academicJournals

Vol. 9(19), pp. 1449-1453, 8 May, 2014
DOI: 10.5897/AJAR2013.7428
Article Number: B355F8844525
ISSN 1991-637X

http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

Competitiveness of flaxseed with weeds under different row spacings

Patrícia Perreira Dias*, Deonir Secco, Reginaldo Ferreira Santos, Doglas Bassegio, Ivan Werncke, Samuel Nelson Melegari de Souza and Felipe S. Santos

UNIOESTE – Western Paraná State University – Post-graduation Program, Master Course of Energy in Agriculture, Rua Universitária, 2069, CEP: 85.819-130 Bairro Faculdade, Cascavel, Paraná, Brasil.

Received 5 June, 2013; Accepted 16 April, 2014

The aim of this study was to evaluate the effect of the weed competition with different spacings in the culture of flaxseed (*Linum usitatissimum* L.). The experiment was conducted at the Campus of Unioeste - Cascavel, Paraná State, using the split-plot design in which the plots consisted of presence and absence of weeds and subplots consisted of row spacings (0.15, 0.30, and 0.45 m) with six replications. Plant height, number of capsules, stems and seeds per plant and yield (kg.ha^{-1}) were determined. The increase of spacings between rows and the coexistence with the weed community were detrimental to production components of flaxseed.

Key words: *Linunm usitatissimu* L., competition, spatial arrangement of plants.

INTRODUCTION

Flaxseed (*Linum usitatissimum* L.) is a herbaceous plant that belongs to the Linaceae family, with more than 200 recognized species (Cui, 1998). The energy use of flax seeds can give a new direction to this culture, since its seed is rich in oil. The seeds contain about 38% oil, that once extracted can be used to produce biofuels (Rabetafika et al., 2011).

Spacing and spatial arrangement are the main factors related to the degree of interference between crops and weeds, as they act on the precocity and intensity of shading of the crop over weeds (Dias et al., 2009; Tharp and Kells, 2001; Norris et al., 2001; Knezevic et al., 2003). Balbinot and Fleck (2005) emphasize that the competitiveness of crops is dependent on factors such as: cultivated species, morphological and physiological characteristics of the genotypes, weed species present in the area and time of their emergence, and also environmental conditions, especially temperature, solar radiation and rainfall.

Barreyro and Vallduvi (2002) determined the critical period of interference for the culture of flaxseed between 30 and 80 days of sowing, observing significant losses when the culture was subjected to infestation throughout the cycle. The authors emphasize that it is a tool to reduce damage by weeds and use different alternatives for management and control. Several studies have been developed to analyze the behavior of the infestation in the spatial distribution of crops between rows of soybean (Melo et al., 2001), beans (Burnside et al., 1998) and corn (Ramos and Pitelli, 1994) and peanut (Pitelli et al.

*Corresponding author. E-mail: eng.amb.patricia@gmail.com

Tablel 1. Chemical attributes of an oxisol before the establishment of the experiment.

Layer	pH	M.O.	P	Al	H+Al	Ca+Mg	K	S	CTC	V
cm	$CaCl_2$	g dm^{-3}	mg dm^{-3}	-------------------	$cmol_c dm^{-3}$	-------------------				%
0-20	5.37	50.29	19	0.25	6.93	17.6	0.22	17.82	24.75	72.00

2002). However, studies on flax are practically nonexistent.

One way to increase the competitiveness of the crop is by reducing the spacing, so that the crop canopy closes between rows faster and shades the weeds. In that sense, the purpose of this experiment is to investigate the potential development of golden flaxseed (*Linum usitatissimum* L.), with and without weed infestation in different row spacings.

MATERIALS AND METHODS

The experiment was conducted under field conditions in the agricultural year of 2012, during the period from April to August 2012 at UNIOESTE (State University of Western Paraná), located in the city of Cascavel, Paraná, Brazil, latitude 24°53'47" S and longitude 53°32'09"W. The region presents mesothermal and super humid temperate climate, Cfa climate type (Koeppen) (Caviglione et al., 2000). The average annual temperature in the region is 19.6°C, annual rainfall of 1971 mm and 2462 h of sunshine per year (IAPAR, 2011). Monthly averages of temperature and precipitation are shown in Figure 1 and Table 1.

