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Effect of seed priming with plant defence activators on growth parameters and disease incidence in bell pepper under nursery conditions

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ABSTRACT

The effect of different plant defence activators on the seedling growth and disease incidence in bell pepper cv Solan Bharpur was studied under nursery conditions in the Department of Seed Science and Technology Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh laid out in randomized complete block design (RCBD) in 2019. It was observed that amongst different treatments applied as seed priming before sowing in nursery, highest emergence of 86.34, 83.25 and 82.41 per cent was recorded in treatments T_5 (Salicylic acid @ 75 ppm + potassium nitrate @ 1.5% for 8 hours), T_7 (Butyric acid @ 100 ppm + potassium nitrate @ 1.5%) and T_4 (Potassium nitrate @ 1.5%/10 hours) respectively. At 28 and 42 days after sowing, the seedling height was significantly highest (4.62 and 12.21 cm respectively) in treatment T_5. Minimum ungerminated seeds were observed in T_5 (13.66%) and T_7 (16.75%). Lowest incidence of damping off (5.43%) was recorded in T_7. In case of viruses, the minimum incidence of 2.90 and 3.05 per cent was recorded in the seedlings raised from the seeds treated with T_7 and T_5 respectively. Application of salicylic acid @ 75 ppm + potassium nitrate @ 1.5 per cent for 8 hours or butyric acid @ 100 ppm + potassium nitrate @ 1.5 per cent for 4 hours as seed priming before sowing in nursery, enhanced the seedling growth parameters significantly and also reduced the incidence of diseases like damping off and viruses in bell pepper cv Solan Bharpur under nursery conditions.

Keywords: Defence activators; seed priming; seedling; parameters; disease incidence

INTRODUCTION

Bell pepper (*Capsicum annuum* L) is an important solanaceous vegetable cash crop cultivated in the temperate and tropical areas of the world. The fruits of bell pepper are rich in protein, fibre, carbohydrates, fats, vitamin A and C, minerals and bioactive substances like capsaicin, carotenoids, flavonoids and other secondary metabolites. In India, it is grown mainly in Himachal Pradesh, Andhra Pradesh, Uttarakhand and West Bengal (Darjeeling area) as a summer crop and in the states of Maharashtra, Karnataka, Uttar Pradesh and Tamil Nadu as autumn crop and around 496 thousand metric tonnes of bell pepper is produced in an area of 34 thousand hectares (Anon 2019). In Himachal Pradesh, it is grown mainly as summer and rainy season crop in an area of 2.5 thousand hectares in the districts of Solan, Kullu, Shimla, Mandi, Sirmour, Chamba and Kangra with a production of 58.2 thousand metric tonnes (Anon 2017).

The growth, yield and health of the plants after transplanting and fruits and seeds after harvesting depend on nursery raising. During nursery production, high soil moisture and changing temperature lead to occurrence of several diseases and retarded growth of plants. Most of these diseases are seed borne in nature and are carried from nursery to field as primary source of pathogens through infected seeds. To check these pathogens and enhance growth and yield parameters, seeds need to be primed with non-toxic chemicals or phytohormones called plant defence activators before sowing in the nursery. Plant defence activators like salicylic acid (SA), jasmonic acid (JA), β-amino butyric acid (BABA) and potassium nitrate

(KNO_3) are phytohormones which act by granting resistance to plants against pathogens by boosting up their defence mechanisms and do not have direct toxic effect on the pathogens. Salicylic acid is an important signaling molecule in plant defence increasing the long-term immunity through systemic acquired resistance (SAR) pathway (Shah 2003).

BABA is a non-protein amino acid considered to be an inducer of broad-spectrum resistance in a variety of crops (Cohen 2002). These plant defence activators especially SA and BABA increase the tolerance of the plants to many biotic and abiotic stresses by administering the activity of antioxidant enzymes, pathogenesis related proteins and other defence related enzymes at cellular level and also increase plant growth under stress conditions (Idrees et al 2011).

