cropping seasons, provided that the water stress does not last more than 10 days during its reproductive stage.
Keywords: profitability; *Vigna unguiculata*; water stress; cropping season.

Demanda hídrica e viabilidade técnico-econômica do feijão-caupi cultivado em diferentes cenários produtivos

RESUMO - A demanda hídrica e a eficiência agronômica e econômica do feijão-caupi estão fortemente relacionados com as práticas agrícolas e a condições climáticas. Este trabalho teve como objetivo determinar em qual época de cultivo o feijão-caupi apresenta maior demanda hídrica e máxima eficiência agronômica e econômica em função do estresse hídrico, nas condições edafoclimáticas da região semiárida do nordeste do Brasil. O feijão-caupi foi cultivado em dois períodos de cultivo (chuvoso e seco) e submetido a cinco formas de estresse hídrico (sem estresse hídrico, suspensão de água de 5, 10 e 15 dias e plantio de sequeiro) com quatro repetições, iniciado nas fases de floração e enchimento de grãos, em sistema de plantio direto. Foram avaliados parâmetros agronômicos (produtividade, biomassa, índice de colheita e eficiência do uso da água) e econômicos (renda bruta, renda líquida, taxa de retorno e margem de lucro). A demanda hídrica do feijão-caupi no período seco foi 20,2% superior a do período chuvoso, consequentemente, os valores de Kc obtidos também foram superiores nesse período. As condições climáticas ocorridas nos períodos de cultivos e o estresse hídrico influenciaram negativamente no desempenho agronômico e rentabilidade financeira do feijão-caupi, sendo mais evidenciada no cultivo de sequeiro. Para as condições edafoclimáticas do estudo, o feijão-caupi pode ser cultivado sem significativas perdas de produtividade e rentabilidade em ambos os períodos de cultivo, desde que o estresse hídrico não seja superior a 10 dias durante sua fase reprodutiva.
Palavras-chave: rentabilidade; *Vigna unguiculata*; estresse hídrico; época de cultivo.

1. INTRODUCTION

Among all economic activities, agriculture is considered the activity that most depends on environmental conditions, especially climatic conditions. Agricultural crops, when poorly supplied with water and subjected to high temperatures, cannot achieve their full development, causing yield losses and, consequently, lower profits for the agricultural sector (FÉLIX et al., 2020).

In the Northeast region of Brazil, cowpea cultivation assumes great socioeconomic importance, as in general it is practiced by small family farmers, since cowpea is considered a subsistence crop, is an important component in production systems and is one of the main sources of income and employment for the region, and also for its high nutritional value (FREIRE FILHO et al., 2005). The cowpea crop is characterized mainly by its rusticity, good adaptation to the semi-arid climate and its high nutritional value (MELO et al., 2022).

However, family farming faces major problems to achieve high yield, and this is mainly due to the fact that farmers are not able to exploit the production potential of the crop due mainly to the spatial-temporal variability of rainfall. In addition, there is still a lack of adoption of minimal techniques that enhance the increase in crop yield, such as the use of irrigation and varieties that are more resistant to drought (ABREU ARAÚJO et al., 2019; LOPES et al., 2019).

Water scarcity is the main condition that interferes with crop yield in the semi-arid region. Therefore, prior knowledge on the agroclimatic requirements of crops adequately assists agricultural planning, aiming to achieve greater yield, profitability and reduction of losses due to climatic factors, with temperature and precipitation being the climatic elements that most affect common bean development (LACERDA et al., 2010). In the case of cowpea, in the flowering and grain filling stages, water stress tends to drastically reduce its yield (SOUZA et al., 2015; ALMEIDA et al., 2019).

Thus, it is crucial to know in detail the water need of cowpea crop in order to maximize the production potential and minimize production costs, thus improving the management of available water resources, especially where they are scarce (MURGA-ORRILLO et al., 2016). The cowpea crop has a short cycle and, because of this, it is greatly influenced by droughts and dry spells, and even excess water can severely affect its growth, so it is indispensable to perform an adequate management of the crop in order to satisfactorily meet its water demand (FREITAS et al., 2014; ABREU ARAÚJO et al., 2019).

