Proc. Fla. State Hort. Soc. 117:61-63. 2004.

INFLUENCE OF IN-ROW DISTANCES ON POTATO (*SOLANUM TUBEROSUM*) SEED YIELD AND ECONOMIC FEASIBILITY

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Abstract. **Field studies were conducted in the Dominican Republic to determine the effect of in-row spacing on 'Granola' potato (*Solanum tuberosum* L.) seed yield and economic feasibility. In vitro seedlings were transplanted on raised beds with in-row spacing of 0.20, 0.25, 0.30, 0.35, and 0.40 m, and 0.75 m between planting beds. The results indicated that in-row distances of 0.20 and 0.25 m increased total tuber number and weight, and tuber weight per plant. The marginal return rate increased by 13% when in-row distance decreased from 0.35 to 0.25 m.**

Potato (*Solanum tuberosum* L.) multiplication can occur through sexual and asexual methods. Although sexual potato seed is used to breed potato varieties, tubers are regularly used to produce this crop under field conditions. Because of this situation, potato multiplication programs are found throughout the world to ensure tuber quality and supply. These programs rely on open-field, greenhouse or hydroponic systems to obtain small tubers or 'minitubers', which are used for further multiplications. In order to obtain minitubers, *in vitro* potato seedlings are transplanted in potting medium and grown from 6 to 10 weeks, depending on the potato variety (Bryan and Melendez, 1985). In most cases, the minitubers produced are between 5 and 15 mm in diameter and have the potential to produce complete potato plants. After 6 to 12 weeks under diffuse-light storage, potato minituber sprouting occurs and these are planted in the field to obtain basic potato tubers.

One of the main concerns about potato basic tubers or 'seed' is the lack of information on specific horticultural management recommendations for potato seed production, since these practices are different from potato commercial production. Among those practices, in-row spacing and planting densities are critical to improve tuber number during each planting cycle. It is well known that planting densities can alter above- and below-ground biomass accumulation of vegetable species (Radosevich et al., 1997; Roush et al., 1989). Previous studies have indicated that different potato varieties have distinctive yield patterns, such as tuber number, weight, and distribution in time (Aviles, 2001). Thus, any planting density variation could influence biomass accumulation and subsequently tuber number.

This research was supported by the Florida Agricultural Experiment Station, and approved for publication as Journal Series No. R-10495.
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For any potato seed program, obtaining many medium-size minitubers is more important that producing a few large tubers. Because of this situation, it is important to obtain the largest number of tubers in the smallest space possible. Currently, there is scarce information about the effect of in-row spacing on basic potato seed. The objective of this study was to determine the influence of in-row spacing on 'Granola' potato seed yield and economic feasibility.

Materials and Methods

Two field studies were conducted between 2001 and 2002 at the Constanza Horticultural Experimental Station of the Dominican Institute for Agricultural and Forestry Research (IDIAF, in Spanish). The average annual temperature and rainfall at Constanza are 18 °C and 1,026 mm, respectively. The Constanza-IDIAF station is located 1,164 m above sea level, with sandy clay soils with pH 6.7 and organic matter content of 5%. Six-cm tall 'Granola' in vitro seedlings were transplanted in plastic trays filled with Sunshine Mix-3® (Sun Gro Horticulture, Seba Beach, Alberta, Canada). Potato seedlings were maintained in a 60%-light reduction greenhouse. One week before transplanting, substrate was fertilized with 15-15-15 (N-P-K) at a rate of 50 kg ha^{-1}. Irrigation was provided twice a day with microsprinklers.

After 2 weeks in the greenhouse, four-true-leaf seedlings were transplanted in open-field beds separated 0.75 m apart. Following soil test recommendations, 15-15-15 (N-P-K) fertilizer at a rate of 545 kg ha^{-1} was applied at 7 and 45 d after transplanting (DAT). Sprinkler irrigation and manual weed control were used throughout the seasons. Five in-row distances (0.20, 0.25, 0.30, 0.35, and 0.40 m) were established with four replications in a randomized complete block design. Experimental units were manually harvested 75 DAT and tubers of ≥5 mm in diameter were counted and weighted. Treatment means were adjusted with covariance prior to regression analysis ($p = 0.05$). Standard errors were used to separate treatment means (SAS, 1999).

The relationship between in-row distances and tuber number was described with the following logistic model,

$$y = c + d/1 + \exp^{(-a + bx)}$$

where y is the response variable, x is the in-row spacing, a and b are the parameters that determine the shape of the curve, and c is the lower asymptote (Halford et al., 2001; Martin et al., 2001). In terms of economic feasibility, dominance analysis was performed to determine the best two alternatives to be compared. Afterwards, partial budget analysis was performed to compare those alternatives and to determine the best marginal return rate (MRR) among in-row potato distances.

