Reprint **ISSN 1923-7766 (Web Version)**

International Journal of Experimental Agriculture

(Int. J. Expt. Agric.)

Volume: 5 **Issue: 1** **January 2015**

Int. J. Expt. Agric. 5(1): 13-20 (January 2015)

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ISSN-1923-7766 (Online)
Int. J. Expt. Agric. 5(1):13-20(January 2015)

EFFECT OF GROWING CONDITIONS AND SEED TREATMENT ON THE GROWTH AND DISEASE REACTION OF CAPSICUM

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Accepted for publication on 5 January 2015

ABSTRACT

Doullah MAU, Debnath A, Ashrafuzzaman M (2015) Effect of growing conditions and seed treatment on the growth and disease reaction of capsicum. *Int. J. Expt. Agric.* 5(1), 13-20.

A pot experiment was conducted to find out the best growing conditions for production of healthy capsicum fruit at the Bangladesh Agricultural University campus. Seeds were treated prior to sowing with skimmed milk suspension at 1:4 dilutions and garlic extract at 1:2 dilutions to get rid of seed borne pathogens. One seedling was placed in a single pot. The pots were placed in different places *viz*. open roof, green house, net house and open space. The net house condition was found to be the best in preventing disease intensity and severity as well as in healthy capsicum fruit production. Seed treated with garlic extract was found to be the better. Treatment combination "net house × garlic treatment" gave comparatively the better result amongst all other combinations in terms of yield contributing characters, disease severity and fruit yield.

Key words: *capsicum, plant extract, seed treatment, virus disease, growing conditions*

INTRODUCTION

Capsicum (*Capsicum annuum* L.) is one of the important vegetables and a spices crop in the world belonging to the solanaceae family. It is also known as paprika, pimento, sweet pepper, red pepper and bird pepper depending upon the type and the way in which it is used. Sweet peppers, sometime known as green or bell peppers which may be eaten as cooked or raw, sliced in salads. The sweet pepper is relatively non-pungent with thick flesh, and is the world's second most important vegetables after tomato (Anon. 1989).

In Bangladesh, sweet pepper (Capsicum) is considered as a minor vegetable crop and its production statistics is not available. Presently the high class restaurants import it from India and Thailand to meet the local demand. Still its demand is expanding very fast with urbanization and growth of tourism industry and the fast food restaurants. Now farmers are trying to cultivate sweet pepper for its high market value.

The sweet capsicum is highly sensitive to environmental factors. Thus, it is mostly cultivated under polytunnels or glass-house in European countries and Japan where night temperature, light intensity, relative humidity etc. are controlled to maintain the quality and yield of crop (Uffelen and Bakker, 1987). Capsicum is reported to be infected by large number of viruses including *Tobacco mosaic*, *Tobacco etch*, *Cucumber mosaic*, *Potato virus X* and *Potato virus Y* (Purseglove *et al.* 1981; Brunt *et al.* 1996). *Tobacco mosaic virus* (TMV), *Cucumber mosaic virus* (CMV), *Tobacco etch virus* (TEV), *Potato virus Y* (PVY), *Potato virus X* (PVX), *Tobacco ring spot virus* (TRSV), *Tobacco rattle virus* (TRV) and *Alfalfa mosaic virus* (AMV) are the major viruses affecting capsicum (Fujisawa *et al.* 1990; Sharma *et al.* 1993; Kiss 1988; Brunt *et al.* 1996). The diseases cause heavy loss in yield of the crop.

Considering the importance of capsicum (paprika) in our commerce for cultivation, disease especially viral diseases are the main constrains for production (Sherf and MacNab, 1986). Diseases can be managed by using different botanicals and insecticides especially for viral infection for reducing yield loss. The management of diseases employing environment friendly materials gained momentum as mankind became more environment conscious. Botanical extracts and such other organic substances would be good replacement of toxic pesticides (Ragupathi and Veeragatham, 2002; Harbant *et al.* 1999). For this reason cultural management is the next best option to combat the diseases of capsicum. That's why the research work has been undertaken to determine different environmental conditions that affect plant development and to determine the efficacy of organic substances to manage seed-borne diseases and their interaction effects.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at Seed Pathology Centre, Bangladesh Agricultural University during the period of December, 2006 to July, 2007. The capsicum cultivar: paprika was used in this study. A total of 150 healthy looking seeds were taken. Seeds were treated with skimmed milk and garlic extract for the management of seed borne pathogens.

Fifty seeds were treated with skimmed milk. The milk suspension was made at the ratio of 1:4 (Milk powder: Water). Seeds were soaked for three minutes in the milk suspension followed by washing with distilled water for one time and drying on clean blotter paper before sowing. The same amount of seeds (50) was also treated with garlic extract at the ratio of 1:2. Seeds were soaked in the freshly prepared garlic extract thoroughly so that

total surface of seed gets a film of extract. Treated seeds were washed with distilled water followed by drying on clean blotter paper before sowing. Seeds were then allowed to germinate in sterilized seed bed.

Preparation of soil for pot

Sandy loam soil was sun-dried and sterilized with Formalin @ 3 ml/1000 ml water per cubic feet soil and covered by polythene sheet for 72 hours. After that polythene sheet was removed to expel the vapor of formalin. Well decomposed dry cow dung and sterilized soil at the ratio of 1:1 (cow dung: soil) were well mixed thoroughly for making rich soil before filling the pots.

