Row Arrangement Can Affect Yield and Pod Distribution Pattern of Trellised Snow Peas

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Abstract. Trellised plants of 'Oregon Sugar Pod II' and 'Snowflake' snow peas (*Pisum sativum* var. *macrocarpon* Ser.) were grown in single and double rows on 1-m centers at a constant population of 20 plants/m² in 1988 and 1990. Plants of 'Oregon Sugar Pod II' produced a greater number and weight of fresh pods than plants of 'Snowflake' in both years. Plants grown in double rows (10 cm within-row spacing) produced a greater number and weight of fresh pods than plants grown in single rows (5 cm within-row spacing) in 1988, but not in 1990. Vine dry weights were greater from plants grown in double rows than from plants grown in single rows in both years. Double rows seemed more promising for home gardeners than for commercial growers because of the increased branching and more widely scattered pod distribution on plants grown in double rows compared with plants grown in single rows.

Edible-podded peas, or snow peas, are a labor-intensive, high-value crop that can yield marketable quantities of produce from small land areas (Valenzuela, 1983). A 1988 survey estimated that 56% of U.S. consumers had tried snow peas (King, 1988), and imports are required to meet the U.S. demand (Klassen, 1987). Thus, there is good potential for snow peas as an alternative crop for small farmers. As with many specialty vegetables, however, cultural information is limited (Sharma et al., 1986).

Most of the horticultural research on peas has dealt with the green-shell seed crop, which is primarily mechanically harvested and grown almost exclusively for processing. Peas grown for green-shell seeds have varied in their response to plant arrangement and crop density. Meadley and Milbourn (1970) found no yield differences in crops of 'Dark Skinned Perfection' sown at 43, 97, or 172 seeds/m² with a rectangularity of 1:1. Yield per unit area showed no consistent relationship with plant density in a study by Salter and Williams (1967). However, Vincent (1958) ob-

tained more harvestable pods and a higher yield of shelled peas with spacings of 5 × 20 cm and 10 × 10 cm than with a spacing of 2.5 × 41 cm.

Snow peas typically are grown on trellises and require repeated hand harvesting (Klassen, 1987; Valenzuela, 1983). Thus, spacing requirements are quite different from those used in green-shell seed production. Within-row × between-row spacings recommended for trellised snow peas vary from 2 to 4 cm × 150 to 178 cm (Valenzuela, 1983) to 2.5 to 5 cm × 91 cm (Mansour, 1988). No references were found on row arrangement, although the trellis system lends itself to the possibility of double rows.

The purpose of this study was to compare growth and yield of trellised snow peas in response to a single-row and a double-row arrangement of a constant population per unit area (20 plants/m²).

The experiments were conducted in 1988 and 1990 at the Nursery Research Station, Stillwater, Okla., on a Norge loam (fine-silty, mixed, thermic Udic Paleustoll). Weeds were controlled with a preplant-incorporated application of 2,6-dinitro-N,N-dipropyl-4-(trifluoromethyl)benzenamine (trifluralin) at 785 g·ha⁻¹ in 1988 and with a preemergence application of 2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl) acetamide (metolachlor) at 1.12 kg·ha⁻¹ in 1990. No insecticides or fungicides were applied to the pea plants. Dual-chambered trickle irrigation tubing was installed on 10 May 1988, and the crop was irrigated on this date and again on 14 May. Supplemental irrigation was not used in 1990.

Two cultivars [Oregon Sugar Pod II (OSP II) and Snowflake] and two row arrangements (single and double) in factorial combination were arranged in randomized complete blocks, with four replications. Seeds were hand-planted in plots that were 3 m

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Table 1. Yield characteristics of two cultivars of trellised snow peas grown in single or double rows at Stillwater, Okla.