Results and Discussion

There were no significant treatment by trial interactions. Therefore, data from the two trials were combined for analysis and discussion. In-row distances influenced potato tuber

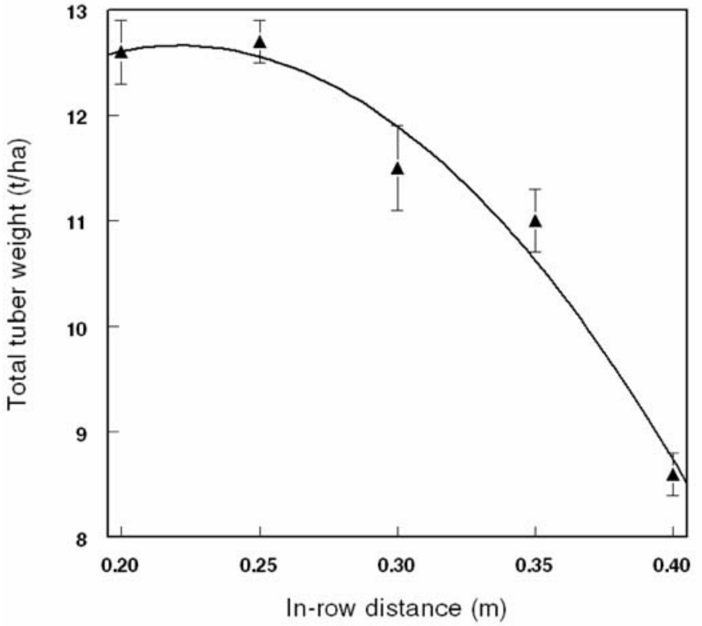

Fig. 1. Effect of in-row distances on 'Granola' potato tuber weight. Regression equation for potato tuber weight is $y = 6.66 + 54.31x - 122.86x^2$; $r^2 = 0.92$.

weight and number. For total tuber weight, a quadratic model ($y = 6.66 + 54.31x - 122.86x^2$; $r^2 = 0.92$) described this response (Fig. 1). No significant differences were observed between 0.20 and 0.25 m, which had the highest potato tuber weight. At the same time, planting at 0.30 or 0.35 m between plants resulted in the same tuber weights. The regression model indicated that changing in-row distances from 0.25 to 0.35 m would cause a 9% tuber weight decrease.

A logistic model characterized both total tuber number and tuber number per plant (Figs. 2 and 3). For total tuber number, this model was $y = 6420 + 2310/1 + e^{(-17.8 + 63x)}$; $r^2 =$

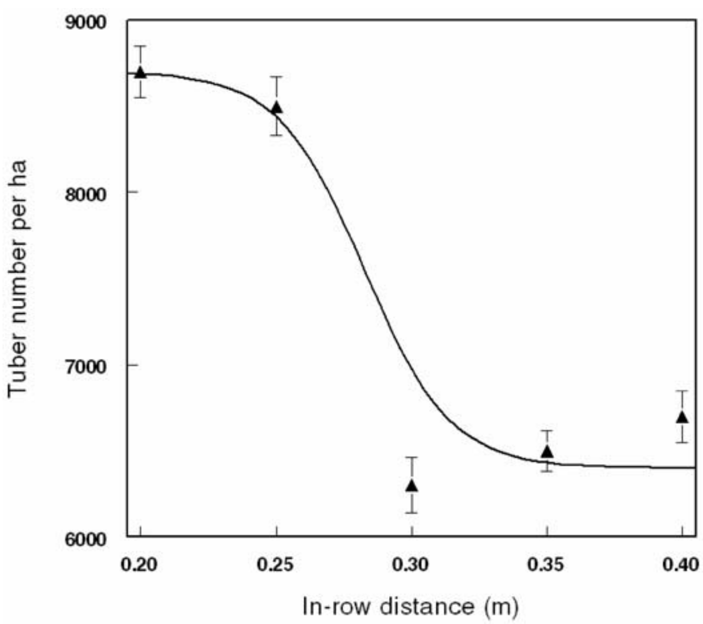

Fig. 2. Effect of in-row distances on 'Granola' potato total tuber number. Regression equation for potato total tuber number is $y = 6420 + 2310/1 + e^{(-17.8 + 63x)}$; $r^2 = 0.86$.