JA is known to negotiate biotic and abiotic stresses like wounding and herbivory and some developmental processes viz seed germination, root growth, flowering, fruit ripening and senescence (Delker et al 2006). It activates resistance pathways and defence gene expression due to its action as a wound hormone. Whereas KNO_3 is known to play a vital role in the adaptation of cells to abiotic stresses by helping in the normal functioning of plants such as water uptake, root growth and maintenance of turgor pressure during pathogen attack (Bardhan et al 2007).

MATERIAL and METHODS

The present investigations were carried out in the Department of Seed Science and Technology, Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during 2019 under nursery conditions in the field. The seeds of bell pepper cv Solan Bharpur were subjected to biopriming treatments with plant defence activators viz SA @ 75 pmn for 8 hours (T_1), JA @ 100 ppm for 4 hours (T_2), BABA @ 100 ppm for 4 hours (T_3), KNO_3 @ 1.5 per cent for 10 hours (T_4), SA @ 75 ppm + KNO_3 @ 1.5 per cent for 8 hours (T_5), JA @ 100 ppm + KNO_3 @ 1.5 per cent for 4 hours (T_6), BABA @ 100 ppm + KNO_3 @ 1.5 per cent for 4 hours (T_7) and untreated control (T_0) and were sown in nursery. Each treatment was replicated thrice. The nursery was raised following the standard procedure and the observations were recorded for total emergence (%), speed of germination, seedling height (cm), ungerminated seeds and disease incidence (%) (damping off and viruses).

Required amounts of chemicals were weighed on an electronic weighing balance for three replications of each concentration of SA, BABA and KNO_3 and in micropipette of JA. Measured amount of chemical was put in a beaker having small amount of distilled water, stirred with a glass rod and made to 1 litre by adding distilled water. Required number of seeds were taken for nursery sowing, put in sterilized glass beakers and dipped in priming solutions of different treatments. The primed seeds were shade-dried to their original moisture content before sowing.

Seedling growth parameters like total emergence (%) was calculated by counting the total seedlings emerged in each replication using the following formula:

$$\text{Total emergence (\%)} = \frac{\text{Number of seedlings emerged}}{\text{Total number of seeds used}} \times 100$$

Speed of germination was calculated by counting the number of seedlings emerged on each day from the first count day to the final count day described by Maguire (1962). Number of seedlings emerged on 1^{st} day/day of 1^{st} count + number of seedlings emerged on 2^{nd} day/day of 2^{nd} count ……+ number of seedlings emerged on last day/day of last count. Seedling height was measured from the base of the plant to the top of the main axis and the mean height was expressed in centimetres. The height of the seedlings was recorded at weekly interval. Incidence of diseases like damping off and virus attack was observed in the nursery and were recorded using the following formula:

$$\text{Disease incidence (\%)} = \frac{\text{Number of diseased seedlings/plot}}{\text{Total number of seedlings/plot}} \times 100$$

The statistical analysis for randomized complete block design (RCBD) was done as per design of the experiment with the standard procedure as suggested by Gomez and Gomez (1984). The level of significance for different variables was tested at 5 per cent value of significance.

RESULTS and DISCUSSION

Total emergence, speed of emergence and seedling height: The data presented in Table 1 indicate that total emergence was found to vary from

Table 1. Effect of seed priming with plant defence activators on total emergence (%) and speed of emergence in bell pepper under nursery conditions

