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COMPARATIVE ANALYSIS OF PHYSIO-MORPHOLOGICAL TRAITS OF CHILLI GROWN UNDER DISTINCTIVE ENVIRONMENTAL CONDITIONS IN BANGLADESH

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ABSTRACT

In Bangladesh, chilli is one of the popular spices grown in many different places around the country and in the world. This spice grows in many different environments; however, the yields do vary. In the present investigation, the open field and glasshouse experiments were compared using cultivars CO277 and CO272. The results revealed that CO277 produced the highest leaf area per plant and the lowest in root volume, fruit diameter and stem dry weight for both field and glasshouse. For the cultivar CO272, the highest was fruit length and individual fruit weight for the field condition and the lowest in fruit diameter and stem dry weight in the glasshouse. Therefore, it can be concluded that chilli cultivar, CO277 can be grown in a glasshouse with a higher yield as compared to the open field condition.

Keywords: Chilli, glasshouse, open field, yield parameter

INTRODUCTION

As a shade-loving spice, chilli can be grown in an open field whereas, in agro-silvicultural systems, it is grown under different tree components nowadays, in Bangladesh perspectives. Although chilli is perennial it is grown as an annual however, annual crops are very exposed towards light and water stress at a critical stage of development. In order to establish cultural practices and develop new chilli cultivars which are able to tolerate adverse light and water situation, it is important to understand the eco-physiology of the species.

Glasshouse also known as a greenhouse can be used in many exterior buildings that are made up of translucent material which include an artificial heat source, used for growing plants. If the temperature is high enough, the structure may also be called a hothouse. The aim is to have a protective surrounding for the plants to be able to survive a longer growing season. Inside a glasshouse, the atmosphere should always be adjusted towards specific needs in terms of gardening.

Considerable research work has been done on chilli at home and abroad but most of these works are confined to the areas of cultivation and production, cytology and so forth. In eight cultivars of *Capsicum annuum*, Hossain (1990) has studied quantitative characters which are plant height, primary and secondary branches per plant, leaf area, days to flower, fruit length and volume, number of fruits and yield per plant. It has been found to be highly significant in all the traits the researcher studied. Singh and Singh (1976) in their study with aid quantitative characters of chilli, found the characters to be influenced by genotype environmental interactions. [3]

A number of works have been conducted on the yield morphology and physiology of chilli in different parts of the world (Cochran, 1932) but reports in this context under Bangladesh conditions are scanty (Shapla, 2001). Some of the previous research works carried out in different parts of the world on chilli in relation to the present investigation is briefly reviewed here. Eamus (1987) studied behavior, leaf water potential of chilli, water stress and *Solanum melongena* as influenced by the growth history. Stressed plants growing in a soil water level at the permanent wilting point will usually recover when irrigated after a short wilting duration however, older leaves may abscise when new leaves will be

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reduced in size and several days may be required for leaf photosynthesis to reach the pre-stress levels (Begg and Tumer, 1976). Photosynthesis, the relation of water, assimilates partitioning in pepper leaves (*Capsicum annuum*) transplants which were studied by Aloni *et al.* 1991. Photosynthesis, transpiration, stomata diffusive resistance and relative water content of *Capsicum* (bell pepper) grown under water stress were studied by Rao *et al.* 1988. It is reported that Khan *et al.* (2004) worked on moisture stress of chilli in a Bangladesh perspective. Beese and Moshrefi (1985) investigated the physiological reaction of chilli to water and salt stress. Techawongstein *et al.* (1982) reported the more pronounced of the number of fruit per plant, fruit weight, mature fruit yield and total yield in gradual stress plants than those in the sudden stress plants in chilli. In addition, it is reported from this study that chilli plants subjected to water stress reduced yield by suppressing the number of fruits per plant and development of the fruit (weight per fruit, fruit length and fruit diameter).

The difference in the response of plants to water stress under control of environmental conditions that is phytotron or greenhouse and field experiment is well documented (Begg *et al.*, 1976 and Kramer, 1985). Shapla (2001) studied morpho-physiological features of nine indigenous cultivars of chilli exposing them to different levels of shade (reduced light). The cultivars were similar to the present study; they were CO277, CO 492, CO 436, CO 126 and so forth. The researcher exposed the cultivars to 75%, 50% and 25% Photosynthetically Active Radiation (PAR) and it was reported that different cultivars responded differently to different stresses.

The purpose of this investigation was to find out about the development of the two levels of the growth parameters at the seeding stage of two chilli cultivars grown in a glasshouse and a field towards the morpho-physiological features of shoot and root of chilli cultivars with other parameters in the glasshouse and the field.

