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Potential yield of Canola under Different Irrigation Frequencies and Nitrogen Levels in the Brazilian Centre-West Region

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Introduction

Canola (*Brassica napus* L.) from the family of crucifers is the third most cultivated oilseed crop worldwide, after palm and soybean. (Takashima et al. 2013). Canola is grown in Brazil, consisting an area of 46,300 hectares concentrated mainly in the southern region, which accounts for 94% of the country's production (Bergmann et al. 2013). In 2011/2012, crop production was 52,000 tons with an average yield of 1,226 kg ha^{-1}.

Nitrogen is essential to achieve canola yield potential (Hamzei & Soltani 2012). With higher doses of nitrogen, 60 kg ha^{-1}, El-Howeity & Asfour (2012) obtained a higher number of pods per plant and thousand grain weight. According to Beaudette et al. (2010) the best yield results are achieved with a nitrogen level of 80 kg N ha^{-1}, whereas Dogan et al. (2011) and Kamkar et al. (2011) had higher yields with levels above 180 kg N ha^{-1} under irrigation.

Canola is sensitive to water stress during periods of flowering and grain filling. Research studies have shown a reduction in the number of pods per plant, thousand grain weight and yield due to water stress around 34, 35 and 20-45%, respectively, in two consecutive years (Tohidi-Moghadam et al. 2009; Faraji et al. 2008).

As few research studies have been done with canola grown off season in the Brazilian Center-west, we assessed crop yield potential under different irrigation frequencies and nitrogen levels over two years.

Material and methods

The experiment was conducted at the Experimental Station of Irrigation, Faculty of Agricultural Sciences at the Federal University of Grande Dourados from May to September 2012 and repeated from May to September 2013.

We used a randomized block split plot design with four repititions totaling 60 experimental plots. Three irrigation frequencies (without irrigation - SI, weekly irrigation - IS, irrigation three times a week - I3S) were used in the plots, whereas the subplots received five nitrogen levels (DN): 0, 30, 60, 90 and 120 kg ha^{-1} in 2012, and 0, 60, 120, 180 and 240 kg ha^{-1} in 2013. Urea was used as a nitrogen source.

The plots were irrigated by drip tapes installed between plant rows. Irrigation management was conducted by reading the water tension in soil tensiometers installed at a depth of 0.20 m. Readings of soil water tension were made on Mondays, Wednesdays and Fridays. All treatments received 20mm of irrigation before starting the treatments.

At the end of each experimental cycle we evaluated the morphological components: plant height (cm), number of branches and aboveground dry weight (g $plant^{-1}$), and productive components: number of pods, thousand grain weight (g), grain yield (kg ha^{-1}), oil content of grain (%) and oil yield (kg ha^{-1}).

The components were subjected to an analysis of variance at 5% probability. In cases of significant differences we applied the Tukey test for irrigation frequencies and conducted a regression analysis for nitrogen levels.

Results and discussion

All components were affected by different irrigation frequencies except for the number of branches and the number of pods in 2012 (Table 1). Regarding different levels of nitrogen, we found significant differences for dry weight, thousand grain weight and oil content in 2012. In 2013 the components: plant height, number of pods, dry weight, grain and oil yield were significantly influenced by different levels of nitrogen. Significant interactions between irrigation frequencies and nitrogen levels were found only for thousand grain weight and oil content in 2012 and for the number of pods in 2013.

Table 1. Analysis of different irrigation frequencies of nitrogen on morphological and productive components of canola. Dourados/MS, 2012/2013

Parameters	Variation Source					
	2012			2013		
	Irrigation	Nitrogen levels	Interaction IxDN	Irrigation	Nitrogen levels	Interaction IxDN
Morphological components						
Height	**	NS	NS	*	**	NS
Number of branches	NS	NS	NS	**	NS	NS
Number of pods	NS	NS	NS	**	**	**
Dry weight of shoots	**	**	NS	*	**	NS
Productive components						
Grain yield	**	NS	NS	**	**	NS
Thousand grain weight	**	**	**	*	NS	NS
Oil content	**	**	**	**	NS	NS
Oil yield	**	NS	NS	**	**	NS

* Significant at 5% probability by F test; ** Significant at 1% probability by F test; NS Non significant

Conjoint analysis of the experiments carried out in 2012 and 2013 (Table 2) showed no significant difference among treatments between 2012 and 2013 for the yield, considering different irrigation frequencies and nitrogen levels.

Table 2. Canola yield in two crop years. UFGD, Dourados-MS, 2012/2013

Year	Irrigation			Nitrogen levels		
	I3S	IS	NI	0	60	120
	Yield (kg ha^{-1})					
2012	2999.33 a	2730.42 a	1262.04 b	2214.21 a	2454.42 a	2323.15 a
2013	2228.33 a	1520.37 a	30.92 b	968.61 b	1541.75 a	1269.25 ab
Average	2613.83 a	2125.39 b	646.48 c	1591.41 b	1998.09 a	1796.20 ab

(1) In each row, values followed by the same lowercase letter do not differ significantly at 5% probability by Tukey test; in each column, the capital letter compares 2012 to 2013.

The highest yield of canola, 2,999.33 kg ha^{-1} was obtained with irrigation, especially when it was applied more frequently, three times a week. Similar results were obtained by Hamzei & Soltani (2012). On the other hand, the lowest yield was obtained in non-irrigated plots in the second year, 30.92 kg ha^{-1}. This is due to water stress promoted by natural rainfall and the occurrence of frost during flowering. Takashima et al. (2013) also found that the occurrence of frost during flowering is one of the main factors limiting canola development in Argentina.

Conclusions

The authors conclude that additional irrigation should be used in the Brazilian cerrado to ensure a maximum yield potential of canola, as the highest grain yield in this study, 2,999.33 kg ha^{-1}, was obtained through irrigation performed three times a week.

Canola yields demonstrate a positive result with increasing levels of nitrogen, which shows the importance of using this nutrient for achieving high levels of grain yield and oil. Considering two years of evaluation, the highest grain yield was obtained with 60 kg ha^{-1} of nitrogen.

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