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Effect of Priming on Microtubers Sprouting and Physiological Storage Attributes of Potato

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ABSTRACT

An experiment was conducted at ICAR-Central Potato Research Station, Gwalior (MP) during 2012-13.Ten microtubers of three varieties *viz. Kufri* Chandramukhi, *Kufri* Lauvkar and *Kufri* Sindhuri were primed with total seven treatments for 10 minutes include water control (hydropriming) and fungicide mancozeb @1% and five bioagents *viz* B-5 (*Bacillus substallis*) @ 0.8%, *Trichoderma viridie* @ 1%, *Trichoderma harzanium* @ 1%, *Aspergillus niger* @1% and *Phosphorous solubilizing bacteria* @1% at 10 days interval up to 60 days (total 7 dates) and stored at ambient temperature. At the end of storage period of 70 days *Kufri* Lauvkar recorded significantly higher physiological loss in weight (0.88g and 57.26%) over other two cultivars, highest tuber sprouting was recorded in *Kufri* Sindhuri (91.25%) over other varieties and tubers rottage was significantly higher in in *Kufri* Lauvkar (30%) over *Kufri* Chandramukhi (17%), *Kufri* Sindhuri (11%). Among priming treatments, significantly higher Physiological weight loss was observed in *B. substalis* @ 0.8% (50.90%) and higher sprouting in control (55.56%) and B-5 (52.22%) over other priming treatments. Significantly higher microtubers were rotted in all the priming treatments over control (12.22%) and *T. harzanium* @1% (14.44%). Priming with B-5 (*B. substallis*) @ 0.8% in *Kufri* Sindhuri resulted in higher sprouting. Less physiological weight loss but higher rottage percent was observed in *Kufri* Sindhuri during storage at ambient temperature.

1. Introduction

Seed priming is a pre-sowing method of improving germination, for the purpose of reducing the time from sowing to emergence also improving emergence uniformity (Gupta et al. 2008). This technique involves seed hydration (usually within 10-20% of full imbibition) sufficient to permit pre-germinative metabolic events to proceed, but insufficient to allow radicle protrusion (Taylor et al. 1998). Seed priming has been commonly used to reduce the time between seed sowing and seedling emergence and to synchronize emergence (Parera et al. 1994). Microtubers are small, *in vitro* produced tubers varying in size and weight from 3-12 mm and 0.02 to 1.0 gm. respectively produced under sterile pathogen-free conditions (Chandra et al. 1992). Micro-tubers come in different sizes, have different dormancy requirements and differ widely in relative growth potential and productivity (Badoni and Chauhan 2010). Microtubers of potatoes have outstanding advantages as small volume, light weight, unlimited producing seasons, easy to storage, faster reproducing rate and is an important component, along with plantlets and minitubers for seed potato production programs (Rosu et al. 2004; Sarkar and Naik 1999). For micro-tubers, timing of sprouting after natural breaking of dormancy can be critical for good emergence and early development (Garner and Blake 1989). Rapid and uniform sprouting of the seed (pieces) is a pre-requisite for establishing a healthy crop (Suttle 2008).

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Potato minitubers are not plantable immediately after harvest and during unknown period after that, so they have dormancy period during which the tubers will never germinate. Duration of dormancy in potato minitubers depends on cultivar, ripening time, growth condition, maintenance condition in store and the tuber size. (Emilson 1999). Various strains of *Trichoderma* have been founded to be effective in plant growth characteristics and enhance biomass production (Shoresh 2010). These fungi inhabit plant root and plant growth characteristics by increasing evolution and production of plants (Yedidia et al. 2001). Improved root growth and abiotic stress will enhance systemic resistance to diseases, increase nutrient uptake and stimulate competence utilization, moreover; they will increase leaf greenness and amplify percentages and rates of germination of seeds (Bjorkman et al. 1998; Harman, 2000; Yedidia et al. 2001). Considering the above fact that no information is available on the priming effect on storability and sprouting behavior of microtubers of Indian potato cultivars, the present work was undertaken to study the priming technique for improving storage and germination potential of microtubers.

