

# Effect of Spacing on the Growth and Yield of Spanish Pepper (*Capsicum annum* L.) Grown Under Rain Shelter.

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## ABSTRACT

An experiment was conducted to investigate the effect of spacing on the performance of Spanish pepper grown under rain shelter. The performance of the crop under rain shelter was compared with a crop grown in an open field with 3 different spacing levels (30x30 cm, 30x45 cm, and 30x60 cm). A drip irrigation system was used to give optimum water requirement to the crop. According to the results, the growing conditions and spacing levels were not significantly influencing the Spanish Pepper yield. However, the treatments significantly affected the branching habit. The results indicated that, though the yield differences were not significant between rain shelter and out door conditions, the quality of pods were significantly higher under the rain shelter. Further, the closer spacing has given higher yield per unit area under both conditions. Therefore, the 30x30 cm spacing and rain shelter condition could be recommended for testing under farmer field condition.

**KEY WORDS:** Spanish Pepper, Rain Shelter, Spacing, Yield, Growth

## INTRODUCTION

Chillies are green or dried fruits of pungent forms of *Capsicum annum*, which is widely cultivated throughout the world, more specifically in the tropical and subtropical regions. The pods are rich in vitamins, especially in vitamins A and C. It is a very important and indispensable item in every kitchen for its pungency, spicy taste, besides the appealing colour, which adds to the food (Bose, *et al.*, 1986).

Trials with different spacings indicated the superiority of 30x30 cm yielding 1596 kg dry pods/ha, which account for 11.4 % and 35.83 % higher than 45x30 cm or 45x45 cm spacing, respectively (Selvaraj, *et al.*, 1974).

The cultivated area of chilli in Sri Lanka was 19830 ha in 2000 with an average production of 55860 mt (Anon, 2000). In 2004, it was around 10200 mt from 13821 ha (Anon, 2004). However, chilli production declined steadily during the last decade and the present out put is about one third of the out put in the early 1990s.

Among the commonly cultivated *Capsicum* species of the world, Spanish pepper has high demand in the export market and a popular consumer item in Europe, Japan and Middle East countries. The pods are low in pungency, olive green in colour, 98-135mm in length and 10-16mm in width with wrinkled neck area.

To get the ideal characters well drained, moderately fertile soil with a pH of 6-7 and a day temperature of 18-29 °C and night temperature of 15-18 °C are necessary. Sun Frost (Pvt) Ltd. imports Spanish Pepper pods to Sri Lanka for processing and bottling for exportation. Importing pods of Spanish pepper is costly. Hence, the company is presently engaged in cultivating Spanish Pepper in Sri Lanka by fulfilling requirements of the cultivar to get a profitable yield. Due to lack of recognition of this particular chilli variety, farmers and people who are involved in this industry are facing difficulties in identifying and selection of suitable agronomic practices. Therefore, this study was

designed to identify the spacing requirement and performance of Spanish Pepper under rain shelter conditions.

## MATERIALS AND METHODS

An experiment was conducted at the faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila, (Low country Intermediate Zone) during the period of November 2004 to April 2005.

The crop was cultivated under two conditions which served as main treatments. The two main treatments were the rain shelter (Rain shelter condition) and the open environment (Outdoor condition). The field was ploughed up to 25-30 cm depth, harrowed and leveled.

Six raised beds were prepared 60 cm apart, three in each main treatment. Each bed served as a replicate (Three replicates in the open environment and three replicates in the rain shelter). Each bed was divided equally into three sub plots, for three spacing levels.

An equal amount of cowdung was applied to each plot and mixed thoroughly. After leveling, basal dressing (Ammonium Sulphate 500, Triple Super Phosphate 600, Potassium Sulphate 600, Magnesium Sulphate 600 kg/ha) was applied and mixed well with the soil. Two days after application of the basal dressing, transplanting was done. Only healthy, vigorous 4 weeks old seedlings were transplanted.

Three hundred and sixty seedlings were used for the experiment. They were transplanted using three different density levels. The treatments used in the trial are given below.

