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Effect of abiotic hot water seed treatment on capsicum (*Capsicum annuum*) growth and yield

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ABSTRACT

The present study was carried out to extrapolate the effect of the hot water seed treatment comprised of different ranges of temperature (47-49, 50-52 and 53-55°C) and different duration of time (30, 45 and 60 min.) on growth parameters and yield attributes in bell pepper (*Capsicum annuum* L.) cv. Solan Bharpur during 2015-16. The aim of the study was to attain better plant establishment and to get good yield in bell pepper. Under protected condition, the hot water treatment of bell pepper seed at 50-52°C for 30 min. showed maximum values, viz. plant height, average fruit length, number of fruits per plant, fruit yield per plant and fruit yield/ha. Also, this treatment resulted in minimum days to first marketable picking and maximum harvest duration. Hot water seed treatment at 50-52°C for 30 min. proved effective in increasing growth and yield in bell pepper cv. Solan Bharpur.

Key words: Bell pepper, Hot water seed treatment, Yield attributes

Bell pepper (*Capsicum annuum* L.) also known as sweet pepper, capsicum or Shimla mirch belongs to family solanaceae. It is a high value vegetable and an important cash crop grown in the world. It has attained a status of high value crop in recent years because of its delicacy and pleasant flavour coupled with rich content of ascorbic acid and other vitamins and minerals (Agarwal *et al*. 2007). In gaseous exchange and seed germination, seed coat plays inhibitory role. Kher and Nataraj (2015) stated that seed dormancy can be broken by hot water treatment, treatment with gibberellic acid, stratification, scarification, chilling treatment, soaking seeds in water and treatment with acids. Speedy germination and vigorous seedlings results into higher crop yield. Mcdonnell *et al*. (2012) observed that dipping seeds in hot water at different temperature affect the seed germination as seeds given hot water seed treatment of 70-80°C showed better growth compared to seeds given hot water seed treatment with 80°C. Owing to the sensitivity of seeds to high temperature, hot water treatment must be applied in strictly controlled manner with ensured uniform treatment for all seeds. High temperature may affect some species even at very short treatment times. So, seeds must be treated at desired temperature for particular time period. It also becomes an alternative method for conventional farming especially in case of failure of chemicals permitted for seed treatment. The more importance of hot water seed treatment for organic farming was reported by Trueman and Wick (1996). Baker (1962), Gabrielson (1983), Hoffmann *et al.* (1994) and Jahn *et al.* (2000) showed further examples for hot water treatment application. The experiment was designed to study the effect of different temperature and time combinations of hot water seed treatment on growth parameters, fruit characters and yield attributes in bell pepper.

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MATERIALS AND METHODS

The present experiment was conducted at experimental farm and laboratory of Dr Y S Parmar University of Horticulture and Forestry, Solan during 2015-16. The experimental farm is located at an altitude of 1183 meters amsl with latitude of 30.51ºN and longitude of 77.09ºE the mid-hill zone of Himachal Pradesh, India observed with GARMIN'S GPS 12 Personal Navigator. The soil texture of polyhouse was loam to clay loam having *p*H ranging from 6.85-7.05. The healthy, disease free, bold and uniform seeds of bell pepper cv. Solan Bharpur, were obtained and treated with hot water in automatically controlled hot water bath tub at different temperature range for discrete time period. All the treated seeds were planted in naturally ventilated (top and side ventilated) polyhouse having an area of 200 m^2. The polyhouse was equipped with drip irrigation system and drip lines were spaced at 45 cm apart. The experiment in protected condition was laid in Randomized Block Design with 10 treatments replicated three times taking six plants per replication.

