Black Polyethylene Tunnel Covers Affect Plant Production and Quality of Sweetpotato Transplants

D.R. La Bonte and A.Q. Villordon
Department of Horticulture, Louisiana State University Agricultural Center, Louisiana Agricultural Experiment Station, Baton Rouge, LA 70803

J.R. Schultheis and D.W. Monks
Department of Horticultural Science, North Carolina State University, Box 7609, Raleigh, NC 27695

Additional index words. Ipomoea batatas, transplants, propagation

Abstract. **The influence of a black polyethylene tunnel cover (BTC) was evaluated for its effect on quantity and quality of sweetpotato [*Ipomoea batatas* (L.) Lam.] transplants in plant beds in Louisiana and North Carolina. Use of BTC increased production of 'Beauregard' transplants from 63% to 553% in comparison with the bare ground control. 'Jewel' was less responsive; BTC treatments increased transplant production by at least 48% in Louisiana over the bare ground control, but no increase was observed in North Carolina. Individual transplant weight was at least 34% less in BTC treatments than in the control. The first harvest of cuttings in BTC beds was at least 14 days prior to that in control beds. Transplant quality was assessed as yield of storage roots in repeated trials that extended throughout the normal growing season. Yield of storage roots was not affected by BTC in early season plantings, but was frequently lower for BTC treatment transplants in middle and late season plantings. We therefore do not recommend this method as a means of increasing sweetpotato plant production from bedded roots.**

A typical sweetpotato grower in the southeastern United States requires ≈4 million transplants to produce a crop on 120 to 140 ha (La Bonte and Cannon, 1997). A grower must retain ≈1.2 MT of roots per ha planted, or ≈8% of the previous-year's crop, to generate an adequate supply of transplants. Growers typically initiate sweetpotato propagation beds in late February or early March and cover the beds with black or clear polyethylene mulch to raise soil temperature and promote early sprouting and transplant emergence. The mulch is removed when sprouts reach the soil surface (Wilson and Averre, 1989). Various clear polyethylene and spunbonded polyester row covers also promote early transplant production (Porter, 1991) and increase transplant weight in sweetpotato (Walker and Randle, 1986).

However, in neither study did various row cover treatments increase transplant production in comparison with black polyethylene mulch.

Growers are now switching to more costly, virus-tested, foundation seed stock and tissue-culture–derived plant material. Thus, a practical means of increasing plant production could offset the higher prices now paid for seed stock and reduce the amount of seed that must be saved for transplant production. The objective of this study was to investigate the effect of BTC on quantity and quality of transplants. Quality was evaluated as root yield over a normal growing season.

Materials and Methods

Effect of black polyethylene tunnel cover (BTC) on transplant production from 'Beauregard' and 'Jewel' sweetpotato roots was assessed in a randomized complete-block design experiment with three replications in Baton Rouge, La., in 1992 and 1994, and five replications in Clinton, N.C., in 1992 and 1993. Each plot in Louisiana was 2.5 m long and 0.3 m wide on raised beds 1.2 m apart, while in North Carolina each plot was 1.5 m long and 0.3 m wide on raised beds 1.5 m apart. In Louisiana, 60 'Beauregard' and 55 'Jewel' roots weighing a total of 18 kg were placed in each respective plot, while about half this number and weight were used in North Carolina. All treatments received 13N–5.7P–10.8K at 338 kg·ha^{-1}. The fertilizer was initially topdressed and incorporated into 5 cm of soil used to cover the roots; subsequent topdressed

fertilizer and irrigation were supplied as needed. Black polyethylene (32 mm) film mulch (for Louisiana, Ken-Bar, Reading, Mass.; for North Carolina, AEP Plastic, South Hackensack, N.J.) was placed directly on the soil surface of all plots in Louisiana on 17 Mar. 1992 and 29 Mar. 1994 and removed ≈30 d later when sprouts reached the soil surface. In North Carolina, roots were bedded on 10 Apr. 1992 and 30 Mar. 1993 and the film mulch was removed ≈30 d later.

Two treatments were applied to each clone after the film mulch was removed: 1) BTC was supported by galvanized steel wire hoops 38 cm over the bed with 25-cm slits spaced every 25 cm and anchored by soil, and 2) a bare soil control. All control plots were harvested when plants were ≈23 to 25 cm tall. In 1992, BTC plots in Louisiana were uncovered when plants were ≈21 cm tall for a 5-d, full-sun exposure, enabling plants to gain pigmentation (de-etiolation) before cutting. In North Carolina there was no acclimation period before harvest. In 1993, BTC plots in North Carolina were uncovered for 3–5 d when plants were ≈23 cm tall. In 1994, BTC plots in Louisiana were uncovered for 10 d when plants were ≈18 cm tall. The length of full-sun exposure in BTC treatments was increased during the 3-year study in an attempt to prevent yield declines in BTC transplants. All plants were harvested from BTC plots and plants ≈23 cm or taller were retained, counted, and weighed. The BTC treatment was reapplied immediately after each cutting. Nearly all cuttings were made before 15 July.

