Planting Arrangement and Density of Transplants Influence Sweet Spanish Onion Yields and Bulb Size

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Abstract. Sweet Spanish onion (*Allium cepa* L. cv. Granex 33) was transplanted in two, three, or four rows per bed at 7.6, 15.2, or 22.9 cm in-row spacings resulting in plant populations ranging from 41,000 to 246,000 plants/ha during Winter 1991. Interactions between number of rows per bed and in-row spacings were nonsignificant for onion yield and bulb size traits. As number of rows per bed increased or in-row spacings decreased, marketable onion yield linearly increased and mean bulb size (g/bulb) decreased. Percentage of small, medium, and large bulbs was unaffected by number of rows per bed, but percentage of small and medium-sized bulbs increased and percentage of large bulbs decreased as in-row spacing decreased. Onion yields linearly increased, but at the expense of smaller-sized bulbs, whether plant populations were increased by more rows per bed or narrower in-row spacings.

Selection of optimum plant populations is one critical decision that onion growers must address before planting. In Florida, transplanting is recommended for onion plant populations <197,000 plants/ha and direct-seeding for plant populations of 247,000 plants/ha or greater (Hayslip et al., 1987). Generally, higher onion yields occur with increasing plant populations (plants/ha) (Bleasdale, 1966; Brewster and Salter, 1980; Kelbert et al., 1962; McGeary, 1985). The objective of this investigation was to determine the effects of increasing plant populations and varying planting arrangement on yield and bulb size of sweet Spanish onions.

Materials and Methods

The experiment was conducted at the Indian River Research and Education Center, Ft. Pierce, Fla. Soil was characterized as Oldsmar fine sand (sandy, siliceous, hyperthermic, Alfic Arenic Haplaquods). Raised beds, 15 cm high, 1.1 m wide, and 2.1 m apart, were constructed; fertilizer at 192N–70P–138K (kg·ha⁻¹) was broadcast and soil incorporated into the beds. Due to heavy rainfalls during January and February totaling 25.4 cm, additional fertilizer (83N–13P–36K; kg·ha⁻¹) was broadcast onto the beds on 7 Feb. 1991. Continuous subsurface irrigation was used throughout the growing season. Standard pest control practices were used as needed to control insects, dis-

eases, or weeds (Hayslip et al., 1987).

Greenhouse-grown 'Granex 33' onions (7 weeks old, Speedling 080A; Speedling, Sun City, Fla.), a recommended cultivar for Florida producers (Hayslip et al., 1987), were transplanted on 6 Dec. 1990. Within a single raised bed, planting arrangements consisted of two rows spaced 46 cm apart, three rows spaced 23 cm apart, or four rows spaced 23 cm apart. Transplants were spaced 7.6, 15.2, or 22.9 cm apart within the rows. The nine combinations of rows per bed × in-row spacings resulted in populations ranging from ≈41,000 to ≈246,000 plants/ha (Table 1). Plots were 3.1 m long. A randomized complete-block experimental design with each treatment replicated four times was used.

The center 2.7-m section of each plot was manually harvested on 3 Apr. 1990. Bulbs were graded into marketable and cull (cracks, splits, doubles) bulbs and weighed. Marketable bulbs were sized into 2.5 to 5.0 (small), 5.1 to 7.6 (medium), and >7.6 (large) cm diameter categories (U.S. Dept. of Agriculture, 1985) and counted. Percent bulb size (number) distribution data were subjected to square root arcsin transformation. The data were subjected to an analysis of variance and main effect means separated into orthogonal

contrasts by the SAS software program (SAS Inst., 1989).

Results and Discussion

Rows per bed × in-row spacing interactions were nonsignificant for each measured trait; therefore, main effects of rows per bed and in-row spacing only are presented (Table 2). Marketable onion yields increased linearly and mean bulb size (g/bulb) decreased linearly as number of rows per bed increased from two to four or in-row spacing decreased from 22.9 to 7.6 cm (Table 2). Percent cull bulbs were <9% and were not significantly affected by number of rows per bed or in-row spacing treatments.

The majority of marketable bulbs were large (>7.6 cm) regardless of plant population. Distribution of onion bulb sizes was not affected by the number of rows per bed (Table 2). However, there was a quadratic or linear increase in percentage of small or medium-sized bulbs, respectively, as in-row spacing decreased. As in-row spacing decreased, there was a quadratic decrease in percentage of large bulbs. Onion yields or bulb size was influenced by number of rows per bed and in-row spacing, with no differential yield response between row number per bed and in-row spacing (Table 2). Overall, onion yields can potentially increase with higher plant populations than those tested, but at a sacrifice of producing smaller bulbs.

Onion planting arrangements with rectangularity of 8:1 resulted in 15% to 20% (Brewster and Salter, 1980) and 10% (Frappell, 1973) onion yield reductions as compared to 1:1 (square) rectangularity spacing patterns. Our plant population ranged from rectangularity of 6:1 (45.7 cm between-row and 7.6 cm in-row spacing) to 1:1 (22.9 cm between-row and 22.9 cm in-row spacing) (Table 1). Since our plant populations were confounded with plant arrangement in rectangularity, inferences between onion yields and rectangularity would be difficult to ascertain.

Our data suggests that onion yields increased with higher plant populations but at the expense of smaller bulbs. These results are similar to those reported by McGeary (1985). Further studies are required to assess the economical constraints of growing onions at higher plant populations with related higher production costs and potentially higher yields but smaller sized bulbs than those grown at lower plant populations.

Table 1. Onion plant populations at various planting arrangements.

Rows/bed (no.)	Spacing (cm)		Rectangularity ^a	Plant population (plants/ha)
	Between-row	In-row		
2	45.7	7.6	6:1	123,016
	45.7	15.2	3:1	61,508
	45.7	22.9	2:1	41,008
3	22.9	7.6	3:1	184,524
	22.9	15.2	1.5:1	92,262
	22.9	22.9	1:1	61,508
4	22.9	7.6	3:1	246,032
	22.9	15.2	1.5:1	123,016
	22.9	22.9	1:1	82,010

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¹Professor.

^aRatio of between-row spacing and in-row spacing.

Table 2. Mean onion yields and marketable onion bulb size distribution as influenced by plant population and planting arrangement.

Treatment	Marketable yield		Culls (%)	Bulb size categories (%) ^z		
	Mg·ha ⁻¹	g/bulb		Small	Medium	Large
Rows/bed (RB)						
2	18.2	287	4.9	7.5	26.1	66.4
3	24.9	269	6.7	5.6	24.4	70.0
4	27.7	227	7.8	10.0	32.6	57.4
Significance ^y	L**	L*	NS	NS	NS	NS
In-row spacing (IRS) (cm)						
7.6	29.2	176	3.0	14.8	42.1	43.1
15.2	22.6	273	8.1	4.6	22.6	72.8
22.9	18.5	333	8.3	3.7	18.4	77.9
Significance ^y	L**	L**	NS	Q*	L**	Q*
RB × IRS	NS	NS	NS	NS	NS	NS

^zCategories based on total marketable bulb number.^yL = linear, Q = quadratic.NS, *, **Nonsignificant or significant at $P \leq 0.05$ or 0.01 , respectively.

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