MATERIALS AND METHODS

The present investigation was carried out in the glasshouse in polybags and in the field condition in the selected cultivars at Bangladesh Agricultural University (BAU), Mymensingh, in the year of 1998-1999 (Rabi season). The cultivars were collected from the spices research center, BARI.

For the present investigation, the two chilli cultivars (CO277 and CO272) were used in the glasshouse in polythene bags as well as in the field. For the open field experiment, the soil falls under the Old Brahmaputra Flood Plain Alluvial Tract (FAO UNDP, 1988) which is characterized as a silty loam type having a pH of 6.8 (nearly neutral). For the glasshouse experiment, the plants were raised in polybags using a mixture of sand and soil compost as the growing medium. The polythene bag experiment selection was conducted on the basis of dry matter growth. Polybags were evenly watered and after 8 hours of drainage, samples were collected and oven dried at 120°C.

Experiments were laid out in split-split plot design with three replications and the treatments considered cultivars of chilli, viz, CO277 and CO272 and different environments viz, glasshouse and open field. For proper sunshine absorption, containers were arranged in north-south rows. Fertilizers were applied in each bag after 10 to 15 days of stress imposition on a day when the treatments received water. Every irrigation aimed to return the bag to its capacity level so that the whole of the growing medium in each bag of every treatment received optimum moisture.

For the field experiment, 20 days old seedlings were transplanted in the plots of 1.2 x 1.2 m with 40 x 40 cm planting distance, nine plants considered as experimental events. All the experimental plots were encircled with polythene by entering 40 cm inside the soil so that no moisture could enter from the root zone of the plants laterally inside the plot.

This method was followed for the accuracy of the experiment. The average temperature, average relative humidity, rainfall, wind speed, pan evaporation/day and average sunlight were 23.99°C, 78.43%, 13.36 mm, 4.42 km/h, 3.04 and 7.45 h/day on November 15th, 1999. For the glasshouse experiment, the treatment of irrigation applied following the farmer's common practice in the field that is simple and the crude method based on their experience. Whenever irrigation is applied, it was aimed at attaining field capacity around the root zone of the plants. Field capacity was determined by the

moisture meter. The simple method of irrigation which is practiced by chilli farmers of Bangladesh was followed in this experiment so that the results of the present experiment reflects the practical implications in relation to the chilli production of the country.

Data was recorded based on the number of leaves per plant, leaf area per plant (cm^2), plant height (cm), canopy diameter (cm), root length (cm), root volume (ml), number of fruits per plant, fruit length (mm), fruit diameter (mm), individual fruit weight (mg), fruit yield per plant (mg), leaf dry weight (g), stem dry weight (g), root dry weight (g) and fruit dry weight per plant (g). The harvests were 4 categories: first = 35 days after sowing, second = 42 days after sowing, third = 49 days after sowing and lastly, 56 days after sowing. Analyzed data on different parameters were collected for the different shoot and root characters. Statistical analysis was carried out using the MSTAT.

RESULTS AND DISCUSSION

Effect of the cultivars at different growth stages under field conditions:

The number of leaves per plant: Statistical significant difference in the number of leaves between two cultivars of chilli under studying this experiment was found in (Table 1). The cultivar CO277 gave the higher number of leaves (393.31) than that of CO272 (321.42). The maximum number of leaves was found in CO277 due to the effect of watering at an eight-day interval.

Leaf area per plant: The difference in leaf area between two cultivars of chilli was significant (Table 1). The cultivar CO277 gave the higher area of the leaf (2163.44 cm^2) than that of the test cultivar C0272 (1721.90 cm^2). The leaf area was found highest in CO277 because of the effect of watering at an eight-day interval.

Plant height: Difference of plant height of chilli was significant (Table 1). The cultivar CO277 gave the higher area of the leaf (74.39 cm) than that of the test cultivar CO272 (64.24) cm. Plant height was affected by watering at a half-month interval.

Canopy diameter: Significant difference was found in canopy diameter of the two cultivars (Table 1) where the higher canopy diameter was given by the cultivar CO277 (52.89 cm) and CO272 (37.21 cm). Cultivars were watered at an eight-day interval which resulted in CO277 having a higher diameter.

Root length: The two test cultivar produced root length of significant difference (Table 1). The cultivar CO277 produced root length of (530.20 cm) which was higher than that of CO272 (423.31 cm). Also, cultivars were watered at an eight-day interval.

