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RESEARCH ARTICLE

PRIMING IMPROVES GERMINATION AND SEEDLING GROWTH PERFORMANCE OF ACCELERATED AGED SEEDS OF TOMATO.

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Abstract

Seed priming is a cost effective technique which not only improves seed germination but also reduces time of seedling emergence and improves stand establishment. The present study was conducted to study the effect of various seed priming treatments (Hydration, KNO_3 and GA_3) on percent germination and growth indices of two tomato cultivars Varkha Bahar-1 and Varkha Bahar-2. Seed priming improved all morphological parameters such as percentage germination, seedling length, seedling fresh and dry weight and vigour index as compared to control. Seed priming with GA_3 showed more promotry effect followed by KNO_3 and hydration at higher concentration. Similarly seed treatment for 48 hrs showed more promotory effect as compared to 24 hrs treatment in both the cultivars at both concentrations although the effect was more pronounced in Varkha Bahar-1 as compared to Varkha Bahar-2.

Introduction:-

Tomato is one of the most important vegetable crops which is grown throughout the world (Choudhury *et al* 2013). China, the largest producer, accounted for about one quarter of the global output, followed by United States of America, India and Turkey (Patel and Rai 2018). In India, it is an important cash crop for small-holders and medium-scale commercial farmers. Seed, being a basic and crucial input, plays an important role in crop production. Hence, use of quality seeds is an effective means of improving the crop yield. Recently, many strategies have been applied to improve seed quality based on genetic and physiological approaches. Among the various strategies, priming is one of the most important physiological methods which improves the seed performance and provides faster and synchronized germination (Ashraf and Foolad 2005, Paparella *et al* 2015). Various seed priming techniques, have been developed in crop plants, which include hydro priming (soaking in water), halo-priming (soaking in inorganic salt solutions NaCl, KNO_3, $CaCl_2$ etc.), osmo priming (soaking in organic osmoticum like sugar, PEG etc.) and hormonal priming (soaking in different hormones like GA, kinetin etc.) (Paparella *et al* 2015, Hussain *et al* 2016). Ahmadvand (2012 a, b) observed rapid seed germination and uniform emergence by seed priming technology along with improved seedling establishment under stress conditions. Priming with potassium nitrate (KNO3), PEG and NaCl have been shown to improve the seed germination, seedling emergence and the initial growth of various plant species (Zhang *et al* 2012). The present research was planned to investigate the effect

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of hydro and hormonal priming and duration of priming on seedling growth performance of accelerated aged seeds of tomato.

Materials And Methods:-

The present study was conducted in Plant Physiology laboratory, Seed Technology Centre of Punjab Agricultural University, Ludhiana. It is situated at 30^0-54'N latitude, 75^0-45'E longitude and at a mean height of 247 meters above sea level. It is placed in south-Central plain region of Punjab having subtropical and semi-arid climate.

The seeds of two cultivars of tomato Punjab Varkha Bahar-1 and Punjab Varkha Bahar-2 were procured from the Director Seeds, PAU Ludhiana and used for studies pertaining to seed germination, early seedling growth and vigour index after artificially accelerated aging. For accelerated aging, the seeds were kept in dessicator at 40^0 C and 100% RH for 72 hours. The treatments were allotted in completely randomized design (CRD) in three replications. The following treatments were included:

T0- Control -No treatment
T1- Hydration - for 24 and 48 hours at 25°C
T2- KNO_3 - 50 mM for 24 and 48 hours at 25°C
T3- KNO_3- 150 mM for 24 and 48 hours at 25°C
T4- GA_3 - 10 ppm for 24 and 48 hours at 25°C
T5- GA_3 - 20 ppm for 24 and 48 hours at 25°C

The accelerated aged seeds of both tomato cutivars were sterilized by dipping in sodium hypochlorite solution (5%) for five minutes followed by drying on filter paper. Fifty seeds of each variety were subjected to hydro-priming (water), hormonal priming (GA_3) and chemical priming (KNO_3) for 24 and 48 hrs. After seed treatments, seedlings were raised between the two layers of germination paper kept in growth chamber with temperature of 25±2˚C. Effect of seed treatments was assesed in terms of percent seed germination, seedling length (cm), seedling fresh and dry weight (mg) and vigour index at 14 DAS. The germination percentage was expressed as per ISTA rules (ISTA 2008).