Many studies have been conducted to assess the influence of agricultural practices and climatic conditions on the yield and economic efficiency of cowpea (CASTRO JÚNIOR et al., 2015; SILVA et al., 2016; ANDRADE JUNIOR et al., 2018). In this context, the objective of this study was to determine in which cultivation time cowpea has maximum agronomic and economic efficiency as a function of water stress under the edaphoclimatic conditions of the semi-arid region of northeastern Brazil.

2. MATERIAL AND METHODS

This study was conducted at the Experimental Station (EstAgro) belonging to the Academic Unit of Atmospheric Sciences (UACA) of the Federal University of Campina Grande - UFCG, in the state of Paraíba, at the coordinates 07° 13' 50" S latitude and 35° 52' 52" W longitude and 526 m altitude. The soil of the area has a sandy texture. According to Coelho; Soncin (1982), based on Köppen's climate classification adapted to Brazil, the state of Paraíba has a mesothermal subhumid climate, with well-defined dry season (4 to 5 months) and rainy season (autumn to winter).

Two experimental campaigns were carried out, the first from February 2 to May 14, 2021 (rainy season), and the second from September 1 to November 9, 2021 (dry season). The environmental conditions during the experimental periods were obtained daily, and their mean values are shown in Figure 1. Water stress in the reproductive stage began on March 29 and ended on April 12, 2021, in the rainy season, and began on October 19 and ended on November 2, 2021, in the dry season.

Cowpea was cultivated in two cropping seasons (rainy and dry) and subjected to five forms of water stress (without water stress, water suspension for 5, 10 and 15 days and rainfed cultivation), under no-tillage system. The experimental area had 10 masonry beds with dimensions of 8 m x 1 m. Each experimental plot was composed of one bed. In plots that received water deficit treatments, irrigation was suspended in the flowering stage of the crop, period in which 70% of the plants had at least one flower.

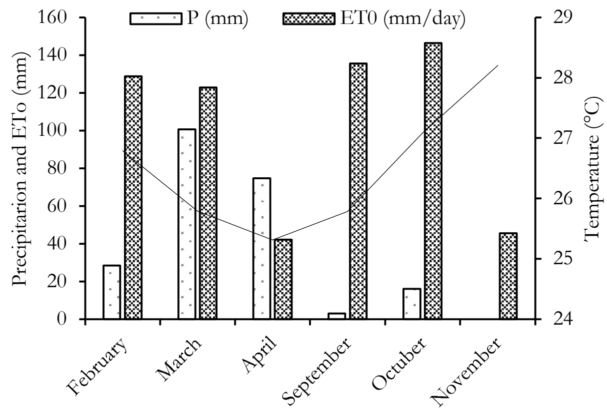

Figure 1. Climatic data observed during the experiments.
Figura 1. Dados climáticos observados durante a condução dos experimentos.

Before planting the crop, a chemical-physical analysis of the soil was performed in the 0-20 cm layer of the profile, for chemical characterization, and the results were: pH in water- 6.2; organic matter – 11.12 g.kg^{-1}; base saturation (V) – 68.75%; Na^+, $H+Al^{3+}$, Ca^{2+} and Mg^{2+} - 0.04, 2, 2.27, and 1.7 $cmol_c.dm^{-3}$; and P and K^+ - 30.95 mg.dm^3 and 142.51 mg.dm^3, respectively. The soil of the area has sandy texture and its values of water content at field capacity (-0.01 Mpa) and permanent wilting point (-1.5 Mpa), considering the 0-0.4 m layer, were 7.3% and 4.6% on a volume basis, respectively.

Sowing was carried out manually, after opening the holes with a hoe, at spacing of 0.5 m between rows and 0.5 m between plants, placing 3 to 4 seeds per hole and leaving only 3 plants per hole, which resulted in a planting density of 120,000 plants ha^{-1}.

Water replacement was based on 100% crop evapotranspiration (Etc), which was estimated according to Bernardo, Soares e Mantovani (2006), with Kc values of cowpea determined by Silva et al. (2016) and reference evapotranspiration (ET_0) estimated using the equation proposed by Allen et al. (1998). The data required to estimate ET_0 were collected daily through an automatic agrometeorological station (Irriplus, E5000 model) installed in the experimental area.