<u>Treatment</u>	<u>condition</u>
T1	Rain shelter condition/Indoor
T2	Open environment /Out door
S1	30x30 cm spacing (111,111 plants/ha)
S2	45x30 cm spacing (74,074 plants/ha)
S3	60x30 cm spacing (55,555 plants/ha)

Drip system was used to irrigate the plants. Weeding and application of fungicides and insecticides were done when necessary. Ammonium sulphate (200 kg/ha), Triple super phosphate (100 kg/ha), Potassium nitrate (200 kg/ha), and Calcium nitrate (200 kg/ha) were added as top dressing, 30 days after transplanting. Second top dressing was applied 30 days after first top dressing. Quantity of each fertilizer was similar to that of first top dressing.

The experiment was laid out in a split plot design with three replicates, each replicate having three plots. Each plot consisted of 29 plants (30x30cm), 17 plants (30x45cm) and 14 plants (30x60cm). Five randomly selected plants from each plot were used for the data collection. The data were analyzed using the Statistical Analysis System (SAS) package (Anon, 1999). The parameters recorded were, plant height at 30 day intervals (cm), number of branches at 30 day intervals, yield per plant (g), number of pods per plant, pod length (cm) and pod diameter (cm). Ten pods from each treatment were randomly selected for recording of pod diameter (Verneer caliper reading) and pod length (cm)). Light was measured using a Tube Solarimeter and Microvolt Integrator (Type MV2)

The total pod yield per plant was recorded separately for each treatment and means were compared using General Linear Model. Ten pods were selected from each main treatment and mean pod length, pod diameter, and pod weight were measured. Means were compared using t test. Forty five plants were selected to get the measurements of number of branches and plant height. Mean values were compared using General Linear Model.

## RESULTS AND DISCUSSION

Harvesting started 41 days after transplanting in both outdoor and rain shelter conditions. Light level and temperature at different dates of harvesting are given in table 1.

### a) Number of branches

1-month after transplanting no significant differences were observed among treatments for branching habit (Table 2). After 2 months, out door condition recorded the highest mean value (9.97) and was significantly different from rain shelter condition that recorded the lowest mean value (6.84). Further, differences between three plant densities were not significant. However, Levy *et al.* (1983) reported that, higher density could reduce the lateral branching in chilli.

### b) Plant height

1month after transplanting, significant differences were observed among treatments for plant height (Table 3). Rain shelter was significantly effective and highest values for plant height (26.9 cm, 30.2 cm, 29.6 cm) were observed under Rain shelter condition for three densities. However, there was no significant spacing effect within the rain shelter. The values recorded after 2 months did not show any significant differences for plant height (Table 3). Revanappa *et al.* (1998) too reported that, plant height

increases with plant density in chilli. Leonardi (1996) reported that, shading could increase the plant yield.

**Table 1. Light level and temperatures recorded at different dates of harvesting.**

Dates of harvesting	Light Intensity (mv)		Temperature °C	
	OD	RS	OD	RS
1 <sup>st</sup> (02/02/2005)	77	31	30	31
5 <sup>th</sup> (12/02/2005)	74	20	29	31
10 <sup>th</sup> (24/02/2005)	62	20	33	29
15 <sup>th</sup> (15/03/2005)	70	23	30	29

OD- Outdoor: RS- Rain Shelter

**Table 2. Mean number of branches of Spanish pepper recorded at 1 month and 2 months after transplanting.**

Spacing	Number of branches			
	1 MAT		2 MAT	
	OD	RS	OD	RS
S1	2 <sup>a</sup>	4 <sup>a</sup>	10 <sup>a</sup>	6 <sup>b</sup>
S2	2 <sup>a</sup>	5 <sup>a</sup>	10 <sup>a</sup>	8 <sup>b</sup>
S3	3 <sup>a</sup>	4 <sup>a</sup>	9 <sup>a</sup>	6 <sup>b</sup>
Lsmean	2.3	4.33	9.97	6.84

Treatment means in column having a common letters are not significantly different by PDIFF 5%. IMAT- 1 Month after Transplant 2MAT- 2 Months after Transplant