Treatment	Total emergence (%)*	Speed of emergence**
T_1: Salicylic acid (75 ppm/8 h)	80.85 (9.05)	78.32 (62.23)
T_2: Jasmonic acid (100 ppm/4 h)	74.80 (8.71)	73.40 (58.99)
T_3: Butyric acid (100 ppm/4 h)	77.52 (8.86)	76.66 (61.10)
T_4: Potassium nitrate (1.5%/10 h)	82.41 (9.13)	78.53 (62.39)
T_5: Salicylic acid @75 ppm + potassium nitrate @ 1.5% for 8 h	86.34 (9.35)	82.05 (64.95)
T_6: Jasmonic acid @ 100 ppm + potassium nitrate @ 1.5% for 4 h	77.62 (8.87)	78.94 (62.68)
T_7: Butyric acid @ 100 ppm + potassium nitrate @ 1.5% for 4 h	83.25 (9.18)	80.58 (63.85)
T_0: Control	73.33 (8.62)	71.96 (58.02)
$CD_{0.05}$	0.22	3.18

*Values in parentheses are square root transformed values, **Values in parentheses are angular transformed values

the lowest of 73.33 and 74.80 per cent in T_0 (Control) and T_2 (Jasmonic acid @ 100 ppm/4 h) respectively, the two being at par, to the highest of 86.34, 83.25 and 82.41 per cent in treatment T_5 (Salicylic acid @ 75 ppm + potassium nitrate @ 1.5% for 8 hours), T_7 (Butyric acid @ 100 ppm + potassium nitrate @ 1.5%) and T_4 (Potassium nitrate @ 1.5%/10 hours) respectivley, the three being at par.

The highest speed of emergence of 82.05, 80.58, 78.94, 78.53 and 78.32 was exhibited in seeds treated with T_5, T_7, T_6 (Jasmonic acid @ 100 ppm + potassium nitrate @ 1.5%), T_4 and T_1 (Salicylic acid @ 75 ppm/8 hours) respectively which were at par. The minimum speed of emergence was recorded in T_0 (71.96), T_0 (73.40) and T_3 (Butyric acid @ 100 ppm/ 4 h)(76.66) which were at par.

The height of seedlings under nursery conditions varied among treatments during different durations of 28, 35 and 42 days after sowing (Table 2). At the time intervals viz 28 and 42 days after sowing, the seedling height was significantly highest (4.62 and 12.21 cm respectively) in treatment T_5. After 35 days of sowing, highest plant height was observed in T_5 (7.61 cm) and T_7 (7.52 cm) which were at par. The lowest seedling height after 28, 35 and 42 days of sowing was observed in T_0 (3.92, 6.37 and 9.85 cm respectively).

The above results obtained in Tables 1 and 2 are in line with the work of Agoncillo (2018) who showed that priming of hot pepper seeds with combination of acetyl salicylic acid and potassium nitrate significantly improved the per cent germination, speed of emergence, seed vigour index I and II and height of the seedlings as compared to priming with other combinations of plant defence activators. This could be due to the reason that SA improves seed germination by promoting the synthesis of proteins that are essential for germination and mobilization or degradation of seed proteins accumulated during seed maturation and the biosynthesis of several enzymes involved in the metabolic pathways suggesting that SA promotes the release from a quiescence state to the establishment of a vigorous seedling (Rajjou et al 2006). Also the prevalence of the K^+ in the KNO_3 is believed to have improved phytomass production increasing photosynthetic activity and effective translocation of assimilates to reproductive parts leading to higher and faster germination (Mengel 1976).

Disease incidence in seedlings: The data presented in Table 3 indicate that the minimum ungerminated seeds were observed in T_5 (13.66%) and T_7 (16.75%) which were at par with each other, while the maximum were observed in control T_0 (26.67%), T_2 (25.20%), T_3 (22.48%) and T_6 (22.38%), all being at par. These results are similar to the findings of Khan et al (2009) who observed uniformity in emergence and seedling establishment on priming the bell pepper seeds with SA and acetyl salicylic acid under normal as well as saline conditions indicating the decrease in number of ungerminated seeds.