Irrigation was applied by a drip system with flow rate of 4.5 L.h^{-1} at a service pressure of 2 kgf. Cm^{-2} and adopting a 90% application efficiency, and the system had two lines per bed and one dripper per hole. A two-day interval between irrigations was adopted. Irrigations were always carried out during the morning, between 06h and 08h, and when rainfall volume did not exceed the water demand of the crop.

The cowpea variety cultivated was 'Costela de vaca' (Heirloom), due to its acceptance by family farming in the Northeast region of Brazil (SILVA; NEVES, 2011). This cultivar has a semi-prostrate growth habit, its flowering begins at 40 days after sowing, and its maturity is reached between 71 and 80 days after sowing. Its average yield is generally more than 1,000 kg ha^{-1} under rainfed regime (SANTOS; LIMA, 2015).

During the stay of the crop in the field, manual weeding was carried out to control spontaneous plants, whereas insects and diseases were controlled using agroecological practices and alternatives aiming at an agrochemical-free production. Etc was determined using equation proposed by Libardi (1995):

$$ET_C = P + I \pm \frac{D}{A} \pm \Delta s \pm R \quad (01)$$

where: ETc - Crop evapotranspiration (mm/day); P - Precipitation (mm/day); I - Irrigation; Δs - Water storage variation in the soil profile; R - Surface runoff; D/A - Deep drainage or capillary rise.

Soil moisture was monitored using a capacitance probe, diviner 2000® model. Precipitation (P) was collected daily at the Irriplus Automatic Meteorological Station, irrigation (I) through irrigation monitoring, while surface runoff (R) and deep drainage/capillary rise (D/A) were considered null as the bed area is relatively small and irrigation is carried out only according to the water need of the crop and moistening the soil only up to the root system.

Water storage variation in the soil profile (Δs) was determined by the difference between the values of the initial (Θ_1) and final (Θ_2) water contents, considering the maximum depth of the crop root system (Z_{WB}), which was 40 cm, through equation:

$$\Delta S = (\theta_2 - \theta_1) \, . \, Z_{WB} \quad (02)$$

where: Δ_S: Water storage variation on the days considered (mm); θ_2: Soil water content found at time 2 (final), $m^3.m^{-3}$; θ_1: Soil water content found at time 1 (initial), $m^3.m^{-3}$; Z_{WB}: Depth considered for water balance (0.4 m).

The Kc values of cowpea cv. 'Costela de vaca' were estimated for the treatment that did not suffer water restriction through equation (3), according to Doorenbos e Pruitt (1977). The crop cycle was divided into development stages as proposed by Allen et al. (1998), and the details to obtain it are described in Murga-Orrillo et al. (2016), through equation:

$$K_C = ET_C/ET_O \quad (03)$$

where: Kc - crop coefficient; ETc - crop evapotranspiration (mm); ETo - reference evapotranspiration (mm).

Evaluations of agronomic characteristics were performed as each plot reached physiological maturity. The following agronomic characteristics were evaluated in each treatment: grain yield (quantified by the weight of dry grains harvested in a usable area of the plot of 1m², expressed in $kg.ha^{-1}$); biomass (obtained by weighing the plant shoots, excluding pods, expressed in $kg.ha^{-1}$); harvest index (measured by the ratio between dry grain yield and biomass, expressed as a percentage) and; water use efficiency, determined by the ratio between grain yield and the total water depth applied (irrigation + precipitation), expressed in $kg.ha^{-1}.mm^{-1}$.

In both experiments, production costs were determined and the following economic indicators were calculated: gross revenue (GR) expressed in Reais, determined by multiplying the dry grain yield of each treatment by the product value paid to the producer of the region in June 2021, which was R$ 3.38 per kg of dry grain, and in December 2021, which was R$ 5.11 per kg of dry grain, with the values practiced obtained based on the data of Conab (National Supply Company); net revenue (NR) expressed in Reais, obtained by subtracting the production costs (PC) from the gross revenue (GR); rate of return (RR) expressed in Reais, determined by the ratio between the total revenue and production costs (PC), a variable that represents how many Reais are obtained in exchange for each Real applied in the system; profit margin (PM), obtained by the ratio between net revenue and gross revenue. The methodology used to calculate these indicators was recommended by Bezerra Neto et al. (2010).

