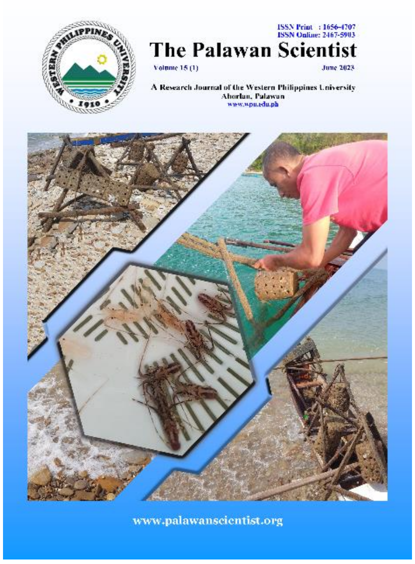
Original Article



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Influence of different population densities of *Portulaca oleracea* L. on growth and yield of transplanted onion *Allium cepa* L.

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ABSTRACT

Portulaca oleracea is one of the weeds of onion in the Philippines. Its negative impact on growth and yield, however, has not been quantified. An experiment was conducted to determine the influence of different density levels of *P. oleracea* on growth and yield of transplanted onions. The weed was allowed to grow with the onion at 0, 5, 10, and 15 plants 176 cm^{-2} from the day of planting until harvest. The experiment was arranged in randomized complete block design with four replications. Growth and yield of transplanted onions were influenced by different densities of *P. oleracea*. The fresh weight of bulbs was reduced by 32.7, 51.3, and 73.6%; the dry weight by 39.6, 59.8, and 71.9% when the weed competed at 5, 10, and 15 plants 176 cm^{-2}, respectively. Correlation and regression analyses showed that the population density of *P. oleracea* were strongly, negatively correlated as well as it influenced by 98.54 and 93.45%, respectively, on the fresh and dry weight of transplanted onion. This study confirmed that *P. oleracea* is truly a weed of transplanted onion implying that it could potentially reduce yield if left unmanaged throughout the crop's growing cycle. Thus, it must be managed effectively whenever seen infesting transplanted onions in the country. Although the results were obtained only under screenhouse conditions, the findings suggest the need to develop a holistic weed control strategy against the weed.

Keywords: additive design, common purslane, crop-weed competition, olasiman, Portulacaceae

INTRODUCTION

Bulb onion *Allium cepa* L. is one of the major rice-based crops (rice-onion, rice-corn, and other rice-vegetable cropping systems) in the Philippines (PhilRice 2007). In 2021, the bulb onion was planted on 19.3 thousand ha with a production volume of 218 thousand metric tons valued at PHP11,501,200,000 (PSA 2022). These figures are expected to further rise to meet the demands for culinary purposes.

Weeds are one of the groups of pests that need to be considered when growing onions. This is because weeds, if left unmanaged, will reduce yield of onions. In fact, in a field study in Nueva Ecija, weeds left uncontrolled reduced the yield of red and white onions by as much as 78 and 97%, respectively (Baltazar et al. 1998a). In another study, the yield of red onion reduced by 79% when major weeds such as *Cyperus rotundus* L., *Echinochloa colona* (L.) Link., and *Trianthema portulacastrum* L. were left to grow and compete in the field (Baltazar et al. 1998b). Thus, it is important that weeds must be managed to ensure the quantity and quality of yield as well higher income from the planting of onions.