Variable	Fresh pods						Vine dry wt	
	Count (no./m ²)		Wt (g·m ⁻²)		Average wt/pod (g)		(g·m ⁻²)	
	1988	1990	1988	1990	1988	1990	1988	1990
Cultivar (C)								
Oregon Sugar Pod II	248	189	767	496	3.1	2.6	289	207
Snowflake	200	141	556	364	2.8	2.6	270	194
Main effect	---	*	**	**	**	NS	NS	NS
Row arrangement (R)								
Single row	203	159	593	416	2.9	2.6	257	175
Double row	245	171	730	444	3.0	2.6	302	225
Main effect	---	NS	**	NS	NS	NS	**	*
C × R interaction	*	NS	NS	NS	NS	NS	NS	NS

NS, *, ** Nonsignificant or significant at $P = 0.05$ or 0.01 , respectively.

Fig. 1. Nodal distribution patterns of pod dry weight for two cultivars of trellised snow peas in response to row arrangement at 71 days after planting. Stillwater, Okla., 1990.

long and on 1 m centers. Seeds were planted 2.5 cm apart in single rows, and seedlings were thinned to 5 cm apart after emergence. Seeds were planted 5 cm apart in double rows, and seedlings were thinned to 10 cm apart after emergence. There was ≈ 20 cm between the double rows within each plot.

Trellises were constructed following thinning. Metal posts 1.8 m high were set at 1.5-m intervals down the centers of the plots. A single wire was installed atop the posts, and the trellis netting was set up. The netting was a commercial nylon-line product in 1.5×18 -m units. Guard rows also were trellised to mitigate possible border or windbreak effects.

Pods were harvested four times in each study, with one harvest about every 3 days. Four harvests were sufficient because the dwarf cultivars used did not have the long-term yield potential of standard cultivars such as 'Mammoth Melting Sugar' (Valenzuela, 1983). Also, the rising late spring temperatures were unfavorable for continued production of marketable pods. Pods were counted after each harvest and fresh weights were recorded. Vines were cut at soil level following the last harvest, bagged, dried at 50C for at least 4 days, and weighed.

In 1988, a preplant soil test (McEkeath and Johnson, 1990) indicated 11N-226P-615K ($\text{kg}\cdot\text{ha}^{-1}$). Soil was prepared with a broadcast, preplant-incorporated application of N at $45 \text{ kg}\cdot\text{ha}^{-1}$ from $\text{NH}_4\text{N O}_3$. Seeds were planted on 24 Feb. and seedlings were thinned on 6 Apr. All plots had complete stands (60 plants) after thinning. Harvests began on 14 May and ended on 24 May.

In 1990, a preplant soil test indicated 7N-253P-721K ($\text{kg}\cdot\text{ha}^{-1}$). Soil was prepared with a broadcast, preplant-incorporated application of N at $49 \text{ kg}\cdot\text{ha}^{-1}$ from $\text{NH}_4\text{N O}_3$. Planting was delayed until 18 Mar. due to recurring rainfall. Seedlings were thinned on 22 Apr. Each plot was divided into a 2.2-m section for yield data and a 0.8-m section for plant architecture sampling. All plots had complete stands after thinning (44 plants in yield areas, 16 plants in architecture areas). Harvests (2.2-m sections only) began on 23 May and ended on 1 June.

Plant architecture samples were taken on 28 May 1990 [71 days after planting (DAP)], just before the third harvest date. Plants at both ends of the 0.8-m areas were left as guards. The remaining plants were cut at soil level and stored at 8C for 24 to 48 h. Five plants were randomly chosen from each plot,

and each chosen plant was evaluated individually. All nodes on the main stem and on branches were counted. The first node above soil level was considered "node 1". Pods were removed from the plants according to nodal origin along the main stem. Branches were classified by main stem node of origin, and pods on branches were kept separate from pods on the main stem. All plant material (including vines) from 28 May was dried at 80C for 3 days and then weighed.

