

Influence of *Raphanus raphanistrum* L. Density and Relative Time of Emergence on Bean Crop

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Abstract

The objective of this study was to evaluate the influence of emergence times and density of *R. raphanistrum* plants on bean cv. 'Rubi' development and pods production. The experimental design utilized was factorial (2 x 5) in randomized blocks with three replications. There were two relative times of emergence of wild radish in relation to bean (at the same day of bean and when the bean had the first trefoil fully expanded) and four *R. raphanistrum* densities (1, 2, 4 and 8 plants per pot, or 3.33, 6.66, 13.32 and 26.64 plants m⁻² and a control with only one bean plant). There was no difference between the relative times of weed emergence on the bean development. The presence of *R. raphanistrum* from 2 plants per pot provided negative effect on the beans features dry weight of leaves, leaf area, and dry weight of pods.

Keywords: *Phaseolus vulgaris*, weeds, wild radish, competitive potential

1. Introduction

The Brazilian production of beans is estimated around 3.5 million of tons for 2012 (CONAB, 2012). The bean production could be affected by the presence of weeds and the crop productivity can be reduced until 80% (Parreira et al., 2011; Scholten et al., 2011). Regarding the commonly weed species on bean crop, the dicotyledonous weeds affect more the bean development and productivity than monocotyledonous ones (Deuber, 2007).

The time length of coexistence between crop species and weeds can influence the interference rate and reduce the crops growth, development and productivity (Karam & Cruz, 2004). About the bean cultivar 'Carioca', there were found reduction of 67% on grain production when the crop coexisted with the weed community during all its life cycle (Salgado et al., 2007). The time of coexistence of weed and crops is usually measured in relation to emergence of crop and weeds. It was verified that when the emergence of the weed beggarticks (*Bidens pilosa* L.) is closer of the emergence of bean 'Carioca IAPAR 77', biggest was the negative effects on the crop. It was verified that from the presence of 4 plants m⁻² of beggarticks there were 51.4% of reduction on stem dry weight and 12.8% on height of bean plants (Parreira et al., 2007).

Echinochloa crus-galli (L.) Beauv. sown at 30 plants m⁻² and emerged when the corn had three fully expanded leaves, led 14% of reduction in the crop grain production. When that weed emerged after the corn has had seven fully expanded leaves, there was only 4% of productivity reduction (Bosnic & Swanton, 1997). In soybean crop, there was 42.4% of reduction on grain production when the weed community emerged four days before the soybean. Whereas the emergence combined with the soybean, the reduction was 22.7% (Rizzard et al., 2004).

Wild radish (*R. raphanistrum* L.) is an important weed wide spread at temperate regions and subtropical regions of the world. In Brazil, the infestation occurs with intensity in the Southern Region and in smaller scale at the Midwest Region (Walsh et al., 2001; Wandscheer & Pastorini, 2008). It is an annual plant, herbaceous, erect, of 50-100 cm high with reproduction by seed (Wandscheer & Pastorini, 2008). *R. raphanistrum* infestations hider

harvest due their fibrous stems block machinery, and seed pods contaminate the harvested grain, incurring dockage when the grain is sold. That weed also can act as an alternative host to a number of important plant pests and diseases of crops (Cheam & Code, 1995).

Although the high relevance of this weed scarce is the information about the ecological relationship of this weed on the bean crop. *R. raphanistrum* was the most aggressive weed among six studied in bean, it reduce even 34% the crop productivity (Barroso et al., 2010).

The objective of this work was to evaluate the influence of different densities of *R. raphanistrum* plants and its relative time of emergence in relation to bean crop.

2. Method

This assay was carried out in an experimental area in Jaboticabal, São Paulo State, Brazil. The plots consisted by pots with a volume of 90 L and area of 0.30 m². The pots were filled with a Clayey Red Latosol (Oxisol) with the following characteristics: pH in 0.01 mol L⁻¹ CaCl₂: 5.3; P (resin): 128 mg dm⁻³; K: 2.4 mmol_c dm⁻³; Ca: 59 mmol_c dm⁻³; Mg: 13 mmol_c dm⁻³; H+Al: 42 mmol_c dm⁻³; sum of bases: 74.4; CEC_(pH 7.0): 116.4; base saturation: 64%; sand: 386 g kg⁻¹; silt: 458 g kg⁻¹; clay: 156 g kg⁻¹. Each pot contained only one bean plant besides the *R. raphanistrum*.

The experimental design utilized was randomized blocks with three replications and the treatments arranged in a factorial scheme 2 x 5. One factor studied was two times of *R. raphanistrum* emergence: in the same time of bean emergence or 0 days after bean emergence (0 DABE) and 14 days after bean emergence (14 DABS). The other factor consisted by four *R. raphanistrum* densities: 1, 2, 4 and 8 plants per pot. Those densities were equivalent to 3.33, 6.66, 13.32 and 26.64 plants m⁻², respectively. There was a control that consisted by only one bean plant.

To carry out this experiment, a previous assay was done in order to indentify the time of emergency of the variety of *R. raphanistrum* and cultivar 'Rubi' of bean utilized. It was sowing more seeds than necessary in order to obtained all the number of plants wanted to each treatment. The plants that emerged at the wanted time was marked with colored wire and the remainder was thinned.

At the end of the assay (90 days after plant emergence), was evaluated leaf area (LiCor, mod. LI 3000A), dry weight of leaves (determined after it reaches constant dry weight when dried in a forced air oven at 70 °C), number of pods, dry weight of pods, and plant height of each plant of bean.