A total of three earthen pots (size: 14") were taken for each treatment and surface sterilized with formalin followed by drying before use.

Preparation of Pot

At first the pots were filled with khoa up to 2" and then coarse sand for 3" at the bottom of the pots on which the pre-mixed organic matter rich soil were placed keeping about 2" margin at the top of each pot. About 32-day old healthy looking seedling was transplanted at the centre of each pot. After planting, a stick was provided per pot for support to the growing plants. Three pots were prepared for each treatment. A total of nine pots with transplanted seedlings were then placed according to design.

The pots were then placed in four different environments *viz*. Roof, glass house, open space and net house.

Growing conditions and treatments:

Four growing conditions P_1 = Roof, P_2 = Net house, P_3 = Green house and P_4 = Open space and three seed treatments T_0 = Control, T_1= Skimmed milk and T_2 = Garlic extract were used in the experiment.

Data collection

Data in respect of the following parameters (Table 1) were collected at 15, 30, 45, 60 and 75 DAT (Day after transplanting).

Table 1. Different parameters of Capsicum

A. Yield contributing parameters	B. Plant health parameters	C. Yield parameter
1.Plant height (cm)	1.Number of healthy plants/treatment	1. Fruits per plant (g)
2.Number of leaves per plant	2.Number of diseased plants per treatment (mosaic/leaf spot/leaf blight/others)	
3.Number of branches per plant	3.Number of symptom bearing leaves per plant	
4.Number of fruit set per plant	4. Diseased leaf area	
5.Number of mature fruits per plant		

Statistical analysis

The experiment was set up in a Completely Randomized Design (CRD) with three replications maintaining proper control. Analysis was done using MSTAT computer package program. Mean differences were adjudged by Duncan's Multiple Range Test (DMRT).

RESULT AND DISCUSSION

Effect of growing conditions on yield contributing characters of capsicum

Effect on plant height

Pots were placed in different conditions in order to make different growing conditions which are presented in Table 2. There were significant variation in plant height at 15, 45, 60 and 75 DAT among the places but at 30 DAT there was no significant variation. At 15 DAT, the highest (13.93 cm) plant height was observed in P_3 (green house) which was statistically similar with P_4 (open space) as 12.41 cm and P_2 (net house) as 12.92 cm. The lowest 10.08 cm plant height was recorded in P_1 (roof). The plant height continued to increase up to 60 DAT.

At 30 DAT the effect of growing condition on plant height was insignificant, i.e. the condition (placement) did not differ significantly from one another. At 45 DAT, the highest plant height was observed in P_4 (32.11 cm) which was statistically similar with P_2 (31.43 com) and followed by P_3 (28.22 cm). The lowest 24.24 cm plant height was recorded in P_1 which was statistically similar to P_3. At 60 DAT, the highest 36.06 cm plant height was observed in P_4. The lowest 24.76 cm plant height was recorded in P_1 which was statistically similar with P_3. At 75 DAT, the highest 45.67 cm plant height was observed in P_4. The lowest 24.94 cm plant height was recorded in P_1 which was statistically similar with P_3.

Effect on leaf

In case of number of leaves, the highest number of leaves/plant was 9.56 in P_1 at 15 DAT which was statistically almost similar with P_2 (9.11) and the lowest was observed in P_4. At 30 DAT, the highest number of leaves/plant was 18.89 in P_2 and the lowest number was 9.00 in P_4. At 45 DAT, the highest number of leaves/plant (34.56) was observed in P_2 and lowest (8.22) was in P_3. The same trends were found at 60 and 75 DAT. From the table

it was appeared that number of infected leaves showed as decline. This is due to shedding of infected leaves after 45 DAT (Table 2).

Effect on branch

Significant variations were also observed among the growing conditions on number of branches/plant of capsicum at 15, 30, 45, 60 and 75 DAT (Table 2). At 15 DAT only plants placed on roof and in the net house started branching. The highest number of branches/plant (0.67) was observed in P_1 at 15 DAT and 0.33 number of branch, in average, were developed in the plants at P_2 (net house). At 45 DAT more or less branching was observed in all the test plants in all the growing conditions. The highest number of branches/plant (4.22) was observed in P_1 at 30 DAT and lowest was 0.11 in P_3. The number of branches/plant (7.56) in P_1 was statistically similar with P_2 and the number of branches (2.11) of P_3 was statistically similar with P_4. At 60 DAT, the highest number was 10.11 which were statistically similar with P_1 and the lowest (2.00) was recorded in P_3. At 75 DAT, the highest number of branch/plant was 10.67 in P_2 which was statistically similar with P_4 and lowest was 2.44 in P_3 (Table 2).