Calculation was performed considering that the production costs (PC), such as soil tillage, planting, cultural practices, harvest, among others, were variable for all treatments, and that the irrigation system was already in full operation in the field, to evaluate only the variable cost of the water depth, because the variation in the volume of water applied does not influence the cost of the initial investment with the irrigation project.

The agronomic and economic data obtained were subjected to analysis of variance and, when there was significant effect for water stress, regression analyses were performed, and their significance was checked by the correlation coefficient through the F test at 5% probability level, considering the means fitted when R^2>0.7. The analyses were performed using PAleontological STatistics software version 3 (PAST 3) (HAMMER, 2017).

3. RESULTS

The cycle of cowpea cv. 'Costela de vaca' in both cropping seasons was completed at 70 days, distributed as follows: 13 days (Stage I); 28 days (Stage 2); 13 days (Stage III) and 16 days (Stage IV), showing a cumulative total ETo of 291.6 mm in the rainy season and 327.7 mm in the dry season, which represented a 20.2% increase in crop water demand in this period (Table 1). The highest values of ETo and ETc were observed in stage II. According to Silva et al. (2016), this behavior can be explained by the greater development of plants, as the crop has a greater increase in leaf area and, consequently, increase in its evapotranspiration.

Table 1. Duration of initial (I), vegetative development (II), flowering/reproductive (III) and final (IV) phenological stages of cowpea crop and values of reference evapotranspiration (ETo), crop evapotranspiration (ETc) and crop coefficient (Kc) for each stage.
Tabela 1. Duração dos estádios fenológicos, inicial (I), desenvolvimento vegetativo (II), floração/reprodutivo (III) e final (IV) da cultura do feijão-caupi e valores da evapotranspiração de referência (ETo), evapotranspiração da cultura (ETc) e o coeficiente de cultivo (Kc) para cada estágio.

Stage	Rainy Season				Dry Season		
	Duration	ET_0	ETc	Kc	ET_0	ETc	Kc
I	13	63.7	54.1	0.8	62.3	55.4	0.8
II	28	122.4	118.7	0.9	125.2	127.7	1.0
III	13	49.0	45.6	0.9	60.9	59.1	0.9
IV	16	56.5	49.2	0.8	79.3	73.0	0.9
Total	70	291.6	267.6	-	327.7	315.2	-

For the water use efficiency of cowpea, maximum WUE was observed in the rainy season (Figure 2) in the treatments that received irrigation (greater than 5.7 kg ha^{-1} mm^{-1}), while in the rainfed treatment, the WUE was only 2 kg ha^{-1} mm^{-1}. In the dry season, the WUE was lower than 5 kg ha^{-1} mm^{-1} in all irrigated treatments, but in the rainfed treatment, the WUE was 21 kg ha^{-1} mm^{-1}. Certainly, agricultural practices of mulching and no-tillage in the cultivation of cowpea, even subjected to water stress, contributed to better water use efficiency in both cropping seasons.