Portulaca oleracea L., also known as "common purslane, pigweed, or olasiman", is a C_4 plant that proliferates both by seeds and vegetative stem cuttings (Merrill 1912; Galinato et al. 1999; Ferrari et al. 2020). One mature plant of it could produce a mean of 10,000 seeds plant^{-1} at a mean weight of 0.07 mg seed^{-1} (Galinato et al. 1999). Many of its seeds germinate at the soil surface, particularly when exposed at 30/20°C alternating day/night temperatures with 12/12 h light/dark conditions; no germination at all for those buried at a soil depth of 2 cm (Chauhan and Johnson 2009). Its cut stems with nodes, on the other hand, are the only ones that produce new leaves; those with attached leaves produced the newest leaves (Proctor et al. 2011). In addition, its cut stems with nodes had >70% survival; those from the internodes had 0% survival under field conditions. *Portulaca oleracea* is one of the common weeds of rainfed rice and rice-based crops in the country like corn, tomato, eggplant, string beans, and yam (Fabro and Barcial 2015; Gonzales 2017; Galinato et al. 1999; Donayre et al. 2018). It is also one of the common weeds infesting many bulb onion fields (Baltazar et al. 1999; Casimero 2000; PhilRice 2007). Its negative impact on the growth and yield of direct-seeded onion has been reported in other countries. For example, it reduced the yield of direct-seeded onion by 9, 68.3, and 83.5% when allowed to compete from 0 to 40 days after planting; 53, 81, and 93% when allowed to compete from the day planting until harvest (Adams 1977). Under Philippine conditions, however, its impact has not yet been quantified in either direct-seeded or transplanted onion. Hence, this paper aimed to determine the influence of the different population density of *P. oleracea* on the growth and yield of transplanted onion.

METHODS

Location and Materials

The study was conducted at the experimental area of the Crop Protection Department, College of Agriculture, Central Luzon State University (CLSU), Science City of Munoz, Nueva Ecija from November 2018 to April 2019. The greenhouse, where the experiment was conducted, was made of steel frames covered with fine nets in all the sides as well as the roofing. It was also built in an open space away from trees and buildings. The soil (Maligaya soil series) used as a medium for planting was collected from the same field area and location. To avoid the growth of other plants, collected soil samples were pulverized, placed inside a polypropylene plastic bag at 2 kg bag^{-1}, and sterilized by mixing with water and heating for 8 h in a huge cylindrical metal drum. After sterilization, the soil sample in each bag was allowed to cool and then transferred later into plastic containers.

Red Pinoy was used as the test onion variety. It was prepared by planting 4-5 seeds hole^{-1} on a seedling tray previously filled with sterilized soil. All germinating seeds were allowed to grow until 40 days under saturated and full sunlight conditions. Mature seeds of *P. oleracea*, collected from onion fields of Sto. Domingo, Nueva Ecija, were also seeded at 10 seeds hole^{-1} on a seedling tray with sterilized soil. One-week-old growing seedlings were thinned and maintained at 2-3 seedlings hole^{-1}. Seedlings were allowed to grow until 40 days under moist and full sunlight conditions.

Experimental Design

Cylindrical plastic container (area=176 cm^2, depth=10 cm), filled with 10 kg of sterilized moist soil, was used as the experimental unit of the study. Each center of the container was transplanted with one 40-day-old seedling of bulb onion as shown in Figure 1 (Islam et al. 2009; Casimero 2000). Following the procedure of Chauhan and Johnson (2009) in growing seeds, 40-day-old seedlings (3 leaf-stage) of *P. oleracea* were planted in each container at 0, 5, 10, and 15 plants container^{-1} or plants 176 cm^{-2}. The planting distances between the crop and weed were 10, 5-10, and 2.5-5 cm for 5, 10, and 15 plants 176 cm^{-2}, respectively. On the other hand, the distances between each weed were 10, 5, and 2.5-5 cm in the same order of plants 176 cm^{-2}. Each experimental unit with transplanted bulb onion and *P. oleracea* at different densities were arranged in randomized complete block design with four replications. All plants inside each experimental unit were grown until the crop's maturity. All plants were nourished with synthetic fertilizers at 67-21-21 kg of N, P_2O_5, and K_2O ha^{-1} recommended rates. Water was also supplied in each box and maintained at saturation level whenever necessary. An additive design of the crop-weed competition, where the density of onion was held constant and that of *P. oleracea* was kept increased, was utilized to determine the outcome of *P. oleracea* - onion competition (Swanton et al. 2015).

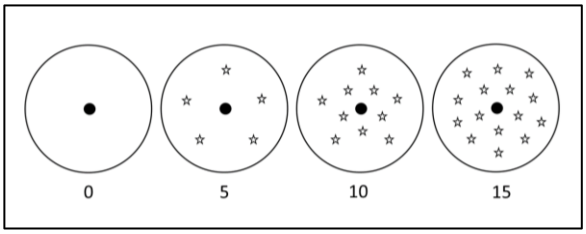

Figure 1. Position of transplanted onion (circles) relative to different densities of *Portulaca oleracea* (stars) inside the experimental unit.