Plants from all treatments were transplanted in early to late May (first planting), late May to mid-June (second planting), and late June to early July (third planting). Transplants for the control treatment were sometimes obtained in ancillary beds of the same clone. Twenty transplants per plot were placed 0.3 m apart within rows and 1.2 m between rows (1.1 m in North Carolina) in a randomized complete-block design with four replications. Commercial sweetpotato cultural practices were followed (Boudreaux, 1994; Wilson and Averre, 1989). Roots were harvested at maturity 97 to 121 d after transplanting. Yield was calculated for the commercially important U.S. no. 1 grade roots (roots 5.1 to 8.9 cm diameter and 7.6 to 22.9 cm long). Yield of other grades was omitted because treatments did not alter their weight appreciably. All data were analyzed by analysis of variance using the GLM procedure of SAS (SAS Institute, Cary, N.C.). Year and location were considered separately because the protocol for the BTC treatment varied for location and year. Means for each variable were separated using LSD at $P \le 0.05$.

Results and Discussion

Yield of transplants. In Louisiana, cuttings were harvested four (1994) and six (1992) times from BTC treatment beds vs. three harvests of the control beds in both years in Louisiana. A longer acclimation period for BTC treatments in 1994 reduced the number of harvest dates. The first harvest of cuttings in

BTC treatment beds was 28 d (1992) and 14 d (1994) prior to plant cutting in control beds (Table 1). In North Carolina in 1992, cuttings were harvested four times from BTC treatment beds vs. two times from control beds. A longer acclimation period in 1993 reduced the number of harvest dates for BTC treatment beds to three; control beds of 'Beauregard' and 'Jewel' were harvested two and three times, respectively. The first harvest of cuttings in the BTC treatment ranged from 37 d (1992) to 14 d (1993) prior to plant cutting in control beds. Our data demonstrate that BTC treatments hastened transplant production in comparison with black polyethylene mulch controls. The present study, however, did not include any perforated or double-slitted clear covers, which reportedly increased early transplant production of 'Travis' sweetpotato by 8 to 12 d over black polyethylene mulch controls (Porter, 1991).

In Louisiana, total plant production in 1992 and 1994 was increased ($P \leq 0.05$) by BTC treatment (Table 1). In 1992, a total of 1603 and 425 transplants were cut in BTC treatment beds and control beds of 'Beauregard', respectively. In 1994, the difference in transplant production between BTC treatment (2155 plants) and the control (1291 plants) for both cultivars was less but still significant. Results for 'Jewel' were similar. In North Carolina, similar result were obtained for 'Beauregard', but total plant production was not affected in 'Jewel'. Our data demonstrate that: 1) BTC increased total transplant production consistently in 'Beauregard' over control treatments; and 2) BTC increased total transplant production in 'Jewel' only in Louisiana. In previous research, various clear covers did not increase total plant number relative to black polyethylene mulch controls (Porter, 1991; Walker and Randle, 1986).

In Louisiana, BTC plants of 'Beauregard' and 'Jewel' weighed 72% and 62% less, respectively, than did the controls in 1992 (data not shown); less etiolation in 1994 reduced weight differences of BTC vs. control plants to 34% or less. In North Carolina, BTC plants of both clones weighed at least 50% less than the controls in both years. In 'Travis', weight of plants under perforated or double-slitted clear covers did not differ from the no cover control (Porter, 1991).

Root yield. In Louisiana, differences in root yield were observed between treatments in two of the three plantings in 1992 and in one of the two plantings in 1994 (Table 2). In 'Beauregard', yields of U.S. no. 1 grade roots from BTC transplants were 33% to 41% (1992) and 51% (1994) less than that from control transplants; in 'Jewel', yields were 28% to 54% (1992) and 67% (1994) less. No differences occurred in the first planting of each respective year when environmental conditions were best, i.e., adequate rainfall and moderate temperatures. A longer acclimation period in 1994 did not reduce the decline in yield of BTC transplants nor moderate the reduction in initial vine growth and full canopy development observed in all plantings in both years.

Table 1. Effect of black tunnel cover treatment on plant production of 'Beauregard' and 'Jewel' sweetpotato.

	Clone			
	Beauregard		Jewel	
	Treatment[z]			
Observation	Control	BTC	Control	BTC
	Louisiana, 1992			
Number of harvests	3	6	3	6
Date of first harvest	29 May	1 May	29 May	1 May
Total number of transplants[y]	142 b[x]	534 a	90 b	346 a
	Louisiana, 1994			
Number of harvests	3	4	3	4
Date of first harvest	16 May	2 May	16 May	2 May
Total number of transplants	430 b	718 a	224 b	427 a
	North Carolina, 1992			
Number of harvests	2	4	2	4
Date of first harvest	14 July	7 June	17 June	2 June
Total number of transplants	98 b	575 a	283 a	347 a
	North Carolina, 1993			
Number of harvests	2	3	3	3
Date of first harvest	17 June	10 May	1 June	10 May
Total number of transplants	351 b	572 a	812 a	734 a

[z]Control = control bed (bare soil); BTC = black tunnel cover.
[y]Plants 23 cm in length.
[x]Mean separation within rows and clones by LSD, $P \leq 0.05$.