Root volume: The difference in root volume between the two test cultivars was found significant (Table 1). The cultivars were watered at a half month interval.

Number of fruits per plant: The two test cultivars produced significantly different number of fruits per plant (Table 1) and were watered at an eight-day interval. The higher no. of fruits per plant was produced by the cultivar CO277 (189.24) and lower by CO272 (137.91).

Fruit length: Difference between the two cultivars was significant (Table 2). The higher fruit length was given by the cultivar CO277 (34.40 mm) and lower by CO272 (26.05 mm). Both cultivars were watered at an eight-day interval.

Fruit diameter: Significant difference in the fruit diameter of two cultivars was found (Table 2). The fruit diameter was higher (8.17 mm) in CO277 than that of cultivar CO272 (6.87 mm). Likewise, both cultivars were watered at an eight-day interval.

Individual fruit weight: Significant difference was found in the individual fruit weight of the two cultivars (Table 2). The cultivar CO277 gave the higher individual fruit weight (476.32 mg) and the cultivar CO272 gave lower values (437.30 mg).

Fruit yield per plant: The difference in fruit yield produced by the two cultivars per plant was significant (Table 2). The higher fruit yield per plant was produced by the cultivar CO277 (89.67g) than that of the other test cultivar CO272 (60.60g).

Leaf dry weight: The leaf dry weight produced by the two cultivars observed (Table 2). The cultivar CO277 gave the higher leaf dry weight (4.40 g) than that of the cultivar CO272 (3.13 g).

Stem dry weight: The stem dry weight produced by the two test cultivars differed significantly (Table 2). The higher stem dry weight was given by the cultivar CO277 (9.15 g) and lower by CO272 (7.60g).
Root dry weight: The root dry weight produced by the two cultivars was found significantly different (Table 2). The cultivar CO277 gave the higher root dry weight (3.26 g) than the other test cultivar CO272 (1.97g).
The dry weight of fruits per plant: The two test cultivars produced a significantly different dry weight of fruits per plant (Table 2). The cultivar CO277 produced a higher dry weight of fruits per plant (18.28 g) than that of the cultivar CO272 (13.25 g).
Accordingly, the individual fruit weight, fruit yield per plant, leaf dry weight, stem and root dry weight and the dry weight of fruits per plant were highly affected by the weekly interval of watering.

Table 1. Effect of two chilli cultivars on the vegetative growth parameters in the field condition

Treatments	No. of leaves/plant	Leaf area/ plant (cm^2)	Plant height (cm)	Canopy diameter (cm)	Root length (cm)	Root volume (ml)	No. of fruits/plant
CO277	393.31	2163.44	74.39	52.89	528.3	11.27	189.2
CO272	321.42	172.9	64.24	37.21	423.3	9.24	137.9
LSD (0.05)	9.9	32.72	2.38	1.51	23.64	0.34	8.44
CV (%)	7.35	4.47	9.1	8.89	13.17	8.83	13.68

Table 2. Effect of two chilli cultivars on the yield and yield contributing characters in the field condition

Treatments	Fruit length (mm)	Fruit diameter (mm)	Individual fruit weight (g)	Fruit yield/plant (g)	Leaf dry weight (g)	Stem dry weight (g)	Root dry weight (g)	Dry weight of fruits/plant (g)
CO277	34.4	8.17	476.3	89.67	4.4	9.15	3.26	18.28
CO272	26.05	6.87	437.3	60.60	3.13	7.6	1.97	13.24
LSD (0.05)	1.34	0.31	17.25	1.88	0.14	0.24	0.12	0.67
CV (%)	11.8	10.81	13.32	12.98	9.9	7.56	11.78	11.29

Effect of the cultivars at different growth stages under glasshouse conditions

The number of leaves per plant: Significant difference in the number of leaves between two cultivars of chilli under studying this experiment was found (Table 3). The cultivar CO277 produced more leaves (322.88) than that of CO272 (265.73).
Leaf area per plant: The difference in leaf area between two cultivars of chilli was significant (Table 3). The cultivar CO277 gave the higher area of leaf 1817.45 cm^2 than that of the test cultivar CO272 is 1477.70 cm^2.
Plant height: the plant height difference in the two cultivars of chilli was significant (Table 3). The cultivar CO277 gave the higher area of leaf 68.69 cm than that of the test cultivar CO272 (59.10) cm.
Canopy diameter: Significant difference was found in canopy diameter of the two test cultivars (Table 3). The higher diameter was produced by the cultivar CO277 (49.23 cm) than that of CO272 (36.38 cm).
Root length: The cultivars produced root length of significant difference (Table 3). The cultivar CO277 produced root length of (409.64 cm) which was higher than CO272 (334.38 cm).
Root volume: The difference in root volume between the two test cultivars was found significant (Table 3) CO277 produced a volume of 9.92 ml whereas CO272 produced 8.08 ml.