The experimental setup used was the split plot scheme, in which the plots consisted of the presence and absence of weeds and subplots consisted of row spacings (0.15, 0.30, and 0.45 m) with six replications. The subplots consisted of six rows (5 m long), with a useful area of four central lines. The sowing of flaxseed was held manually on April 14th, 2012 in the lines starting with a manual furrowing. As for the sowing operation, a final population of 333,000 plants.ha^{-1} was obtained to all spacings. Base fertilization rate was 200 Kg ha^{-1} of formula 02-20-18. Weed control in the area with no competition was carried out manually. No agrochemical was applied during the experiment. The following characteristics were evaluated: plant height, number of stems, seeds and capsules per plant and yield (Kg ha^{-1}). In order to determine the parameters of production ten plants in each plot were sampled. Grain yield was obtained by manual harvesting of central lines in each experimental unit. Subsequently, the tracking and weighing of grains took place. The yield was corrected to 13% moisture, and results were expressed in Kg ha^{-1}.

In order to characterize the weed community in treatments where the crop was under interference, two frames of 0.25 m^2 were sampled. Weeds were collected, identified and counted. The results were submitted to analysis of variance and the interaction between factors and their means were compared by Tukey's test at 1 and 5% probability, using the statistical package Assistat ® version 7.5 beta (Silva and Azevedo, 2002). Data unfolding was performed when the interaction infestation x spacing was significant.

RESULTS AND DISCUSSION

The weed community consisted of the following species: *Raphanus sativus* (8.19%), *Lolium multiflorum* (16.78%), *Sonchus asper* (1.12%), *Galinsoga parviflora* (0.29%), *Bidens pilosa* (0.14%), *Ambrosia elatior* (5.05%), *Mollugo verticillata* (24.53%), *Taraxacum officinale* (23.20%), *Facelis apiculata* (3.68%), *Croton glandulosus* (2.35%), *Eupotarium pauciflorum* (3.04%), *Fumaria officinalis* (2.74%), *Diodia teres* (0.98%), *Richardia brasiliensis* (4.90%), *Bromus catharticus* (2.06%), *Emilia fosbergii* (0.44%), *Sida rhombifolia* (0.44%).

The rainfall at the experimental site (Figure 1) was considered good for the development of the culture, despite the uneven distribution, it can be said that the production performance was not influenced by soil water deficit. According to Hocking et al. (1997) and House et al. (1999), factors such as low rainfall and high temperatures during the anthesis and grain filling stage have a significant effect on flaxseed yield.

The performance of the analysis of variance is presented in Table 2. One can observe a significant difference for all production components analyzed in relation to infestation. The spacings did not influence in plant height. The interaction between infestation x spacing did not affect the number of capsules per plant.

Plant height was influenced by infestation (Table 2) and by the interaction Infestation x Spacing. Regarding the level of infestation, it can be seen that when flaxseed was grown in larger spacings (0.45 m) interaction between the weed and the culture had no effect on plant height (Table 2). Melo et al. (2001), when determining the period previous to the interference in a soybean crop with row spacings of 30 and 60 cm found no influence of the presence of weeds in plant height as well as in the first pod insertion and 100 seed weight. Balbinot and Fleck (2005) found no significant effect of row spacing on plant height on a corn crop.