2. Material and Methods

An experiment was conducted at the ICAR-Central Potato Research Station, Gwalior (MP) during 2012-13. Microtubers were produced in the laboratory at CPRI, Shimla from *in-vitro* raised virus free microplants following standard protocol. These were store in cold store at 4^0C and taken out before the present study. Ten microtubers of three varieties *viz. Kufri* Chandramukhi, *Kufri* Lauvkar and *Kufri* Sindhuri were primed with total seven treatments for 10 minutes which includes water control and fungicide mancozeb @1% and five bioagents *viz.* B-5 (*Bacillus substallis*) @ 0.8%, *Trichoderma viridie* @ 1%, *Trichoderma harzanium* @ 1%, *Aspergillus niger* @1% and phosphorous *solubilizing bacteria* @1% along with control, at 10 days interval up to 60 days (total 7 dates) and stored at ambient temperature. Each treatment was replicated three (details are given in Table 1). Data were collected separately for physiological loss in weight at 10 days interval and final physiological loss after 70 days of storage, dormancy duration *i.e.* sprouting behavior at 10 days interval final sprouting percent after 70 days of storage i.e. at the end of storage were also observed. Similarly rotttage at 10 days interval in microtubers and percent after 70 days of storage i.e. at the end of storage were also observed. Data was analyzed statistically by analysis of variance (ANOVA) with Completely Randomized Design (factorial) and means were separated according to the least significant differences (LSD) at 0.05 level of probability.

3. Results and Discussion

3.1 Priming effect on Physiological loss in weight (PLW)

The observations recorded during storage reveled that among varieties, *Kufri* Sindhuri (1.32g) recorded significantly higher microtuber weight during overall storage period of 70 days over other two varieties *Kufri* Chandramukhi (1.04 g) and *Kufri* Lauvkar (1.02 g) (Table 1), but at the end of storage period of 70 days, *Kufri* Lauvkar recorded significantly higher physiological loss in weight (0.88g and 57.26%) over other two cultivars (Table 2). Storage of microtubers under different temperatures led to different kinds of losses: in a refrigerator (4°C) more than 40% physical damage was observed, while under higher temperatures 24% tubers weight loss occurred after 60 days (Hossain *et al*. 2002). Significantly higher Physiological loss in weight in microtubers of cultivar *Kufri* Pukhraj than *Kufri* Chipsona-1 has been reported during storage of tubers of at room temperature (Kumar et al. 2005 and Sharma *et al*., 2012). This confirms the varietal differences in storage.

Among treatments, overall Physiological weight was significantly higher in control, priming with *B- substalis* @ 0.8%, *T. vridie* @1% and *T. harzanium* @1% over other priming treatments (Table 1), the resistance of tomato seeds to deterioration in storage is decreased by priming (Argerich et al. 1989). Similar trend was recorded in the present study (Table 1). But at the end of storage (70 days) significantly higher physiological weight loss was observed in *B-Substalis* @ 0.8% (50.90%) over other priming treatments and control (Table 2). Significant decrease in the overall weight loss after each 10 days was observed from initial storage (1.51g) to end of storage (0.80 g) (Table 1). Minimum weight loss was in T. viride (34.9%) closely followed by T. viride + P. fluorescence + tracel integration (35.4%) priming in comparison to control (41.9%) for 6 mm grade of microtubers in 35 days to 130 days of storage under Shimla conditions (CPRI 2014). The overall minimum weight loss at the end of storage was 57.2% in carbendazim primed minituber followed by P. fluorescence priming (59.2%) after 306 days of storage when stored separately in yellow cloth bag, muslin cloth bag, plastic net bag and gunny bag in culture room (non-hermatic) at 22 ± 1^oC temperature with 16 hours light and 8 hours darkness after priming (CPRI 2015). In the interaction study of varieties and priming treatments, in *Kufri* Chandramukhi, overall physiological weight was significantly higher in priming with *T. Harzanium* @1% during storage period over other priming treatments and control. In *Kufri* Lauvkar overall physiological weight was significantly higher in priming with control, priming with water (hydropriming), *A. niger* @1% and phosphorous solubilizing bacteria @1% over *T. vridie*

@1%. In *Kufri* Sindhuri, physiological weight was significantly higher in all other priming treatments and control over hydropriming. In the interaction study of varieties and storage interval, significantly higher weight loss was started after 20 days of storage in *Kufri* Chandramukhi and *Kufri* Sindhuri, but in *Kufri* Lauvkar significantly higher weight loss was started after 10 days of storage. In interaction study of priming treatments and storage, significant decrease was recorded after 20 days of storage in all the priming treatments and control, highest weight was recorded in *T. Harzanium* @1% priming treatment over other treatments during storage duration.