**Table 3. Mean plant height of Spanish pepper recorded at 1 month and 2 months after transplanting.**

Spacing	Plant height (cm)			
	1MAT		2 MAT	
	OD	RS	OD	RS
S1	19.0 <sup>a</sup>	26.9 <sup>b</sup>	28.8 <sup>b</sup>	32.9 <sup>b</sup>
S2	18.2 <sup>a</sup>	30.2 <sup>b</sup>	28.9 <sup>b</sup>	36.3 <sup>b</sup>
S3	20.7 <sup>a</sup>	29.6 <sup>b</sup>	28.4 <sup>b</sup>	36.7 <sup>b</sup>
Lsmean	19.3	28.9	28.7	35.3

Treatment means in column having a common letters are not significantly different by PDIFF 5%.

### c) Pod length

The pod length was not significantly different among two main treatments (Table 4). The highest pod length (8.3cm, 8.96cm) was observed in the 1<sup>st</sup> pick under both conditions and the lowest pod length (2.66cm, 6.35cm) was observed at the 15<sup>th</sup> pick. A sudden reduction in length was observed at 15<sup>th</sup> pick (2.66cm) in outdoor condition. However, two main treatments gave the same pod colour, olive green, which is the typical color of the Spanish Pepper. The wrinkle neck area was clearly present under the rain shelter condition. Specified pod length for the Spanish Pepper is 6-8 cm. This pod length was achieved correctly within 1<sup>st</sup>, 5<sup>th</sup>, 10<sup>th</sup> picks under both conditions while it was difficult to achieve during latter picks.

### d) Pod diameter

The diameter of pods under different main treatments did not show a significant difference (Table 4). The highest pod diameter (2.79cm) which was observed in the 15<sup>th</sup> pick in outdoor condition would not be acceptable by the exporters. When the length reduced the pod diameter increased in outdoor condition. Specification for the diameter was 8-10mm. However, during the last picks it was difficult to achieve under out door condition. Pods were short and thick (2.79cm). It reduced the quality of the pods.

**Table 4. Pod length (cm) and Pod diameter (cm) of Spanish Pepper recorded in 1<sup>st</sup>, 5<sup>th</sup>, 10<sup>th</sup>, and 15<sup>th</sup> picks at Makandura**

Picks	Length (cm)		Diameter (cm)	
	OD	RS	OD	RS
1 <sup>st</sup> (02/02/2005)	8.3 <sup>a</sup>	8.96 <sup>a</sup>	1.12 <sup>a</sup>	1.22 <sup>a</sup>
5 <sup>th</sup> (12/02/2005)	7.29 <sup>a</sup>	7.99 <sup>a</sup>	1.04 <sup>a</sup>	1.03 <sup>a</sup>
10 <sup>th</sup> (24/02/2005)	7.49 <sup>a</sup>	7.49 <sup>a</sup>	1.01 <sup>a</sup>	1.01 <sup>a</sup>
15 <sup>th</sup> (15/03/2005)	2.66 <sup>b</sup>	6.35 <sup>a</sup>	2.79 <sup>b</sup>	0.81 <sup>a</sup>
Lsmeans	6.43	7.69	1.49	1.01

The same letter within a column means are not significantly different at P=0.05

#### e) Pod weight

Significantly higher pod weight was recorded under rain shelter conditions throughout this experiment. It was evident that, rate of reduction in pod weight under rain shelter towards the latter part of the crop was much lesser than the crop grown in outdoor condition. This shows that rain shelter has significantly affected towards maintaining required pod weight through out the experimental period than the out door conditions (figure 1).

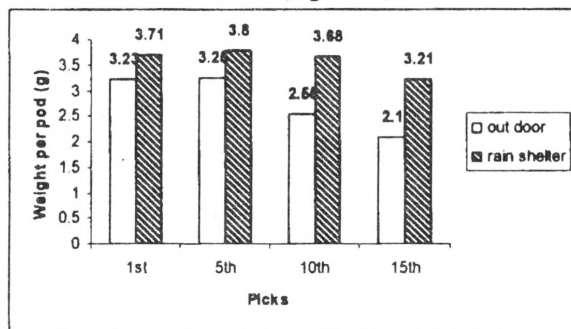


Figure 1. Mean pod weight of Spanish pepper (g) under rain shelter and out door condition recorded in 1<sup>st</sup>, 5<sup>th</sup>, 10<sup>th</sup> and 15<sup>th</sup> picks at Makandura.

