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INFLUENCE OF PRE SOWING HEAT AND NON CHEMICAL TREATMENTS ON MORPHOLOGICAL ECONOMIC CHARACTERS AND PATHOGEN CONTROL IN BRINJAL

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ABSTRACT

Vegetables are very important in human diet. Out of all vegetables brinjal is one of them and it is cultivated globally on a large scale. The study was conducted to estimate the effect of hot water hot air and microwave seed treatment in controlling seed-borne diseases of brinjal under warm and rainy conditions of Himachal Pradesh to identify superior and stable non-chemical methods of seed treatment. For that, seven treatments were evaluated with three replications in randomized block design during 2020 and 2021. The aim of our study was to evaluate the best organic alternative to get rid of the chemical method of seed treatment. Seed treatment with heat like wet heat (hot water), dry heat (hot air) and electromagnetic seed treatments (microwave) play a vital role in eliminating pathogens from seeds without affecting crop growth and yield. Mean performance analysis of field parameters showed the maximum plant height (60.45), days to first marketable picking (75.33), average fruit weight (66.33) and fruit yield/ha (310.28 q), and minimum diseases (%) of Southern blight (8.33%) and Phomopsis blight (11.26%) was obtained by hot water seed treatment of 49°C/ 60 minutes in brinjal. The present study's results provide a strong base for identifying superior nonchemical methods of seed treatment and effective strategies for enhancement of fruit yield characters and controlling disease incidence in brinjal.

Key words : Hot water, Hot air, Microwave, Harvest, Yield, Nonchemical Organic and Plant growth.

Introduction

Brinjal (*Solanum melongena* L.) is often known as aubergine. It is cultivated as a key vegetable crop in tropical nations like India, Bangladesh, Pakistan, Indonesia, and the Philippines (Sekara *et al.*, 2007). It is indigenous to Southern India. A significant portion of the crops' annual output is lost as a result of these seed-borne infections, which include nematodes, fungi, bacteria and viruses. It is the most significant vegetable in India and is referred by designation of "king of vegetables" due to its wide availability in food. It is the fourth most significant vegetable crop in India, after tomato, potato and onion (Singh *et al.*, 2014). It is mostly grown as a warm-season and rainy-season crop in the hilly state. High rainfall causes an increase in disease incidence (Singh *et al.*, 2014). Seed borne disease like leaf spot, dry rot , fruit rot and blight are the main diseases of brinjal as described by Singh *et al.* (2014). According to reports, the most of these diseases are due to seed infection. Environmental contamination along with health hazards arise from chemical seed treatments and their applications in crops. It is advised to employ fewer chemicals in order to protect vital soil bacteria and natural biodiversity. Therefore, it is preferable to treat seeds using less expensive, less dangerous, non-chemical and environment friendly ways. Numerous non-chemical seed treatment techniques have been developed to manage disease-transmitted by seeds which ultimately improve the characteristics of plant growth (Aladjadjiyan, 2007). Infections within seeds can be removed using microwave, hot air, and hot water treatments. Pathogen transmission originates from contaminated seeds. The use of fungicides and bactericides is decreased if seeds are treated effectively (Babadoost and Zhang, 2020). The main source of inoculum overwintered in plant seeds and vegetative parts are declined by hot water, hot air, and microwave seed treatment (Grondeau *et al.*, 1994). Hard-coated seeds that have undergone thermal processing become water permeable, enhance germination, and improve the plant growth factors (Baskin *et al.*, 2000). The stimulation of the physiological and biochemical mechanisms of seeds as a result of hot water or hot air treatment has removed seed coat-related dormancy and increased the rate of germination ((Denton *et al.*, 2013). According to research by Islam and Meah (2011), hot water treatment of seed at 56 °C for 15 minutes or more is beneficial against diseases like Phomopsis blight of brinjal. According to Prasad and Nautiyal (1996), hot water seed treatment improved plant development and germination as compared to untreated seeds. Hossain *et al*. (2009) investigated how hot water seed treatment affect diseases like *Phomopsis vexans* in brinjal and found that a 55°C hot water seed treatment for 5 minutes has effective negative impact on the disease infection. Hossain *et al*. (2009) investigated hot water seed treatment for those seeds which was affected by diseases like *Phomopsis vexans* in brinjal and discovered that hot water seed treatment at 55 °C for l5 minutes effectively decreased disease incidence. Vegetable seeds were exposed to hot air seed coat treatments, and it was found that hot air seed treatment was more efficient than seed coating treatment in removing seed-borne diseases (Song and Zhen, 2008). According to Babadoost and Zhang (2020) sesame and vegetable seeds exposed to 2.45 GHz microwave radiation germinated more quickly and produced more fruits per unit of plant. According to Grosch and Hopwood (1979) microwave radiation destroyed the fungus in its embryonic stage, prohibited it from replicating, and resulted in increment of pathogen opposition. As claimed by Taheri *et al*. (2018) microwave radiation for 60 seconds effectively entered the seed coat of lentil seeds and decreased seed infection of *Ascochyta* spp. without altering the seed's composition. In the Solanaceae family, hot air treatment at 80°C has disinfected the seed surface and significantly enhanced seed germination and seedling growth (Li *et al.*, 2009). In contrast to hot water treatments and chemical treatments, Ling (2010) found that thermophysical dry heat seed treatment at 80°C for 72 hours reduced seed-borne Pepino Mosaic Virus with the least effect on seed germination. Gama *et al.* (2014) heated the seeds of Solanaceae at different temperatures for periods of time and discovered that heating the seeds at 70°C for 12 days was the most efficient way to limit the growth of the fungus *Alternaria* spp. on Solanaceae crop plants.