Data Collection

The growth and development of bulb onion were measured in terms of height; number, length, and weight of leaves; length of bulb and roots; and fresh and dry-weight of bulbs. Using a meter stick, the height of bulb onion was determined by measuring it from the base to the tip of the tallest leaf of each plant 60 days after planting (DAP). Using a ruler, the average length of the leaves was also determined by measuring the length of the three leaves close to the base of each plant. The number of leaves per plant was manually counted while the root and bulb lengths as well as the bulb-widths were measured using either a ruler or Vernier caliper (0-150 mm, Mituyo, Japan). Using a sharpened knife, the bulb of each onion was separated from the shoots (leaves) during the harvesting time. The fresh weights of leaves and bulbs were then separately recorded using a digital weighing balance (A&D Electronic Balance FX-3000). To determine the dry weights, the leaves and bulbs were placed separately inside a paper bag. Each bag was then placed inside an oven for drying within 48 h at 70˚C. After drying, the leaves and bulbs were weighed using a digital weighing balance. Percentage reductions on growth variables and bulb weight (Y) of onion were calculated using the equation below:

$$Y = \frac{(Yo - Y1)}{Yo}\ (100)$$

where, Y_0 as the mean value at 0 plants 176 cm^{-2} and Y1 as the mean values at 5, 10, and 15 plants 176 cm^{-2}, respectively.

Statistical Analysis

All the data were subjected to ANOVA using the Statistical Tool for Agricultural Research (STAR v. 2.0.1) of International Rice Research Institute. The treatment means, on the other hand, were compared using the Tukey's HSD at 5% level of significance. A Pearson-product moment correlation coefficient was also computed to determine the strength and direction of relationship between the population density of *P. oleracea* and the fresh and dry bulb weights of transplanted onion. In addition, a simple linear model (Y = bx + a) was also fitted to the population density of *P. oleracea* and the fresh and dry bulb weights of transplanted onion to create a prediction model.

RESULTS

Influence on Growth Parameters

Values of the height and number of leaves of onion were high when *P. oleracea* was absent; lowest when the weed was present at 15 plants 176 cm^{-2} (Table 1). No significant difference was observed in height at 5, 10, and 15 plants 176 cm^{-2}. But there was significant difference between the height of onions at 0 and 15 plants 176 cm^{-2}. The number of leaves had no significant difference at 0 and 5 plants 176 cm^{-2}. Similarly, no difference was observed at 5, 10, and 15 plants 176 cm^{-2}. There were significant differences, however, at 0 plants 176 cm^{-2} compared to 10 and 15 plants 176 cm^{-2}. The length of leaves of onion also measured high in the absence of the weed. But the measurement was not significantly different when the weed was present at 5 and 10 plants 176 cm^{-2}. The length of leaves at 5 and 10 plants 176 cm^{-2} was not significantly different; however, it was significantly different at 15 plants 176 cm^{-2}. The dry weight of the leaves of onion was also highest when the weed was absent. The dry weight, however, was not significantly different when the weed was present at three densities.

From 0 plants 176 cm^{-2}, the height of onion was reduced by 16.8, 29.9, and 40.1%; the number of leaves by 39.1, 60.9, and 71.7%; the length of leaves by 17.6, 31.4, and 42.1%; and the dry weight of leaves by 30.4, 37.7, and 55.9%, when the weed was allowed to compete at 5, 10, and 15 plants 176 cm^{-2}, respectively (Table 2).

Table 1. Mean (± se) height, number, length, and dry weight of leaves of transplanted onion as influenced by different population densities of *Portulaca oleracea*. In each column, means with the same letters are not significantly different at 5% level.