An F test was performed on the collected data, and averages were compared with a Tukey test with 5% probability.

3. Results and discussion

No importing the relative time of emergence and the plant density per pot, the presence of *R. raphanistrum* did not influenced the height and the number of pods per plant of bean (Table 1). However, the height of the bean ranged from 8.3 cm to 12 cm. These results differed for soybean, when Carvalho et al. (2010) noted that soybean plants that coexisted with 16 plants m⁻² of the weed *E. heterophylla* had 12% of its height reduced.

Significant interaction was observed in leaf area, dry weight of leaves and dry weight of fresh pods (Table 2). In all these parameters, it was shown that when the weed density per pot was increased, the bean plants were injured. However, generally there were no much differences between the times of weed emergency on crop variables.

Table 1. Effect of relative time of *R. raphanistrum* emergence and density on height and number of pods per plant of bean.

Relative time of <i>R. raphanistrum</i> emergence (DABE)	Height (cm)	Number of pods
0	9.66 a ¹	19.93 a
14	9.86 a	17.93 a
<i>R. raphanistrum</i> density (plants per pot)		
0	8.33 a	22.66 a
1	9.44 a	18.83 a
2	9.88 a	18.50 a
4	9.40 a	15.66 a
8	12.00 a	19.00 a
F(time of emergence)	0.04 NS	1.09 NS
F(density)	1.91 NS	1.36 NS
F(time of emergence x density)	0.13 NS	1.10 NS
CV (%)	25.53	27.59

NS, not significant. DABE: days after bean emergence.

¹Within a column, means followed by the same lowercase letter are not significantly different according to Tukey's F-protected test at P = 0.05.

Table 2. Effect of relative time of emergence and density of *R. raphanistrum* plants on the bean features: leaf area (cm²), dry weight of leaves (g), and fresh weight of pods (g).

Leaf area		
<i>R. raphanistrum</i> density (plants m ⁻²)	Relative time of <i>R. raphanistrum</i> emergence	
	0 DABE	14 DABE
0	1652.88 A a ¹	1652.88 A a
1	1605.84 A a	1533.84 A a
2	1223.43 A b	1253.21 A bc
4	865.93 B bc	1146.92 A cd
8	743.54 A b	833.05 A d
Dry weight of leaves		
<i>R. raphanistrum</i> density (plants m ⁻²)	Relative time of <i>R. raphanistrum</i> emergence	
	0 DABE	14 DABE
0	13.06 A a	13.06 A a
1	9.74 A ab	8.64 A ab
2	7.75 A b	5.90 A b
4	5.13 A b	7.57 A b
8	7.30 A b	8.97 A b
Fresh weight of pods		
<i>R. raphanistrum</i> density (plants m ⁻²)	Relative time of <i>R. raphanistrum</i> emergence	
	0 DABE	14 DABE
0	74.06 A a	74.06 A a
1	46.66 A b	55.69 A ab
2	47.06 A b	52.17 A ab
4	39.25 A b	41.41 A b
8	54.35 A b	38.65 A b

DABE: days after bean emergence.

¹Within a column, means followed by the same lowercase letter and means within a row followed by the same uppercase letter are not significantly different according to Tukey's F-protected test at P = 0.05.

The density of weeds was important in the parameter leaf area. The leaf area of the bean that coexisted with 8 plants of *R. raphanistrum* was 55% less than the control without weeds. In the density of 4 plants per pot, there was difference on the leaf area of the bean emerged at the same time of *R. raphanistrum* emergence in compare to the weed emerged at 14 DABE. In the two relative times of *R. raphanistrum* emergence, from two weeds per pot there was decreased of this feature. It was found by Aguyoh & Masiunas (2003) that when the bean emerged together with the weed *Digitaria sanguinalis* (L.) Scop., it had 24.5% of its leaf area reduced. Following the same authors, when that weed emerged after the bean had the first trefoil shown there was no effect on crop leaf area.

Regarding the dry weight of bean leaf, it was 59 and 45% less since two *R. raphanistrum* emerged at 0 and 14 DABE, respectively, compare to the control. For soybean, the emergence at the same time of the weeds *Bidens pilosa* L. and *Sida rhombifolia* L. reduced at 23% its dry weight (Fleck et al., 2004). In that study, the weed emergence four days after the soybean emergence did not result in differences within the different densities. According to Parreira et al. (2007), when beans emerged 14 days before the *Bidens pilosa* emergence the reduction on dry weight of leaves reached 49% in compare to control without the weed. That value was close of the one found in the present study.

The emergence time was not an important factor for dry weight of bean pods once there was no difference between its treatments (Table 2). In contrast, the factor weed density provided significantly losses. At the higher density, there was reduction of more than 26% and 47% in dry weight of pods when the bean coexisted with weeds that emerged at 0 and 14 DACE, respectively. This value was next of the one found by Parreira et al. (2007). In that study, the bean that emerged at the same time of *B. pilosa* had its dry weight of pods reduced at 37%, regardless the weed density.

4. Conclusion

Plants of bean that coexisted with *R. raphanistrum* that emerged at same time of the crop and the ones that coexisted with the weeds emerged when the bean had the first trefoil fully expanded had both similar developments.

On the bean plant that coexisted with from 2 plants of *R. raphanistrum* per plot (or 6.66 plants m⁻²) there was negative effect on the most variables relation to bean development and productivity.

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