$$\text{Percent germination} = \frac{\text{No. of seeds germinated}}{\text{Total no of seeds}} \times 100$$

To determine seedling length, ten normal seedlings from each replication were taken. The root (from the collar region to the tip of root) and shoot length (from the collar region to the point of attachment of cotyledons) were measured using centimetre scale. Average root and shoot length of ten seedlings was expressed in centimeters. The fresh and dry weight of ten healthy seedlings was recorded in milligrams with the help of weighing balance. Vigour index of seeds were calculated as suggested by Abdul Baki's Anderson (1973). The data on seedling growth parameters were evaluated and analysis of variance (ANOVA) was done statistically using CPCS1 software. The effect of seed treatments, duration of seed treatment and cultivars were evaluated by the least significant difference (LSD) test at $P<0.05$.

Results And Discussion:-

According to the results, all seedling characters viz. germination percent, root length (cm), shoot length (cm), seedling fresh weight and dry weight (gms) and seedling vigour index were affected by the priming treatments in both cultivars and there was completely significant difference between control (unprimed seeds) and primed seeds.

Percent germination

Seed germination and seedling growth, are two critical stages for plant establishment and the most sensitive to abiotic stress (Patade *et al* 2011). The data regarding percent germination of unprimed (UP) and chemical, water and hormonal primed seeds of tomato is represented in Table 1. All priming treatments were effective in ameliorating the detrimental effects of seed aging. Seeds primed for 48 hrs with GA_3 @ 20 ppm showed maximum percent germination i.e. 86.4 in Varkha Bahar-1 and 83.8 in Varkha Bahar-2. Seed treatment with GA_3 @ 20 ppm for 24 hrs also showed more percent germination but percent germination was recorded low as compared to 48 hrs treatment in both the cultivars. Similarly, seed priming with KNO_3 @ 150 mM for 48 hrs resulted in higher percent germination as compared to KNO_3 at 50 mM in both cultivars but Varkha Bahar-1 showed more percent germination than Varkha Bahar-2. This finding is in conformity with reports of other researchers such as Harris (2002) in wheat, Ghassimi *et al* (2008) on lentil and Bradfor *et al* (1990) on pepper. Seed priming stimulates many of the metabolic processes involved with the early phases of germination. Priming with potassium nitrate (KNO3), PEG or NaCl

have been shown to improve the germination, seedling emergence and the initial growth of various plant species (Govinden and Levantard 2008, Zhang *et al* 2012).

Fresh and dry weight

The results showed that the effect of priming was significant on fresh weight of seedlings (Table 2). Maximum seedling fresh weight (492 mgs) was reported with GA3 @ 20ppm primed seeds followed by GA_3 @ 10ppm (474 mgs) primed seeds for 48 hrs. Same trend was observed when seeds were primed with GA_3 for 24 hrs at both concentrations. Lowest value of seedling fresh weight found in unprimed seeds i.e. control (395 mgs). Seed priming with KNO_3 for 48 hrs with both the concentrations 50 mM and 150 mM showed an increase in fresh weight as compared to 24 hrs seed treatment, but more increase was observed in Varkha Bahar-1 than Varkha Bahar-2. The hydration treatment of seeds showed an increase in seedling fresh weight of seedlings of both the varieties Varkha Bahar-1 and Varkha Bahar-2 as compared to control, but more increase was observed in Varkha Bahar-1 when the seeds were hydrated for 48 hrs on comparison with 24 hrs.

