PROCEEDINGS

OF THE

38th ANNUAL MEETING

June 30th – July 5th 2002
Hôtel Méridien, Trois-Ilets, Martinique

**"Quel devenir pour l'agriculture caribéenne ?
Qualité, économie, progrès social, environnement"**

**"What is the future of Agriculture in the Caribbean ?
Quality, Economy, Social Progress, Environment"**

**"¿ Cuàl es el futuro de la Agricultura en el Caribe ?
Cualidad, Economía, Progreso Social, Medio ambiente"**

UE

Conseil Régional de la Martinique

Conseil Général de la Martinique

CHAMBRE D'AGRICULTURE MARTINIQUE

**Proceedings edited by:**

Xavier MERLINI
Isabelle JEAN-BAPTISTE,
Hélène MBOLIDI-BARON

**Published by:**

Ministère de l'agriculture de l'alimentation de la pêche et des affaires rurales

LE LAMENTIN Ville festive

AMADEPA
Ex Hotel de ville, Rue Schoelcher,
97 232 Lamentin, Martinique
E-mail : amadepa@wanadoo.fr
Phone : 596 76 62 36
Fax: 596 76 66 95

# IN-ROW PLANT SPACING AFFECTS GROWTH AND YIELD OF FOUR HOT PEPPER CULTIVARS

D.A.O'Keefe and M.C. Palada

Agricultural Experiment Station, University of the Virgin Islands, RR2 Box 10,000, Kingshill, St. Croix, U.S. Virgin Islands 00850. E-mail : mpalada@uvi.edu

## RESUME

Un essai à la ferme fut conduit pour déterminer un espacement optimum sur la ligne des cultivars de Piment fort des Antilles (Capsicum chinense L). « Habanero », « West Indian Red » et deux cultivars de piments forts de « Scotch Bonnet » furent plantés à trois espacements différents de 40, 46, et 61 cm. Toutes les parcelles de traitement consistaient en trois rangées, avec un espacement constant de 0,91m entre rangs. L'étude expérimentale était complétée par trois blocs aléatoires divisés en parcelles. Les distances d'espacement étaient le traitement principal et les cultivars étaient le traitement secondaire. Les données collectées incluaient huit plants à la première récolte, le nombre et le poids frais des fruits, le nombre de récoltes et la période de production. Le rendement était estimé par calcul du nombre de plants par hectare multiplié par le rendement moyen par plante. Le "West Indian Red" planté à 40 cm de distance de plantation produisit le plus fort rendement de tous les traitements. La densité de plantation optimum pour "Yellow Scotch Bonnet" fut obtenue avec la distance de plantation de 61 cm. "Jamaïca (Red) Scotch Bonnet" produisait un rendement similaire à 46 et 61 cm de distances de plantation. "Habanero" produisit le plus petit rendement à la distance de plantation la plus élevée (61cm). La réponse des cultivars à la distance de plantation était très nette ($P< 0,05$) et l'interaction de la distance de plantation et du cultivar était aussi considérable ($P< 0,05$). Cette étude indique que les cultivars de piments varient dans leur distance de plantation d'espacement optimum pour parvenir à de hauts rendements.

## ABSTRACT

An on-farm trial was conducted to determine optimum plant spacing for West Indian hot pepper (Capsicum chinense L) cultivars. 'Habanero,'' West Indian Red' and two 'Scotch Bonnet' hot pepper cultivars were planted at three in-row spacings of 41, 46 and 61 cm. All treatment plots consisted of three rows with constant row spacing of 0.91m. The experimental design was three randomized complete blocks of split- plots. The in-row spacings were the main plots and the cultivars were the subplots. Data collected included plant height at first harvest, number and fresh weight of fruits, number of harvests and production period. Yield was estimated by computation of the numbers of plants per hectare factored by the average yield weight per plant. Optimum planting density for 'Jamaica (Red) Scotch Bonnet' and 'Yellow Scotch Bonnet' was at the widest in-row spacing of 61 cm. The 'Scotch Bonnets' also showed a trend of taller plants producing more of fruits as in-row plant spacing was increased. Differences in yield response of cultivars to in-row spacing was significant ($P< 0.05$), however, yields from 'Habanero' and 'West Indies Red' were less affected. Analysis revealed that yield was mostly influenced by cultivar. In-row spacing x cultivar interaction was not as significant. This study indicates that in-row spacing for attaining the best yield is highly variable for hot pepper cultivars.

