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Evaluation of Transplant Root Length on Bell Pepper Yield and Quality

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Objective:

Bell pepper (*Capsicum annuum*), when direct seeded develops a taproot, however, most peppers are grown as transplants, causing plants to develop a fibrous root system. This study was conducted to try to maintain that taproot as much as possible to see what effect a taproot-type structure might have on fruit quality and yield.

Summary:

Allowing bell pepper transplants to develop a taproot system was detrimental to early plant growth. However, it did not have a significant detrimental effect on most fruit yield and quality parameters measured, and by final harvest, plants of all three root length treatments had similar above ground plant weights.

Methods:

Fertilizer: Prior to planting, nitrogen (33-0-0), potassium (0-0-62), sulfur (95%), and boron (Solubor) were broadcast at 100, 175, 25, and 20 pounds per acre, respectively. After planting, nutrients were applied through the drip irrigation system using Nitro Plus (18N-5Ca-1.5Mg and a proprietary growth regulator) at 15 gallons/acre injected on 19, and 24 June, 1, 8, and 15 July. Harvest More Urea Mate (5-10-27 plus minor nutrients) was then injected through the drip at 20#/acre on 22 and 29 July, 5, 12, 19 and 26 August; 2, 9, and 16 September.

Planting: Seed of 'Outsider' (Syngenta Seeds, Inc.) bell pepper was started in three sizes of clear, plastic tubes: Treatment 1 was 30.5 x 1.9 cm, Treatment 2 was, 17.1 x 2.54 cm, and Treatment 3 was 7.6 x 3.87 cm. Each tube was filled with a commercially available organic-based transplant media. Tube size was adjusted so each seedling had similar soil volume. Seedling spacing during the transplant stage was also set so each seedling had similar space (Figure 1). Seed was started in the greenhouse 28 and 29 March 2019. Transplants were set to the field 30 May on raised, black plastic mulched beds, 6" high, 22" wide at the top and 5.5-feet on center. Plants were set in double rows 14" between rows and 18" in the row (10,560 plants/acre). Treatment 1 seedlings were planted by making a pilot hole with a standard soil probe, pinching the base of the tube in one hand, the base of the plant in the other, and pulling the plant out of the tube. The root system was intertwined enough with the soil that the entire contents of the tube came out and could be slid into the pilot hole (Figure 2). Other treatments could be planted by digging the transplant hole slightly deeper by hand.

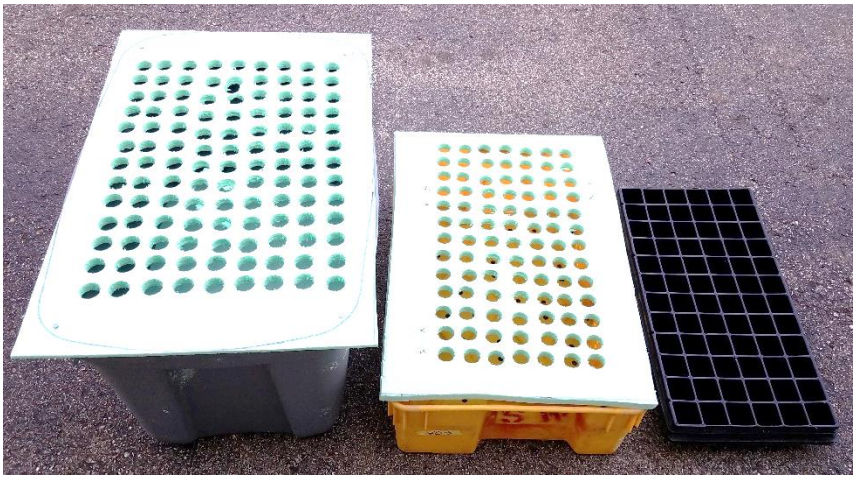

Figure 1. Transplant containers used to produce pepper transplants with root lengths of 30.5, 17.1, and 76 cm (left to right).

Figure 2. Planting method for Treatment 1 plants. Note the strong tap root on the plant on the left.

