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Leaf Lettuce: An Alternative for Virginia's Eastern Shore*

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Romaine and Boston lettuce (*Lactuca sativa* L., Compositae) were identified as economically feasible alternative crops for eastern Virginia (Sterrett et al. 1996; Kalo 1997). Although lettuce is one of the most widely consumed vegetables, much of the production is concentrated in western states. Per capita consumption of leaf lettuce has increased from a low of 1.1 kg in 1986 to an estimated 3.4 kg in 1999 and currently represents 24% of total head lettuce consumption (USDA 1999).

Although neither Boston nor Romaine lettuce is expected to become a dominant crop on the Eastern Shore, successful production and marketing of lettuce will increase growers' options for crop diversification. Growers of new or non-traditional crops are likely to experience one or more production and marketing problems, including reliance on expensive hand labor, lack of registered plant protective chemicals, or effectively selling in non-traditional markets or easily saturated markets (Reiners 1992). Other areas are examining the market potential of non-iceberg types of lettuce grown on plastic mulch, including North Carolina (Scherer 2000) and Alabama (Simonne et al. 1997).

Traditionally, direct-seeded lettuce has been overseeded and hand-thinned after plant emergence to achieve the desired plant population. Lettuce yield is directly proportional to plant population and plant size uniformity (Seale et al. 1994). The cost of production could be reduced by precision seeding but near perfect plant populations are needed for lettuce to be economically feasible in Virginia (Kalo 1997). In preliminary studies, reduced plant establishment was associated with soil crusting prior to emergence (Sterrett and Savage, unpubl. data).

The Bojac sandy loam soil (mixed, thermic Typic Hapludult) that is predominant on the Eastern Shore is known for crusting, particularly after heavy rainfall. Banding vermiculite directly over broccoli [*Brassica oleracea* (Italica group)] seed was recommended to improve plant emergence in southeast Virginia but was only successful with adequate soil moisture (C.R. Odell, pers. commun.). Ellis (1965) found improved emergence following application of either sand or perlite, but the lighter weight perlite was easier to apply. Seale et al. (1994) reported improved plant emergence using calcined montmorillonite clay fired at high temperature compared with the same clay fired at low temperature or a peat-vermiculite mix, which were both water absorbent. Locally available organic by-products could reduce production costs, but need to be evaluated for effectiveness in promoting stand establishment of direct-seeded lettuce.

Sand becoming embedded in the crown of the plant is another a serious concern for lettuce growers on the Eastern Shore (Sterrett and Savage, unpubl. data). Alternative management strategies may reduce soil movement associated with rainfall events, thereby facilitating the production of leaf lettuce as a new crop for this region.

The overall goal was to examine the production feasibility of Boston and Romaine type lettuce in eastern Virginia and to determine the impact of production practices on product quality. Strategies that are not effective, or are detrimental to product quality, need to be identified to minimize potential grower risk. Therefore, the objectives were to 1) evaluate influence of physical soil anti-crustants on plant emergence and yield of direct-seeded lettuce, and 2) examine effect of alternative management strategies on sand movement into and retention in lettuce crowns.

METHODOLOGY

The study designed to address concerns associated with plant establishment of direct-seeded lettuce was conducted in fall of 1996 and 1997. The study to examine potential loss of head quality from sand moving into the crown and becoming embedded in the succulent leaf and petiole tissue of transplanted lettuce was conducted in spring 1999 and 2000.

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Plant Establishment

Plots were 7.6 m long in 1996, 4.6 m in 1997 and 1.5 m wide with 0.3 m between beds, three rows per bed each year. Fertilizer was broadcast prior to bed establishment (112 kg N/ha, 49 kg P/ha, 93 kg K/ha) with an additional 56 kg N/ha sidedressed (Table 1). Readily available organic amendments were incorporated (0–5 cm) or banded on the bed surface on the row prior to planting (18 m^3/ha); vermiculite was surface applied at the same volume but not incorporated (Table 2). In 1996, 'V2251', 'Emperor', and 'Fallgreen' lettuce were planted (one in each row on bed), in each treatment. 'Ideal' Romaine lettuce was planted in 1997. Stand counts were completed 14 days after planting. Average head wt. was determined at harvest. The 1996 study was planted as a split plot, cultivar as the subplot, with four replications. The 1997 study was planted in a randomized complete block design with four replications. Waller-Duncan least significant difference (LSD) tests were used to separate differences among means (P=0.05).