As for the number of capsules, one may note the significance of the infestation and spacing in relation to the component (Table 3). Interaction between factors did not influence the number of capsules per plant. The coexistence of culture with the infestation resulted in a reduction of 56% capsules per plant. Andrade et al. (1999) observed a reduction in the number of pods/plant in beans with greater spacing with coexistence due to the competition with weeds. According to the authors with greater spacing there is proper closing of the culture, providing greater infestation and better conditions for their development. According to Teasdale (1995), the adoption of smaller spacings increases the competitiveness of the crop with weeds due to the greater amount of light that is intercepted by the crop

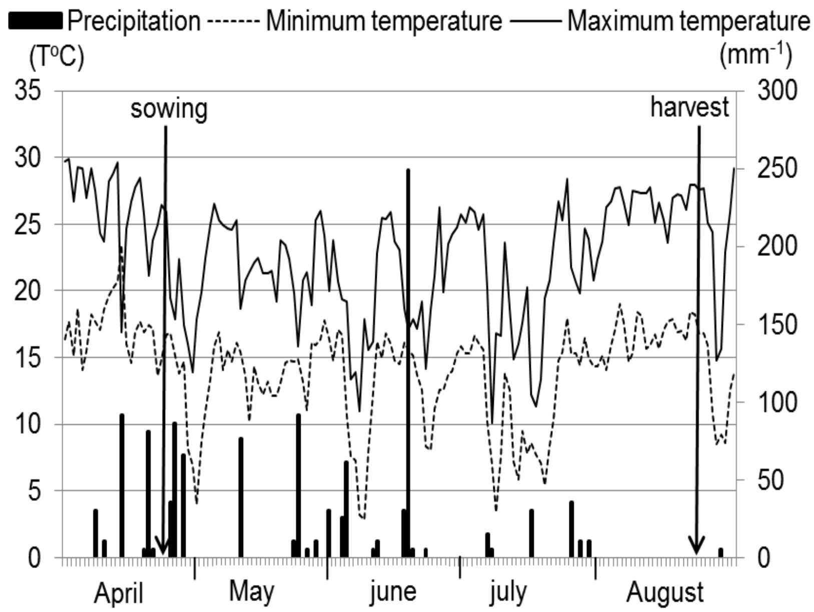

Figure 1. Precipitation (mm^{-1}) and temperature (T°C) recorded during the experiment.

Table 2. Height, number of stems, number of capsules, number of seeds and yield.

Treatments	**Plant height**	**Capsules**	**Stems**	**Seeds**	**Yield**
Infestation (I)	**---cm---**	**------------ number/plant----------**			**---Kg.ha^{-1}---**
Without	76.61^{b}	32.16^{a}	2.05^{a}	237.50^{a}	1228.03^{a}
With	84.50^{a}	13.44^{b}	1.38^{b}	105.45^{b}	606.81^{b}
C.V.(%)	6.34	30.89	49.35	32.65	31.72
Spacing (S)					
0.15	79.08	17.83^{b}	1.33^{b}	111.94^{b}	1107.29^{a}
0.30	83.08	28.83^{a}	1.41^{b}	230.68^{a}	1130.71^{a}
0.45	79.50	21.75^{ab}	2.41^{a}	171.80^{ab}	514.25^{b}
C.V. (%)	6.29	36.83	41.29	39.29	36.19
I	**	**	*	**	**
S	n.s.	*	**	**	**
IxS	*	n.s.	*	**	**

n.s. = Not significant, * = significant at the 5% probability level, ** = significant at 1% probability.

Table 3. Deployment of interaction infestation x spacing for plant height.

Infestation	**Spacing**		
	0.15	**0.30**	**0.45**
Plant height			
without	71.83^{bA}	79.00^{bA}	79.00^{aA}
With	86.33^{aA}	87.16^{aA}	80.00^{aA}

Columns = lowercase; Lines = uppercase; Means followed by the same letter do not differ statistically among themselves. ns = not significant, * = significant at the 5% probability; ** = significant at 1% probability.

Table 4. Deployment of interaction infestation x spacing for number of stems, number of seeds and yield.