***Portulaca oleracea* (plants 176 cm^{-2})**	**Growth parameters**			
	Height of $plant^{-1}$ (cm)	**No. of leaves $plant^{-1}$**	**Length of leaves $plant^{-1}$**	**Dry weight of leaves $plant^{-1}$ (g)**
0	40.6 (±3.2)^{a}	6 (±0.5)^{a}	35.8 (±2.5)^{a}	3.1 (±0.3)^{a}
5	33.8 (±4.3)^{ab}	5 (±0.5)^{ab}	29.5 (±4.5)^{ab}	2.2 (±0.4)^{a}
10	28.4 (±3.4)^{ab}	4 (±0.5)^{b}	24.5 (±2.8)^{ab}	2.0 (±0.4)^{a}
15	24.3 (±2.2)^{b}	4 (±0.3)^{b}	20.4 (±1.7)^{b}	1.5 (±0.5)^{a}

Table 2. Percentage reductions on height and number, length, and dry weight of leaves of onion as influenced by different population densities of *Portulaca oleracea*.

***Portulaca oleracea* (plants 176 cm^{-2})**	**Reductions (%)**			
	Height of $plant^{-1}$ (cm)	**No. of leaves $plant^{-1}$**	**Length of leaves $plant^{-1}$**	**Dry weight of leaves $plant^{-1}$ (g)**
5	16.8	39.1	17.6	30.4
10	29.9	60.9	31.4	37.7
15	40.1	71.7	42.1	55.9

Measurements in bulbs and roots of onions were high when the weed was absent (Table 3). Bulb and root lengths at 0 plants 176 cm^{-2}, however, had no significant differences when the weed was present at 5, 10, and 15 plants 176 cm^{-2}. Likewise, bulb diameter at 0 plants was not different at 5 and 10 plants except at 15 plants 176 cm^{-2}. From 0 plants 176 cm^{-2}, bulb length reduced by 3.4, 8.1, and 9.4%; bulb diameter by 21.8, 28.8, and 51.8%; and root length by 6.7, 14, and 23.1% when the weed was at 5, 10, and 15 plants 176 cm^{-2}, respectively (Table 4).

Influence on Yield

Fresh and dry weights of bulbs were also high when *P. oleracea* was absent (Figure 2). The weight of bulbs at 0 plants 176 cm^{-2}, however, did not differ at 5 and 10 plants 176 cm^{-2} except at 15 plants 176 cm^{-2}. From 0 plants 176 cm^{-2}, the fresh weight of bulbs reduced by 32.7, 51.3, and 73.6%; and the dry weight of bulbs by 39.6, 59.8, and 71.9%; when the weed was allowed to compete at 5, 10, and 15 plants 176 cm^{-2}, respectively (Table 5).

Correlation and Regression

The population density of *P. oleracea* were strongly negatively correlated to the fresh (R = -0.993) and dry bulb weights (R = -0.967) of transplanted onion. The simple linear regression analysis also showed that 98.54 and 93.45% of fresh and dry bulb weights of transplanted onion, respectively, were influenced by the population density of *P. oleracea*. Further analysis also showed that the population density of the weed was a significant predictor and contributor to both the fresh and dry bulb weights of the crop at 5% level of significance (P = 0.033). The final predictive models for the fresh weight of bulb was y = -1.672(*P. oleracea* population density) + 33.69 while for the dry weight of bulb was y = -0.2146(*P. oleracea* population density) + 4.212 (Figure 3).

Table 3. Mean (± se) bulb length, bulb diameter, and root length of transplanted onion as influenced by different population densities of *Portulaca oleracea*. In each column, means with the same letters are not significantly different at 5% level of significance.

***Portulaca oleracea* (plants 176 cm^{-2})**	**Growth Parameters**		
	Bulb length plant^{-1} (cm)	**Bulb diameter plant^{-1} (cm)**	**Root length plant^{-1} (cm)**
0	8.0 (±0.6)^{a}	4.0 (±0.4)^{a}	5.5 (±0.5)^{a}
5	7.7 (±0.4)^{a}	3.1 (±0.5)^{ab}	5.1 (±0.8)^{a}
10	7.4 (±0.5)^{a}	2.9 (±0.3)^{ab}	4.7 (±0.5)^{a}
15	7.3 (±0.4)^{a}	1.9 (±0.5)^{b}	4.2 (±0.5)^{a}

Table 4. Percentage reductions on bulb length, bulb diameter, and root length of transplanted onion as influenced by different population densities of *Portulaca oleracea*.