The dry weight of seedlings differed significantly among the treatments and cultivars at both durations (Table 3). The hydration treatment increased the dry weight of seedling over control (9.5 in Varkha Bahar-1 and 9.0 in Varkha Bahar-2). The dry weight of seed increased with increase in duration of hydro-priming (48 hrs) (12.0 in Varkha Bahar-1 and 10.9 in Varkha Bahar-2) as compared to 24 hrs (11.4 in Varkha Bahar-1 and 10.3 in Varkha Bahar-2). Varkha Bahar-1 showed more increase in dry weight as compared to Varkha Bahar-2 with all the treatments. Among the KNO_3 treated seeds, the seeds soaked for 24 hrs in 50 mM KNO_3 recorded the less dry weight of seedlings as compared to the seeds treated with 150 mM for 24 hrs. Priming with GA_3 at both the concentrations (10 ppm and 20 ppm) for 48 hrs showed the maximum dry weight of seedlings. GA_3 seed treatment with 20 ppm showed more dry weight as compared to GA_3 with 10 ppm concentration. Similar effect was notified in the seed treatment for 48 hrs which showed more dry weight content on comparison with 24 hrs in both the varieties. But, Varkha Bahar-1 showed more dry weight as compared to Varkha Bahar-2.

Shoot length and root length

The data revealed that shoot length was affected by different priming treatments, and length was significantly different across varieties (Table 4). Trends of changes in shoot length with seed priming were similar in root length. Priming with solutions of KNO3, GA3 and water exhibited the improved shoot length, while least shoot length was recorded in control. Faster seed-germination can cause greater shoot and root length in treated seeds. Nascimento (2003) has reported that the pre-treatment of melon seeds with different solutions increased plumule length resulted from the longer period of time for seedling growth as a result of a faster germination.

Significant differences were found to exist between the varieties and among the priming treatments on root length (Table 5). The hydro-primed seeds for 48 hrs showed more increase in the root length than 24 hrs in both tomato varieties Varkha Bahar-1 and Varkha Bahar-2. Varkha Bahar-2 showed less shoot length than Varkha Bahar-1. KNO_3 @ 150 mM also increased root length on seed treatment for 48 hrs as compared to 24 hrs. Similar trend was observed in seed treatment of accelerated aged seeds with 50 mM KNO_3 but increase was observed when the seeds were treated for 48 hrs duration as compared to 24 h. The hydration treatments for 48 h showed an increase as compared to 24 h seed treatment along with control in Varkha Bahar-1. Similar effect was observed in the hydrated accelerated aged seeds of Varkha Bahar-2. While the effect was more pronounced in Varkha Bahar-1 than Varkha Bahar-2. Demir and Oztokat (2003) also found that root and shoot length increased in seeds due to hormonal priming as compared to non-primed seeds. Similar finding were also reported by Farooq (2007).

Vigour Index

All seed priming treatment showed positive effect on the seedling vigour index (Table 6). Maximum seedling vigour index (1283.52) was recorded when seeds were primed with GA3 @ 20ppm followed by GA3 @ 10 ppm (1117.20) for 48 hrs (Table 6). Seed priming with GA_3 at both concentrations for 24 hrs showed same trend but it was recorded lower as compared to treatment for 48 hrs. Similarly, seed treatment with KNO_3 at both the concentrations (50 mM and 150 mM) showed higher vigour index as compared to control although more increase was observed with KNO_3 @ 150 mM. Minimum seedling vigour index (479.75) was recorded in unprimed seeds (control). Kathiresan *et al* (1984) reported the increase in seedling vigour which may be due to enhanced oxygen uptake and the efficiency of mobilizing nutrients from the cotyledons to the embryonic axis. Bakht 2011 and Ruan *et al* 2002 reported similar findings.

Table 1:-Effect of seed priming for 24 and 48 hrs on percent seed germination of two tomato (*Lycopersicon esculentum* L.) cultivars Varkha Bahar-1 and Varkha Bahar-2.

TREATMENTS	**VARKHA BAHAR-1**		**VARKHA BAHAR-2**	
	24 h	**48 h**	**24 h**	**48 h**
CONTROL	60.5	60.5	58.5	58.5
HYDRATION	60.2	69.1	62.4	65.6
KNO_3 (50mM)	70.6	75.6	67.6	70.5
KNO_3 (150mM)	73.7	79.2	71.8	75.4
GA_3 (10ppm)	78.8	83.5	76.1	80.1
GA_3 (20ppm)	82.6	86.4	80.3	83.8
CD at 5%	A= 0.8203, B = 0.4736, C= 0.4736, ABC= 1.6407			

Table 2:- Effect of seed priming for 24 hrs and 48 hrs on fresh weight (mgs) of seedlings of two tomato (*Lycopersicon esculentum* L.) cultivars Varkha Bahar-1 and Varkha Bahar-2.