3.2 Priming effect on sprouting

Post-harvest dormancy of potato tuber has always posed a problem for their immediate use when wanted. The nature of dormancy of minituber or microtubers was consistent with field grown potato (Habib, 1999). Among varieties, average sprouted tuber number was significantly lower in *Kufri* Lauvkar (0.87) and *Kufri* Chandramukhi (0.54) over *Kufri* Sindhuri (3.45) during overall storage period of 70 days (Table 1), but at the end of storage period, significant and highest tuber were sprouted in *Kufri* Sindhuri (9.1) over other varieties (Table 2).) Significant differences were reported in sprouting speed of microtubers in six cultivars. Microtubers with 3 g weight sprout after 10 days, while microtubers with 375 and 750 mg sprout after 15 and 13 days respectively (Struik and Lommen 1999). Sprouting was maximum in *Kufri* Bahar (97.6%), closely followed by *Kufri* Badshah (96.2%) and minimum in *Kufri* Pukhraj (65.5%) (Sharma et al. 2012). Among priming treatments, significantly higher sprouting was recorded in control (1.83) and priming with B-5 (1.82) over other priming treatment during overall period. At Shimla, effect of biopesticide priming on microtubers sprouting behavior at ambient temperature revealed that there was no adverse effect of high dose of *T. viride* (3%), *P. fluorescence* (3%) and mancozeb (0.4%) on sprouts growth, shoot and root development of microtubers (CPRI, 2013). Seed priming with KNO_3 at 118 mol·m-3 + $K3PO_4$ 1 at 90 mol·m-3 for 5 days (priming) and also soaking in1500 ppm of GA for 1 day and prolonged storage substantially increased seedling vigor in the three TPS progenies (Pallais et al. 1991). Overall sprouting initiated after 30 days of storage and thereafter significantly increased at each 10 days of storage up to end of storage. Among priming treatments, non-significantly higher sprouting was recorded in control (55.56%) and B-5 (52.22%) over other priming treatments (Table1). Percent increase in germination over control in 6 mm grade varied from 13.3 to 33.3% with maximum in T. viride and pencycuron priming for 30 min and storage up to 35 days to 130 days in all the three grades of microtubers (CPRI 2014). The maximum sprout length in aeroponic minitubers was with priming in tricel, mancozeb, P. fluorescence and T. viride (6.2 cm) when primed with different bioagents *i.e.* T. viride (1%), P. fluorescence (1%), carbendazim (0.3%), captan (0.3%), carbendazim±captan (0.3 +0.3%), mancozeb (0.3%) tracel (0.3%) and stored in nonhematic culture room at 16 hours light (irradiance of 60 umol/m2 /s) and 8 hours dark photoperiodism at 22+1^{o}C (CPRI 2015). In the interaction study of varieties and priming treatments, in *Kufri* Chandramukhi, overall sprouting was significantly higher during storage period in control, hydro priming and priming with B-5@ 0.8% over other priming treatments. In *Kufri* Lauvkar, significantly higher sprouting of tubers was recorded in priming treatments *viz.* hydropriming, *A. niger* @1% and control over *T. vridie* @1% (0.58). In *Kufri* Sindhuri significantly higher sprouting of tubers was recorded in all priming treatments over hydro priming (2.50). In the interaction study of varieties and storage duration interval on sprouting of tubers, sprouting of tubers was started after 50, 40 and 30 days of storage in *Kufri* Chandramukhi, *Kufri* Lauvkar and *Kufri* Sindhuri respectively, where significant increase in number of sprouted tubers were recorded in all the varieties after respective date of initiation of sprouting. In the interaction study of priming treatment and storage duration interval on sprouting of tubers, in all the treatments sprouting of tubers started after 20 days of storage and in majority of treatments significant increase in number of sprouted tubers were recorded after 40 days of storage up to 60 days of storage.