Table 2. Effect of growing places on yield contributing characters of capsicum

Conditions	Plant height (cm)					Number of leaves /plant					Number of branch /plant				
	15	30	45	60	75	15	30	45	60	75	15	30	45	60	75
Roof (P_1)	10.08b	17.36	24.24b	24.76c	24.94c	9.56a	12.89b	21.44b	18.00b	31.89a	0.67a	4.22a	7.56a	9.56a	7.00b
Net house (P_2)	12.92ab	18.19	31.43a	32.24b	32.89b	9.11ab	18.89a	34.56a	37.22a	36.22a	0.33b	1.11b	7.44a	10.11a	10.67a
Green house(P_3)	13.93a	17.19	28.22ab	27.11c	25.78c	8.00b	9.67bc	8.22d	7.00c	4.56c	0.00b	0.11c	2.11b	2.00c	2.44c
Open space(P_4)	12.41ab	15.28	32.11a	36.06a	45.67a	6.22c	9.00c	15.67c	16.78b	24.89b	0.00b	1.33b	3.22b	4.11b	8.11ab
Level of Sig.	*	NS	**	**	**	**	**	**	**	**	**	**	**	**	**
LSD	2.73		4.26	3.73	5.65	1.20	3.42	4.33	5.00	5.86	2.04	0.76	2.04	2.07	3.21

In column, the figures having common or without letter(s) do not differ significantly as per DMRT; * = Significant at 5% level of probability; ** = Significant at 1% level of probability; NS = Not significant

Effect on fruit set

Fruit set started at 30 DAT but there was no significant difference among growing conditions (placement of pots). There was significant variation in the number of fruit set per plant at 45, 60 and 75 DAT among the conditions. At 45 DAT, the highest number of fruit set per plant was 2.67 in P_2 which was statistically similar with P_4. The lowest was 1.56 in P_3 which was statistically similar with P_1. The highest number of fruit set was observed at 45 DAT. New fruit setting thereafter decline. However, fruit setting continued up to 75 DAT. These fruit setting also was influenced by conditions (Table 2).

At 60 DAT, the highest number of fruit set per plant (1.67) was recorded in P_2 which was statistically similar with P_1 and P_4 and the lowest (0.67) was observed in P_3 which was statistically similar with P_1 and P_4. At 75 DAT, the highest number of fruit set per plant (1.33) was recorded in P_2 which was statistically similar with P_1. The lowest number of fruit set per plant (0.44) was observed in P_3 which was statistically similar with P_1 and P_4 (Table 2).

Effect on mature fruit

The effect of growing condition (placement of pots) of plants on the availability of matured fruits per plant has been presented in Table 2. Mature fruits were first available at 45 DAT at P_1, P_2 and P_3 but arrival of mature fruit at P_4 was firstly at 60 DAT. The effect of different growing conditions on number of mature fruit per plant was found to be significantly different at 45 DAT but at 60 and 75 DAT there was no difference. At 45 DAT, the highest number of mature fruits per plant was 0.89 in P_2 which was statistically similar with P_1 and no fruit was observed in P_4 (Table 2).

Table 2. Effect of growing places on yield contributing characters of capsicum (Contd.)

Conditions	Number of fruit set per plant				Number of mature fruit per plant		
	30	45	60	75	45	60	75
Roof	3.22	1.67b	1.22ab	0.89ab	0.67ab	0.89	0.44
Net house	3.78	2.67a	1.67a	1.33a	0.89a	1.00	0.89
Green house	2.44	1.56b	0.67b	0.44b	0.11bc	0.56	0.33
Open space	3.44	2.56a	1.22ab	0.67b	0.00c	0.78	0.33
Level of Sig.	NS	*	*	*	*	NS	NS
LSD		0.84	0.60	0.53	0.60		

In column, the figures having common or without letter(s) do not differ significantly as per DMRT; * = Significant at 5% level of probability; NS = Not significant

Interaction effect of seed treatment and growing conditions on the yield contributing parameters of capsicum

The effect of different growing condition (placement of pots) with different seed treatments on the potted plants are presented in Table 3. The interaction effect on plant height was found significant at 45 and 60 DAT only but

at 15, 30 and 75 DAT, there was no significant difference. At 45 DAT, the highest (37.00 cm) plant height was recorded in P_2T_2(net house × garlic treatment) which was statistically similar with P_1T_1, P_1T_2, P_2T_0, P_3T_1, P_3T_2, P_4T_0, P_4T_1 and P_4T_2 and lowest (13.67 cm) plant height was observed in P_1T_0 (roof × control). The P_4T_2 (open space × garlic treatment) plants have been observed to grow in height faster than the others and at 60 DAT, the highest (39.17 cm) plant height was found was found in P_4T_2 which was statistically similar with P_2T_2 (net house × garlic treatment). The treatment combinations of P_3T_2, P_4T_0 and P_4T_1 were significantly close to P_4T_2. The lowest (14.67 cm) plant height was observed in P_1T_0 (roof × control) which was statistically similar to P_3T_0 (green house × control).

Effect on leaves

Significant variation was observed on the number of leaves per plant at 15, 30, 45, 60 and 75 DAT (Table 3). The maximum number (14.33) of leaves was found in P_1T_2 (roof × garlic treatment) which was statistically close to P_2T_1 (net house × skimmed milk) and the minimum number (1.67) was found in P_3T_0 (green house × control). At 30 and 45 DAT, the highest (24.67 and 45.00) number of leaves per plant was found in P_2T_2 (net house × garlic treatment) and lowest (6.67 and 7.33) was observed in P_3T_0. Production of leaves was at its peak in almost all the treatment combinations. However, the number of leaves continued to grow at P_2T_1 and P_2T_2, treatment combinations. At 60 and 75 DAT, the highest (61.33 and 58.33) number of leaves per plant was found in P_2T_2 (net house × garlic treatment) and the lowest (6.00 and 2.33) was found in P_3T_1 (green house × skimmed milk).

