Reduced Plant Populations Save Seed Costs Without Reducing Yield or Quality of 'Alltop' Turnip Greens

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Abstract. Growers of turnip 'greens' [*Brassica rapa* L. (Rapifera Group)] are accustomed to planting 5.6 to 10 kg of seed per hectare. A study was conducted in 1985 to determine whether reduced plant populations could be used without reducing yield or quality for 'Alltop', a hybrid cultivar with relatively expensive seed. A trial planted on 4 Apr. showed that populations could be reduced from 64 to 33 plants/m of row without reducing yield or quality. A second trial, planted on 30 Aug., used populations of 36, 26, and 16 plants/m of row. Again, there were no statistically significant reductions in yield or quality as populations decreased. However, yields from the 36 and 16 plants/m treatments differed by almost 7 t·ha⁻¹, indicating substantial variability. A conservative approach would be to use a population of 33 to 36 plants/m of row (≈ 725,400 plants/ha) to provide a balance between seed costs and yield. This can be achieved by seeding rates of 2.2 to 2.8 kg·ha⁻¹.

Turnip greens are grown both for fresh market and for processing. The crop is established by direct seeding in the field.

McFerran et al. (1962) seeded 'Shogoin' turnip greens at 3.4, 6.7, 10.1, and 13.5 kg·ha⁻¹ in Arkansas. These seeding rates had no effect on total yields. However, leaf greenness decreased and percentage of leaf blade relative to petioles increased as seeding rates increased from 3.4 to 13.5 kg·ha⁻¹. McFerran et al. (1962) recommended a planting rate of 6.7 to 10.1 kg of seed per hectare. Del Vane and Harmon (1970) seeded 'Shogoin' turnip greens at 2.8, 5.6, and 11.2 kg·ha⁻¹ in spring and fall trials in Georgia. As in the McFerran et al. (1962) study, seeding rates had no effect on total fresh weight yields. The percentage of leaf blade relative to petioles also was not affected by seeding rate, although leaves were an undesirable light green with the 11.2 kg·ha⁻¹ rate.

On the basis of studies such as these, growers of turnip greens are accustomed to planting 5.6 to 10 kg of seed per hectare. The advent of hybrid turnip green cultivars has led to questions about the necessity for such high seeding rates. Hybrid cultivars, such as 'Alltop', have the potential to out-

yield older open-pollinated cultivars, such as 'Shogoin', and to produce high-quality greens. However, growers have been reluctant to adopt hybrid cultivars because their seed is relatively expensive. For comparison, average seed prices in 1988 (based on several catalogs) were about \$5/kg for 'Shogoin' vs. about \$45/kg for hybrid 'Alltop'. The present study was conducted to determine whether reduced plant populations could be used for 'Alltop' without reducing the yield or quality of the greens produced.

The experimental area was part of a 2-ha commercial field of 'Alltop' at the Vegetable Research Station, Bixby, Okla., in Spring and Fall 1985. The soil was a Severn very

fine sandy loam [coarse-silty, mixed (calcareous), thermic Typic Udifluvents]. A pre-plant-incorporated application of 2,6-dinitro-N, N, -dipropyl-(trifluoromethyl)benzenamine (trifluralin) at 560 g·ha⁻¹ was made before each experiment to control weeds. Standard commercial foliar insecticides, including a *Bacillus thuringiensis* Berliner product, and fungicides, including a fixed copper product, were used.

Plots 4 m long were established on beds that were 1.93 m wide. Four Stanhay precision seeders (Hestair Farm Equipment, Exning, Newmarket, U.K.) planted four rows spaced ≈ 40 cm apart on each bed. In the spring study, each Stanhay belt had two rows of holes, creating two seedlines spaced 50 mm apart per planted row. There was a single seedline per row in the fall study. Seeding rates were 3 kg·ha⁻¹ in the spring and 2.5 kg·ha⁻¹ in the fall. Differential plant populations were established by leaving all four rows per bed unthinned or by removing ≈ 25% or 50% of the seedlings in a plot. Post-thinning and postharvest stand counts were made in each plot, and plant populations were expressed as the number of plants per meter of row averaged over the four rows per bed.