***Portulaca oleracea* (plants 176 cm^{-2})**	**Reductions (%)**		
	Bulb length plant^{-1} (cm)	**Bulb diameter plant^{-1} (cm)**	**Root length plant^{-1} (cm)**
5	3.4	21.8	6.7
10	8.1	28.8	14.0
15	9.4	51.8	23.1

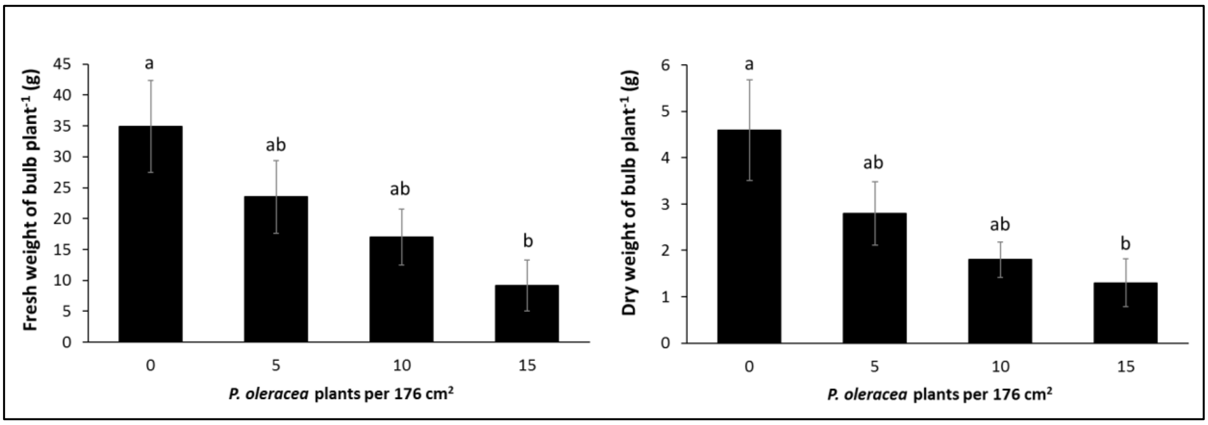

Figure 2. Mean (± se) weight (g) of fresh and dry bulb onion as influenced by different population densities of *Portulaca oleracea* (mean with the same letters are not significantly different at 5% level of significance.

Table 5. Percentage reductions on fresh and dry weights of bulb of transplanted onion as influenced by different population densities of *Portulaca oleracea*.

Portulaca oleracea **(plants 176 cm^{-2})**	**Reductions (%)**	
	Fresh weight of bulb plant^{-1} (g)	**Dry weight of bulb plant^{-1} (g)**
5	32.7	39.6
10	51.3	59.8
15	73.6	71.9

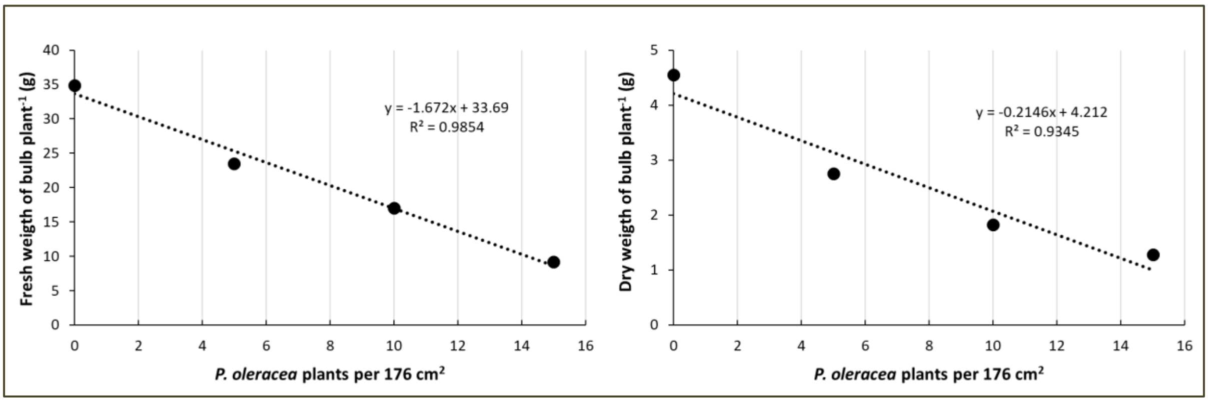

Figure 3. Correlation and simple linear regression between population density of *Portulaca oleracea* and the fresh and dry weights of transplanted onion.