Hot water bath works automatically controlling

temperature with time. Firstly seeds were soaked in normal water for 15 min. wrapped in muslin cloth. Then, poured about 2-3 litre water in the device and it was connected with electricity. With the help of heater coil the device was heated and with the time and thermostat bulb, it was regulated to the desired temperatures such as (47-49), (50-52) and (53-55)°C. With the thermometer the desired temperature was denoted. Generally, it took 10 min by the machine to reach the desired temperature. Time was controlled by stop watch. Once the desired temperature was achieved, the pre-soaked seeds in muslin cloth were dipped in the hot water for a fixed period of time as per the treatment detail. During the dipping, the bag with the seeds was frequently stirred for uniform exposure of seeds to hot water and also to maintain uniform heat all over the tank. At the end of the treatment, seeds were taken out of the hot water bath and spread on blotter paper. After that the blotter paper with seeds was placed in shade for drying of seeds. Then, the seeds were used for test. Plant height was recorded at monthly interval and was measured from the base of the plant to the top of the main axis and mean height was expressed in centimetres. Days to 50% flowering were recorded by visiting the experimental field everyday and were counted right from the date of transplanting to the date when at least one flower appeared in 50%. Number of days from transplanting to days for first marketable harvesting was recorded in each replication. Total numbers of fruits of all the harvest on each of ten randomly taken plants were summed and average was calculated to obtain number of fruits per plant. Average fruit weight (g) was calculated by dividing total fruit weight by total number of fruits harvested in each replication.Ten fresh fruits were selected to measure the fruit length and width with the help of Digital Vernier Callipers. Yield was recorded at every picking in kilograms and added up for all the picking to arrive at the total fruit yield per plant.Yield obtained from each plot was converted to yield in kg/ha.Total number of days from first fruit harvesting to final fruit harvesting were counted and average value was expressed as harvest duration.The statistical analysis for Randomized Block Design was done as per methods suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Seeds soaked at 50-52°C for 30 min. (T_2D_1) resulted in significantly higher plant height at all the time intervals, viz. 30, 60, 90 and 130 days after transplanting i.e. 23.87, 49.12, 60.71 and 96.85 cm, respectively followed by seeds soaked at 47-49°C for 60 min. (T_1D_3). However, the values of both the treatment were statistically at par on 30 and 60 days after transplanting (Table 1). The lowest values were recorded in seeds soaked at higher temperature range 53-55°C for 60 min (T_3D_3), i.e.13.16, 25.55, 38.53 and 57.17 cm after 30, 60, 90 and 130 days after transplanting. In control, the plants achieved intermediate heights of 20.79 cm at day 30, 39.22 cm at day 60, 51.73 cm at day 90 and 82.84 cm at day 130 after transplanting.The increased plant height after hot water treatment at 50-52°C for 30 min might be due to the increased imbibition and stimulated germination related activities such as gibbrellic acid synthesis, RNA synthesis, protein synthesis and DNA replication and finally weakening of the endosperm and thereby increasing germination (Groot and Karssen 1989, Bewley and Black 2000). The increased germination per cent as well as vigour index might have increased field emergence and plant height of treated seedlings under protected conditions in present investigations. The known effect of hot water treatment on seed microflora might have added in the improvement of plant height under present investigations. These findings are in line with Missanjo *et al.* (2014) who found that hot water treatment of seed was found one of the best pre-treatment methods for increasing plant growth of *Acacia polyacantha* seedlings.

Hot water seed treatment had no significant effects on days to 50% flowering, whereas a significant effect on days to first marketable picking of fruit was recorded (Table 1). All the temperature and time combination treatments resulted in almost similar days to 50% flowering. Days to first marketable picking was lowest (60 days) in both the hot water treatment with 47-49°C for 60 min (T_1D_3) and in hot water treatment with 50-52°C for 30 min (T_2D_1), whereas highest (71.67 days) was obtained with hot water treatment with 53-55°C for 45 min (T_3D_2) and hot water treatment with 53-55°C for 60 min (T_3D_3). Seeds kept as control revealed first marketable picking in 65 days.The reason for difference in the days to first marketable picking of fruits is that the character is directly linked to increased growth of the plants after seed treatment. Since, hot water treatment with 50-52°C for 30 min resulted in increased growth as discussed earlier.There was no reference in the

Table 1 Effect of hot water seed treatment on plant height, days to 50% floweringand days to first marketable pickingof bell pepper cv. Solan Bharpur under protected conditions

Treatment	Plant height (cm) after days of transplanting				Days to 50% flower-ing	Days to first market-able picking
	30	60	90	130 (final harvest)		
T_1D_1	19.42	37.33	49.17	81.02	42.67	68.33
T_1D_2	20.75	38.45	51.22	85.98	45.00	65.00
T_1D_3	23.76	45.64	56.21	93.72	43.67	60.00
T_2D_1	23.87	49.12	60.71	96.85	44.00	60.00
T_2D_2	19.74	36.05	50.88	82.90	43.67	65.00
T_2D_3	18.09	33.41	45.92	76.30	43.00	68.33
T_3D_1	20.30	36.02	46.39	78.22	43.33	65.00
T_3D_2	15.78	30.32	41.57	66.26	42.33	71.67
T_3D_3	13.16	25.55	38.53	57.17	41.33	71.67
T_0	20.79	39.22	51.73	82.84	42.67	65.00
CD (P=0.05)	2.46	4.63	4.12	3.72	NS	2.93

Table 2 Effect of hot water seed treatment onfruit characters, yield characters and harvest duration of bell pepper cv. Solan Bharpur under protected conditions