Materials and Methods

The study has been investigated in the Department of Seed Science and Technology of Dr YS Parmar University of Horticulture and Forestry in Nauni, Solan (HP), from the month of March through the month of July 2021. The details of seed treatment was used in our present study was described in Table 1.

Planting Material

The seed and seedlings were purchased from the selling unit of seed science and technology UHF Nauni, Solan (HP). The utilized seeds had a standard germination rate of more than 80% and were six months old.

Site of the experiment

The study was studied out at the farm of the Department of Seed Science and Technology, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan (HP), which is located in the mid-hill region of Himachal Pradesh, India, at an altitude of 1183 meters above mean sea level, latitude of 30.51N and a longitude of 77.09 E.

Climate

The region's climate is typically sub-temperature and semi-humid, with cold winters. Typically, the coldest months are December and January, and the hottest months are May and June.

Experimental layout

Set of seven seed treatments of brinjal were evaluated in three replications in RCBD design during the year 2021. All seven treatments were transplanted in field conditions from a nursery in the month of March. The spacing between plants and rows was kept of 60 × 45 cm. The plot size was 2.4 × 1.35-meters square. The number of plants in one plot was 12 and the total number of plants was 21. All the advised agronomic practices were followed during the experiment for healthy crop growth. Manual weeding was carried out whenever required during the entire experiment period to ensure weed-free plots.

Plant height (cm)

At monthly intervals, the growth of plant was estimated from bottom to the top of the main axis, and thus average plant height was estimated and given in centimetres.

Days to first marketable harvesting (days)

Data on the duration from transplanting to the first day of marketable harvesting were gathered and averages for each treatment and replication were calculated.

Quantity of berries per herb

The total quantity of brinjal collected from all the crops was added up and averages were calculated to determine the quantity of economic berry per plant.

Average fruit weight (g)

This parameter was measured by division of sum total of brinjal berries weight with number of fruits obtained from each plot.

Fruit yield per plot (kg)

The total quantity of all fruits collected from the plants in each plot, excluding any that were infected, was calculated to determine the average fruit yield per plot.

Fruit yield per plant (g)

To calculate this parameter the economic berries weight at each harvesting is calculated in grams and amounted to all the pickings.