3.3 Priming effect on rottage

The observations recorded during storage reveled that among varieties, significantly higher average rottage of tubers was recorded in *Kufri* Lauvkar (0.96), *Kufri* Chandramukhi (0.44), over *Kufri* Sindhuri (0.21) during overall storage period of 70 days (Table 1), similar trend was recorded after 70 days of storage where average tubers rotted was significantly higher in in *Kufri* Lauvkar (30 %) over *Kufri* Chandramukhi (17 %), *Kufri* Sindhuri (11%) Table 2 *i.e.* in the three varieties it ranged from 10 to 30 percent. In the micro-tuber based seed potato production system, about 30-40% micro-tubers are lost during storage (due to drying and rottage) and the emergence of remaining micro-tubers is only 45-50% (Venkataselam et al. 2011).

Table 1. Effect of priming on overall physiological weight, sprouting and rottage of microtubers during storage period at ambient temperature

Varieties/ priming treatments/ storage duration	Physiological Weight (g)	Sprouting (No)	Rottage (No)
Kufri Chandramukhi	1.04	0.54	0.44
Kufri Lauvkar	1.02	0.87	0.96
Kufri Sindhuri	1.32	3.45	0.21
SE (V)	**0.01**	**0.05**	**0.04**
CD0.05 (V)	**0.03**	**0.13**	**0.13**
Control	1.15	1.83	0.31
Water	1.07	1.44	0.78
B- substalis @ 0.8%	1.14	1.82	0.56
T. vridie@1%	1.14	1.57	0.47
T. harzanium @1%	1.25	1.65	0.26
A. niger @1%	1.11	1.56	0.65
Phosphorous solubilizing bacteria @1%	1.07	1.57	0.67
Mancozeb @1%	1.09	1.51	0.61
SE (T)	**0.02**	**0.07**	**0.07**
CD 0.05 (T)	**0.06**	**0.21**	**0.21**
0 days	1.51	0.00	0.00
10 days	1.39	0.00	0.00
20 days	1.26	0.00	0.03
30 days	1.18	0.50	0.13
40 days	1.06	1.07	0.33
50 days	0.95	2.43	0.71
60 days	0.87	4.36	1.18
70 days	0.80	4.60	1.93
SE (D)	**0.02**	**0.07**	**0.07**
CD 0.05(D)	**0.06**	**0.21**	**0.21**
SE (VxT)	**0.03**	**0.13**	**0.13**
CD0.05 (VxT)	**0.09**	**0.37**	**0.36**
SE (VxD)	**0.03**	**0.13**	**0.13**
CD 0.05(VxD)	**0.09**	**0.37**	**0.36**
SE (Tx D)	**0.05**	**0.21**	**0.20**
CD 0.05(Tx D)	**0.15**	**0.60**	**0.59**

Proportions of viable micro-tubers at the end of storage was the highest (68.4%) in *Kufri* Badshah and the lowest (26.5%) in *Kufri* Pukhraj, which can be attributed to the better quality of micro-tubers with intact lenticels in *Kufri* Badshah and vice-versa in *Kufri* Pukhraj when stored in a refrigerator under continuous darkness at a temperature of 4^0C and relative humidity of 85-90% for three months and after three months, micro-tubers were shifted to incubation (culture) room at a temperature of 22 + 2°C for 2 weeks followed by storage for 2-weeks at room temperature (about 18^0C) for sprouting (Sharma *et al*., 2012). Among treatments, during the whole storage period significantly higher average tubers were rotted in all the treatments except control over *T. harzanium* @1% (Table 1), similarly at the end of storage period, non-significantly higher tubers were rotted in all the priming treatments over control (12.22%) except *T. harzanium* @1% (14.44%) (Table 2). The non-germinated/rotted/dried microtubers was 12.5% in carbendazim, pencycuron and tracel priming in comparison to control (32.5) in 4 mm grade microtubers in 35 days to 130 days of storage in all the three grades of microtubers (CPRI, 2014). In the interaction study of varieties and priming treatments, in *Kufri* Chandramukhi significantly higher rottage was recorded in priming treatment with *B-substalis* @ 0.8%, *A. niger* @1%, *PSB* @1% and mancozeb@1% over Control and *T. harzanium* (0.08) @1%. In *Kufri* Lauvkar significantly higher rottage was recorded in priming treatment with *A. Niger* @1%, *PSB* @1% and mancozeb @1% and hydro priming over *T. harzanium* @1% (0.54), but in *Kufri* Sindhuri significantly higher rottage of tubers was