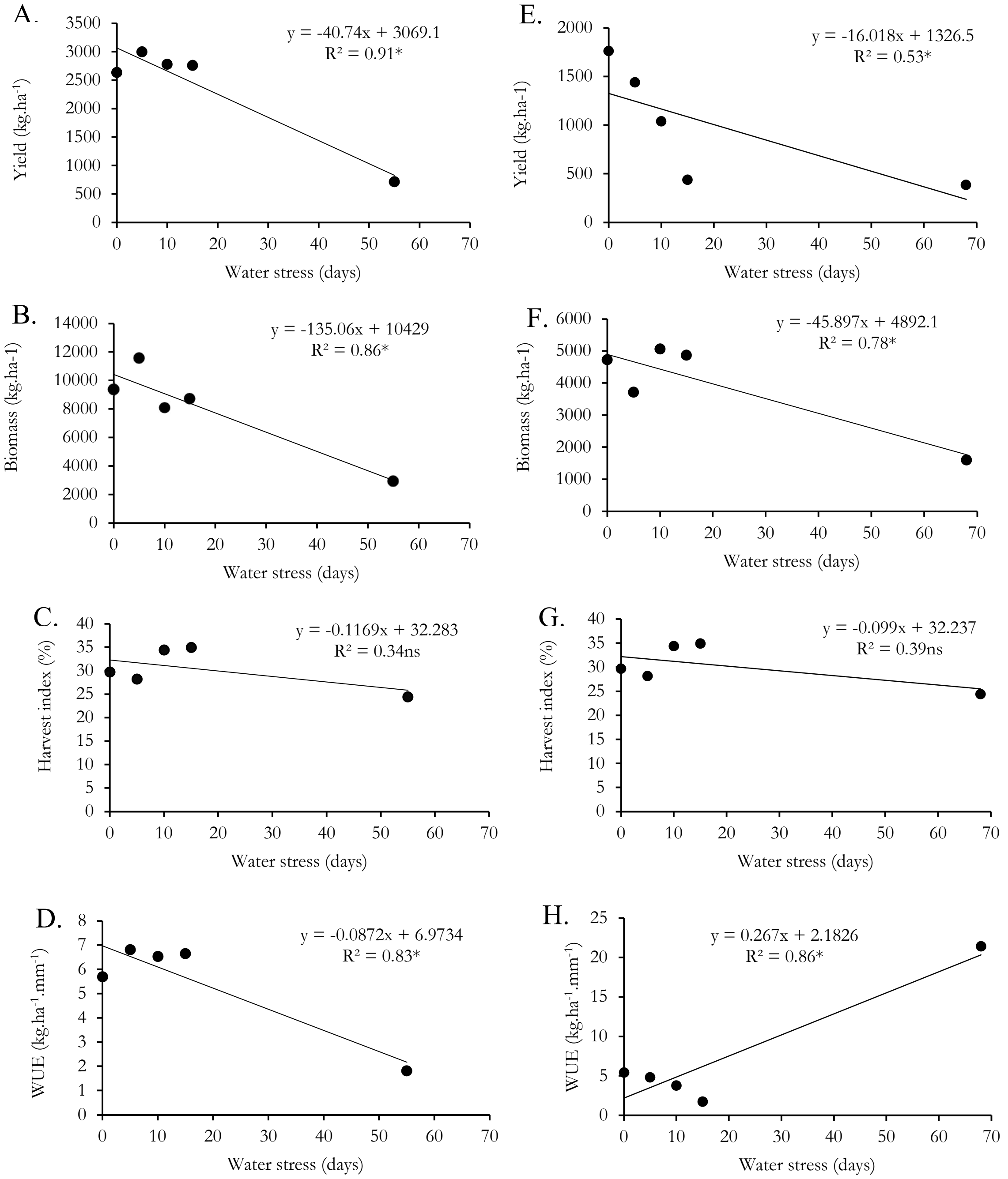

Figure 2. Yield, biomass, harvest index and water use efficiency of cowpea as a function of water stress cultivated in rainy season (A, B, C, D) and dry season (E, F, G, H), respectively. R^2- coefficient of determination; *significant and ^{ns} not significant by F test at 5% probability level.

Figura 2. Produtividade, biomassa, índice de colheita e eficiência do uso da água do feijão-caupi em função do estresse hídrico cultivado em período chuvoso (A, B, C, D) e período seco (E, F, G, H), respectivamente. R^2- coeficiente de determinação; *significativo pelo teste F a 5% de probabilidade.

Significant decreasing linear responses were observed in all economic viability indicators (Figure 3). However, these linear correlations between economic indicators and the effect of water stress for cowpea cultivation in the dry season have values below 0.7, but with high statistical significance. This suggests that the profitability of cowpea was affected more strongly by water restriction, and these reductions were more evident in the rainfed cultivation system. However, the profitability of cowpea cultivated under rainfed regime can be increased if it is intercropped with other crops, such as corn, due to the positive return of net revenue and the rate of return (CARVALHO et al., 2017).

Therefore, in the present study, it was verified that the climatic conditions that occurred in the cropping seasons and water stress influenced the agronomic performance and financial profitability of cowpea. This highlights the strong influence of environmental and management conditions on yield and profitability of cowpea cultivated under the edaphoclimatic conditions of the northeastern semi-arid region. The use of irrigation is a technology that acts positively in maximizing these results.

Table 1. Economic viability indicators of cowpea as a function of water stress in two cropping seasons in Campina Grande-PB.
Tabela 1. Indicadores de viabilidade econômica do feijão caupi em função do estresse hídrico, em duas épocas de cultivo, em Campina Grande.