Fruit yield per hectare (q)

In this parameter, 20% area of field has observed as deflation.

Fruit yield /ha was work out on the basis of fruit yield/m²

$$\text{Fruit yield/m}^2\ (\text{g}) = \frac{\text{Fruit yield per plot (kg)}}{\text{Size of plot}}$$

$$\text{Fruit yield/ha (q)} = \frac{\text{Fruit yield per plot (g)} \times 1000 \times 0.80}{\text{Size of plot (m}^2) \times 1000}$$

Harvest duration

The total days between the first and last fruit harvests has summed, and the mean value was represented as days for harvest

Disease incidence (%)

Using the following formula, the occurrence of several diseases such as Southern blight and Phomopsis fruit rot was noted in the field:

Statistical analysis

The statistical analysis was done as per the Randomized Complete Block Design (RCBD) design of the experiment as suggested by Gomez and Gomez (1984) using computer software OP Stat.

Results and Discussion

In the field, the effects of untreated (control), dry air seed treatment at (72°C for 48 hours and 74°C for 36 hours), wet seed treatment (49°C for 60 minutes and 50°C for 30 minutes) and microwave radiation treatment of seed (10 seconds and 15 seconds) were assessed.

Table 1 : Treatment details.

Treatment	
T_1	Microwave Treatment (10 s)
T_2	Microwave Treatment (15 s)
T_3	Hot Air Treatment (72°C/48 h)
T_4	Hot Air Treatment (74°C/24 h)
T_5	Hot Water Treatment (49°C/60 min)
T_6	Hot Water Treatment (50°C/30 min)
T_7	Control

Influence of wet heat, dry heat and radiation seed treatment on plant height in brinjal under field conditions

Table 2 showed that seeds subjected to thermophysical treatments resulted in noticeable variations in plant height (cm) at various temperatures and for varying lengths of time. The experiment's findings regarding plant height revealed that the highest plant heights were measured in the treatment (seed treatment with hot water at 49°C for 60 minutes.) at 30, 60 and 90 days following transplanting, respectively. This treatment was statistically comparable to seed treatment with microwave at 15 seconds. The lowest plant height was measured from T_4 that 29.64, 41.39, 48.90 at 30.00, 60.00 and 90.00 days after transplanting, respectively. It was followed by 30.63, 45.58 and 52.65 cm, at 30.00, 60.00 and 90.00 days, respectively, from T_3. The plant height in the control treatment was 31.94 cm, 47.35 cm and 54.51 cm, respectively, at 30.00, 60.00 and 90.00 days after transplanting in the field circumstances.

Influence of wet heat, dry air and radiation treatment of seed on first harvestable maturity picking and average fruit weight in brinjal under field conditions

The information in Table 3 demonstrated that hot water treatment (49°C for 60 minutes) had the lowest days for first harvesting (75.33) the greatest days for first harvestable picking in T_4; hot air seed treatment; 74°C/24 hours. The hot water seed treatment increased the metabolism and enzymatic processes of seedlings, which led to faster plant growth characteristics like flowering and days to first marketable picking and resulted in the lowest days of first marketable picking ever recorded (Begum and Lokesh, 2012).

Influence of wet heat, dry air and radiation seed on quantity of berries per herb and harvest duration in brinjal under open environment

The fruit yield data in Table 4 showed that the

Table 2 : Effect of thermophysical seed treatments on plant height in brinjal under field conditions.

Treatment	Plant height (cm) after days of transplanting		
	30	60	90
T_1: Microwave 10 sec	35.59	47.59	55.47
T_2: Microwave 15 sec	40.61	54.00	60.33
T_3: Hot air 72°C/48 h	30.63	45.58	52.65
T_4: Hot air 74°C/24 h	29.64	41.39	48.90
T_5: Hot water 49°C/60 min	41.63	55.10	60.45
T_6:Hot water 50°C/30 min	36.43	50.50	56.28
T_7: Control	31.94	47.35	54.51
C.D. (0.05)	1.37	2.49	3.10

Table 3 : Effect of thermophysical seed treatments on first harvestable picking and average fruit weight in brinjal under field conditions.

