CARIBBEAN FOOD CROPS SOCIETY

37

Thirty Seventh Annual Meeting 2001

Trinidad and Tobago

Vol. XXXVII

Proceedings of the Caribbean Food Crops Society. 37:197-201. 2001

EFFECTS OF HIGH PLANT POPULATION DENSITIES ON YIELDS, PLANT AND FRUIT CHARACTERS OF THE HOT PEPPER CULTIVAR, WEST INDIES RED

*H. V. Adams, **F.B. Lauckner**, and D. D. Sisnett, Caribbean Agricultural Research and Development Institute, Graeme Hall, Christ Church, Barbados*

ABSTRACT: Seven different plant population densities were tried on the hot pepper cultivar, 'West Indies Red', in two important trials, one was done in 1998 and the other in 1999 in Barbados. The population densities ranged from 5,744 plants up to 40,000 plants per hectare. The results showed a linear increase in yields as the plant population density increased. However, the yield from 30,000 plants per hectare did not differ significantly from that obtained from 40,000 plants per hectare. The yield per hectare from the highest plant population density of 40,000 plants was 123% higher than the yield from the farmer practice (9,570 plants/ha). The changes in treatments did not affect berry shapes and sizes. However, the plants grew taller and narrower as the population density increased.

INTRODUCTION

The hot pepper crop is growing in importance as exports and regional acreage have increased over the recent past. All the indicators are that the hot pepper industry is a growth economic activity. The demands of the market in United States of America alone far outstrip the total production of the Caribbean which represents less than 1% of that demand. During 1998 the CARICOM countries exported 4,667 tons fresh and processed hot pepper valued at US$10 million (Paul et al., 2000).

The popular hot pepper cultivar in the Caribbean over the past decade has been the "West Indies Red" selected by CARDI (Cooper and Gordon., 1992). The export and domestic markets show a preference for this cultivar whilst the farmers find that it gives the highest yields.

BACKGROUND AND JUSTIFICATION

Yields from the West Indies Red grown on farmers' fields, are far below hot pepper yields obtained in other countries. National yields of fresh berries in Barbados, for example, are around 8,000-10,000 kg/ha whereas those obtained from trials have surpassed 25,000 kg/ha. Comparatively, farmers' yields from other countries are, as follows: China, 22,500 kg/ha; Turkey, 20,400 kg/ha and Thailand, 13,300 kg/ha (Berke and Shieh, 2000).

One of the main reasons for low yields of hot pepper on farms in Barbados is the low plant population densities which are adjusted mostly to facilitate the work of the ridger and tractor which can make raised beds 168 cm apart. This bed width also facilitates mechanical weed control during early crop growth. It is reasoned that an increase in the number of plants per unit area, to approach the high plant population densities of 65,000 to 85,000 plants per hectare as practiced in Mexico, although on the slightly smaller plants of jalapeno and serrano cultivars of chilli pepper (Pozo, 1995), can contribute to increases in yields. It is also felt that closer spacings where the canopy completely covers the soil soon after transplanting will obviate the need for mechanical weed control on the standing crop. Therefore a study was undertaken to investigate the possibilities of planting at higher population densities in Barbados.

MATERIALS AND METHODS

Two trials were conducted in 1998 and 1999 in Barbados. Both trials were irrigated through drip lines which kept available soil moisture around 40-60%.