Treatment	Season	Y (kg ha⁻¹)	TC (R$)	Economic viability indicators			
				GR (R$)	NR (R$)	RR (R$)	PM (%)
T1	R	2633	1998.9	8897.9	6899.0	4.5	77.5
	D	1763	1773.4	9006.4	7233.0	5.1	80.3
T2	R	2998	1948.9	10131.6	8182.7	5.2	80.8
	D	1440	1723.4	7358.4	5635.1	4.3	76.6
T3	R	2780	1848.9	9396.4	7547.5	5.1	80.3
	D	1038	1623.4	5301.6	3678.3	3.3	69.4
T4	R	2760	1698.9	9328.8	7629.9	5.5	81.8
	D	438	1473.4	2235.6	762.3	1.5	34.1
T5	R	710	1498.9	2399.8	900.9	1.6	37.5
	D	385	1273.4	1967.4	694.0	1.5	35.3

GR - gross revenue; NR - net revenue; RR - rate of return; PM - profit margin; TC - total cost; T1 - full irrigation; T2 - 5-day water stress; T3 - 10-day water stress; T4 - 15-day water stress; T5 - rainfed cultivation; R - rainy; D - dry.

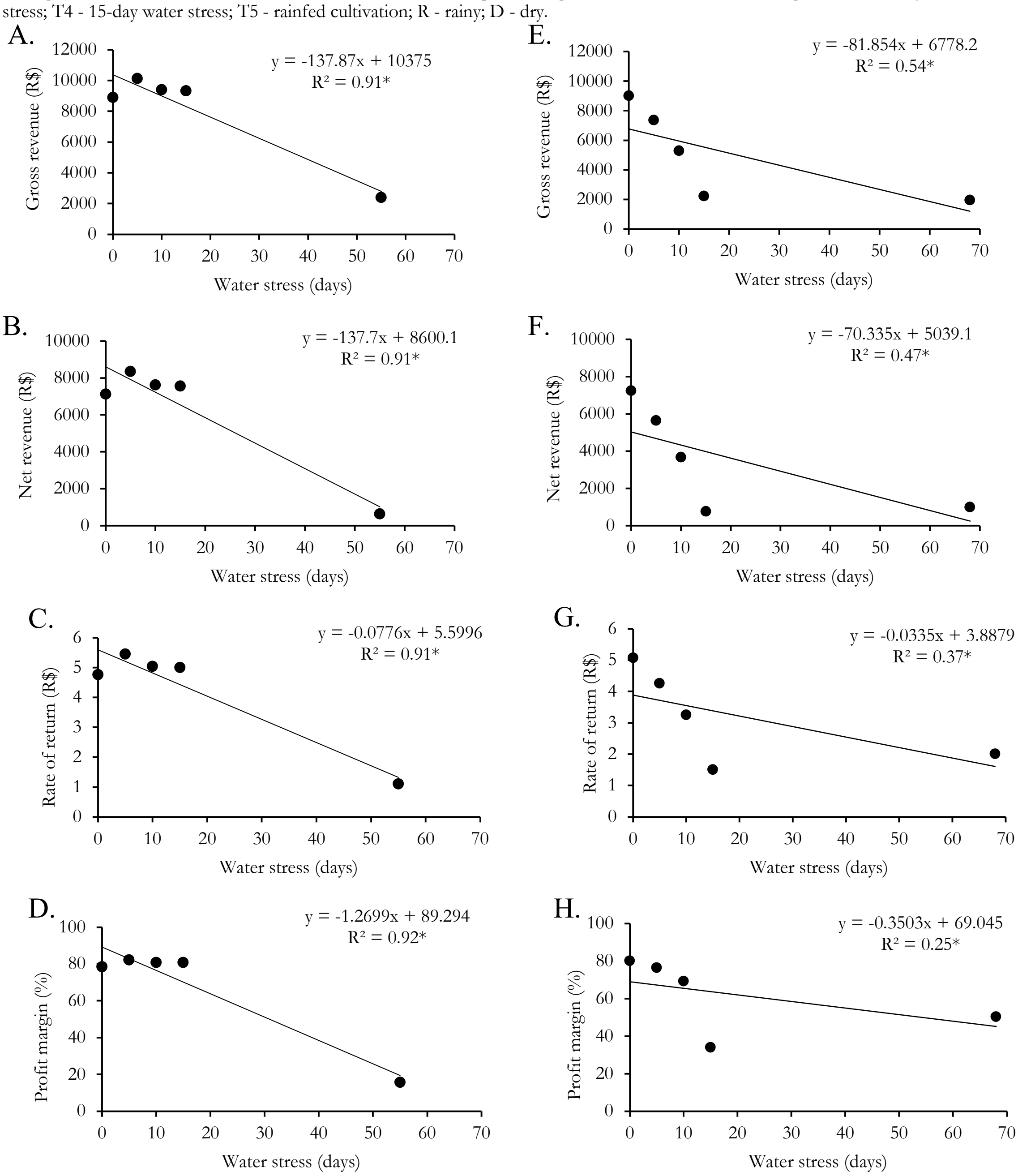

Figure 3. Gross revenue, net revenue, rate of return, profit margin for cowpea grown under water stress in rainy season (A, B, C and D) and in dry season (E, F, G and H), respectively. R^2- coefficient of determination; *significant by F test at 5% probability level.
Figura 3. Renda bruta, renda líquida, taxa de retorno, margem de lucro para o feijão caupi cultivado sob estresse hídrico em período chuvoso (A, B, C e D) e em período seco (E, F, G e H), respectivamente. R^2- coeficiente de determinação; *significativo pelo teste F a 5% de probabilidade.

4. DISCUSSION

In stages I and II, crop water demand showed very similar values in both cropping seasons, and in stages III and IV, crop water demand was higher in the dry season. This occurred due to the climatic conditions observed in the experiments, since at the beginning of the crop cycle, ETo showed high values in both cropping seasons, but at the end of the cycle its values were lower in the rainy season. However, the range of variation in ETo values is considered normal for these times of the year in the city of Campina Grande-PB, since the condition of reduced cloudiness remains during the dry season, which favors the increase of temperatures and global solar radiation, with a direct effect on ETo estimate (HENRIQUE; DANTAS, 2007; JÚNIOR et al., 2018).

The Kc values obtained for cowpea cv. 'Costela de vaca' cultivated under the edaphoclimatic conditions of the *Agreste* region of Paraíba, in the municipality of Campina Grande, PB, were higher in the dry season (Table 1). These Kc values were strongly influenced by soil water content during crop development and by the evaporative demand of the region, since the total rainfall was 205.9 mm in the rainy season and only 19 mm in the dry season. Thus, the Kc values of cowpea found in this study were not compatible with those suggested by FAO-56 Bulletin (ALLEN et al., 1998). Nevertheless, they were very close to the values obtained by Souza et al. (2015) and Silva et al. (2016), who also determined these values under climatic conditions similar to those of this experiment.