Treatment	Days to first harvestable picking	Average fruit weight (g)
T_1: Microwave 10 sec	82.22	56.24
T_2: Microwave 15 sec	81.33	59.75
T_3: Hot air 72°C/48 h	83.55	53.44
T_4: Hot air 74°C/24h	85.72	49.86
T_5: Hot water 49°C/ 60 min	75.33	66.33
T_6: Hot water 50°C/ 30 min	78.66	63.36
T_7: Control	84.61	54.96
C.D. (0.05)	1.00	1.69

Table 4 : Effect of thermophysical seed treatments on fruit yield characters and harvest duration in brinjal under field conditions.

Treatment	No. of berries/herb	Fruit yield/ plant(g)	Fruit yield/ plot(kg)	Fruit yield/ hectare(q)	Harvest duration (days)
T_1:Microwave10 sec	16.66	715.27	8.58	211.93	47.61
T_2: Microwav15 sec	19.22	740.55	8.88	219.42	48.88
T_3: Hot air 72°C/48 h	14.55	629.72	7.55	186.58	45.22
T_4: Hot air 74°C/36 h	12.94	613.89	7.36	181.89	40.05
T_5:Hot water 49°C/60 min	27.33	1047.22	12.56	310.28	58.44
T_6:Hot water 50°C/30 min	22.28	826.39	9.91	244.85	55.50
T_7: Control	16.44	708.33	8.50	209.88	42.27
C.D. (0.05)	3.43	60.07	0.72	17.79	1.02

Table 5 : Effect of different thermophysical seed treatments on disease incidence/severity in brinjal under field conditions.

Treatment	Southern blight*	Phomopsis fruit rot*
T_1: Microwave 10 sec	19.44(4.50)	18.58(4.42)
T_2: Microwave 15 sec	16.66(4.11)	17.01(4.23)
T_3: Hot air 72°C/48 h	25.00(5.09)	27.77(5.34)
T_4: Hot air 74°C/24 h	22.22(4.80)	25.43(5.13)
T_5: Hot water 49°C/ 60 min	8.33(2.75)	11.26(3.46)
T_6: Hot water 50°C/ 30 min	8.33(2.75)	11.93(3.58)
T_7: Control	27.77(5.35)	27.70(5.35)
C.D. (0.05)	1.19	0.73

characteristics of the fruit yield and duration of the harvest under field conditions are significantly influenced by the thermophysical treatment of seeds. Treatment T_5 produced the most fruits per plant, whereas the T_4 and the T_3 treatment produced the least fruits per plant, 12.94 and 14.55, respectively. However, statistically, the results of both treatments were similar. The greatest values of 1047.22 g, 12.56 kg, and 310.28 q fruit yield per plant (g), fruit yield per plot (kg), and fruit yield per ha (q), respectively were found in the T_5 seed treatment. T_4 seed treatment produced the lowest fruit yield per plant (613.89 g), fruit yield per plot (7.36 kg) and fruit yield per hectare (181.89 q), which were similar to T_3 treatment at 629.72 g, 7.55 kg and 186.58 q, respectively. However, statistically, the two treatments were similar. The T_5 seed treatment has the longest harvest time (58.44 days), followed by the T_6 seed treatment and these values were quite distinct from one another. The T_4 seed treatment has the shortest harvest duration. We found that hot water treatment inhibited pathogen activity and produced a resistance mechanism in fruit through the production of lignin scoparone, scopoletin content, and improved fruit yield characters. These findings are consistent with Nafussi *et al*. (2001). According to Hermansen *et al*. (1999) wet heat seed treatment enhanced the germination rate in carrot seeds and consequently increased fruit results. According to Ahmed *et al*. (2010) wet heat seed treatment of sesame seeds at 60 °C increased germination and vigour of seeds. They also noticed that these parameters helpful in improvement of the features like morphological and economic growth of the factors leading to the improvement in fruit production characteristics is the hot water seed treatment’s ability to reduce seed mycoflora. A significant attempt has been made in this regard with the present study on how these heat seed treatment influence an increase in fruit production features in brinjal.