At harvest, plants in a 2.5-m section of each row were cut by hand at ≈ 50 mm above the soil to obtain fresh weight yield. This procedure simulated the cutting height of a commercial mechanical harvester and permitted regrowth of the plants. Row sections of 0.30 m also were sampled to obtain additional data on plant responses. Yellow leaves were separated out and counted. Leaf fresh weights and numbers were recorded. Leaf areas were measured with a LI-COR Model 3100 area meter (LI-COR, Lincoln, Neb.). Leaves then were separated into petioles/midribs and blades using a scalpel, and dried

Table 1. Plant growth and quality and yield characteristics of 'Alltop' turnip greens in response to plant population (Bixby, Okla., Spring 1985). Date of planting was 4 Apr. 1985.

Variable	First harvest ^z				Second harvest ^z			
	Population treatment ^y				Population treatment ^y			
	1	2	3	L*	1	2	3	L*
Plants/m of row after thinning ^w	64	55	33	*	64	55	33	*
Plants/m of row at harvest ^w	49	46	30	NS	48	40	30	*
Leaf no./plant	6.1	6.3	7.2	NS	4.3	4.9	5.8	*
Leaf area/plant (cm ²)	486	486	711	NS	296	347	500	*
Leaf fresh wt/plant (g)	29	29	44	NS	15	18	27	*
Leaf dry wt (%)	8.4	8.6	8.5	NS	9.9	9.9	9.6	NS
Percent blade of leaves	48	50	51	NS	59	61	62	NS
Yellow leaves (% of total leaf no./plant)	3.9	3.6	2.5	NS	3.0	1.9	3.1	NS
Yield, fresh wt (t·ha ⁻¹)	23.9	23.4	23.0	NS	14.5	14.0	15.6	NS

^zHarvests 43 and 60 days after planting, respectively.

^yPlots consisted of four-row beds. 1 = unthinned; 2 = thinned ≈ 25%; 3 = thinned ≈ 50%.

^{*}Linear effect of population nonsignificant (NS) or significant at $P = 0.05$ (*). Quadratic effects never were significant. Coefficients of variation for yield were 13% at first harvest and 20% at second harvest.

^wPopulations averaged over the four rows per bed.

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Table 2. Plant growth and quality and yield characteristics of 'Alltop' turnip greens in response to plant population (Bixby, Okla., Fall 1985). Date of planting was 30 Aug. 1985.

Variable	First harvest ²				Second harvest ²			
	Population treatment ¹							
	1	2	3	L*	1	2	3	L*
Plants/m of row after thinning ^w	36	26	16	**	36	26	16	**
Plants/m of row at harvest ^w	27	20	14	*	26	20	12	*
Leaf no./plant	7.3	8.8	8.6	NS	6.4	7.1	8.6	NS
Leaf area/plant (cm ²)	963	1420	1710	*	685	863	1230	NS
Leaf fresh wt/plant (g)	63	97	125	*	41	54	79	NS
Leaf dry wt (%)	6.1	6.0	6.1	NS	7.4	7.4	7.6	NS
Percent blade of leaves	48	49	51	NS	58	59	61	NS
Yellow leaves (% of total leaf no./plant)	5.5	4.8	1.5	**	0.4	1.3	2.0	NS
Yield, fresh wt (t·ha ⁻¹)	35.0	31.3	28.1	NS	18.6	16.1	17.2	NS

¹Harvests 47 and 75 days after planting, respectively.

²Plots consisted of four-row beds. 1 = unthinned; 2 = thinned = 2570; 3 = thinned = 50%.

Linear effect of population nonsignificant (NS) or significant at $P = 0.05$ () or 0.01 (**). Quadratic effects never were significant. Coefficients of variation for yield were 15% at first harvest and 8% at second harvest.