DISCUSSION

Influence on Growth and Yield

Similar to other plants, the leaves are the primary organ of onion for processing its food by way of photosynthesis. It plays a significant role in relation to yield, particularly during the early bulb developmental stages of many onions. In a study by Siliquini et al. (2015), they reported that onions having 0% defoliation (complete leaf area) at the beginning and later part of the bulb formation had the highest bulb weights produced. But when the leaf areas of onions were intentionally defoliated by 40 and 60% at the beginning of bulb formation, the bulb weights were reduced by 29 and 43% while 4 and 21%, respectively, when defoliation was done at 30 days after the bulb formation. In this study, leaves of transplanted onion was highest when *P. oleracea* was absent. However, when the weed was present, the number, length, and weight of leaves were reduced. Thus, it is no wonder why the height and bulb weights of transplanted onion were severely reduced particularly at 15 plants 176 cm^{-2}. It only implicates that allowing *P. oleracea* to grow and compete until the maturity stage will negatively affect the growth and yield of transplanted onion.

Portulaca oleracea negatively affected the size and weight of bulb of transplanted onion. In fact, the regression analysis showed that its population density had strong and negative correlation to the fresh and dry weights of the crop suggesting that further competition of the weed at higher density and failure to control the weed throughout the crop's growing cycle will definitely result to the reduction on crop's yield. In the United States of America, Doohan and Felix (2012) also reported that *P. oleracea*, together with *Amaranthus blitoides* S. Wats., reduced the yield of the green onion by 22.2 and 32% in 2006 and 2007 field experiments, respectively. Adams (1977), on the other hand, had varying results in their field experiment involving different densities of *P. oleracea* under Michigan State University Muck Farm conditions. They reported that the presence of the weed at 58 plants m^{-2} from day 0 to 30 days after planting (DAP) did not reduce the yield of direct-seeded onion. From 0 to 40 DAP, however, the weed reduced the yield by 9%. At 153 plants m^{-2}, the presence of the weed from 0 to 20 DAP still did not affect the yield; instead, it reduced the yield by 57.6 and 68.3% when present from 0 to 30 and 0 to 40 DAP, respectively. At 463 m^2, the weed did not also significantly affect the yield when present from 0 to 10 DAP. It reduced the yield by 56, 71.2, and 83.5%, on the other hand, when present from 0 to 20, 0 to 30, and 0 to 40 DAP, respectively. When the weed was allowed to compete for the entire growing season, the yield of direct-seeded onion was reduced by 9.9-53% at all densities. Similar to *P. oleracea*, Morla et al. (2022) also reported that *Fimbristylis miliacea* (L.) Vahl had a negative influence on the growth and yield of transplanted and direct-seeded onions. From 5 densities, shoot biomass of *F. miliacea* increased by 1.3-2.7 folds in transplanted onion; 1.6-13 folds in direct-seeded onion as density increased by 15-25. Bulb weights of transplanted onion were reduced by 11, 17.4, 22.1, and 38.7%; direct-seeded onion by 86.4, 89.6, 88.8, and 88.1% at 10, 15, 20, and 25 *F. miliacea* densities, in that order. Bulb weights of direct-seeded onion suffered the greatest reductions due to weed competition.

