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Competitive Interaction between Weeds and Onion Crop

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***Abstract*—** *Among the factors that affect crop productivity are weeds that compete for the resources present in the environment. Then, the objective of this study was to evaluate the competitiveness of turnip and ryegrass infesting the onion crop. The experiment was conducted in a greenhouse, in a randomized complete block design, arranged in a 2x8 factorial scheme, with four replications. In factor A, were allocated the weeds (turnip and ryegrass) and in the B, were allocated populations of these species (0, 1, 2, 3, 4, 5, 6 and 7 pot-1 plants) living with an onion plant. 50 days after transplanting, were evaluated the height, stem diameter, leaf area and dry mass of the aerial part of the onion plants. For the weeds, only the dry mass of the aerial part was determined. In face of the results, it can be observed that the onion has a low competitive capacity, being the turnip the weed more aggressive in the competition, for all evaluated variables.*

Keywords*— *Allium cepa, Raphanus sp., Lolium multiflorum, weed competition.

I. INTRODUCTION

Onion (*Allium cepa* L.) is a vegetable from Central Asia and the Mediterranean, known as the " Queen of Kitchen " because of the characteristic flavor provided to the foods (Sahu et al., 2017). In Brazil, onion is the third vegetable in economic importance owing to the volume produced and rend generated (Kurtz et al., 2016). The Brazilian production in 2018 harvest was approximately 1.7 million ton, with average yield of 26 tons ha-1. Among the Brazilian states, Rio Grande do Sul produced 138,098 tons with an average yield of 20.3 tons ha-1 (IBGE, 2018).

Agricultural crops, including onions, depend on environmental factors for their growth and development. Among the environmental and edaphic factors that influence the productivity of these crops is the interference caused by weeds, which can compete for the available resources in the environment, such as water, nutrients, light and CO2 (Galon et al., 2018). Weeds appear as an obstacle in world agricultural production, causing an increase in the cost of production, reduction in yield and quality of harvested products (Renton & Chauhan, 2017).

Weed interference in vegetables is more intense due to the intensive exploration, frequent preparation, high rates of fertilization, low water restriction and no straw, in the cultivation areas (Souza et al., 2016). In this context, it is favorable the occurrence of fast growing weeds, with a short development cycle and high seed production, significantly increasing the seed bank of the soil (Carvalho et al., 2008). Due to the frequent soil inversion, the germination of positive photoblastic weeds is intensified, because the dormancy overcoming of these seeds occurs due to exposure to light, resulting in the occurrence of high populations of these plants in the area (Silva et al., 2013).

The low competitiveness of onion in relation to weeds is more harmful in the early stages of development, and long periods of competition can reduce in 100% the bulb production, in comparison to the production of an infestation-free farming (Zanatta et al., 2006).

Among the weeds in onion crops, stands out the turnip (*Raphanus sp*.), as an annual winter species, which has a high competitive ability. This fact is due to the high prolificacy, longevity, seed dormancy and germination capacity under adverse conditions of climate and soil. It was found that this species has a competitive capacity of 5 to 10 times greater than ryegrass (*Lolium multiflorum*) when in competition with winter cereals (Costa et al., 2015).

The ryegrass is commonly found in the crops of the southern region of Brazil, this species has elevated seed

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production and easy dispersion, causes losses of wheat production (Agostinetto et al., 2008), in barley (Tironi et al., 2014) and in canola (Galon et al., 2015). It is noteworthy that scarce are the studies that have evaluated the competition effect of turnip and ryegrass on onion culture, thus justifying the present work.

Studies about the competitiveness of crops with weeds allow the development of more sustainable strategies for their management. On this, the objective of this study was to evaluate the competitiveness of turnip and ryegrass when infesting the onion crop.

II. MATERIALS AND METHODS

The experiment was conducted in a greenhouse at the Federal University of Fronteira Sul, in Erechim/RS, in the year of 2018. The experimental units consisted of plastic pots with a capacity of 8 dm3, filled with soil from agricultural area, characterized as Rhodic Hapludox (Soil Survey Staff, 2014). Soil correction was done according to the technical recommendations for onion crop (ROLAS, 2016). Weed seeds were collected in grains commercial areas in the city of Erechim/RS, Brazil.