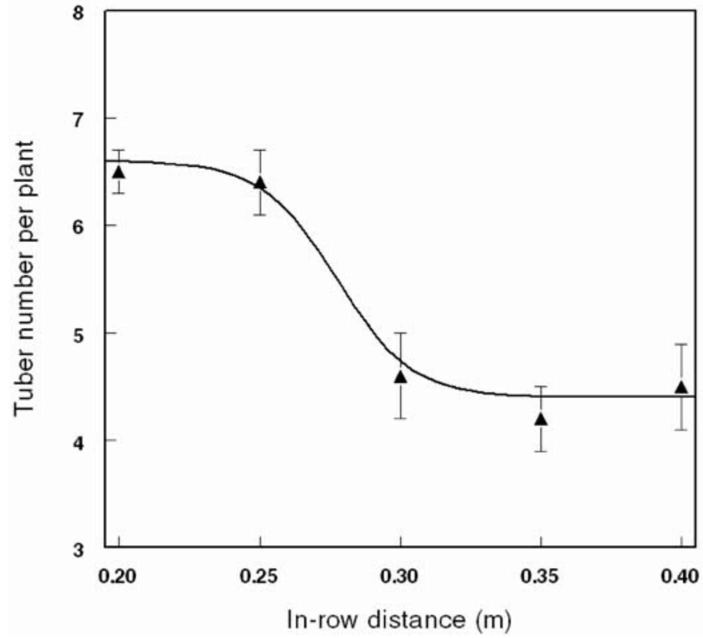

Fig. 3. Effect of in-row distances on 'Granola' potato tuber number per plant. Regression equation for potato tuber number per plant is $y = 4.4 + 2.2/1 + e^{(-20.8 + 75x)}$; $r^2 = 0.84$.

0.86, whereas $y = 4.4 + 2.2/1 + e^{(-20.8 + 75x)}$; $r^2 = 0.84$ characterized tuber number per plant. There was a sharp decrease in total tuber number as in-row spacing changed from 0.25 to 0.30 m, representing an average of 30% reduction. No significant differences were found between 0.20 and 0.25 m, or among the remaining three distances.

This same pattern was followed by tuber number per plant, where maximum values were found with 0.20 and 0.25 m, with an average of 6.5 tubers per plant, which is higher than the international standard of 5 tubers per plant. However, as distances between plants increased to 0.30 m or further, this average decreased to 5 or less tubers per plant. This response to wider in-row spacing can be explained by the reduction of intraspecific competition, resulting in increased biomass accumulation of a few large tubers rather than producing many small tubers. Under commercial conditions, this situation would be desirable, but in potato seed programs it is impor-

Table 1. Partial budget analysis and marginal return rate (MRR) between in-row distances of 0.25 and 0.35 m.

Partial Budgets	0.25 m	0.35 m
Yields (kg/ha)	12,800	11,013
Gross Income (US$/ha)	70,400	60,573
Variable Costs		
In-vitro seedlings ($ per ha)	13,033	10,017
Potting soil ($ per ha)	249	181
Pesticides ($ per ha)	27	19
Hand labor ($ per ha)	618	448
Fertilizers ($ per ha)	53	39
Harvest ($ per ha)	309	224
Total ($ per ha)	14,289	10,928
Net profit (US$ per ha)	56,111	49,645
MRR	1.13	

tant to obtain as many tubers (≥5 mm diameter) as possible per surface unit.

Partial budget analysis reflected that the in-row spacing of 0.25 m had a MRR of 1.13 in comparison with 0.35 m (Table 1). This finding indicated that 0.25 m is not only the best in-row potato distance to produce seed from the horticultural standpoint, but also would result in a 13% increase in net profit to potato seed growers.

Literature Cited

Avilés, J. 2001. Sistemas de producción de semilla. Infoagro-Ministerio de Agricultura y Ganadería de Costa Rica. San José, Costa Rica. 14 July 2001. <http://www.infoagro.go.cr/tecnologia/papa>.

Bryan, J. and N. Meléndez. 1985. Manejo de plántulas *in vitro*, esquejes y tubérculos pequeños en cobertizos. Centro Internacional de la Papa. Lima, Perú. 28 Oct. 2001. <http://www.cipotato.org/potato/seed_systems>.

Halford, C., A. S. Hamill, J. Zhang, and C. Doucet. 2001. Critical period of weed control in no-till soybean (*Glycine max*) and corn (*Zea mays*). Weed Technol. 15:737-744.

Martin, S. G., R. C. van Acker, and L. F. Friesen. 2001. Critical period of weed control in spring canola. Weed Sci. 49:326-333.

Radosevich, S., J. Holt, and C. Ghersa. 1997. Weed ecology: Implications for management. Wiley, New York.

Roush, M., S. Radosevich, R. Wagner, B. Maxwell, and T. Petersen. 1989. A comparison of methods for measuring effects of density and proportion in plant competition experiments. Weed Sci. 37:268-275.

[SAS] Statistical Analysis System. 1999. SAS/STAT user's guide. Version 8. Statistical Analysis System Institute. Cary, N.C.