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INFLUENCE OF PLANT POPULATION ON FRUIT YIELD AND SIZE OF BELL PEPPERS[1]

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Abstract. **Bell peppers (Capsicum annuum L.) 'Early Calwonder' were plug-mix seeded on commercial pepper farms during fall-1983 in Delray Beach and spring-1984 in Loxahatchee, Florida. Treatments consisted of within-row spacings of 5, 10, 15 and 20 inches with 1, 2, or 3 plants per hill. Each treatment combination had 2 rows per bed and bed centers spaced 6 ft apart. Total fruit weight and number per acre increased linearly as within-row spacing decreased in both locations. Total fruit weight and number per acre increased linearly as number of plants per hill increased in the Loxahatchee experiment. Fruit weight and number per plant increased linearly as within-row spacing increased in both experiments. Fruit weight and number per plant increase quadratically and linearly as plants per hill decreased in the Loxahatchee and Delray Beach experiments, respectively. Average fruit size (oz/fruit) did not significantly differ among within-row spacings or number of plants per hill treatments in either experiment. Fruits during the first harvest were lighter green in color at higher plant populations in the Loxahatchee experiment. Results suggest that optimum pepper yields per acre occurred at higher plant population without sacrificing fruit size; however, light green fruit color at higher plant populations detracted from fruit quality.**

About 21,400 acres of bell peppers having a value of $89.7 million were produced in Florida during the 1982-1983 season (1). Most of the crop was grown in south Florida on plastic-mulch covered raised beds. There has been a continuing effort to achieve higher yields in vegetable crops by searching for optimum plant population and plant arrangements. Bell peppers grown on a raised bed plastic-mulch system are either direct-seeded using plug mix (4) or by using transplants. Plant spacing on each bed is generally two-rows spaced 16-20 inches apart and within-row spacings from 9 to 16 inches apart (6). Bed centers for the 42 inch wide bed are 5 to 6 ft apart (6). Locascio and Stall (5) reported an increase in bell pepper yields with double row beds spaced at 4 ft apart compared to 6 ft apart. They also measured no significant difference in pepper yield when comparing 9 and 12 inches within-row spacing. Everett and Subramanya (3) reported that marketable pepper yields increased as within-row spacing decreased from 12 to 4 inches in 2 of 3 experiments. In Georgia, bell peppers grown on unmulched beds produced higher yields as plant populations increased (2).

The purpose of this study was to determine the influence of within-row spacing and number of plants per hill on fruit yield and size of bell peppers.

Materials and Methods

The experiments were conducted on commercial pepper farms near Delray Beach during fall-1983 and near Loxahatchee, FL during spring 1984. 'Early Calwonder' peppers were plug-mix seeded on October 25, 1983 in Delray Beach and on December 9, 1983 in Loxahatchee. Plastic-mulch covered beds were spaced 6-ft apart. Peppers were plug-mix seeded in 2 rows per bed, spaced 20 inches apart.

Fertilization in the Loxahatchee experiment consisted of triple superphosphate at 300 lb./acre and a 5-3.1-4.2 (N-P-K) at 500 lb./acre broadcasted and incorporated prior to bedding. A 18-0-19.1 at 1500 lb./acre was banded in the center of each bed and a 6-1.7-6.6 at 500 lb./acre was applied in split bands, 18 inches apart. Fertilization in the Delray experiment consisted of a 6-8.7-4.2 at 500 lb./acre broadcasted and incorporated prior to bedding. A 18-0-19.1 at 1800 lb./acre was banned in the center of each bed.

Treatments were 5, 10, 15, and 20 inches within-row spacing with 1, 2, or 3 plants per hill. This resulted in 12 treatment combinations with plant populations varying from 8,712 to 104,544 plants per acre (Table 1). Each plot consisted of 40 hills with the center 20 used for fruit yield measurements. The experimental design was a randomized complete block with treatments replicated 4 times.

Table 1. Plant population of 12 within-row spacing and plant per hill treatment combination.

Within-row spacing (inches)	Plants/hill (no.)	Plant population (plants/acre)
5	1	34,848
5	2	69,696
5	3	104,544
10	1	17,424
10	2	34,848
10	3	52,272
15	1	11,616
15	2	23,232
15	3	34,848
20	1	8,712
20	2	17,424
20	3	26,136

Pepper fruits were harvested on February 16 and March 28, 1984 at Delray Beach and April 19, May 7, and May 14, 1984 at Loxahatchee. Marketable fruit weight and number per plot were summed for all the harvest dates. Fruit color was subjectively rated on a scale of 1 (yellow) to 5 (dark green) during the first harvest in the Loxahatchee experiment. Analysis of variance was performed on each measured variable and treatment sum of squares was partitioned into orthogonal contrasts.