Infestation	Spacing		
	0.15	0.30	0.45
Number of stems			
Without	1.16aB	1.83aB	3.16aA
With	1.50aA	1.00aA	1.66bA
Number of seeds			
Without	135.20aB	357.97aA	219.32aB
With	88.68aA	103.40bA	124.28bA
Yield			
Without	1317.18aA	1731.65aA	635.26aB
With	897.41bA	529.76bAB	393.25aB

Columns = lowercase; Lines = uppercase; Means followed by the same letter do not differ statistically among themselves. ns = not significant, * = significant at the 5% probability; ** = significant at 1% probability.

canopy. The number of stems, seeds and yield were affected by the infestation and spacing, as well as the interaction between Infestation x Spacing. Due to the interaction between factors, the unfolding was analyzed in Table 4.

One can verify in what concerns to the number of rods that when the culture was subjected to living with weeds spaced 0.45 m between rows there was a reduction from 3.16 to 1.66 stems per plant. Note that when the culture was kept free from weeds the spacing of 0.45 m between rows provided a greater number of stems per plant.

When observing the differences in the unfolding of interaction infestation x spacing (Table 4) for the component number of seeds per plant, one can notice a negative influence of the coexistence of the crop with the infestation, resulting in the decrease of seeds per plant, matching what was stated by Barreyro and Vallduvi (2002); VallduvI et al. (1997) and Gruenhagen and Nalewaja (1969). When the crop was under infestation there was no difference between the spacings in the production component, however with the spacing of 0.15 m between rows, the infestation did not harm the crop. The highest number of seeds per plant was observed with the spacing of 0.30 m, with no infestation.

For two corn genotypes with presence of weeds, Balbinot and Fleck (2005) observed reduced stem diameter, plant height and all components of grain yield with 11% reduction in the number of grains per ear due to infestation. The yield was influenced by the interaction between infestation x spacing (Table 4). The competition did not affect the productivity with spacing of 0.45 m between rows, but there was an increase of 32 and 70% in the spacings of 0.15 and 0.30 m, respectively, in relation to infestation. Row spacing did not affect productivity when culture competed with weeds. Balbinot and Fleck (2005) obtained better results in grain yield of maize with reduced spacing and no competition.

Barreyro and Vallduvi (2002) found loss of 63, 54 and 79% in 1993, 1994 and 1995 respectively, in the yield of flaxseed when submitted to the competition throughout the cycle. Dias et al. (2009) observed a reduction in productivity from 2,054 to 341 $Kg.ha^{-1}$ in a peanut crop with spacings of 0.8 m between rows due to the interference of weeds, what represents 83% loss of productivity. For the distance of 0.9 m, the coexistence of 140 days between weeds and crop resulted in a production decrease from 1,820 to 82 $Kg.ha^{-1}$,which is equivalent to 95%.

Conclusion

There is an influence of the interaction of factors infestation and spacings on flaxseed development. The lowest row spacing did not affect crop productivity when it was subjected to infestation.

Conflict of Interests

The author(s) have not declared any conflict of interests.

REFERENCES

Andrade CAB, Constantin J, Scapim CA, Lucca BA, Angelotti F (1999). Efeito da competição com plantas daninhas em diferentes espaçamentos sobre o rendimento de três cultivares de feijão (*Phaseolus vulgaris* L.). Ciência e Agrotecnologia 23(3):529-539.

Balbinot JRAA, Fleck NG (2005). Competitividade de dois genótipos de milho (zeamays) com plantas daninhas sob diferentes espaçamentos entre fileiras. Planta Daninha 23 (3):415-421. http://dx.doi.org/10.1590/S0100-83582005000300004

Barreyro RA, Vallduvi GES (2002). Delimitacion del periodo critico de competencia de malezas em el cultivo de lino (*Linum usitatissimum*). Planta Daninha 20(3):399-403.