The experimental design was the randomized block, arranged in a 2 x 8 factorial scheme, with four replications. In factor A, weed species in competition with onion crop (turnip and ryegrass) were allocated and in B the weed densities (0, 1, 2, 3, 4, 5, 6 or 7 plants pot-1) in competition with an onion plant, Baia Periforme cultivar. The experiment was conducted in additive series according to the methodology proposed by Radosevich et al. (2007).

On the center of the experimental unit was planted an onion plant and on the periphery were varied the populations of turnip and ryegrass plants, according to the proposed treatment. The plants deposition were realized by transplanting seedlings that were previously sown in polystyrene trays, and cultivated under the same environmental conditions of the experiment.

The experimental units were maintained equidistant, so that the available surface area for the development of the plants corresponded to the area of the experimental unit.

At 50 DAE after transplant, the height, diameter, leaf area and dry mass of the aerial part of the onion plants were evaluated. The height of plants was measured using a millimeter scale ruler, from the base of the soil to the apex. The diameter of the stem was measured using a pachymeter in a millimeter scale, measuring it to approximately one centimeter of the soil. The leaf area, was used a portable meter model CI-203 Bio Science, quantifying the leaf area (cm2 pot-1) in all plants in each treatment. In order to quantify the dry mass of the aerial part of the species (onion and weeds), the plants were cut close to the soil afterwards they were packed in paper bags and dried in an oven with forced air circulation at a temperature of 65 ± 5 °C until the material reaches constant weight.

The data obtained from the species were submitted to analysis of variance by the F test, in which, when significant were submitted to the linear or non linear regression models for the quantitative factor. The data were submitted by the t test for the qualitative factor, with the exception of the dry mass of the aerial part of weeds that was presented only the standard deviation and the average of four independent biological replicates. All tests were performed at $p \leq 0.05$.

III. RESULTS AND DISCUSSIONS

The results demonstrated that there was interaction between the factors tested (weed species x populations) for all variables evaluated. It was observed that the competition with turnip was more harmful to the onion than the competition with ryegrass (Figures 1, 2, 3 and 4).

The competition caused reduction of height of onion plants when in competition with turnip, with linear decrease in the values, whereas for ryegrass neither an equation was fitted to the data (Figure 1B). As observed in Figure 1A, it was observed that onwards four weeds per pot, turnip was more aggressive in the competition.

When there is an increase in the population of turnip per pot, occurs the decrease in the height of plants, this can be explained by the competition exerted by the turnip roots, considering that the root system is more extensive than the ryegrass and the onion, resulting in a larger surface area of contact with the soil. Due to the competition that occurs with the resources below the soil surface, there is a reduction of the available resources for the growth and development of the crop, and in this case, cessation of plant height growth (Renton and Chauhan, 2017).

According to the results obtained from Koefender et al. (2016), when evaluating onion production of Baia Periforme on monoculture and consortium with lettuce, they observed that in monoculture and spacing of 50 centimeters between plants, there were the best results for the variables tested. As for consortium and smaller spacings, inter and intraspecific competition occurs, reducing the potential for plant development and bulbification of onion (Koefender et al., 2016).

In Australia, turnip is one of the most problematic weeds, mainly because it causes reduced yields in vegetables, problems with multiple resistance that hinder

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control and further increase the damages related to this weed (Ashworth et al., 2016).