Effect on branch

The effect of different treatment combinations on the number of branch per plant was found statistically significant at 15, 30, 45 and 60 DAT but at 75 DAT there was no statistical significant (Table 3). At 15 DAT, the highest number of branch per plant (1.33) was recorded in P_1T_1 and lowest was recorded in P_1T_0 which was statistically similar with the combination of P_1T_0, P_2T_0, P_3T_0, P_3T_1, P_3T_2, P_4T_0, P_4T_1 and P_4T_2. It means that the plants under these treatment combinations did not develop branch at 15 DAT. Even at 30 DAT, there was no branching at the treatment combinations P_2T_0, P_3T_0 and P_3T_1. At 30 DAT, the highest (6.33) number of branch per plant was observed in the combination of P_1T_1 which was statistically similar to P_1T_2.

The highest (14.67 and 20.67) number of branch was observed in the combination of P_2T_2 at 45 DAT and the lowest (1.00 and 2.00) was observed in combination of P_3T_0.

Table 3. Interaction effect of growing conditions and seed treatments on the yield contributing parameters of capsicum at different days of transplantation

Treatments	Plant height (cm)					Numbers of leaves per plant					Number of branch per plant				
Interaction (Conditions × Treatments)	15	30	45	60	75	15	30	45	60	75	15	30	45	60	75
P_1T_0	8.00	10.57	13.67d	14.67d	14.00	2.33f	7.33cd	16.67cd	14.33def	38.67b	0.00c	0.00	4.67cde	7.33c	4.33
P_1T_1	11.53	19.00	29.07ab	29.27bc	29.80	12.00bc	14.00bc	15.67cde	9.67ef	16.00def	0.67b	6.33a	7.33bc	6.00cde	5.33
P_1T_2	10.70	22.50	30.00ab	30.33bc	31.03	14.33a	17.33b	32.00b	30.00bc	41.00b	1.33a	6.33a	10.67b	15.33b	11.33
P_2T_0	7.67	10.17	30.07ab	30.67bc	31.00	2.00f	7.67cd	17.00cd	15.00def	17.00de	0.00c	0.00	2.33de	2.67def	8.33
P_2T_1	13.83	19.23	27.23bc	27.40c	28.00	13.33ab	24.33a	32.67b	35.33b	33.33bc	0.33bc	1.00	5.33cd	7.00c	5.00
P_2T_2	17.27	25.17	37.00a	38.67a	39.67	12.00bc	24.67a	54.00a	61.33a	58.33a	0.67b	2.33b	14.67a	20.67a	18.67
P_3T_0	6.83	10.83	20.83cd	20.33d	20.67	1.67f	6.67d	7.33e	6.67ef	6.33efg	0.00c	0.00	1.00e	1.00a	2.00
P_3T_1	16.53	8.40	29.50ab	27.67bc	27.33	10.67cd	10.33cd	8.00e	6.00f	2.33g	0.00c	0.00	1.67de	2.00ef	2.33
P_3T_2	18.43	22.33	34.33ab	33.33abc	29.33	11.67bc	12.00bcd	9.33d	8.33ef	5.00fg	0.00c	0.33	3.67cde	3.00def	3.00
P_4T_0	7.17	10.67	31.67ab	35.00ab	38.67	2.00f	7.33cd	12.33cde	11.33ef	15.67def	0.00c	0.33	2.00de	2.33def	4.33
P_4T_1	13.70	16.50	30.00ab	34.00abc	43.33	8.67de	10.00cd	15.00cde	16.00de	24.67cd	0.00c	1.33	3.00de	3.67cdef	7.67
P_4T_2	16.37	18.67	34.67ab	39.17a	55.00	8.00e	9.67cd	19.67c	23.00cd	34.33bc	0.00c	2.33b	4.67cde	6.33cd	12.33
Level of Sig.	NS	NS	*	**	NS	**	*	**	**	**	*	**	**	**	NS
LSD			7.39	6.47		2.08	5.93	7.51	8.66	10.1	0.56	1.31	3.54	3.58	

In column, the figures having common or without letter(s) do not differ significantly as per DMRT; * = Significant at 5% level of probability; ** = Significant at 1% level of probability; NS = Not significant

Effect of fruit set

The effect of different treatment combination on the number of fruit set per plant were found to be statistically significant at 30 DAT but at 45, 60, and 75 DAT, there was no statistical significant between the treatment combinations (Table 3). However, irrespective of treatments highest number of fruits was set at 45 DAT, there after the rate declined.

At 30 DAT, the highest (7.33) number of fruit set per plant was recorded in the combination of P_2T_2 which was statistically similar with the combinations of P_1T_2 and P_4T_2. The lowest number of branch per plant was observed in combination of P_2T_0 which was statistically similar with the combinations of P_1T_0, P_3T_0, P_3T_1 and P_4T_1.