http://dx.doi.org/10.1590/S0100-83582002000300010
Burnside OC, Wiens MJ, Holder BJ, Weisberg S, Ristau EA, Johnson MM, Cameron JH (1998). Critical periods for weed control in dry beans (Phaseolus vulgaris). Weed Sci. 46(3):301-306.
Caviglione JH, Kiihl LRB, Caramori PH, Oliveira D (2000). Cartas climáticas do Paraná. Londrina: IAPAR.
Cui WS (1998). Flaxseed: A functional food for the 2st century, Canadian Chemical News 50(5):19.
Dias TCS, Alves PLCA, Pavani MCMD, Nepomuceno M (2009). Efeito do espaçamento entre fileiras de amendoim rasteiro na interferência de plantas daninhas na cultura. Planta Daninha 27(2):221-228.http://dx.doi.org/10.1590/S0100-83582009000200002
Empresa Brasileira De Pesquisa Agropecuária – EMBRAPA (2006). Serviço Nacional de Levantamento e Conservação de Solos. Sistema brasileiro de classificação de solos. 2.ed. Rio de Janeiro: Embrapa Solos: P. 306.
Hocking PJ, Randall PJ, Demarco D (1997). The response of dryland canola to nitrogen fertilizer: partitioning and mobilization of dry matter and nitrogen effects on yield components. Field Crops Res. 54:201–220. http://dx.doi.org/10.1016/S0378-4290(97)00049-X
IAPAR–Instituto Agronômico do Paraná. Médias históricas em estações do IAPAR. (2011). Disponívelem:<http://www.iapar.br/arquivos/Image/monitoramento/Medias_Historicas/Cascav-el.html>. Acesso em: 10 set. 2012.
Knezevic SZ, Evans SP, Mainz M (2003). Row spacing influences the critical timing for weed removal in soybean (*Glycine max*). Weed Technol. 17(4):666-673. http://dx.doi.org/10.1614/WT02-49
Melo HB, Ferreira LR, Silva AA, Miranda GV, Rocha VS. Silva CMM (2001). Interferência das plantas daninhas na cultura da soja cultivada em dois espaçamentos entre linhas. Planta Daninha 19(2):187-191.http://dx.doi.org/10.1590/S0100-83582001000200011http://dx.doi.org/10.1590/S0100-83582001000200005
Norris RF, Elmore CL, Rejmánek M, Akey WC (2001). Spatial arrangement, density, and competition between barnyardgrass and tomato: II. Barnyardgrass growth and seed production. Weed Sci. 49(1):69-76.http://dx.doi.org/10.1614/0043-1745(2001)049[0069:SADACB]2.0.CO;2http://dx.doi.org/10.1614/0043-1745(2001)049[0061:SADACB]2.0.CO;2
Pitelli RA, Gavioli VD, Gravena R, Rossi CA (2002). Efeito de período de controle de plantas daninhas na cultura de amendoim. Planta Daninha 20(3):389-397. http://dx.doi.org/10.1590/S0100-83582002000300009
Ramos LRM, Pitelli RA (1994). Efeito de diferentes períodos de controle da comunidade infestante sobre a produtividade da cultura do milho. Pesquisa Agropecuária Brasileira 29(10):1523-1531.
Rabetafika HN, Remoorte VV, Danthine S, Paquot M, Blecker C (2011). Flaxseed proteins: food uses and health benefits. Int. J. Food Sci. Technol. 46:221–228. http://dx.doi.org/10.1111/j.1365-2621.2010.02477.x
Teasdale JR (1995). Influence of narrow row/high corn population (*Zea mays*) on weed control and light transmittance. Weed Technol. 9(1):113-118.
Vallduvl SGE, Manghi MV, Barreyro RA (1997). Efecto de la presencia de malezas em distintos períodos del cultivo de lino oleaginoso (*Linum usitatissimun* L.). Agrociência 13(3):257-263.
Silva FAZ, Azevedo CAV (2002). Versão do programa computacional Assistat para o sistema operacional Windows. Revista Brasileira de Produtos Agroindustriais 4(1):71-78.
Tharp BE, Kells JJ (2001). Effect of glufosinate-resistant corn (*Zea mays*) population and row spacing on light interception, corn yield, and common lambs quarters (*Chenopodium album*) growth. Weed Technol. 15(3):413-418.http://dx.doi.org/10.1614/0890-037X(2001)015[0413:EOGRCZ]2.0.CO;2
Gruenhagen RD, Nalewaja JD (1969). Competition between flax and wild buckwheat. Weed Sci. 17:380-384.