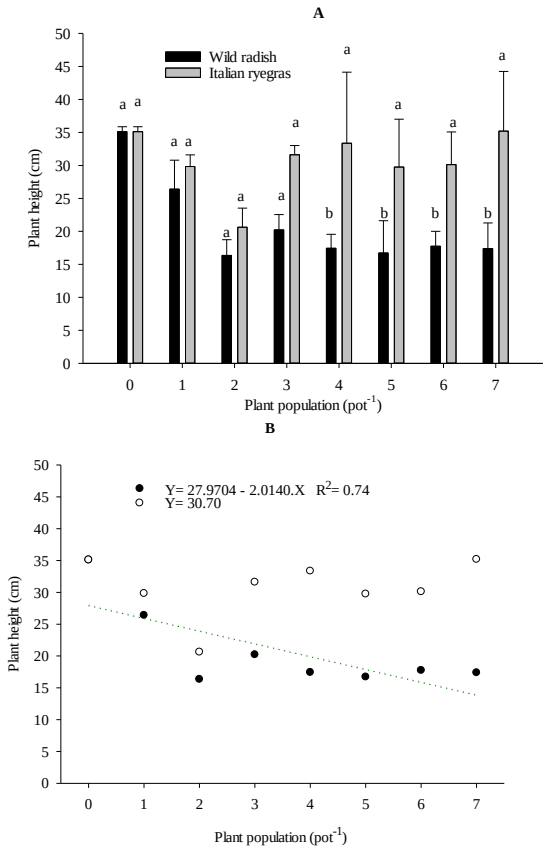

Figure 1. Height of onion plants (cm) as a function of competition with different populations of *Raphanus sp*. (black bars - A and ● – B) and *Lolium multiflorum* (gray bars - A and ○ - B). UFFS, Erechim-RS, 2019.

Turnip competition caused a reduction of 30% in onion stem diameter (Figure 2A) when the free infestation treatment was compared to the maximum population of seven plants of turnip pot-1. It can be observed (Figure 2B) that the diameter decrease occurs in a linear way, while the ryegrass had no adjustment to the equation. Considering that the greater the number of individuals in the weed population, the greater the competition with the crop for the resources present in the environment (Soares et al., 2010). Similar results were observed by Galon et al. (2016) when evaluating the competition of two types of lettuce with ryegrass, with a reduction in stem diameter of 29 and 49% for the smooth and curly types, respectively.

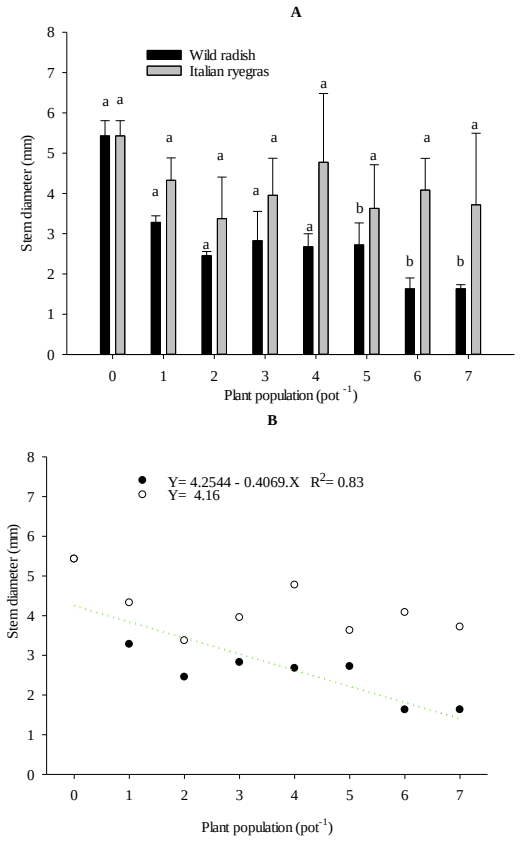

Figure 2. Stem diameter of onion plants (mm) as a function of competition with different populations of *Raphanus sp*. (black bars - A and ● - B) and *Lolium multiflorum* (gray bars - A and ○ - B). UFFS, Erechim-RS, 2019.

For the variable of onion leaf area the competition with turnip was much more aggressive when compared to competition with ryegrass (Figure 3A and 3B). Competitive potential of turnip was observed in relation to ryegrass when these two weeds infested winter cereals (Costa and Rizzardi, 2015). There was a significant reduction in leaf area values of onion in the lowest established competition (one plant pot^{-1}). The interference of one turnip plant caused a reduction of 71% in the leaf area of the onion, and as the population increased, there was an even greater decrease, reaching up to 89% of loss with the maximum population of turnip. The mass of onion bulbs were lower at higher population densities due to increased intraspecific competition for environmental resources (Caruso et al., 2014). In the same way it was observed in the present study, where increasing the turnip population provided a decrease in the leaf area of the onion.