Number of fruits per plant: The cultivars produced significantly different numbers of fruits per plant (Table 3). The higher number of fruits per plant was produced by CO277 (163.55) and much lower by CO272 (125.16).

Fruit length: Difference between the fruit length produced by the cultivars was significant (Table 4). The higher number was given by CO277 (31.88 mm) followed by CO272 (24.04 mm).

Fruit diameter: Significant difference in the fruit diameter of two cultivars was found (Table 4). The fruit diameter was higher (7.13 mm) for CO277 than that of cultivar CO272 (6.18 mm).

Individual fruit weight: Significant difference was found in the individual fruit weight (Table 4). The cultivar CO277 gave 370.31 mg and the cultivar CO272 gave lower values (288.56 mg).

Fruit yield per plant: The difference in fruit yield produced by the two cultivars per plant was significant (Table 4). The higher fruit yield per plant was produced by the cultivar CO277 (60.14 g) than that of the other test cultivar CO272 (35.39 g).

Leaf dry weight: The leaf dry weight given by the two cultivars observed as significant (Table 4) The cultivar CO277 gave the higher leaf dry weight (4.05 g) than that of the cultivar CO272 (2.89 g).

Stem dry weight: The stem dry weight given by the cultivars varied significantly (Table 4). The higher stem dry weight was given by the cultivar CO277 (8.28 g) and lower by CO272 (6.96 g).

Root dry weight: The root dry weight of the two cultivars was found significant (Table 4). The cultivar CO277 had 2.77 g followed by CO272 (1.69 g).

The dry weight of fruits per plant: The two test cultivars produced a significant difference in terms of the dry weight of fruits per plant (Table 4). CO277 produced 16.54 g much more than that of CO272 (9.75g).

Alike the field condition, along with different parameters in connection to watering, glasshouse performance for both of the cultivars had the same watering treatment (weekly interval). In here it is also mentioned that the highest number of open stomata was found in the glasshouse treatment which is responsible for the physiological process. Finally, the selected cultivars were studied for comparative parameters on their physio-morphological characters and dry matter content. The water stress tolerant cultivar, CO277 was found with much higher value than the susceptible cultivar, CO272 in terms of all physio-morphological characters and total dry matter.

Table 3. Effect of two chilli cultivars on the vegetative growth parameters in the glasshouse condition

Treatments	No. of leaves/plant	Leaf area/ plant (cm^2)	Plant height (cm)	Canopy diameter (cm)	Root length (cm)	Root volume (ml)	No. of fruits/plant
CO277	322.88	1817.45	68.69	49.23	409.6	9.92	163.5
CO272	265.73	1477.70	59.10	36.38	334.3	8.08	125.1
LSD (0.05)	9.9	32.72	2.38	1.51	23.64	0.34	8.44
CV (%)	7.35	4.47	9.1	8.89	13.17	8.83	13.68

Table 4. Effect of two chilli cultivars on the yield and yield contributing characters in the glasshouse condition

Treatment	Fruit length (mm)	Fruit diameter (mm)	Individual fruit weight (g)	Fruit yield per plant (g)	Leaf dry weight (g)	Stem dry weight (g)	Root dry weight (g)	Dry weight of fruits per plant (g)
CO277	31.88	7.13	370.3	60.14	4.05	8.28	2.77	16.54
CO272	24.04	6.18	288.5	35.39	2.89	6.96	1.69	9.76
LSD(0.05)	1.34	0.31	17.25	1.88	0.14	0.24	0.12	0.67
CV (%)	11.8	10.81	13.32	12.98	9.9	7.56	11.78	11.29

CONCLUSION

It has been shown that cultivar CO277 has significantly performed better than that of cultivar CO272 in different parameters for both the open field and the glasshouse experiment. Although, in the Bangladesh context, glasshouse is more applicable towards any type of weather because it is possible to create an optimum growing environment, develop in a long-term growing season and also save energy. However, field production is always preferable in terms of increasing production of chilli either in agroforestry practice or others. Lastly, land retains limited resources because of increasing population, hence, proper use and maintenance of land can be done through the planting of a shade loving spice like chilli where the selection of chilli cultivars are crucial for increasing the yield (as other parameters) and also for the overall yield.

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