Head Quality

Wheat (*Triticum aestivum* L., Graminaceae) or cereal rye (*Secale cereale* L., Graminaceae) were planted on beds in the fall of 1998 and 1999. Check treatment was left unplanted. Cover crops were chemically desiccated (glyphosate, 1.4 kg a.i./ha) before spring transplanting (Table 1). Transplants of 'Esmeralda' Boston lettuce and 'Ideal' Romaine were greenhouse-grown and hand planted into strip-tilled plots (3 rows/bed) (Table 1). Plots were 5.5 m in length. Fertilizer was broadcast prior to bed establishment (112 kg N/ha, 49 kg P/ha, 93 kg K/ha) with an additional 56 kg N/ha sidedressed (Table 1). To determine the average portion of the head that was sand-free at harvest, 10 heads were randomly selected from each plot. Heads were weighed, visually inspected, starting at the bottom. Leaves and crown with sand were separated from the clean portion of each head and the clean portion of the heads was weighed. Studies were planted in a randomized complete block experimental design with four replications. Treatment means were separated using orthogonal contrasts.

RESULTS

Plant Establishment

In 1996, there were no significant differences between cultivars (data not shown). No organic amendment significantly improved plant emergence of direct-seeded lettuce in either 1996 or 1997 (Table 2). Since two seed were dropped approximately 2.5 cm apart at 30-cm intervals within the row, the target plant population would be achieved if half of the seed germinated. Wind created substantial off-site movement of vermiculite before irrigation could be initiated in 1996; the treatment was considered impractical for commercial application and was dropped from the 1997 study. Wind movement of straw was also a concern until irrigation commenced. Nearly perfect plant population is needed for lettuce to be an economically viable option for the Eastern Shore (Kalo 1997). Overseeding results in additional labor cost needed to thin the crop when soil and weather conditions promote germination and establishment (Swiader et al. 1980). This study demon-

Table 1. Dates for sowing, transplanting, application of side-dress nitrogen, and harvest, rainfall, maximum and minimum temperature for each experiment.

Activity/Weather	1996	1997	1999[z]	2000[z]
Seed sown	3 Sept.	5 Sept.	22 Feb.[y]	3 Feb.[y]
Desiccated cover crops	--	--	17 March	10 March
Transplanted	--	--	1 April	24 March
Sidedressed N	15 Oct.	29 Sept.	21 April	7 April
Harvest	12 Nov.	17 Nov.	27 May–Boston 4,10 June–Romaine	16 May

[z]*Triticum aestivum* and *Secale cereale* planted as cover crops on 28 Oct., 1999 and 19 Nov., 2000.
[y]Seed sown in greenhouse for transplants.

strated that none of the locally available materials used to offset soil crusting was consistently effective for promoting plant establishment of direct-seeded lettuce.

Commercially, Romaine lettuce is sold as an 11.4-kg box containing 24 heads. Hence, the average head weight should exceed 473 g to be considered marketable (Sterrett et al. 1996). As seen in Table 2, Romaine heads of salable quality were below this average weight in 1997, regardless of treatment at planting. The underweight heads may have been caused in part by high temperature stress. On 23 days in September, maximum daytime temperature exceeded the maximum of 24°C for lettuce (Maynard and Hochmuth 1997). Leaching of nutrients may also have been a factor, since rainfall in October and November exceeded the 61-year average for this location by 31 and 75 mm, respectively. Nicola and Cantliff (1996) noted that yield and earliness were related to season and soil type.

Head Quality

Because of inconsistent germination of direct-seeded lettuce, transplants were used in 1999 and 2000. In 1999, the average head weight of Boston lettuce was reduced when planted into desiccated cover crops while that of Romaine lettuce was significantly improved (Table 3). However, head weight was similar in wheat or rye for either lettuce type. While not significantly different in 2000, the greatest head weight for Boston lettuce was again recorded for the check treatment. The reason for the yield reduction of Boston lettuce but not Romaine is unclear. A reduction in cabbage yield was attributed to an allelopathic response when planted in rye (Hoyt 1999; Roberts et al. 1999) or wheat (Hoyt 1999). If this was an allelopathic response, the smaller, more rosette growth habit of Boston lettuce may have been more receptive than Romaine with the larger, more upright habit and somewhat larger root system. Alternatively, the larger root system of Romaine may simply have resulted in greater utilization of applied N.