Table 2. Effect of seed priming with plant defence activators on seedling height (cm) under nursery conditions

Treatment	Seedling height (cm) after days of sowing		
	28	35	42
T_1: Salicylic acid (75 ppm/8 h)	4.23	7.39	11.23
T_2: Jasmonic acid (100 ppm/4 h)	4.06	6.90	10.45
T_3: Butyric acid (100 ppm/4 h)	4.14	7.25	10.65
T_4: Potassium nitrate (1.5%/10 h)	4.35	7.39	11.35
T_5: Salicylic acid @75 ppm + potassium nitrate @ 1.5% for 8 h	4.62	7.61	12.21
T_6: Jasmonic acid @ 100 ppm + potassium nitrate @ 1.5% for 4 h	4.28	7.46	11.58
T_7: Butyric acid @ 100 ppm + potassium nitrate @ 1.5% for 4 h	4.48	7.52	12.00
T_0: Control	3.92	6.37	9.85
$CD_{0.05}$	0.07	0.11	0.10

Table 3. Effect of seed priming with plant defence activators on disease incidence (%) under nursery conditions

Treatment	Component		
	Ungerminated seeds (%)	Damping off (post-emergence) (%)	Viruses (%)
T_1: Salicylic acid (75 ppm/8 h)	19.15 (4.49)	7.99 (3.00)	5.74 (2.60)
T_2: Jasmonic acid (100 ppm/4 h)	25.20 (5.12)	9.73 (3.27)	10.67 (3.42)
T_3: Butyric acid (100 ppm/4 h)	22.48 (4.84)	7.24 (2.87)	5.73 (2.59)
T_4: Potassium nitrate (1.5%/10 h)	17.59 (4.31)	8.33 (3.06)	7.37 (2.89)
T_5: Salicylic acid @75 ppm + potassium nitrate @ 1.5% for 8 h	13.66 (3.82)	7.85 (2.97)	3.05 (2.01)
T_6: Jasmonic acid @ 100 ppm + potassium nitrate @ 1.5% for 4 h	22.38 (4.83)	9.45 (3.23)	8.74 (3.12)
T_7: Butyric acid @ 100 ppm + potassium nitrate @ 1.5% for 4 h	16.75 (4.21)	5.43 (2.54)	2.90 (1.97)
T_0: Control	26.67 (5.26)	22.44 (4.84)	16.79 (4.22)
$CD_{0.05}$	0.43	0.13	0.13

Values in parentheses are square root transformed values

On the other hand, the data on damping off (post-emergence) reveal that significantly lowest incidence of damping off (5.43%) was recorded in T_7 and the highest (22.44%) in T_0. These results are in line with those of Papavizas and Davey (1963) who reported that treatment with BABA in pea plants provides resistance against oomycetes. Suppression in incidence of damping off has been reported in tomato on higher potassium supply by Kirali (1976).

In case of viruses, the minimum incidence of 2.90 and 3.05 per cent was recorded in the seedlings raised from the seeds treated with T_7 and T_5 respectively which were statistically at par with each other. However, the highest virus incidence (16.79%) was observed in T_0 and rest all the other treatments exhibited intermediate virus incidence. Oka et al (1999) observed that application of BABA provided protection against nematodes and viruses due to its broad range of action.

These results could be due to several biochemical changes induced by treatment of BABA in plants which involved activation of reactive oxygen species (ROS) and glycolate oxidase (GO) strongly connected to defence mechanism. These ROS scavengers pacify the activity of BABA leading to lowest incidence in seeds treated with BABA (Ton and Mauch-Mani 2004). The high potassium concentration in the plant allows it to allocate the resources for the strengthening of cell wall for prevention against insect attack and pest infestation and leads to accessing of more nutrients for plant defence and repairing the damage (Mengel et al 2001).

CONCLUSION

Application of plant defence activators like salicylic acid @ 75 ppm + potassium nitrate @ 1.5 per cent for 8 hours or butyric acid @ 100 ppm + potassium nitrate @ 1.5 per cent for 4 hours as seed priming before sowing in nursery, enhanced the seedling growth parameters significantly and also reduced the incidence of diseases like damping off and viruses in bell pepper cv Solan Bharpur under nursery conditions leading to production of more vigorous and healthy seedlings for transplanting.

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