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Results and Discussion

Marketable fruit weight and number per acre in the experiment located near Loxahatchee were 2 to 3-fold greater than in the experiment located near Delray Beach (Table 2, 3). A freeze occurred in Delray Beach just prior to the anthesis stage of plant growth and resulted in plants with no fruit yields during the first harvest, however, plants sufficiently recovered to produce a marketable second and third harvest.

Within-row spacing and number of plants per hill interactions were not significant except for marketable fruit weight and number per plant in the Loxahatchee experiment (Table 2, 3, 4, 5), therefore, only main effects are presented.

Marketable fruit weight and number per acre increased linearly as within-row spacing decreased in both experiments (Table 2, 3). These results are similar to those reported by Everett and Subramanya (3). Marketable fruit weight and number per acre in the Loxahatchee experiment and marketable fruit number per acre in the Delray Beach experiment also increased linearly as number of plants per hill increased. Average fruit size did not differ significantly at varying within-row spacing or number of plants per hill treatments in either experiment (Table 2, 3). This suggests that increased bell pepper yields were achieved at higher plant population without reducing fruit size. The standard practices in the fields where these experiments were conducted uses approximately 10 inches within-row spacing and 2 plants per hill or 34,848 plants per acre (Table 1). By decreasing within-row spacing from 10 to 5 inches, a 16 and 24% increase in marketable peppers yields per acre were obtained in the Loxahatchee and

Table 2. Main effects of within-row spacing and plants per hill on mean fruit weight and number per acre and mean fruit size (oz/fruit) of 'Early Calwonder' bell peppers grown at Loxahatchee, FL.

Treatment	Marketable fruit		
	1000's/acre	bu/acre[z]	oz/fruit
Within-row spacing (WRS) (inches)			
5	135	1783	5.4
10	115	1506	5.3
15	107	1444	5.4
20	98	1327	5.4
Significant effect[y]	L**	L*	NS
Plants/hill (PH) (no.)			
1	104	1385	5.3
2	112	1531	5.5
3	126	1624	5.2
Significant effect	L**	L*	NS
PH x WRS	NS	NS	NS

[z]Bushel = 25 lb.
[y]Significant F-value at the 1% (**) and 5% (*) levels; linear (L), and non-significant (NS).

Table 3. Main effects of within-row spacing and plants per hill on mean fruit weight and number per acre and mean fruit size (oz/fruit) of 'Early Calwonder' bell peppers grown in Delray, Florida.

Treatment	Marketable fruit		
	1000's/acre	bu/acre[z]	oz/fruit
Within-row spacing (WRS) (inches)			
5	81	790	3.9
10	61	603	4.0
15	53	547	3.9
20	51	458	3.6
Significant effect[y]	L**	L**	NS
Plants/hill (PH) (no.)			
1	67	523	3.9
2	67	602	3.8
3	53	652	3.8
Significant effect	L*	NS	NS
PH x WRS	NS	NS	NS

[z]Bushel = 25 lb.
[y]Significant F—value at the 1% (**) and 5% (*) levels, linear (L), and non-significant (NS).

Table 4. Main effects of within-row spacing and plants per hill on mean fruit weight and number per plant and mean fruit color rating of 'Early Calwonder' bell peppers grown at Loxahatchee, FL.

Treatment	Marketable fruit/plant		
	No.	lb.	Fruit[z] color rating
Within-row spacing (WRS) (inches)			
5	2.25	0.77	2.67
10	4.03	1.31	3.25
15	5.31	1.78	4.13
20	6.73	2.23	4.63
Significant effects[y]	L**	L**	L**
Plants/hill (PH) (no.)			
1	7.12	2.32	4.16
2	3.76	1.30	3.75
3	2.86	0.95	3.09
Significant effects	L**Q**	L**Q**	L**
PH x WRS	**	**	NS

[z]Fruit color rating based on 1 (yellow) to 5 (dark green), first harvest.
[y]Significant F-value at the 1% (**) level; linear (L), quadratic (Q), and non-significant (NS).

Table 5. Main effects of within-row spacing and plants per hill on mean fruit weight and number per plant of 'Early Calwonder' bell peppers grown in Delray Beach, FL.

Treatment	Marketable fruit/plant	
	No.	lb.
Within-row spacing (WRS) (inches)		
5	1.40	0.34
10	1.99	0.49
15	2.87	0.71
20	3.27	0.73
Significant effects[z]	L**	L**
Plants/hill (PH) (no.)		
1	3.39	0.82
2	2.27	0.53
3	1.49	0.35
Significant effects	L**	L**
PH x WRS	NS	NS

[z]Significant F-value at the 1% (**) level; linear (L) and non-significant (NS).

Delray Beach experiments, respectively. By increasing number of plants per hill from 2 to 3, a 6 and 8% increase in marketable pepper yields per acre were obtained in Loxahatchee and Delray Beach experiments, respectively.