Average head weight of Romaine was sufficient to meet market criteria for all but the check treatment in 1999 (Table 3); this indicates that Romaine lettuce has potential as an alternative crop for the Eastern Shore, provided current quality standards can be met. Less sand was found in Boston lettuce grown in rye than wheat in 2000, but the amount of sand found in all treatments in Boston in both years and Romaine in 2000 was commercially unacceptable.

In both 1999 and 2000, sand was found embedded in the lower 40% to 60% of the head for Boston lettuce (Fig. 1). However, less sand was found in Boston lettuce grown in rye than wheat in 2000. The portion of Romaine lettuce head that was free of sand was greater in 1999 than 2000, but not influenced by treatment. Because of dry weather in October 1999, the cover crops for the 2000 trial were planted later than

Table 2. Plant population and average head weight in 1996 and 1997.

	Plant population[z] (%)		Avg. head wt. (g/head)	
Treatment	1996	1997	1996[z]	1997
Peanut hulls, incorporated	53.7	102.5	254	191
Peanut hulls, surface	65.0	80.8	213	144
Pine bark, incorporated	49.0	109.2	222	143
Pine bark, surface	61.0	124.2	232	170
Vermiculite, surface	60.0	--	291	--
Wheat Straw, overlay[y]	54.3	105.8	281	149
Check, bare soil	65.0	102.5	241	177
Waller/Duncan (k=100, P=0.05)	ns	ns	41	ns

[z] Percentage of target population. Germination of all seed would equal 200% of target since two seed were dropped 2.5-cm apart at 30 cm spacing within the row.

[y] Straw was applied (approx. 2.5 cm depth) to top of bed after seeding.

Table 3. Influence of winter cover crops on average head weight and percentage of head sand-free in 1999 and 2000.

	Avg. head wt. (g)		Avg. sand free portion of head (%)	
Treatment	Boston	Romaine	Boston	Romaine
		1999		
Check, bare soil	312	358	47.7	70.5
Wheat	254	506	55.7	65.3
Rye	255	526	51.5	67.3
Significance:				
Cover vs. control	0.01	0.03	ns	ns
Wheat vs. rye	ns	ns	ns	ns
		2000		
Check, bare soil	281	527	44.5	48.4
Wheat	236	486	39.3	46.0
Rye	213	522	51.0	50.8
Significance:				
Cover vs. control	ns	ns	ns	ns
Wheat vs. rye	ns	0.08	0.05	ns

for the 1999 trial (Table 1). The additional three weeks of growth in the fall resulted in cover crops being taller and at a later stage of development at the time of desiccation for the 1999 trial. While the desiccated cover crop residue persisted through harvest in 1999, little cover crop residue, particularly wheat, was evident by harvest in 2000. For these studies, transplanting consisted of a two-stage process with strip-tillage being separate from the transplanting. Use of a strip-till transplanter that mounds the area to be planted, allowing rain water to drain away from the plants, and controls planting depth may prove very beneficial in reducing sand movement into the crowns of the more upright growing Romaine lettuce.

SUMMARY AND CONCLUSIONS

Direct-seeded lettuce was grown with various locally available organic amendments used as soil anticrustants. Plant establishment was more erratic in 1996 than 1997, but not consistently improved with any treatment. The use of transplants may be warranted, since near perfect plant population is needed for economic feasibility and the labor needed for hand thinning of an overseeded crop, if available, is costly.

Movement of sand into the crown during irrigation or rain events is a consistent quality problem lettuce production. Sand accumulation in the crown of Boston or Romaine was not reduced by use of strip tillage in desiccated cover crops. The potential for a clean crop of the succulent, flat growing Boston lettuce under the growing conditions and with the sandy soil of the Eastern Shore of Virginia seems unlikely. Head

Fig, 1. Close-up of Boston lettuce plant showing sand accumulation on lower leaves.

weight of the more upright Romaine lettuce was sufficient to meet market criteria and could be a potential alternative if grown without sand movement into the crown. Improvements in planting and cover crop management may reduce the portion of the head that is unmarketable because of sand.

The future of lettuce as an alternative crop for the Eastern Shore will depend on consistently growing the crop with little or no sand movement into the lettuce crown. Only upright Romaine and other leafy lettuce cultivars will be considered in future work.

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