Trial #1: Six plant population densities including the farmers' practice (control) were tested, as follows.:

5,744	plants/hectare	-	93 cm x 187 cm
9,570	"	-	93 cm x 112 cm (control)
11,488	"	-	93 cm x 93 cm
13,398	"	-	93 cm x 80 cm
17,232	"	-	93 cm x 62 cm
19,140	"	-	93 cm x 56 cm

A 6 x 6 Latin square design was chosen and the net plots at the widest spacing contained 14 plants. The plots measured 4.48 x 4.48 m and all plots were separated by metre wide paths. The data recorded and analysed were as follows: Days from transplanting to 50% flowering in a plot; Average width (cm) of plant canopy from five random plants per plot at 50% flowering; Average plant height (cm) from five random plants per plot at 50% flowering; Yield (kg) of fruits per plot at each picking; Average number of mature fruits per plant harvested from five random plants per plot at each picking; Plant height (cm) of five random plants per plot at each picking; Canopy width (cm) of five random plants per plot at each picking; Average weight (g) of fruit from 10 random fruits per plot at each picking; Average length (cm) of fruit from 10 random fruits per plot at each picking; Average width (cm) of fruit from 10 random fruits per plot at each picking.

The effects due to treatments were determined by the analyses of variance using the MINITAB statistical software (MINITAB, 1996).

Transplanting was done on 10 February 1998 and the first picking took place on 4 May 1998.

Trial #2: The second trial was conducted in the same field as the first. All the field and crop care operations were similar. Based on the results of the first trial, where yield increased linearly from the lowest population density to the highest, it was decided to test still higher densities. The treatments, therefore, were 3 different plant population densities as follows:

10,000 plants/hectare (control)
30,000 " "
40,000 " "

The control was taken as 10,000 plants/ha since it was closest to the farmer practice of 9,570 plants/ha in the first trial.

The three treatments were laid out in a 3x3 Latin square design replicated four times. The size of the experimental plots was 4.20 m x 4.76 m in order to accommodate a minimum of 20 plants in the net plot with the treatment containing the lowest plant population density.

The same set of data as in trial #1, were recorded and analysed using the same methods.

Transplanting was done on 6 May 1999, the first picking on 27 July 1999 and the last and seventh picking on 11 November 1999.

RESULTS AND DISCUSSIONS

Trial #1 (Table 1)

Average plant height and canopy width

These two plant developmental characters were very significantly affected by the treatments. The plants grew taller (P=0.011) and wider (P=0.000) when given more space. Wider spacings produced bigger plants with longer and a larger number of branches.

Yields

The yields from the plots with the higher plant population densities were very significantly higher (P=0.000) than the control (farmer practice). The general clear trend was a linear increase from lower to the higher densities. The widest spacing yielded 19.98 kg/plot and the closest 44.63 kg/plot of fresh pepper, an increase of 123%.

Average number of fruits per plant

The wider spacings yielded more fruits per plant (P=0.021). The clear trend was a linear decrease in the number of fruits per plant from the lowest to the highest plant population densities. This was due to the larger number of longer branches on bigger plants.

Average fruit weight

The general trend was a very gradual reduction in average fruit weight from the control towards the highest plant population density, 11.73g - 11.07g. Despite the significance of these differences (P=0.007), they were too small for practical purposes.

Average fruit width and length

The treatments did not affect these two dimensions of fruit. Coupled with the small differences in average fruit weight, it was clear that higher plant population densities up to 19,140 plants/ha did not affect fruit shape nor size.

Table 1. Comparison between five plant population densities and the control (9,570 plants/ha). Yield components and plant development characters were measured over six pickings on the trial conducted in Barbados in 1998.

Treatment Planst/ha	Yield per plot (kg)	Average number of fruits per plant	Average fruit weight (g)	Average Fruit width (cm)	Average Fruit length (cm)	Average Plant height (cm)	Average width of canopy (cm)
5,744	19.98	38.56	12.28	3.67	4.19	79.68	105.86
9,570 (Control)	33.77	39.02	11.73	3.66	4.10	76.79	99.96
11,488	37.98	33.83	11.98	3.58	4.11	74.30	91.29
13,398	40.54	32.62	11.59	3.61	4.11	73.93	90.46
17,232	41.18	31.61	11.38	3.57	4.08	70.93	84.51
19,140	44.63	30.35	11.07	3.53	3.96	71.37	83.47
SEM (df=23)	2.46	1.97	0.20	0.04	0.07	1.66	1.51
P	0.0***	0.021**	0.007**	NS 0.136	NS 0.313	0.011**	0.000***