Significant decreasing linear responses were observed in all agronomic parameters evaluated, except for water use efficiency in the dry season. This indicates that, regardless of cropping season, cowpea is negatively influenced by water stress. Only the variable referring to the harvest index showed no statistical difference, which points to its insensitivity to the effects of the cropping season and water stress. Water use efficiency in the dry season showed a different response from the expected, because there were reductions in all irrigated treatments, but for the rainfed treatment, its value was very high, hence proving the resistance of cowpea to water stress, which was able to complete its cycle and obtain yield even with minimal water.

Ezin et al. (2021), evaluating the effect of water stress on the agronomic traits of cowpea, also concluded that they were significantly affected mainly when water stress occurred at the beginning of flowering, which negatively affected pod filling, consequently resulting in yield reductions. However, Silva et al. (2021) observed that heirloom cultivars of cowpea responded negatively to water stress, but maintaining pod length and number of seeds per pod. These studies corroborate the results obtained here, proving the production efficiency of the heirloom cowpea cultivar 'Costela de vaca' even when subjected to water stress in its reproductive stage, causing it to be widely cultivated under family farming regime in the northeastern semi-arid region.

Cowpea yield was influenced by water restriction, regardless of the cropping season, with higher yields in all treatments in the rainy season. Under full irrigation conditions, in the rainy season the maximum yield of cowpea (2998 kg ha^{-1}) was observed in the treatment that received a five-day water suspension, while in the dry season, the maximum yield was 1763 kg ha^{-1}. Due to the great climatic variability in the northeastern semi-arid region, the adoption of techniques that enhance the increase of crop yield is of fundamental importance, such as the use of varieties that are more resistant to drought and mulching (Lopes et al., 2019).