Treatment	Avg. fruit weight (g)	Avg. fruit length (cm)	Avg. fruit width (cm)	No. of fruits/ plant	Fruit yield/ plant (g)	Fruit yield/ ha (q)	Harvest duration days
T_1D_1	51.35	6.13	4.97	16.28	836.11	247.74	61.67
T_1D_2	51.92	6.10	4.57	17.94	931.67	276.05	63.33
T_1D_3	53.72	6.23	5.01	18.78	1,008.33	298.77	71.67
T_2D_1	53.84	6.40	5.05	19.11	1,028.89	304.86	71.67
T_2D_2	50.29	5.98	4.99	16.17	813.34	240.99	58.33
T_2D_3	49.96	6.10	4.78	14.67	732.78	217.12	53.33
T_3D_1	51.82	6.00	5.00	15.28	791.67	234.57	55.00
T_3D_2	49.12	5.72	4.50	13.39	657.78	194.90	40.00
T_3D_3	48.71	5.52	4.40	12.28	598.33	177.28	38.33
T_0	51.63	6.06	4.73	16.28	840.56	249.05	61.67
CD (P=0.05)	1.75	0.43	NS	0.83	53.86	15.96	1.54

literature on this aspect; hence, the present findings are new in this regard.

Hot water treatment of seeds resulted in variations in fruit dimensions like length (cm), width (cm) and weight (g) under protected conditions (Table 2). Average fruit weight varied significantly among the treatments and was recorded highest (53.84 g) when seeds were soaked at 50-52°C for 30 min (T_2D_1) followed by hot water treatment at 47-49°C for 60 min (T_1D_3). However, the values of both these treatments were statistically at par with each other whereas fruit weight was lowest (48.71 g) when seeds soaked at 53-55°C for 60 min. (T_3D_3). In control, plants revealed a fruit weight of 51.63 g. Similarly, a significant variation in fruit length (cm) was recorded in this study. Seeds soaked at 50-52°C for 30 min. (T_2D_1) resulted in longest fruit (6.40 cm) followed by (6.23 cm) in seeds soaked at 47-49°C for 60 min (T_1D_3), (6.10 cm) in seeds soaked at 47-49°C for 45 min (T_1D_2), 5.98 in cm in seeds soaked at 50-52°C for 45 min (T_2D_2). However, the values of all these treatments were statistically at par with each other. Whereas seeds soaked at 53-55°C for 60 min (T_3D_3) revealed shortest fruit length (5.52 cm). Like fruit weight, control plants also revealed an intermediate fruit length (6.06 cm). In contrast, no significant variation in fruit width (cm) with respect to different treatments was recorded in present study. Fruit width was non-significantly higher in seeds soaked at 50-52°C for 30 min (T_2D_1) as compared to 53-55°C for 60 min (T_3D_3). The reason behind the increase in fruit characters might be related to plant growth characters as discussed earlier. In bell pepper, meagre report existed on the effect of hot water seed treatment on fruit characters. While in okra (*Abelmoschus esculentus*), Begum and Lokesh (2012) observed that hot water treatment at 52°C for 30 min resulted in the improvement of crop, both in greenhouse and field conditions.

Number of fruits per plant was highest (19.11) when seeds were soaked at 50-52°C for 30 min (T_2D_1), which was statistically at par with the (18.78) seeds soaked at 47-49°C for 60 min (T_1D_3). Lowest number of fruits per plant (12.28) was recorded when the seeds were soaked at 53-55°C for 60 min (T_3D_3). Similarly, the fruit yield per plant (g) and fruit yield per ha (q) were highest (1028.89 g and 304.86 q, respectively) when seeds were soaked at 50-52°C for 30 min (T_2D_1) which was statistically at par with the (1008.33 g and 298.77 q, respectively) seeds soaked at 47-49°C for 60 min (T_1D_3). The lowest fruit yield per plant as well as fruit yield/ha. (598.33 g and 177.28 q respectively) was recorded in seeds soaked at 53-55°C for 60 min (T_3D_3). Furthermore, the harvest duration was highest (71.67 days) in seeds soaked at 47-49°C for 60 min (T_1D_3) and in seeds soaked at 50-52°C for 30 min (T_2D_1) and lowest (38.33 days) in T_3D_3. In control plants, fruit yield and harvest duration had intermediate values between two extremes (Table 2).

Apart from these, the total numbers of seeds per fruit, 1000 seed weight were also found to be enhanced. The hot water seed treatment also reduced the incidence of microflora in the seeds and thereby enhanced the germination percentage and vigour index of the seedlings. All these factors were found to increase the plant growth and fruit yield. Such reasons might have been there under present study also as discussed earlier under growth characters.

It may be concluded that hot water seed treatment at 53-55°C for 60 min can be effectively utilized in improving growth and yield attributes in bell pepper over control. However, further studies are needed to standardize the required temperature for controlling other seed borne microflora to extend the wide use of hot water seed treatment for production of healthy crop of bell pepper.

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