Correlation and regression are statistical techniques that are commonly used to investigate the relationships between two variables (Bewick et al. 2003). Correlation quantifies the strength of the relationship between a pair of variables while the regression expresses the relationship or predicts the outcome of relationships by way of an equation. In this study, the population density of *P. oleracea* were strongly, negatively correlated to the fresh and dry bulb weights of transplanted onion. The simple linear regression analysis also showed that the population density of the weed was a significant predictor and contributor to both the fresh and dry bulb weights of the crop as had been shown in Figure 3. The correlation analysis indicated that the population density of *P. oleracea* was highly involved to the reductions on yield of transplanted onion. The regression analysis, on the other hand, suggest that the simple linear model can be used to predict the outcome of the competition between the population density of *P. oleracea* and the transplanted onion. In the study of Morla et al. (2022) on *F. miliacea* against onion, they also reported that the density and shoot biomass of the weed were strongly negatively correlated to the bulb weights of transplanted onion (r = -0.987, -0.995) and direct-seeded onion (r = -0.986, -0.999). They added that the regression analysis also showed that 97.49 and 99.95% of bulb weights of transplanted onion, and 97.25 and 99.95% of direct-seeded onion were attributed to the density and shoot biomass of *F. miliacea*. They then confirmed that *F. miliacea* is truly a weed of bulb onion and could reduce yield if left uncontrolled throughout the crop's growing season.

Knowledge of weed biology and ecology helps decide what, how, and when to implement control measures effectively. In this study, *P. oleracea* significantly reduced the growth and yield of transplanted onion implying that control must be executed whenever the weed grows and competes in the field. Although the findings were obtained only under screenhouse conditions, the results imply the need of developing a holistic weed control strategy against the weed. In managing weeds of onion, PhilRice (2007) recommends implementing thorough land preparation, rice straw mulching, rice hull burning, hand weeding, and herbicide application.

This study confirms that *P. oleracea* is a weed of transplanted onion and can potentially reduce the yield, especially if left unmanaged at population density of 5-15 plants 176 cm^{-2} from the time of planting until the maturity stage. Thus, it must be managed whenever observed infesting any field of transplanted onion. To find out more about its ecology and management, it is recommended that further *P. oleracea*-onion competition studies must be conducted, particularly under the field conditions; determine its critical period of control in both transplanted and direct-seeded onion; and evaluate different weed control strategies to develop a holistic management system that is effective, economical, and environment-friendly.

FUNDING

This study was personally funded by the first author.

ETHICAL CONSIDERATIONS

Since this study was conducted under greenhouse conditions, the experimental units of each treatment were specifically arranged in a randomized complete design to address the gradients of solar radiation coming from sunrise to sunset.

DECLARATION OF COMPETING INTEREST

The authors declare that there is no competing interests to any authors.

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REFERENCES

Adams NE. 1977. Growth and development of common purslane (*Portulaca oleracea* L.) and its competitive influence with onions on muck soils. MS Thesis. Michigan State University, USA. 49pp. https://d.lib.msu.edu/etd/14535/datastream/OBJ/download/Growth_and_development_of_common_purslane__Portulaca_oleracea_L___and_its_competitive_influence_with_onions_on_muck_soils.pdf. Accessed on 03 April 2022.

Baltazar AM, Martin EC, Casimero MC, Bariuan FV, Obien SR and de Datta SK. 1999. Major weeds in rainfed rice-onion cropping systems in the Asian site in the Philippines. Philippine Agricultural Scientist, 82: 166-177.

Baltazar AM, Bariuan FV, Martin EC, Casimero MC, Bajo FJr, Obien SR, De Datta SK and Mortimer AM. 1998a. In: IPM-CRSP (ed). Complementary weed control strategies in rice-vegetable systems (Evaluation of integrated weed management strategies against weeds in onion. Integrated Pest Management Collaborative Research Support Program: Fifth Annual Report 1997-1998. Virginia Polytechnic Institute and State University, USA. pp. 239-243.