## INTRODUCTION

West Indian hot peppers (Capsicum chinense L) are grown throughout the U.S. Virgin Islands (USVI) and are very popular for "spicing up" the local cuisine. Several hot sauce manufacturers in the region provide a reliable market. Hot pepper is a profitable crop, easily adapted to the growing conditions of the Virgin Islands. Production often occurs on small-scale farms with limited capital resources, thus, a cropping system is needed which is cost efficient yet still results in optimum yields. The University of the Virgin Islands Agricultural Experiment Station (UVI-AES) has conducted several studies to develop improved crop management practices for hot pepper (Palada and O'Keefe, 2001; Crossman, Palada and Davis, 1999; Palada and O'Keefe, unpublished). The 'Scotch Bonnet' types and 'West Indies Red' cultivars were identified as most promising for production in the USVI. The fruits of all C. chinense are described as type 4 and 5 of the Capsicum Descriptor index, however, the different cultivar types are quite varied in shape and size (IPGR, AVRDC and CATIE, 1995). The 'Scotch Bonnets' are known for their tam-o-shanter or bonnet shapes, where as the 'Habanero' are lantern shape and 'West Indies Red' may be described as blocky or cylindrical (Adams and Sisnett, 2001a).

Microirrigation has proven to be the most efficient use of the limited water resources for crop production in the Virgin Islands (Palada, Crossman and Collingwood, 1995). Previous studies have indicated that in the Virgin Islands, hot peppers may produce high yields when grown under low soil moisture conditions and maintained by microirrigation. Water use efficiency was greatest when soil moisture levels were at 60 kPa, which were recorded with tensiometers (Palada and O'Keefe, 2001). The most commonly used drip-line tape has emitters which have been laser-drilled at fixed intervals, and are available with 20cm to 76cm spacings. Local farmers grow hot peppers in rows with 61cm to 91cm between rows and use drip tape with 41cm to 61cm spacing. Hot pepper fields are usually less than 0.5 ha, and it is essential to produce good yields from this limited area.

Studies from other Caribbean research centers have shown that plant spacing can significantly affect hot pepper developmental characteristics such as, plant height, numbers of fruits and canopy development. Most importantly, greater yields were produced from the 'Scotch Bonnet' and 'West Indies Red' cultivars at high plant population densities In Barbados, plant spacing equivalent to 40,000 plants per hectare, increased gross yield weight of 'West Indies Red' by 123%, when compared to production from the traditional plant spacing (McGashlan, 1999; Adams, Laukner and Sisnett, 2001b). These promising results suggest that hot pepper production may also be increased in the Virgin Islands by manipulation of in-row plant spacing. UVI-AES has completed a study to determine the affect of three common in-row spacings on the growth and yield of 'West Indies Red, 'Yellow Scotch Bonnet' 'Jamaica (Red) Scotch Bonnet' and 'Habanero' hot pepper cultivars.

## MATERIALS AND METHODS

An on-farm study was conducted at Estate Glynn on St.Croix, USVI (lat $17^0$ 42' N, long. $64^0$ 48' W). The soil is a Glynn gravely loam(clayey, skeletal, mixed, superactive, isohyperthermic, typic, argiustoll) (Ludo-Lopez et al., 1998). The experimental design was three split-plot randomised complete blocks. In-row plant spacing of 41 cm, 46 cm and 61 cm, were assigned as main plots. The subplots were the hot pepper cultivars, 'Habanero,' 'Jamaica Scotch Bonnet,' 'Yellow Scotch

Bonnet' and 'West Indies Red.' Seeds of 'Habanero' and the 'Scotch Bonnets' were obtained from commercial seed companies in the U.S. mainland, the 'West Indies Red' was from CARDI. Field plots consisted of three 4.26 m rows with 91 cm between the rows. Each plot measured 2.73 m x 4.26m or 11.6 $m^2$. The in-row plant spacing were the same as the emitter spacing of the drip-line tape for microirrigation. Drip-lines of 15 mm Netafim tape (Netafim USA, Fresno, CA) with the three plant spacing were laid out in randomised blocks. The four cultivars were randomised within the main plots.
Seedlings were transplanted on January 18, 2001. An initial application of soluble fertilizer (20-20-20) was applied via fertigation at a rate of 100-100-100 NPK. Three split fertilizer applications were subsequently applied at rate of 50-50-50 NPK, resulting in a total fertilizer application of 250-250-250 NPK. Soil tensiometers (Irrometer Co., Riverside, CA) were installed in each block and 30 kPa soil moisture was maintained during the cropping period.

The first harvest was on April 17, 2001, and the average plant height was recorded. The crop was harvested eight times with the last harvest on June 21, 2001. Five plants were harvested from the middle row of each plot and the number of fruits and fresh weight yield was recorded at each harvest. Fruit size, yield weight and number of fruits per plant averages were computed based on the total harvest per plot. Plant density per hectare equivalents for each in-row plant spacing used to estimate yields (t $ha^{-1}$) were as follows; 41 cm = 27,222 plants per ha, 46 cm = 24,197 plants per ha and 61 cm = 18,150 plants per ha. Data was analysed by General Linear Modelling, using SAS PROC GLM, (SAS Institute, 1995) and analysis of variance was done for fruit size of the individual cultivars.