Effect on mature fruit

The effect of different treatment combination on the number of mature fruit per plant was insignificant at 45, 60 and 75 DAT (Table 3). However, numerically highest number of mature fruit at 45 DAT was available at P_1T_1 and P_2T_2. The trend was found to be same at 60 DAT. At 75 DAT, the scenario changed dramatically and the highest number of mature fruits was available at P_2T_1 and P_2T_2 followed by P_1T_0, P_1T_2, P_2T_0 and P_3T_2. At 75 DAT, the treatment combinations P_1T_1 and P_3T_0 did not bear any mature fruit.

Table 3. Interaction effect of growing conditions and seed treatments on the yield contributing parameters of capsicum at different days of transplantation (Cont.)

	Number of fruit set/plant				Number of mature fruit/plant		
Interaction (Conditions × Treatments)	30	45	60	75	45	60	75
P_1T_0	0.33ef	0.33	0.67	0.67	0.00	0.67	0.67
P_1T_1	3.33bcd	2.00	1.33	0.67	1.33	1.00	0.00
P_1T_2	6.00ab	2.67	1.67	1.33	0.67	1.00	0.67
P_2T_0	0.00f	1.33	0.67	0.67	0.00	0.67	0.67
P_2T_1	4.00bcd	2.67	1.67	1.67	1.33	1.00	1.00
P_2T_2	7.33a	4.00	2.67	1.67	1.33	1.33	1.00
P_3T_0	1.67def	1.00	0.67	0.33	0.00	0.67	0.00
P_3T_1	2.33cdef	1.67	0.67	0.33	0.00	0.33	0.33
P_3T_2	3.33bcd	2.00	0.67	0.67	0.33	0.67	0.67
P_4T_0	3.00cde	3.00	1.00	0.67	0.00	0.67	0.33
P_4T_1	2.33cdef	1.67	1.33	0.33	0.00	0.67	0.33
P_4T_2	5.00abc	3.00	1.33	1.00	0.00	1.00	0.33
Level of Sig.	*	NS	NS	NS	NS	NS	NS
LSD	2.49						

In column, the figures having common or without letter(s) do not differ significantly as per DMRT
* = Significant at 5% level of probability; NS = Not significant

Effect of growing condition of potted plants on disease parameters of capsicum

The health parameter i.e. diseased plant per treatment, symptom bearing leaves per plant and leaf area diseased was found to be significantly influenced by growing condition of the potted plants (Table 4). The intensity of disease slowly but steadily increased from 30 DAT to 75 DAT in all the treatments.

Effect of growing condition on diseased plant

The effects of different conditions on disease development was significantly different at 45, 60 and 75 DAT but there was no significant difference at 30 DAT as no disease appeared on plants except one which was placed on the roof. Tobacco mosaic and leaf spot disease were found to be associated with capsicum. At 45 DAT, the highest (6.67%) disease plant were observed in P_3 (green house) which was statistically similar with P_4 (open space) and P_1 (roof). Net house (P_2) showed the lowest (0.87%) diseased plant. In case of 60 DAT, the highest (14.95%) disease plant were observed in Green house (P_3) and net house (P_2) showed the lowest (3.22%). At 75 DAT, the highest (31.76) diseased plant were recorded in green house and lowest (3.53%) in net house which was statistically similar with open space (P_4) and roof (P_1) (Table 4).

Table 4. Effect of growing conditions on diseases of capsicum

Growing conditions	% Disease plant/treatment				% Symptom bearing leaves /plant				% Leaf area diseased			
	30	45	60	75	30	45	60	75	30	45	60	75
Roof (P_1)	2.18	5.00a	7.44b	4.45b	25.93a	41.30b	84.80a	96.32a	20.00a	22.76b	84.44a	97.22a
Net house (P_2)	0.00	0.87b	3.22c	3.53b	0.00b	64.94ab	75.90b	85.41b	0.00b	63.42a	78.89b	91.11b
Green house(P_3)	0.00	6.67a	14.95a	31.76a	0.00b	51.67ab	89.52a	97.78a	0.00b	51.11a	86.67a	100.00a
Open space (P_4)	0.00	5.65a	6.57b	4.75b	0.00b	71.84a	91.39a	97.85a	0.00b	59.44a	87.78a	100.00a
Level of Significance	NS	**	**	**	**	*	**	**	**	*	**	**
LSD		2.98	2.09	1.68	3.76	22.98	8.00	4.90	2.80	28.02	4.44	3.24

In column, the figures having common or without letter(s) do not differ significantly as per DMRT; * = Significant at 5% level of probability; ** = Significant at 1% level of probability; NS = Not significant

Effect of growing conditions on symptom bearing leaves

The variation of disease severity expressed by % symptom bearing leaves per plant had significantly different at 30, 45, 60 and 75 DAT (Table 4). On an average 25.93% symptom bearing leaves per plant was recorded in roof (P_1) but the plants in net house (P_2), green house (P_3) and open space (P_4) did not show any symptom on leaves at 30 DAT. At 45 DAT, the highest (71.84%) symptom bearing leaves per plant was observed in P_4 which was statistically similar with P_2 and P_3, and the lowest (41.30%) was found in P_1 which was similar with P_2 and P_3. In case at 60 DAT, the highest (91.39%) symptom bearing leaves was observed in P_4 which was similar with P_1

and P_3. At 75 DAT the highest (97.85%) symptom bearing leaves was observed in P_4 which was statistically similar with P_1 and P_3 and lowest (85.41%) was in P_2 (Table 4).