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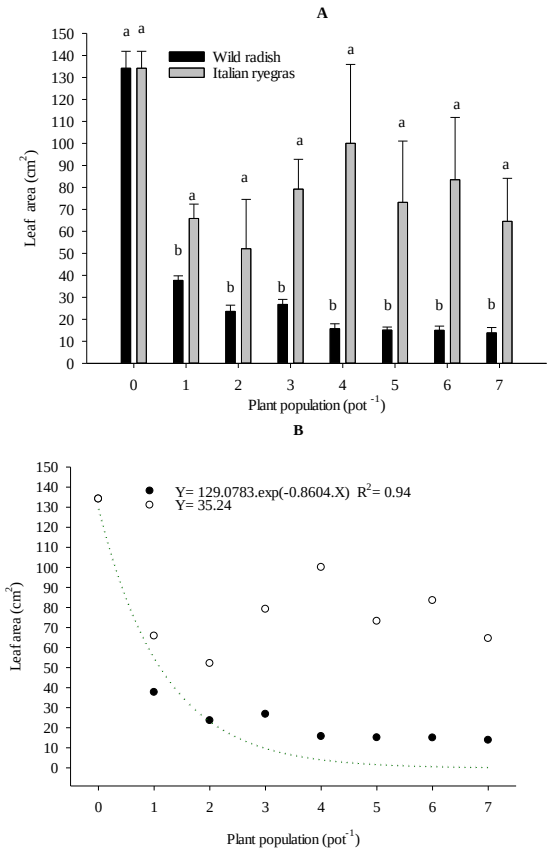

Figure 3. Leaf area of onion plants (cm^2) as a function of competition with different populations of *Raphanus sp*. (black bars - A and ● - B) and *Lolium multiflorum* (gray bars - A and ○ - B). UFFS, Erechim-RS, 2019.

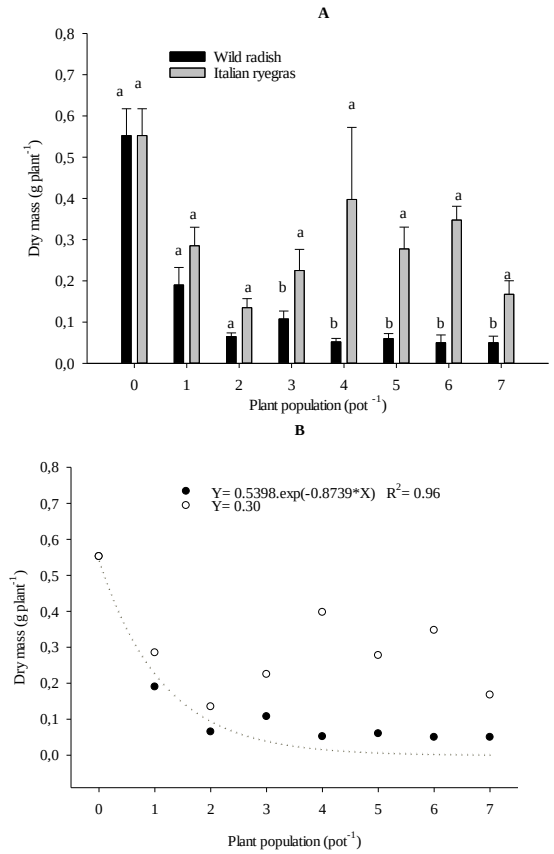

Figure 4. Dry mass of the aerial part of onion plants (g $plant^{-1}$) as a function of competition with different populations of *Raphanus sp*. (black bars - A and ● - B) and *Lolium multiflorum* (gray bars - A and ○ - B). UFFS, Erechim-RS, 2019.

The results demonstrate that there was difference from three plants per pot, with turnip being more competitive than ryegrass (Figure 4A). The dry mass of the aerial part of the onion was directly influenced by the competition, and in the presence of the turnip showed a reduction of 90% of the treatment free of infestation and the maximum population of weeds per pot (Figure 4B). The competition with ryegrass did not fit to the equation, demonstrating an average of 0.3 g $plant^{-1}$.