Marketable fruit weight and number per plant increased linearly as within-row spacing increased in both experiments (Table 2, 3). Marketable fruit weight and number per plant increased quadratically as number of plants per hill decreased in the Loxahatchee experiments. This quadratic response occurred due to a greater increase in fruit weight and number per plant between 1 and 2 plants per hill when compared with 2 and 3 plants per hill. In the Delray experiment, marketable fruit weight and number per plant increased linearly as number of plants per hill decreased. These results suggests that the increases in pepper yields per acre at higher plant populations were not attributed to higher pepper yields per plant or a larger mean fruit size, but rather to more plants per acre with lower production per plant.

In the Loxahatchee experiment, a darker shade of green colored fruit occurred in the first harvest as within-row spacing increased or number of plants per hill decreased. The light green fruit color could detract from fruit quality at higher plant populations.

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BELL PEPPER CULTIVAR TRIALS: SPRING 1983 AND 1984[1]

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Abstract. **Bell pepper (Capsicum annuum L.) cultivars were evaluated at Bradenton in replicated trials in the spring of 1983 and 1984. In 1983, 14 cultivars were evaluated for marketable yield, number of fruit per plant, average fruit weight, and the number of fruit per 25 lb. carton. In 1984, 8 cultivars which looked promising in 1983 were evaluated along with 2 new entries, and were studied by the same parameters with additional information taken for individual fruit dimensions and shape. In the spring of 1983, 'Better Belle' was ranked as the top yielding entry in terms of number of cartons per acre (2357.1 cartons/acre) and the highest number of fruit per plant (10.2). However, there was not a significant difference in marketable yield among 'Better Belle', 'Big Bertha', 'Lady Bell', 'Crispy,' and 'Pro Bell.' Individual fruit weight was greatest for 'Jupiter,' 'Big Bertha', and 'Bell Tower,' (5.5, 5.4, and 5.3 oz, respectively). 'Big Bertha' and 'Lady Bell' had significantly greater yields at the first harvest than 8 other cultivars.**

In the spring of 1984, 'Gator Belle' was ranked as the top yielding entry with 2162.9 cartons per acre, however there was not a significant difference in yield among 'Gator Belle,' 'Crispy,' 'Pro Bell,' 'Bell Boy' and 'Lady Bell'. Individual fruit weight was greatest for 'Big Bertha' with an average fruit size of 4.9 oz. Early yield comparisons show little difference among cultivars in the spring of 1984.

During the 1982-83 pepper season in Florida, 19,700 acres were harvested and yielded 9.5 million bushels with a total value of $89.7 million. When compared to the previous season, production increased 19% due to increased yield per acre and value per bushel rose from $7.00 to $9.45 (2). Florida pepper production accounted for 59% of the total U. S. shipments during the months from October to June in 1982-83, exclusive of incoming shipments from Mexico which decreased Florida's share to 43% (1).

Selection of commercial cultivars by pepper growers is a critical step in the production schedule to assure high and reliable yields from season to season. Numerous pepper cultivars were evaluated at the Gulf Coast Research and Education Center in Bradenton, FL during spring 1983 and spring 1984 for yield and performance characteristics.

Materials and Methods

Spring 1983. Field preparation for the spring 1983 trial began in January, 1982 and consisted of the addition of dolomite at 1 ton/acre and 600 lb./acre superphosphate (0-8.7-0) containing 80 lb./ton micronutrients as F 503 oxide. The land (EauGallie fine sand) was utilized in row crop production of sweet corn in the spring of 1982 and laid fallow in the fall of 1982. Six weeks prior to planting, 7 beds were formed between irrigation furrows on 4.5 ft centers and treated with 66% methyl bromide and 33% chloropicrin at 350 lb./acre. Full bed surface incorporated dressing included 18-0-20.8 (97 lb./acre), (38-0-0 at 97 lb./acre) and superphosphate (0-8.7-0 at 784 lb./acre) containing F 503 oxide micronutrients. A single band of 18-0-20.8 was applied down the center of the bed at the rate of 2352 lb./acre. Beds were covered with black plastic mulch.

Seed of 14 cultivars were sown on December 2, 1982 in wooden flats containing a processed product of spent coal (Saf-T-Blast, Mineral Aggregates, Inc.). Seedlings were transplanted 18 days later into containerized flats (1-1/2 x 1-1/2-inch cells, Todd Model #150) containing a peat, sand, vermiculite, perlite mix (5:3:3:1) amended with superphosphate (2.3 oz), dolomite (15.0 oz), Micromax (2.3 oz), hydrated lime (1.5 oz) and $CaCO_3$ (15.0 oz), all per 0.1 yard^3 of media. Transplants were set in the field on Febru-

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