Effect of growing condition on leaf area diseased

There was significant variation in leaf area diseased at 30, 45, 60 and 75 DAT among the conditions (Table 4). At 30 DAT, leaf area diseased was highest (20.00%) in P_1 and no disease in leaf was found in P_2, P_3 and P_4. At 45 DAT, the highest (63.42%) diseased leaf was observed in P_2 which is statistically similar with P_4 and P_3. The lowest (22.76%) was observed in P_1. In case of 60 DAT, the highest (87.78%) was observed in P_4 which is statistically similar in P_3 and P_1 and the lowest (78.89%) was observed in P_2. On the other hand 100% leaf was hound diseased in P_3 and P_4 at 75 DAT which was statistically similar with P_1 and the lowest (91.11%) was found in P_2.

Table 5. Effect of seed treatments on disease parameters of capsicum plants

Treatments	% Disease plant/treatment				% Symptom bearing leaves /plant				% Leaf area diseased			
	30	45	60	75	30	45	60	75	30	45	60	75
Control (T_0)	1.04	6.35a	9.66a	7.97b	19.44a	54.23	85.91a	96.53a	15.00a	62.15	87.92a	97.50
Skimmed milk (T_1)	0.59	4.34ab	9.03a	18.63a	0.00b	61.51	92.47a	97.33a	0.00b	46.03	85.83a	97.92
Garlic treatment(T_2)	0.00	2.95b	5.45b	6.78b	0.00b	56.57	77.83b	89.16b	0.00b	39.37	79..58b	95.83
Level of Significance	NS	*	**	*	**	NS	**	**	**	NS	**	NS
LSD		2.58	1.81	1.46	3.25		6.93	4.24	2.43		3.84	

In column, the figures having common or without letter(s) do not differ significantly as per DMRT; * = Significant at 5% level of probability; ** = Significant at 1% level of probability; NS = Not significant

Effect of seed treatments on disease parameters of capsicum

Effect of seed treatments on diseased plant

The effect of seed treatments on disease development was significantly different at 45, 60 and 75 DAT but there was no significant difference at 30 DAT (Table 5). At 45 DAT, the highest (6.35%) diseased plant was recorded in T_0 which was similar to T_1 and the lowest (2.95%) diseased plant was observed in T_2 which was similar with T_1. This indicated that not all the diseased at T_2 and T_0 were caused by TMV. The treatment T_1 effectively eliminated TMV from the seed.

In case of 60 DAT, the highest (9.66%) diseased plant was recorded in T_0 which was similar with T_1 statistically and the lowest (5.45%) diseased plant was observed in T_2. At 75 DAT, the highest (18.63%) diseased plant was recorded in T_1 and lowest (6.78%) was observed in T_2 which was statistically similar with T_0.

Effect of seed treatments on symptom bearing leaves

The effect of treatments on % symptom bearing leaves/plant at 30, 60, and 75 DAT were significant except 45 DAT (Table 5). At 30 DAT, the highest (19.44%) symptom bearing leaves was recorded in T_0 and T_1, and T_2 did not show any leaf with symptom. In case of 60 DAT, the highest (92.47%) symptom bearing leaf was recorded in T_1 which was similar with T_0 statistically and the lowest (77.83%) was observed in T_2. At 75 DAT, the highest (97.33%) symptom bearing leaf was recorded in T_1 which was statistically similar with T_0 and the lowest (89.16%) was observed in T_2 which was statistically different from the other two treatments.

Effect of seed treatments on leaf area diseased

The effects of different treatments on leaf area diseased were found significant at 30 and 60 DAT but at 45 and 75 DAT were not significant statistically (Table 5). At 30 DAT, the highest (15.00%) leaf area diseased was recorded in T_0. T_1 and T_2 did not show any symptom on leaf. In case of 60 DAT, the highest (87.92%) leaf area diseased was recorded in T_0 which was similar with T_1 and the lowest (79.58%) leaf area diseased was recorded in T_2. The percentage leaf area diseased shot up from 30 to 45 DAT and thereafter the rate of increment was somehow low.

Interaction effect of growing condition and seed treatments on health parameter of capsicum at different days of transplantation

Effect on disease plant

The effect of growing condition (placement of pots) in combination of different treatments on % disease plant at 45, 60 and 75 DAT was statistical significant but at 30 DAT, there was no significant statistically as at this time at P_1T_0 (control) and P_1T_1 combination only a few plants developed diseases and the rest was disease free (Table 6).

At 45 DAT, the highest (13.89%) disease plant was recorded significantly different in P_3T_0 followed by the treatment combination P_4T_1, and the lowest disease plant was observed in P_2T_0 combination. There was no significant difference was found at the rest of the treatment combinations virtually. In case of 60 DAT, the highest (16.99%) disease plant was recorded in P_3T_1 which was similar to the combination of P_3T_0 and the lowest (1.14%) disease plant was observed in P_2T_2 which was statistically similar with P_2T_1, P_1T_2 and P_4T_2. At

75 DAT, the highest (58.33%) disease plant was recorded in P_3T_1 and lowest (1.16%) was recorded in P_2T_2 which was statistically similar by the combination of P_1T_0, P_1T_2, P_2T_1 and P_4T_2.