^wPopulations averaged over the four rows per bed.

at 50C. Percent blade of leaves was expressed on a dry-weight basis, and percent dry weight of leaves was calculated.

The experimental design was a randomized complete block with four replications. Data were analyzed with an analysis of variance. Linear and quadratic population effects were examined using trend analysis.

Soil for the Spring 1985 experiment was prepared with a broadcast, preplant-incorporated application of 45 kg N/ha. A soil test indicated that adequate P and K were available from fertilization of previous trials. Seeds were planted on 4 Apr., and seedlings were thinned by hand on 24 Apr. All water needs were met by rainfall. Plants were topdressed with 56 kg N/ha on 2 May. The first harvest was on 17 May. Plants were topdressed with 56 kg N/ha on 22 May, and the second harvest was on 3 June. Minimum, maximum, and average air temperatures during the experimental period were 6, 32, and 19C, respectively, with a rainfall total of 212 mm.

Soil for the Fall 1985 experiment was preirrigated and prepared with a broadcast, preplant-incorporated application of 56 kg N/ha. Again, adequate P and K were available from fertilization of previous trials. Seeds

were planted on 30 Aug. Plots were sprinkler-irrigated daily from 31 Aug. through 5 Sept. Seedlings were thinned by hand on 9 Sept. The first harvest was on 16 Oct. Plants were topdressed with 62 kg N/ha on 25 Oct., and the second harvest was on 13 Nov. Minimum, maximum, and average air temperatures during the experimental period were 0.5, 38, and 18C, respectively. The rainfall total was 339 mm, with 265 mm recorded during October alone.

There were significant differences in plant population after thinning in the Spring 1985 experiment (Table 1). However, these differences had disappeared by the first harvest due to plant loss in the high population treatments. As a result, there were no differences in leaf-related variables or in yield at the first harvest (Table 1). Further attrition of plants reestablished significant population differences at the second harvest. Leaf number, area, and fresh weight per plant showed linear increases with decreasing population at the second harvest. However, quality attributes and yield per hectare remained unaffected by population (Table 1).

The lowest population used in the Spring 1985 experiment was targeted as the highest

population for the Fall 1985 experiment to study the effects of very low plant populations (<20 plants/m of row) on yield and quality. Despite these low initial populations, plant loss still occurred between thinning and first harvest (Table 2). Interplant competition may have been more severe than in the spring study due to the hot, dry weather typical of early September in Oklahoma. As in the spring study, the plants tended to compensate for the extra space at low populations by increasing leaf area and leaf fresh weight. Increases in leaf number were not significant in the fall (Table 2). Once again, quality attributes were unaffected by population, with the exception of percent yellow leaves at the first harvest (Table 2). Yields from the 36 and 16 plants/m treatments differed by almost 7 t·ha⁻¹ at first harvest. This yield difference was not statistically significant due to substantial variability (Table 2). However, a yield difference of 7 t·ha⁻¹ would represent a difference of about \$456/ha (based on a price of about \$66/t of greens for freezing), which growers would consider significant.

Yield and quality of 'Alltop' turnip greens were unaffected by plant populations obtained using seeding rates well below 5.6 kg·ha⁻¹. A population of 33 to 36 plants/m of row, in a four-row bed system, may provide a good balance between seed costs and yield. This is equivalent to ≈725,400 plants/ha. Higher initial populations are unlikely to be maintained through harvest due to plant loss and will not result in increased yields. Based on the fall data, a target population of 36 plants/m of row still would provide a margin of safety if stand establishment is less successful than anticipated, in that somewhat lower stands may not result in significant yield reductions. On the basis of these studies and grower experience (D. Smith, personal communication), a population of 33 to 36 plants/m of row maybe achieved by seeding rates of 2.2 to 2.8 kg·ha⁻¹. Individual growers will develop their own seeding rates, contingent upon factors such as season and soil type.

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