NS = non – significance at 5%, *** = significance at 0.1%, ** = significance at 1%

Trial #2 (Table 2)

Yields and yield components

Yield per plant was very significantly affected by the treatments. The lowest plant population density produced 2.73 kg/plant whilst the highest yielded 0.85 kg/plant (P=0.000). This same trend was observed in the previous trial. However, the total yield per net plot and consequently the yield equivalent per hectare increased almost linearly with the increase in plant population density (P=0.000 and P=0.000, respectively). Also the number of fruits per plant decreased with the increase in the plant population density; the control produced 97 more fruits per plant than the closest spacing. However, despite the reduction in yield per plant as the population density increased, the total yield per plot was greatest at the highest plant population density since the larger number of plants per unit area more than compensated for the loss of yield per plant. Conclusively, 40,000 plants per hectare outyielded 10,000 plants per hectare (the control) by 123% (P=0.000).

Average weight of fruit, average length of fruit and average width of fruit were not affected by the treatments. All the three dimensions of fruit size did not change with the increase in plant population density. This was very important to fruit quality and meant that closer spacing of the plants of the cultivar, West Indies Red, presented an opportunity for increasing yields without any decrease in quality of fruits.

Plant development characters

The wider spaced plants grew laterally to fill up the space; canopy width of the control was 121.24 cm whilst that of the closest spacing (40,000 plants/ha) was 103.91 cm (P=0.000). Conversely, the plants grew taller the closer they were planted; the average plant height of the control was 87.97 cm whilst that of the densest plant population was 96.45 cm (P=0.000).

All the trends described above were also observed in population density trials with the cultivar, 'Scotch Bonnet' in Jamaica (McGlashan, 2000).

Table 2. Comparison between a low plant population density (the control, 10,000 plants/ha) and two other densities, three and four times higher. Yield components and plant development characters were combined over seven harvests on the trial with the hot pepper cultivar, West Indies Red, conducted in Barbados in 1999.

Treat. (Plants/ha)	Total yield/ plant (kg)	Total yield/ net plot (kg)	Yield equivalent (kg/ha)	Total no. of fruits/ plant	Mean weight of fruit (g)	Mean length of fruit (cm)	Mean width of fruit (cm)	Mean plant height (cm)	Mean canopy width (cm)
10,000 (Control)	2.73	15.88	15,125	215.04	10.84	3.85	3.11	87.97	121.34
30,000	1.14	34.27	32,641	136.64	11.17	3.84	3.32	93.06	103.75
40,000	0.85	35.46	33,775	117.78	10.90	3.83	3.19	96.45	103.91
SEM (df=23)	0.22	2.42	2,307	12.09	0.24	0.05	0.059	1.21	1.75
P	0.000* **	0.000 ***	0.000 ***	0.000 ***	NS 0.598	NS 0.977	NS 0.055	0.000* **	0.000 ***

NS = non-significance at 5%, *** = significance at 0.1%

CONCLUSIONS

From the two separate trials conducted on seven different plant population densities (range 5,744 to 40,000 plants/ha) with popular hot pepper cultivar, West Indies Red, the following conclusions are drawn: higher plant population densities produced highest yields of mature berries. Increase of yield from lowest to highest plant population density was linear. Despite the fact that closely spaced plants produced a smaller number of berries per plant than widely spaced plants, the larger number of plants per unit area at the closer spacings more than compensated, hence the higher yields at the higher plant population densities. Closer spaced plants grew taller and narrower than those at wider spacings (low plant population densities). Berry size, shape and weight were not affected by the higher plant population densities. Fruit qualities remained the same at wide or close spacings.

The economic impact of higher plant population densities should be measured and closer plant spacings should be considered for inclusion in production systems for high yields

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