It is noticed that the onion culture presents less ability to compete with the weeds. The results corroborate with the observed by Qasem (2006), in which it obtained a reduction of 62% in the average yield of onion free of the infestation when compared to the infested treatment. Silva et al. (2013), observed a decrease in the fresh mass of watermelon according to the increase of time of coexistence with weeds, in conventional culture system. Therefore, it can be reported that occurs a similarity of comportment with the watermelon and onion in face of the competition with the weeds.

Due to its rapid growth and establishment, turnip was the weed species that accumulated more dry mass, at all densities, when compared to ryegrass (Figure 5A). In all evaluated variables, greater losses were observed when the crop competed with turnip, demonstrating a larger competitive ability than ryegrass (Figures 1, 2, 3 and 4). These results reinforce the studies that demonstrate the greater competition capacity of the turnip compared to ryegrass (Rigoli et al., 2008; Costa & Rizzardi 2015). Characteristics such as higher leaf area, root size and volume, may contribute to this superiority of turnip in competing with the resources of the ambient (Georgescu et al., 2016).

In contrast to the rapid development of the turnip, the Baia Periforme onion cultivar has slow growth, with a lower accumulation of fresh mass until 56 and 74 days after sowing and transplanting of the seedlings respectively (Vidigal et al., 2010). Thus, the low competitive capacity of the onion may be tied to the slow initial growth.

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For each additional turnip and ryegrass plant, was obtained a linear increase of 0.62 and 3.52 g pot-1, respectively. It is probable that in addition to competition with onion, interspecific competition also occurred, due to the minimal increase of the dry mass of the aerial part of the turnip plants. The same effect was not observed for ryegrass, which presents a rapid increase in dry mass of the aerial part as plant density increases (Figure 5B). Galon et al. (2016) observed that the dry mass of ryegrass demonstrated stability from the density of 707 plants m^{-2}, approximately five times the total density of the present study.

The lower accumulation of dry mass of the ryegrass over the initial period of establishment may have been the characteristic of the ryegrass that most contributed to the low competitiveness with the onion. Cultural management practices, such as sowing density, reduction of line spacing, as well as more competitive cultivars, can support in the management of weeds (Bajwa et al., 2017).

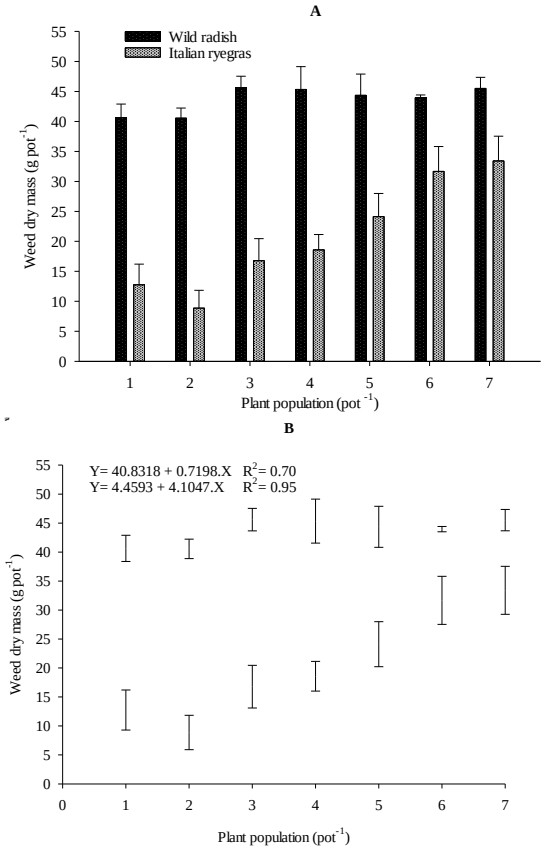

Figure 5. Dry mass of the aerial part (g pot^{-1}) of *Raphanus sp.* (blach bars - A and ● - B) and *Lolium multiflorum* (gray bars - A and ○ - B) as a function of competition with onion and plant population (pot^{-1}). Averages and standard deviation of 4 independent biological replicates. UFFS, Erechim-RS, 2019.

IV. CONCLUSIONS

For all tested variables (plant height, stem diameter, leaf area and dry mass), there were losses of the onion in competition with the turnip.

When comparing the weeds turnip and ryegrass, it is concluded that turnip is more competitive with onion in relation to ryegrass, regardless of the population tested.

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