Baltazar AM, Bariuan FV, Martin EC, Casimero MC, Bajo FJr, Obien SR, De Datta SK and Mortimer AM. 1998b. In: IPM-CRSP (ed). Integrated weed management strategies in rice-onion systems. In: Integrated Pest Management Collaborative Research Support Program: Sixth Annual

Report 1998-1999. Virginia Polytechnic Institute and State University, USA,.pp. 341-349.
Bewick V, Cheek L and Ball J. 2003. Statistics review 7: Correlation and regression. Critical Care., 7(6): 451-459. http://doi: 10.1186/cc2401
Casimero MC. 2000. Population dynamics, growth, and control of weeds in rainfed rice-onion cropping systems (Ph.D. Dissertation). University of the Philippines Los Baños, College, Laguna, Philippines. 139pp.
Chauhan BS and Johnson DE. 2009. Seed germination ecology of *Portulaca oleracea* L.: an important weed of rice and upland crops. Annals of Applied Biology, 155: 61-69. http://dx.doi.org/10.1111/j.1744-7348.2009.00320.x
Donayre DKM, Martin EC, Santiago SE and Lee JT. 2018. Weeds in Irrigated and Rainfed Lowland Ricefields in the Philippines (2nd ed). Philippine Rice Research Institute, Maligaya, Science City of Muñoz, Nueva Ecija, Philippines. 196pp. https://www.philrice.gov.ph/databases/references/. Accessed on 15 November 2018.
Doohan D and Felix J. 2012. Crop response and control of common purslane (*Portulaca oleraceae*) and prostrate pigweed (*Amaranthus blitoides*) in green onion with oxyfluorfen. Weed Technology, 26(4): 714-717. https://doi.org/10.1614/WT-D-12-00032.1
Fabro LE and Barcial PM. 2015. Weeds of vegetables. In: dela Cueva M, Pascual CB, Bajet CM and Dalisay TU (eds). Pest and Diseases of Economically Important Crops in the Philippines. Pest Management Council of the Philippines, Inc. c/o Crop Protection Cluster, University of the Philippines Los Banos, College, Laguna, pp. 554-580.
Ferrari RC, Cruz BC, Gastaldi VD, Storl T, Ferrari EC, Boxall SF, Hartwell J and L Freschi. 2020. Exploring C_4-CAM plasticity within the *Portulaca oleracea* complex. Scientific Reports, 10: 14237. http://doi:10.1038/s41598-020-71012-y
Galinato MI, Moody K and Piggin CM. 1999. Upland Rice Weeds of South and Southeast Asia. International Rice Research Institute, College, Laguna. 156pp.
Gonzales AT. 2017. Survey and identification of common weeds associated with rice and vegetable production in Rosario, La Union, Philippines. Universal Journal of Plant Science, 5(3): 37-40. http://doi:10.13189/ujps.2017.050301
Islam MN, Baltazar AM, De Datta SK and Karim ANMR. 2009. Management of purple nutsedge (Cyperus rotundus L.) tuber populations in rice-onion cropping systems. The Philippine Agricultural Scientist, 92(4): 407-418.
Merrill ED. 1912. The Flora of Manila. Bureau of Science, Manila, Philippines. 490pp.
Morla AA, Ocampo CP and Donayre DKM. 2022. Influence of *Fimbristylis miliacea* (L.) Vahl on growth and yield of bulb onion (*Allium cepa* L.). Rice-based Biosystems Journal, 10: 1-10.
PhilRice (Philippine Rice Research Institute). 2007. Integrated Pest Management in Rice-Vegetable Cropping Systems. Philippine Rice Research Institute, Maligaya, Science City of Muñoz, Nueva Ecija, Philippines. 158pp.
Proctor CA, RE Gaussoin and ZJ Reicher. 2011. Vegetative reproduction potential of common purslane (*Portulaca oleracea*). Weed Technology, 25(4): 694-697. http://doi:10.1614/WT-D-11-00045.1
PSA (Philippine Statistics Authority). 2022. 2021 Selected Statistics on Agriculture and Fisheries. Philippine Statistics Authority, Diliman, Quezon City, Philippines. 59pp. https://psa.gov.ph/sites/default/files/%28ons-cleared%29_SSAF%202022%20as%20of%2030082022_ONS-signed.pdf. Accessed on 10 November 2022.
Siliquini OA, Orioli GA and Lobartini JC. 2015. Onion yield as affected by plant density, nitrogen level, and loss of leaf area. Φyton International Journal of Experimental Biology, 84: 338-344.
Swanton CJ, Nkoa R and Blackshaw RE. 2015. Experimental methods for crop–weed competition studies. Weed Science, 63 SPI: 2-11. https://doi.org/10.1614/WS-D-13-00062.1

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