Effect on leaf symptom bearing leaves

The effect of growing conditions of test capsicum plants in combination with different seed treatments on % symptom bearing leaves per plant at 30, 45, 60 and 75 DAT was statistically significant (Table 6). In fact there was no disease symptom development on leaves except at P_1T_0 treatment combination. This is, at 30 DAT, the highest (77.78%) symptom bearing leaves was recorded in P_1T_0 and lowest was recorded in the combination of P_1T_1, P_1T_2, P_2T_0, P_2T_1, P_2T_2, P_3T_0, P_3T_1, P_3T_2, P_4T_0, P_4T_1 and P_4T_2.

At 45 DAT, the highest (91.73%) symptom bearing leaves per plant were recorded in P_4T_2 which was statistically similar with P_2T_0, P_1T_1, P_1T_2, P_2T_1, P_3T_0, P_3T_1, P_4T_0 and P_4T_1. The lowest symptom bearing leaves was recorded in P_1T_0 which was similar with P_2T_2 and P_3T_2. In case of 60 DAT, the highest (95.24%) symptom bearing leaves was recorded in P_3T_1 which was statistically similar by combination of P_1T_0, P_1T_1, P_2T_0, P_2T_1, P_3T_0, P_3T_2, P_4T_1 and P_4T_2, and the lowest (53.88%) was in P_2T_2. At 75 DAT, the highest (100%) symptom bearing leaves was recorded in the treatment combinations of P_3T_0, P_3T_1 and P_4T_0, and the lowest (69.67%) was observed in P_2T_2.

Effect on leaf area diseased

The effect of different conditions in combination with different treatments on the leaf area diseased at 30 and 75 DAT was statistically significant and at 45 and 60 DAT was non-significant (Table 6). Eventually % leaf area diseased could be observed only in the treatment combination of P_1T_0 at 30 DAT which was 60.00%. There was no diseased leaf at all in the combinations of P_1T_1, P_1T_2, P_2T_0, P_2T_1, P_2T_2, P_3T_0, P_3T_1, P_3T_2, P_4T_0, P_4T_1 and P_4T_2. In case of 75 DAT the highest (100%) leaf area diseased was observed in P_1T_2, P_3T_0, P_3T_1, P_3T_2, P_4T_0, P_4T_1 and P_4T_2 which was statistically similar with P_2T_1, P_1T_0 and P_1T_1, and the lowest (83.33%) was recorded in P_2T_2 (Table 6).

Effect on yield

The effect of different growing condition and treatments on fruit yield per plant was statistically non significant (Table 6). However, numerically, the treatment combination of P_2T_2 showed the highest (33.10 g) fruit yield per plant where as the lowest (7.07 g) yield was in P_1T_0.

Table 6. Interaction effect of different growing conditions and seed treatment on the plant health at different days of transplantation

Treatments	% diseased plant per treatment				% Symptom bearing leaves/plant				% leaf area diseased				Fruit yield per plant
Interaction (Conditions × Treatments)	30	45	60	75	30	45	60	75	30	45	60	75	
P_1T_0	4.17	6.38bc	7.26def	2.72fg	77.78a	0.00c	81.77ab	95.83a	60.00a	66.67	83.33	96.67ab	7.07
P_1T_1	2.38	5.34bcd	11.03cd	8.18d	0.00b	59.69ab	94.87a	95.83a	0.00b	0.80	85.00	95.00ab	8.53
P_1T_2	0.00	3.28bcd	4.03fg	2.46fg	0.00b	64.21ab	77.76b	97.30a	0.00b	0.80	80.00	100.00a	20.87
P_2T_0	0.00	0.00d	6.72ef	6.36de	0.00b	84.31a	82.21ab	90.30a	0.00b	50.27	83.33	93.33b	8.97
P_2T_1	0.00	1.94bcd	1.80g	3.07fg	0.00b	73.49ab	91.62ab	96.25a	0.00b	80.00	83.33	96.67ab	32.23
P_2T_2	0.00	0.67cd	1.14g	1.16g	0.00b	37.01bc	53.88c	69.67b	0.00b	60.00	70.00	83.33c	33.10
P_3T_0	0.00	13.89a	15.60ab	16.39c	0.00b	70.83ab	85.00ab	100.00a	0.00b	76.67	90.00	100.00a	20.10
P_3T_1	0.00	3.33bcd	16.99a	58.33a	0.00b	50.83ab	95.24a	100.00a	0.00b	53.33	86.67	100.00a	10.17
P_3T_2	0.00	2.78bcd	12.26bc	20.56b	0.00b	33.33bc	88.33ab	93.33a	0.00b	23.33	83.33	100.00a	9.83
P_4T_0	0.00	5.13bcd	9.04cde	6.39de	0.00b	61.77ab	94.66a	100.00a	0.00b	55.00	90.00	100.00a	0.00
P_4T_1	0.00	6.73b	6.30ef	4.93ef	0.00b	62.02ab	88.15ab	97.22a	0.00b	50.00	88.33	100.00a	9.60
P_4T_2	0.00	5.09bcd	4.36fg	2.94fg	0.00b	91.73a	91.35ab	96.33a	0.00b	73.33	85.00	100.00a	14.37
Level of Sig.	NS	*	*	*	**	**	**	**	**	NS	NS	**	NS
LSD		5.17	3.62	2.91	6.51	39.80	13.87	8.49	4.86			5.61	