The trial was planted as a completely randomized design with 16 plants per plot and 4 replications. Four guard plants separated plots.

Weed control: Weeds were controlled by black plastic on the beds. Between row weeds were controlled through hand hoeing and cultivating.

Plant care: Plots were irrigated as needed and insects and diseases controlled using standard commercial practices.

Harvest and data collection: Immediately prior to planting, the above ground plant portion of ten random plants per treatment were weighed and the height measured. The root portion of the plant was not weighed due to the inability to remove rooting media. Height of 10 plants/plot was again measured on 9 July. Harvest was conducted 28 August, 9 and 23 September. Fruit was graded into Jumbo, Extra Large, Large, Medium, Number 2 and Culls. Each category was counted, weighed and converted into bushels per acre. Average number one fruit weight was also determined. Immediately after last harvest of commercial quality fruit, ten plants from each plot were cut at ground level and weighed. Weight included stems, leaves and unharvested fruit.

Results:

Similar to other crops in Southwest Michigan in 2019, pepper production was difficult. Cool, wet conditions in June made plant establishment and early growth difficult. Additional fertilizer was applied to try to overcome this condition but did not have the desired effect on increasing plant performance.

Top growth differences became visible as seedlings developed in the greenhouse. Plants in the longer rooted treatment were visually smaller than other treatments (Figure 3). This was verified through plant height and weight measurements at transplanting (Table 1). This difference continued to the 9 July height measurement but by the end of the growing season there was no difference in plant weight. The differences noted during early plant development in Treatment 1 could be due to the plant partitioning energy to taproot development instead of stems and leaves.

Figure 3. Seedling growth on 3 May (left) and 29 May (right). Note that on 3 May, all three treatments had roots reaching the tube bottom.

Other traits with significant differences at harvest were Average Number 1 fruit weight and yield of Extra Large Fruit (Table 1). Treatments 1 and 3 had statistically similar values for these two traits.

Having a longer transplant root had little to no apparent effect on most fruit yield and quality traits measured in this study. The extra effort required to raise and plant long rooted transplants is not warranted, in fact in some cases, it may be detrimental. Successful economic pepper production depends on developing strong plants prior to first fruit set. Once fruit are set, pepper plants appear to concentrate energy on developing fruit and not developing more plant, and if there is not a sufficient amount of plant, plant growth slows or ceases and has a negative effect on subsequent yields.

Table 1. Yield in bushels/acre of 'Outsider' bell pepper as affected by three root transplant lengths in 2019 at the Southwest Michigan Research and Extension Center, Benton Harbor, Michigan. Plants were set in double rows, 5.5 feet between rows, with 18" between plants in the row (10,560 plants/acre).

Trt. (tube lgth and dia)	**Total Yield**	**Avg. No. 1 Fruit Wt.**	**Yield Jumbo**	**Yield X-Large**	**Yield Large**	**Yield Med.**	**Yield No. 2**	**Yield Cull**	**Transplant Weight (g)[1]**	**Final Plant Wt. (g)[2]**	**Transplant Ht. (cm)[3]**	**Plant Ht. (cm)[4]**
1 (30.5 x 1.9 cm.)	895	**184[1]**	75	**111**	83	137	284	205	5.6	541	20.2	31.6
2 (17.1 x 2.54 cm.)	890	164	37	45	72	152	319	266	**7.1**	599	**25.9**	**36.0**
3 (7.6 x 3.87 cm.)	840	**180**	50	**105**	73	126	257	229	**6.5**	572	**25.2**	**33.6**
lsd 0.05	**ns**	**12**	**ns**	**60**	**ns**	**ns**	**ns**	**ns**	**0.8**	**ns**	**1.7**	**3.0**

[1]Numbers in bold are not significantly different from the highest number in that column.
[2]Measurements taken 24 September 2019 and included all above ground portion (stems, fruit, and leaves)
[3]Measurements taken 29 May 2019 and only included the above ground portion.
[4]Measurements taken 9 July 2019.