Table 2. Effect of production of cuttings for transplanting under black tunnel covers on yield of 'Beauregard' and 'Jewel' sweetpotato roots.

| | | Yield[z] (t·ha⁻¹) | | |
Clone	Treatment[y]	Planting 1	Planting 2	Planting 3
		Louisiana, 1994		
Beauregard	BTC	13.9 a[x]	11.4 b	14.7 b
	Control	10.5 a	16.9 a	25.1 a
	LSD$_{0.05}$	3.5	3.6	7.2
Jewel	BTC	12.1 a	7.0 b	12.0 b
	Control	11.3 a	15.1 a	16.6 a
	LSD$_{0.05}$	3.8	4.9	4.1
		Louisiana, 1994		
Beauregard	BTC	14.1 a	5.2 b	---
	Control	16.4 a	10.7 a	---
	LSD$_{0.05}$	5.1	4.9	---
Jewel	BTC	---	2.7 b	---
	Control	---	8.1 a	---
	LSD$_{0.05}$	---	4.9	---
		North Carolina, 1992		
Beauregard	BTC	24.5 a	17.6 b	23.6 a
	Control	22.3 a	32.3 a	13.1 b
	LSD$_{0.05}$	10.7	6.0	8.3
Jewel	BTC	16.1 a	19.0 a	7.8 a
	Control	24.2 a	21.9 a	5.0 a
	LSD$_{0.05}$	18.8	7.0	9.3
		North Carolina, 1993		
Beauregard	BTC	24.7 a	19.2 a	24.1 b
	Control	25.9 a	15.4 a	34.0 a
	LSD$_{0.05}$	13.2	4.9	7.7
Jewel	BTC	23.4 a	6.4 a	16.7 a
	Control	30.9 a	5.9 a	18.2 a
	LSD$_{0.05}$	9.6	1.8	8.9

[z]U.S. no. 1 (roots 5.1 to 8.9 cm diameter and 7.6 to 22.9 cm long).
[y]Control = transplants from control beds; BTC = transplants from black tunnel cover.
[x]Mean separation within locations, years, plantings, and clones by LSD, $P \leq 0.05$.

In North Carolina, differences were observed between treatments in the second and/or third plantings in each year (Table 1). Yield reductions for 'Beauregard' BTC transplants ranged from 45% in 1992 (second planting) to 29% in 1993 (third planting) in comparison with controls. In 1992 and 1993, BTC treatment did not reduce yield in 'Jewel'. Results in North Carolina were similar to those in Louisiana for the first planting, i.e., yield was not affected by BTC in either clone. Results dif-

fered for the second and third plantings; BTC treatment did not reduce yield of 'Jewel' and yield increased 45% in 'Beauregard' in the third transplanting in 1992. Increased yields in 'Beauregard' are in part explained by an apparent increased survival of BTC transplants in this field planting; concomitantly, these plants appeared to be less vigorous in the field than were control plants, as observed in Louisiana. We did not investigate the de-etiolation process in sweetpotato. The prime effect of

light on plant organ development is to accelerate all phases of the division–enlargement–maturation sequence (Smith, 1975). Walker and Randle (1986) found that clear row covers did not alter yield over no cover controls in one early season yield trial. We know of no yield data for late season transplants grown under clear covers.

Black tunnel covers increase the number and earliness of transplants in comparison with bare ground production. However, clones may respond differently in different environments. Yield of early season BTC transplants was consistently similar to that of controls, implying a potential value in this method for early season transplantings. However, results were inconsistent with later transplanting dates; BTC transplants did not always yield at normal levels. This fact limits the value of this method.

Literature Cited

Boudreaux, J.E. 1994. Commercial vegetable production recommendations. Louisiana Coop. Ext. Serv. Publ. 2433.

La Bonte, D.R. and M.J. Cannon. 1997. Production and utilization of sweetpotato in the United States, p. 29–32. In: D.R. La Bonte, M. Yamashita, and H. Mochida (eds.). In: Proc. of Intl. Workshop on Sweetpotato Production System toward the 21st Century, Miyakonojo, Miyazaki, Japan.

Porter, W.C. 1991. Bed covers alter temporal distribution of production of sweetpotato transplants. HortScience 26:252–253.

Smith, H. 1975. The photocontrol of seedling development, p. 139–157. In: Phytochrome and photomorphogenesis. McGraw-Hill Co., Maidenhead, U.K.

Walker, D.W. and W.M. Randle. 1986. Influence of row covers, mulch, and bedding dates on early production of sweet potato transplants. HortScience 21:1354–1356.

Wilson, L.J. and C.W. Averre. 1989. Growing and marketing quality sweet potatoes. North Carolina Agr. Ext. Serv. No. AG-09.