The lowest yields were observed in rainfed cultivation, with values of 710 and 385 kg ha^{-1}, for the rainy and dry seasons, respectively. The reduction of yield under rainfed conditions was 73% for the rainy season and 78% for the dry season, thus evidencing the importance of using irrigation to increase crop yield. The average national yield of cowpea under rainfed regime in the 2020/2021 season was 494 kg ha^{-1} (CONAB, 2021).

Silva; Neves (2011), evaluating different cowpea cultivars under rainfed and irrigated regimes, obtained average yield values around 700 kg ha^{-1} and above 1000 kg ha^{-1}, respectively. Santos; Lima (2015) and Souza et al. (2020) obtained yields above 1500 kg ha^{-1} under rainfed regime for the heirloom cowpea cv. 'Costela de vaca'; however, in the study regions, the rainfall totals during the crop cycle were higher than 350 mm. The interaction of cowpea performance in irrigated and rainfed cultivation systems suggests a strong influence of environmental factors on its yield, making it dependent on environmental variations and management (SILVA et al., 2017).

However, De Brito et al. (2016) evaluating the yield and use of water in the cultivation of common bean under different types of mulch and subjected to water restriction, found that mulching did not contribute to minimizing the negative effect of water restrictions on crop yield and water use efficiency. Nhanombe (2019), evaluating the effects of water restriction on common bean cultivated in no-tillage and conventional systems, found that cultivation in no-tillage system promoted water saving of 60 mm ha^{-1} and increased WUE by 34.48%.

Cowpea has good water use efficiency, which enables its cultivation in different cropping seasons; however, the basic costs of production, depending on environmental conditions, such as the action of water stress and agricultural practices used in its cultivation, such as no-tillage and mulching, in addition to the use of cultivars adapted to local climatic conditions and acceptance by producers, directly contribute to the economic viability of cowpea.

The economic viability indicators for cowpea cultivation (Table 1) indicate that cowpea can be produced in Campina Grande-PB in the rainy and dry seasons, provided that the water restriction during the flowering and grain filling stages does not exceed 10 consecutive days and its cultivation is carried out under irrigated regime. The profit margin with the use of full irrigation throughout the crop cycle was 77.5% and 80.3% for cowpea cultivation in the rainy and dry seasons, respectively. As the price difference of the kilo of cowpea paid to the producer between the cropping seasons was R$ 1.73, it is more profitable for the producer to grow it in the dry season. On the other hand, the rainfed cultivation, despite having shown lower yield, is still profitable.

Silva et al. (2016), analyzing the economic viability of cowpea grown under irrigation and rainfed regime, obtained economic efficiency values of 80% and 70%, respectively. The authors suggested that the effective operating cost can be reduced with the use of labor from family farming.

The total production costs (Table 1) were higher in the rainy season because, in addition to irrigation, there were occurrences of rainfall, resulting in a higher growth of spontaneous plants (weeds), consequently, a greater number of weeding operations was necessary for their control. Nevertheless, as the planting system was no-tillage and irrigation was localized, spontaneous plants were suppressed and did not interfere in cowpea yield.

One of the main factors that interfere in cowpea yield is weed growth, and yield can be reduced by up to 73.5% when weeds grow in the area throughout the crop cycle (LACERDA et al., 2020). One of the solutions for weed suppression in cowpea cultivation in both irrigated and rainfed regimes is the use of mulch (JÚNIOR et al., 2019; PEREIRA et al., 2020).

5. CONCLUSIONS

There was a greater water requirement by cowpea cultivated in the dry season, so the Kc values found in this period were higher than those obtained in the rainy season. The agricultural practices of no-tillage and mulching promoted higher yields of cowpea, although its cultivation was influenced by the climatic conditions of the cropping seasons and water stress. Nevertheless, cowpea showed positive results of economic viability in both cropping seasons, provided that the water stress does not last more than 10 days during its reproductive stage. These results will allow farmers to plan more efficiently cowpea production in its different cropping seasons, in order to maximize crop yield, consequently increasing its economic results.

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