## RESULTS

The 'Scotch Bonnets' were tallest when grown at the 61cm in-row spacing. Plant height was tested using the general linear model; plant height = replication, in-row space, cultivar. The effect of in-row spacing was significant ($P< 0.001$). This response was most evident with 'Yellow Scotch Bonnet' ($P< 0.05$). As indicated in Table 1, all cultivars had less plant height at the 46 cm than at 41cm spacing. There were no significant differences for plant height of 'West Indies Red' and 'Habanero.' All cultivars produced more fruits per plant at the 61 cm spacing than closer in-row spacing. This increase was most significant for 'Jamaica Scotch Bonnet'($P< 0.01$) in which average fruits per plant of the 41 cm, 46 cm and 61 cm spacing were, 54.6, 59.7 and 73.06 respectively.

Size of fruit, as measured by fruit weight, was influenced most by the cultivar ($P< 0.01$). Analysis of variance of in-row spacing revealed no significant differences of fruit size within an individual cultivar.

Yields per hectare (t $ha^{-1}$) were usually greater at the 61cm in-row spacing, which realized a 34% increase for 'Habanero' to as much as 75% more for 'Yellow Scotch Bonnet'(Figure 1). GLM analysis for the model: yield= replicate, in-row spacing, cultivar, revealed the trend for increased yields at wider spacing (Table 2). However, only the 'Scotch Bonnet' cultivar yields were clearly affected. Yields of 'Habanero' and 'West Indies Red' were nearly the same from the 41 cm and 61cm plant spacing. It should be noted that, a slight decrease of yield occurred at the 46 cm spacing, for West Indies Red' and 'Yellow Scotch Bonnet' which may have been caused by poor field conditions within a replicate block. In concurrence with more fruit production, 'Jamaica Scotch Bonnet' best fit the GLM ($P< 0.01$) for yield response to the in-row spacing (Table 2). Yield steadily increased as in-row spacing was increased (Figure 1).

## CONCLUSION

Each hot pepper cultivar was unique in growth habit, fruit production and yield response when grown at different in-row plant spacing. 'Habanero' and 'West Indies Red' were less affected by plant spacing. Adams (2001a) found that the plant architecture of 'West Indies Red' significantly changed in response to wider spacing, however, this may have been a matter of greater variability in the plant population densities studied. He also determined that higher plant densities resulted in far greater yields. In comparison, we found yields were less when spacing was closer within the row, but the difference was insignificant. Thus it may be surmised that increasing yield per hectare requires sufficient numbers of plants.

When the 'Scotch Bonnet' type cultivars were compared to 'West Indies Red' and 'Habanero,' the 'Jamaica Scotch Bonnet' showed the greatest trend of more fruit production and increased yields as in-row spacing expanded. The 'Yellow Scotch Bonnet' responded similarly and showed a significant increase of plant height. Taller plants producing more fruits resulted in greater yields at the 61cm spacing.

In-row plant spacing for production of optimum yields varies and may be influenced by cultivar type.

## ACKNOWLEDGMENT

The authors gratefully acknowledge the work of Srs. Paulino Perez, Research Assistant, and Nelson Benitez, Agricultural Aide, for their assistance with the field experiment, and, Ms. Jeanmarie Mitchell, Research Analyst, for recording the data. We also thank the farmer, Mr. Sekou George, Estate Gylnn, St. Croix, for his participation in this study.

Funding for this research was provided by the Tropical and Subtropical Agricultural Research (T-STAR) administered by the Caribbean Basin Advisory Group (CBAG) under the U.S. Department of Agriculture (USDA).

## LITERATURE CITED

Adams, H.V. and Sisnett, D.D., 2001a. Development of Breeding Lines from the Hot pepper Cultivar 'West Indies Red.' Proc. Caribbean Food Crops Soc., 37, 15-20 July, 2001. Port-of-Spain, Trinidad and Tobago.

Adams, H.V., Laukner, F.B. and Sisnett, D.D., 2001b. Effects of High Plant Densities on Yields, Plant and Fruit Characters of the Hot Pepper Cultivar 'West Indies Red.' Proc. Caribbean Food Crops Soc. 37, 15-20 July, 2001. Port-of-Spain, Trinidad and Tobago.

Crossman, S.M.A, Palada, M.C. and Davis, A.M., 1999. Performance of West Indian Hot Pepper Cultivars in theVirgin Islands. Proc. Caribbean Food Crops Soc. 35: 169-177.