#### f) Number of pods

Number of pods per plant were not significantly different between outdoor and rain shelter condition (Table 5). It is clear from the results that, in outdoor condition, the highest number of pods (39.33) were recorded in 30x30cm spacing, while lowest pod number (36.66) was recorded in 45x30cm. Under the rain shelter condition, the highest pod number was recorded in 45x30cm spacing and the lowest was in 60x 30cm spacing.

Table 5. The average number of pods of Spanish pepper under rain shelter and out door conditions

Spacing	Number of pods	
	OD	RS
S1	39.33 <sup>a</sup>	32 <sup>a</sup>
S2	36.66 <sup>a</sup>	42.3 <sup>a</sup>
S3	37.33 <sup>a</sup>	30.33 <sup>a</sup>

Treatment mean in column having a common letters are not significantly different by PDIFF 5%

#### g) Pod yield

Yield per plant obtained under two main treatments were not significant. The densities, too, did not show any significant differences except for the S<sub>3</sub> in rain shelter, which was significantly lower than the

other two. However, when yields were evaluated per unit area (Table 6) it was evident that, the closer spacing (30 x30 cm) gave significantly higher yields in open area while under rain shelter the significant yield difference was seen only in S<sub>3</sub> which was much lower than S<sub>1</sub> and S<sub>2</sub>. Another striking factor was that the yields under out door Condition were higher than the rain shelter condition. Similar higher yields were obtained by Selvaraj *et. al* (1974), and Rawanappa *et. al.* (1998) in chilli.

Table 6. Effect of spacing and rain shelter on Spanish pepper yield.

Spacing	Yield (g)/plant		Yield (kg)/1000 m <sup>2</sup>	
	OD	RS	OD	RS
30 x 30 cm	116.28 <sup>a</sup>	89.70 <sup>a</sup>	1291.97 <sup>a</sup>	996.70 <sup>a</sup>
45 x 30cm	99.53 <sup>a</sup>	111.28 <sup>a</sup>	737.28 <sup>c</sup>	824.29 <sup>a</sup>
60 x 30cm	104.9 <sup>a</sup>	73.99 <sup>b</sup>	582.80 <sup>c</sup>	411.05 <sup>b</sup>

Treatment means in column having a common letters are not significantly different by PDIFF 5%

### CONCLUSIONS

Highest yield per unit area was obtained from 30x30 cm spacing for both out door and rain shelter conditions. The number of pods did not vary significantly among the treatments. However, the pod weight showed significant increase under rain shelter conditions. Further, pod length and diameter were maintained at uniform size under rain shelter than out door condition. This uniformity in size, diameter and length may contribute largely towards export quality of the pods. Therefore, results indicate that, though the yield differences were not significant between rain shelter and out door condition, the quality of pods were significantly better under rain shelter. Further, the closer spacing (30x30 cm) has given higher yield per unit area under both conditions. Therefore, the spacing (30x30 cm) and the rain shelter could be recommended for testing Spanish pepper under farmer field conditions.

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### REFERENCES

- Anon (2000 and 2004). Annual Report, Central Bank of Sri Lanka.
- Bose, T.K., Kabir, J., Maity, T.K., Parthasarathy, V.A. and som, M. G. (1986). *Vegetable Crop I*: 165, 166, 205, 211
- Leonardi, C. (1996) *Cotture Protette*, 25: 61 - 65
- Levy, A., Palenitch, D., Mehagem, E., Admati, E., Shifriess, C. and Barzilai, M. (1983) *Hassadeh*, 63: 1626 - 1628
- Revanna, Nalawdi, U. G. and Chetti, M. B. (1998) *Karnataka J. Agric. Sci.*, 11: 122 - 126
- Selvaraj, K.V., Subramaniam, S. and Rajasekharan, R. (1974) *Madras Agric. J.*, 61: 889