TREATMENTS	**VARKHA BAHAR-1**		**VARKHA BAHAR-2**	
	24 h	**48 h**	**24 h**	**48 h**
CONTROL	395	395	378	378
HYDRATION	417	429	396	411
KNO_3 (50mM)	439	450	420	431
KNO_3 (150mM)	455	461	432	446
GA_3 (10ppm)	468	474	445	459
GA_3 (20ppm)	481	492	466	473
CD at 5%	A= 0.8836, B= 0.5101, C= 0.5101, ABC= 1.7673			

Table 3:- Effect of seed priming for 24 hrs and 48 hrs on percentage germination dry weight (mgs) of seedlings in two tomato (*Lycopersicon esculentum* L.) cultivars Varkha Bahar-1 and Varkha Bahar-2.

TREATMENTS	**VARKHA BAHAR-1**		**VARKHA BAHAR-2**	
	24 h	**48 h**	**24 h**	**48 h**
CONTROL	9.5	9.5	9.0	9.0
HYDRATION	11.4	12.0	10.3	10.9
KNO_3 (50mM)	12.6	13.3	11.7	12.4
KNO_3 (150mM)	13.5	14.1	12.6	13.3
GA_3 (10ppm)	14.3	15.2	13.2	14.4
GA_3 (20ppm)	14.9	16.8	14.3	15.5
CD at 5%	A= 0.8205, B= 0.4737, C= 0.4737, ABC= NS			

Table 4:- Effect of seed priming for 24 and 48 hrs on shoot length (cms) of seedlings of two tomato (*Lycopersicon esculentum* L.) cultivars Varkha Bahar-1 and Varkha Bahar-2.

TREATMENTS	**VARKHA BAHAR-1**		**VARKHA BAHAR-2**	
	24 h	**48 h**	**24 h**	**48 h**
CONTROL	11.5	11.5	10.6	10.6
HYDRATION	12.2	12.7	11.3	11.9
KNO_3 (50mM)	12.9	13.5	12.4	13.0
KNO_3 (150mM)	13.7	14.4	13.1	13.7
GA_3 (10ppm)	14.6	15.0	13.8	14.5
GA_3 (20ppm)	15.2	15.6	14.7	15.1
CD at 5%	A= 0.8205, B= NS, C= NS, ABC= NS			

Table 5:- Effect of seed priming for 24 and 48 hrs on root length (cms) of seedlings of two tomato (*Lycopersicon esculentum* L.) cultivars Varkha Bahar-1 and Varkha Bahar-2.

TREATMENTS	**VARKHA BAHAR-1**		**VARKHA BAHAR-2**	
	24 h	**48 h**	**24 h**	**48 h**

CONTROL	4.7	4.7	4.3	4.3
HYDRATION	5.3	5.6	4.8	5.2
KNO_3 (50mM)	5.7	6.2	5.3	5.8
KNO_3 (150mM)	6.2	6.7	5.9	6.3
GA_3 (10ppm)	6.7	7.2	6.4	6.9
GA_3 (20ppm)	7.3	7.7	7.0	7.4
CD at 5%	A= 0.8205, B= NS, C= NS, ABC= NS			

Table 6:- Effect of seed priming for 24 and 48 hrs on vigour index of two tomato (*Lycopersicon esculentum* L.) cultivars Varkha Bahar-1 and Varkha Bahar-2.

TREATMENTS	**VARKHA BAHAR-1**		**VARKHA BAHAR-2**	
	24 h	**48 h**	**24 h**	**48 h**
CONTROL	479.75	479.75	436.5	436.5
HYDRATION	640.68	709.20	539.72	606.04
KNO_3 (50mM)	763.56	872.48	673.92	750.20
KNO_3 (150mM)	859.95	975.72	778.68	869.82
GA_3 (10ppm)	983.84	1117.20	872.52	1009.44
GA_3 (20ppm)	1081.74	1283.52	1005.29	1143.90
CD at 5%	A= 0.7967, B = 0.4599, C= 0.4599, ABC= 1.5934			

A= Variety
B= Treatment
C= Time

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