Table 2. Effect of priming on physiological weight loss, sprouting and rottage of microtubers after 70 days of storage at ambient temperature

Varieties/ priming treatments	**Physiological Weight loss**		**Sprouting**		**Rottage**	
	g	**%**	**No.**	**%**	**No.**	**%**
Kufri Chandramukhi	0.56	42.21	1.9	19.17 (4.30)	1.7	17.08 (3.90)
Kufri Lauvkar	0.88	57.26	2.8	28.33 (5.29)	3.0	30.00 (5.49)
Kufri Sindhuri	0.69	41.40	9.1	91.25 (9.58)	1.1	10.83 (3.00)
SE (V)	**0.04**	**2.25**	**0.34**	**0.20**	**0.37**	**0.29**
CD0.05(V)	**0.12**	**6.50**	**0.98**	**0.58**	**1.07**	**0.82**
Control	0.69	45.12	5.6	55.56 (7.18)	1.2	12.22 (3.22)
Water	0.66	46.20	4.1	41.11 (6.32)	2.3	23.33 (4.81)
B- substalis @ 0.8%	0.79	50.90	5.2	52.22 (6.89)	2.4	24.44 (4.52)
T. vridie@1%	0.69	45.18	4.2	42.22 (5.89)	1.9	18.89 (3.84)
T. harzanium @1%	0.73	45.71	4.7	46.67 (6.41)	1.4	14.44 (3.43)
A. niger @1%	0.71	47.12	4.3	43.33 (5.97)	2.0	20.00 (4.28)
Phosphorous solubilizing bacteria @1%	0.72	48.60	4.7	46.67 (6.45)	2.1	21.11 (4.61)
Mancozeb @1%	0.69	46.88	4.2	42.22 (6.01)	2.0	20.00 (4.30)
SE (T)	**0.03**	**1.38**	**0.21**	**0.33**	**0.23**	**0.47**
CD 0.05 (T)	**0.07**	**3.98**	**0.60**	**NS**	**0.65**	**NS**
SE (VX T)	**0.07**	**3.90**	**0.59**	**0.58**	**0.64**	**0.81**
CD 0.05 (VX T)	**0.20**	**11.26**	**1.69**	**NS**	**1.85**	**NS**

* Data in parenthesis are square root transformed value

recorded in hydro priming (0.62) over all other priming treatments and control. In the interaction study of varieties and storage duration interval on rottage of micro tubers, rottage initiated after 10 days, 20 days and 30 days of storage in *Kufri* Lauvkar, *Kufri* Chandramukhi and *Kufri* Sindhuri, respectively. In *Kufri* Lauvkar, significant increase in rottage of tubers was started after 30 days of storage and continued up to end of storage and in *Kufri* Chandramukhi and *Kufri* Sindhuri significant increase started only after 50 days and 60 days of storage respectively. In the interaction study of priming treatment and storage duration interval on rottage of tubers, among treatments rottage initiated after 20 days in hydro priming and priming with phosphorous solubilizing bacteria @1%, in other treatment rottage initiated after 30 days of storage except *T. harzanium* @1% where rottage initiated after 50 days of storage.

Conclusion

Priming with B-5 (*B. substallis*) @ 0.8% in *Kufri* Sindhuri resulted in higher sprouting but all the priming treatment resulted in higher physiological weight loss and rottage of tubers than control. Less physiological weight loss but higher rottage percent was observed in *Kufri* Sindhuri during storage at ambient temperature.

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