Influence of hot water hot air and microwave seed treatment under field conditions on disease incidence/severity (%) in brinjal

The incidence of disease data was statistically examined and the results are shown in Table 5. It was found that there were significant variations between the different thermophysical seed treatments. It is clear from the data in Table 5 that hot water, hot air and microwave treatment of seeds have demonstrated successful outcomes against diseases like Southern blight and Phomopsis fruit rot in field settings. T_5 treatment was associated with the lowest disease incidence of Southern blight (8.33%) and Phomopsis fruit rot (11.26%). In contrast, when wet heat seed treatment was performed at 49°C for 60 minutes, the infection of Southern blight and Phomopsis fruit rot was recorded at 8.33% and 11.93%, respectively. The results of the two treatments were comparable. The disease incidence of Southern blight and Phomopsis fruit rot was observed at 25.00% and 27.77% from T_3, followed by T_4 (hot air seed treatment at 74°C/24hours), where 22.22% of Southern blight and 25.43% of Phomopsis fruit rot were recorded. The highest disease infection of Southern blight and fruit rot was recorded to be 27.27% and 27.77%. All treatments' values were statistically equivalent to one another. As per claimed by Schirra et al. (2000) hot water seed treatments have contributed to the lower occurrence of seed-borne Phomopsis fruit rot disease with hot water treatment of seed. Hot water seed treatments are more successful at decreasing the occurrence of disease because they penetrate the seed tissue and get rid of both external and internal seed-borne pathogens. In addition, when compared with microwave seed treatment and hot air seed treatment, the hot water treatment enhanced plant growth attributes. This is due to the fact that hot air seed treatment results in a shortage of storage compounds for seed germination, which lowers germination rates and reduces plant growth traits like plant height and leaf size, which lowers the level of tolerance to pathogen infection. Miller and Ivey (2004) observed a decrease in tomato and bell pepper seed-borne diseases like anthracnose and collar rot by using wet heat seed temperature at 50 to 55°C for 25 to 30 minutes. As claimed by Abrha *et al*. (2015), heat seed treatments at 46 to 50°C of garlic cloves effectively reduced the fungus that produced sclerotia as fruiting structures.

Conclusion

The goal of the study was to find a superior and stable non-chemical seed treatment method for brinjal. Mean results for all the plant and fruit attributes revealed sufficient variance for heat seed treatment. In general, the most reliable and effective seed treatment approach was hot water seed treatment. Seed treatment with T_5 was employed to measure the highest plant height. T_5 seed treatment showed the shortest time to the first marketable picking (75.33 days) and the greatest mean berries quantity (66.33 g). In T_5 the greatest number of fruits per plant (27.33), fruit yield per plant (1047.22 g), fruit yield per plot (12.56 kg), fruit production per ha (310.28 q), and maximum harvest period (58.44 days) were documented. In T_5 seed treatment, the incidence of Southern blight (8.33%) and Phomopsis fruit rot (11.26%) was lowest. Maximum number of days for the first marketable plucking (84.61 days), Untreated plots have the lowest average fruit weight (54.96 g), the lowest number of fruits per plant (16.44), highest disease incidence (27.77%, 27.70% of Southern blight and Phomopsis fruit rot, respectively) and the minimum fruit yield (8.50 kg), fruit yield per plot (8.50 kg), and fruit yield per ha (209.88 q). Under field conditions, a hot water seed treatment at 49°C for 60 minutes significantly enhanced the morphological characteristics and economic characters. Under field conditions, this approach has also shown to be successful in significantly reducing the prevalence of diseases like Phomopsis disease in brinjal. The findings of the current study provide a solid basis to determine an improved seed treatment approach for future non-chemical cultivation of brinjal.

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