In column, the figures having common or without letter(s) do not differ significantly as per DMRT; * = Significant at 5% level of probability; ** = Significant at 1% level of probability; NS = Not significant

Capsicum can be grown in Bangladesh if the growers can afford to grow the crop in such conditions ensuring vector free, low temperature, low humidity and high sanitation. The crop is highly sensitive to environmental factors (Uffelen and Bakker, 1987). Before doing that it must be ensured the seeds are pathogen free by nature or by proper treatment (Audhikari 2005). In the present study green house did not work properly that's why the result obtained from green house highest intensity and severity of diseases and failed to sustain the benefits of seed treatment.

The net house condition was the best as this conditions did successfully put restriction to vector to be able to visit the capsicum plants though the temperature and relative humidity in the net house condition was controlled, it was lower than the green house because of air blow which was restricted in the green house. Open roof has been selected as a location of pot culture just to see the possibility of roof culture of capsicum. It was clear from

the results that open roof was not a very good condition as it supported high disease intensity and severity and has failed to the best support and contribute to the yield contributing factors and yield of capsicum. For the same reasons, apparently, the open space condition of potted plants did not give the best result.

Among the organic seed treatments- garlic extract and skimmed milk treatment, garlic extract has been proven to the better. It was probably due to the fact that garlic extract was rather an "all-rounder" where the skimmed milk was effective only against viruses which are seed-surface borne. This result is supported by Islam *et al.* (2001), they found that seed treatment with garlic extracts at different concentrations reduce seed borne infection. Portree (1996) suggested that routine use of skim milk prevent any potential spread of virus in the crop. For the same reasons the treatment combination P_2T_2 gave the best result amongst all the other combinations in terms of disease intensity, disease severity, supporting yield contributing parameters and finally supporting fruit yield highly significant.

CONCLUSION

The research work was carried out at four different conditions (pot placement) namely roof, net house, green house and open space at Seed Pathology Centre, BAU, Mymensingh. Seed of capsicum was treated with garlic extract (1:2) and skimmed milk (1:4) solution to observe their individual and combination effect. The net house condition and seed treated with garlic extract was found to be the best combination to get better yield and less disease.

REFERENCES

Anonymous (1989) Tomato and pepper production in the Tropics. Asian Vegetable Research and Development Centre (AVRDC) Taiwan. p. 585.

Audhikari KK (2005) Study on mosaic disease of capsicum. MS Thesis, Department of Plant Pathology, BAU Mymensingh. p. 31-79.

Brunt AA, Crabtree K, Dallwitz MJ, Gibbs AJ, Watson L, Zurcher EJ (1996) Plant viruses Online: Description and lists from the VIDE database version: 20th August 1996.

Fujisawa I, Anong SJ, Shen YS, Zhou AJ (1990) Identification of virus diseases affecting some vegetables crops in West Malaysis and The Southern part of China. Tropical Agri. Res. Series. 23, 218-228.

Harbant S, Korpraditskul V, Singh H, Vichai K, Singh RP, Saxena RC (1999) Evaluation of some plant extracts against aphids key vector of chilli virus complex. Azadirachta Indica A Juss. Malaysia. p. 139-146.

Islam SMA, Hossain I, Fakir GA, Doullah MAU (2001) Effect of Physical Seed Sorting, Seed Treatment with Garlic Extract and Vitavax-200 on Seed-borne Fungal Flora and Seed Yield of Jute (*Corchorus capsularis* L.). *Pakistan J. Bio. Sci.* 4(12), 1509-1511.

Kiss EF (1988) New experiences with the role of aphids vectors of paprika viruses. Novenyvedelem, Hungary. 24(4), 151-154.

Portree J (1996) Greenhouse vegetable production guide for commercial growers. Province of British Columbia Ministry of Agriculture, Fisheries and Food.

Purseglove JW, Brown EG, Green CL, Robbins SRJ (1981) Spices. John Wiley and Sons. Inc. London and New York: Longman.1, 331-349.

Ragupathi N, Veeragavatham D (2002) Management of chilli mosaic virus disease using insecticides, botanicals and barrier crop. South Indian Hort., 50(1-3), 273-275.

Sharma PN, Chowfla SC, Garg ID, Khurana SMP (1993) Properties of the viruses associated with mosaic disease complex of bell pepper. Indian Phytopath. 46(4), 347-353.

Sherf AF, MacNab (1986) Vegetable diseases and their control, 2nd Edition. John Wiley and Sons, New York, p. 520-525.

Uffelen JAM, Bakker JC (1987) Groenten Fruit, 43: 37. In: Vegetable crops. Vol. 1. Ed. Bose TK, Kabir J, Maity VA Naya Prokash, Kolkhata. p.155-264.