Data initially were evaluated with an analysis of variance as a split plot in time, so that the main effect of years was tested using replications within years as the error term. The three-way interaction (year $\times$ cultivar $\times$ row arrangement) never was significant, but two-way interactions with year were common. Therefore, separate analyses were run for each year's data. A significant cultivar $\times$ row arrangement interaction for pod number/m² in 1988 was evaluated with an interaction least significant difference. No other significant interactions were evident in either year.

Plants of 'OSP II' produced a greater number and weight of fresh pods than plants of 'Snowflake' in both years (Table 1). The interaction analysis (not presented) showed that at a given plant arrangement, 'OSP II' produced more pods than 'Snowflake' in 1988; however, the difference was 31% with double rows vs. 18% with single rows. Individual pods of 'OSP II' were heavier than those of 'Snowflake' in 1988 but not in 1990. The two cultivars did not differ in vine dry weight.

Plants grown in double rows produced a greater number and weight of fresh pods than plants grown in single rows in 1988 but not in 1990 (Table 1). The interaction analysis showed that double rows increased pod production compared with single rows for both cultivars in 1988, but by different amounts (27% for 'OSP II' vs. 14% for 'Snowflake'). Individual pod weights were unaffected by row arrangement. Vine dry weights consistently were greater from plants grown in double rows than from plants grown in single rows.

Plants of 'OSP II' and 'Snowflake' did not differ in number of nodes (total or pod-bearing) at 71 DAP in 1990 (Table 2). The trend toward higher yield in 'OSP II' than in 'Snowflake' was becoming apparent, although differences in pod number per plant were not yet significant. There was no significant difference in harvest index between the two cultivars at 71 DAP.

Plant architecture at 71 DAP in 1990 clearly was affected by row arrangement (Table 2). Plants grown in double rows had an average of over eight more nodes than plants grown in single rows, primarily due to branching, although plant density was the same for both systems. Peas have shown increased branching in response to reduced plant densities in other studies (Meadley and Milbourn, 1970; Vincent, 1958). However, the increased branching of double-row plants in our study resulted in an average of only one more pod-bearing node per plant (Table 2). Conse-

Table 2. Plant growth and pod distribution responses¹ of two cultivars of trellised snow peas grown in single or double rows at 71 days after planting, Stillwater, Okla., 1990.

Variable	Nodes/plant (no.)			Pod-bearing nodes/plant (no.)			Pods/plant						Harvest index ^y (%)
	MS	B	Total	MS	B	Total	Count (no.)			Dry wt (g)			
							MS	B	Total	MS	B	Total	
Cultivar													
Oregon Sugar Pod II	19.4	7.6	27.0	4.5	0.7	5.2	8.0	1.1	9.1	2.1	0.2	2.3	21.8
Snowflake	18.5	4.6	23.1	4.8	0.5	5.3	7.6	0.6	8.2	1.6	0.1	1.7	17.6
Main effect	**	NS	NS	*	NS	NS	NS	NS	NS	*	NS	**	NS
Row arrangement													
Single row	18.6	2.3	20.9	4.6	0.1	4.7	8.1	0.1	8.2	1.9	<0.1	1.9	21.7
Double row	19.4	9.9	29.3	4.7	1.0	5.7	7.5	1.5	9.0	1.9	0.2	2.1	17.7
Main effect	*	**	**	NS	**	**	NS	**	NS	NS	*	NS	NS

¹Pod distribution: MS = main stem, B = branches. Node 1 was the first node above soil level. All cultivar × row arrangement interactions were nonsignificant at $P = 0.05$.

²Harvest index = [pod dry wt./ (dry wt. of stems + leaves + pods)] × 100.

NS, *, ** Nonsignificant or significant at $P = 0.05$ or 0.01 , respectively.

quently, the total number and weight of pods per plant were not significantly affected by row arrangement. Harvest indices were not significantly affected by row arrangement.