IPGR, AVRDC and CATIE, 1995. Descriptors for Capsicum (Capsicum spp.). International Plant Genetic Resources Institute, Rome, Italy; the Asian Vegetable Research and Development Center, Taipei, Taiwan, and the Centro Agronomic Tropical de Investigación y Ensenanza, Turrialba, Costa Rica.

Lugo-Lopez, M.A., Beinroth, F.H. , Santiago, C.L. and Branno, G.R., 1998. Updated Taxonomic Classification of the Soils of the U.S. Virgin Islands, 1997, Bulletin 257. University of Puerto Rico, College of Agricultural Sciences, Mayaguez, Puerto Rico and Agricultural Experiment Station, Rio Piedras, Puerto Rico.

McGaslan, D., 1999. Evaluation of 'Scotch Bonnet' Pepper (Capsicum chinense Jacq.) Under Different Plant Densities. Proc. Caribbean Food Crops Soc. 34, Abstr., p. 24.

Palada, M.C., Crossman, S.M.A. and Collingwood, C.D., 1995. Improving vegetable production using microirrigation in the Virgin Islands. pp. 502-509 In: Freddie Lamm (ed.). Microirrigation for a Changing World: Conserving Water Resources/Preserving the Environment. Proc. 5th International Microirrigation Congress, Orlando, Florida. American. Soc. of Agric. Engineers (ASAE) 4-95.

Palada, M.C. and O'Keefe, D.A., unpublished data "Study of Scoville Heat Unit (SHU) response of hot pepper and yield production under three soil moisture levels."

Palada, M.C. and O'Keefe, D.A., 2001. Response of Hot Pepper Cultivars fto Levels of Drip Irrigation in the Virgin Islands. Proc. Caribbean Food Crops Soc. 37, 15-20 July, 2001. Port-of-Spain, Trinidad and Tobago.

SAS Institute, 1994. The SAS system for Windows. Release 6.10. SAS Inst., Cary, NC.

**Table 1. Effect of three in-row plant spacing on growth and fruit production of four hot pepper cultivars. Means of three replicate blocks**

| Determinant (d) | In-row Space | Habanero | Jamaica Scotch Bonnet | West Indies Red | Yellow Scotch Bonnet |
|---|---|---|---|---|---|
| AVE. plant height (cm) 1st harvest | 41 cm | 42.6 | 36.7 | 45.1 | 49.1 |
| | 46 cm | 39.1 | 35.4 | 40.8 | 47.5 |
| | 61 cm | 45.9 | 41.4 | 45.3 | 56.7 |
| | Pr >F[1] | 0.37 NS | 0.08* | 0.21 NS | 0.03** |
| Number fruits per plant | 41 cm | 57.9 | 54.6 | 51.7 | 37.3 |
| | 46 cm | 68.0 | 59.7 | 51.0 | 29.9 |
| | 61 cm | 75.0 | 73.1 | 58.0 | 61.9 |
| | Pr >F[1] | 0.28 NS | 0.008*** | 0.79 NS | 0.18 NS |
| Fruit size (grams) | 41 cm | 8.3 | 8.9 | 13.1 | 12.9 |
| | 46 cm | 8.9 | 9.4 | 11.0 | 13.2 |
| | 61 cm | 8.7 | 10.1 | 13.0 | 13.1 |
| | Pr >F[2] | 0.80 NS | 0.36 NS | 0.58 NS | 0.60 NS |

1. PROC GLM (SAS); Model d=rep, in-row space, cultivar
2. PROC ANOVA (SAS); analysis of variance of response to in-row space within cultivar.

NS = not significant

* = significant at P< 0.10, ** P< 0.05, ***P< 0.01

**Table 2. General Linear Model, PROC GLM (SAS), analysis of effect of in-row spacing on yield of four hot pepper cultivars**

| | DF | MS | F | Pr > F |
|---|---|---|---|---|
| Model[1] | 17 | 61.916 | 4.68 | 0.0011 |
| Replication | 2 | 339.577 | 25.65 | < 0.0001 |
| In-row space[2] | 2 | 107.08 | 8.09 | 0.0031 |
| Cultivar[3] | 3 | 10.81 | 0.82 | 0.5013 |
| In-row space X cultivar | 6 | 10.45 | 0.79 | 0.5900 |

1. Model; yield= replication, in-row spacing, cultivar.
2. In-row spacing = 41 cm, 46 cm, 61 cm.
3. Cultivars = 'Habanero,' 'Jamaica Scotch Bonnet,' 'Yellow Scotch Bonnet,' and 'West Indies Red.'

**Figure 1. Estimated yield (t ha$^{-1}$) of hot pepper cultivars; 'Habanero' (HB), 'Jamaica Scotch Bonnet' (JSB), 'West Indies Red' (WIR), and 'Yellow Scotch Bonnet' (YSB) from three in-row plant spacing**