Frequency distributions for percentage of total pod dry weight per node at 71 DAP in 1990 are illustrated in Fig. 1. The first pod-bearing node on the main stem was node 12 for 'OSP II' and node 10 for 'Snowflake'. The position of the first pod-bearing node for either cultivar was unaffected by row arrangement, in agreement with the findings of Gritton and Eastin (1968). However, yields were less concentrated along the main stem axis in plants from double rows compared with plants from single rows, particularly for 'OSP II'. Also, both 'OSP II' and 'Snowflake' produced > 99% of their total pod dry weight at 71 DAP on racemes arising from the main stem when grown in single rows. In contrast, 15% ('OSP II') and 7% ('Snowflake') of the total pod dry weight at 71 DAP was located on branches in plants grown in double rows. Most branch pods were located on tillers arising from nodes 1 and 2 (Fig. 1).

Pod yields were higher in 1988 than in 1990 (Table 1), probably due to the later planting date in 1990. Delays in planting have reduced yields in other studies with shelled peas (Boswell, 1926; Smittle and Bradley, 1966). The 1990 crop had less time to develop before the onset of high air temperatures, which are known to reduce the average

number and weight of pea pods per plant (Boswell, 1926). Since pods on branches tend to mature later than those from racemes on the main stem (Meadley and Milbourn, 1970), pod production from branches may have been limited in 1990. Similarly, the 1990 data suggest that the increased yield from plants grown in double rows in 1988 may have resulted from additional pod-bearing nodes on branches. Plant architecture was not examined in 1988, but vine dry weights were higher with double rows (Table 1).

A double-row arrangement has the potential to increase yields of trellised snow peas grown at a plant population of 2.0×10^5 plants/ha when compared with single rows. However, double rows may be most useful to home gardeners. The reductions in between-row alley space, more widely scattered pod distribution on the plants, and additional vertical planes in which pods may occur with a double row can combine to make picking less efficient on relatively large acreages where harvest labor is a limiting factor. This labor problem, along with the inconsistent yield response from double rows, may lead commercial growers to favor a single-row arrangement.

Literature Cited

Boswell, V.R. 1926. The influence of temperature upon the growth and yield of garden peas. *Proc. Amer. Soc. Hort. Sci.* 23:162-168.

Gritton, E.T. and J.A. Eastin. 1968. Response of peas (*Pisum sativum* L.) to plant population and spacing. *Agron. J.* 60:482-485.

King, K. 1988. Specialties jazz up retail produce sales. *The Packer* 95(27):19A.

Klassen, P. -1987. Sharecropping works well in western sugar peas. *Amer. Veg. Grower* 35(9):56-57.

Mansour, N.S. 1988. Edible pod peas. Unnumbered mimeo. Coop. Ext. Serv., Oregon State Univ., Corvallis.

McElreath, D.L. and G.V. Johnson. 1990. Oklahoma State University Soil, Water, and Forage Analytic Laboratory procedures manual. Publ. AGRON 90-1. Okla. State Univ., Stillwater.

Meadley, J.T. and G.M. Milbourn. 1970. The growth of vining peas. II. The effect of density of planting. *J. Agr. Sci. (Cambridge)* 74:273-278.

Salter, P.J. and J.B. Williams. 1967. The effect of irrigation on pea crops grown at different plant densities. *J. Hort. Sci.* 42:59-66.

Sharma, G. C., C. Sabota, J. Schenk, J.C. Anderson, and E.V. Warm. 1986. Production and marketing of exotic vegetables. Res. Bul. PS 86-1. Alabama A&M Univ., Normal.

Smittle, D. and G. Bradley. 1966. The effects of irrigation, planting and harvest dates on yield and quality of peas. *Proc. Amer. Soc. Hort. Sci.* 88:441-446.

Valenzuela, L.H. 1983. Edible pod pea production in California. Lflt. 21328. tip. Ext. Serv., Univ. of Calif., Davis.

Vincent, C.L. 1958. Pea plant population and spacing. *Wash. Agr. Expt. Sta. Bul.* 594.