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SPROUTING BEHAVIOR OF AEROPONIC MINITUBERS OF DIFFERENT VARIETIES

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ABSTRACT: This experiment was performed to investigate the effect of environmental conditions (controlled and natural indoor environment) and harvesting period on sprouting behavior of aeroponic minitubers of seven potato varieties. Data was collected on weight loss percentage, sprouting percentage and emergence percentages for all varieties and treatments. The weight loss percentage in open environment was 20.82 percent which was 203.06 percent higher than controlled environment (6.87%). Highest weight loss was observed in Kufri Badshah (21.58%) followed by Kufri Pukhraj (16.09%) whereas; minimum weight loss was recorded in Kufri Himalini (7.94%). On the other hand, sprouting and emergence percentages were significantly high under controlled temperature conditions as compared to natural indoor conditions. After 30 days of keeping for sprouting in different environments highest sprouting percent was recorded in variety Kufri Himalini (90.93%) followed by Kufri Chipsona-1 (86.67%). Minitubers harvested in the month of February recorded higher sprouting percent (98.84%) as compared to March (84.46%) and April (65.16%) harvested mini-tubers.

KEYWORDS: Minitubers, potato, sprouting

INTRODUCTION

Potato production in India during 2016 was 43.77 million tons from 2.13 million ha area with a productivity of 20.55 t/ha (FAOSTAT). Seed is major input in potato cultivation accounting for 45-50 percent of total cost of cultivation (Singh *et al.*, 2008). Potato productivity is severely constrained by limited high quality seed tubers which are precipitated by inefficiencies in various stages in the seed production system. Availability of disease free planting material is a critical input in augmenting potato production in the country.

Conventional way of producing quality pre basic potato seed is to multiply clean *in vitro* material in protected conditions. But this method is labour intensive, expensive, requires more area and slow multiplication rate (yields of 5 to 10 tubers per plant). Another constraint is the degeneration of seed stocks from one generation to another due to accumulation of viruses and viroids. To overcome this problem, recently CPRI has put very high emphasis on producing healthy mother stock of seed potato using high tech methods such as aeroponics (Singh and Rana, 2014). Aeroponics offers the potential to improve production and reduce costs compared to conventional methods or to the other soilless method of hydroponics. There is a tremendous scope to increase healthy seed production vertically by adopting aeroponic technology of seed system. The method can produce higher yields (up to 10-times higher), more quickly, and at lesser cost than conventional growing methods. We do not need any excess area for aeroponic based healthy seed production. Desired size of minitubers can be harvested sequentially and this could reduce the cost of minituber production. Aeroponics has finally left the laboratories and entered into the commercial cultivation arena. Studies shown that the mean potato tuber yield under aeroponics

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is better than conventional means (Otazu, 2008; Tsoka *et al*., 2008). Such results clearly indicate that aeroponics system could be effectively used for potato propagation and has found maximum application in potato seed production (Goo *et al*., 1996; Ritter *et al*., 2001; Factor *et al*., 2007).

Efficient management and utilization of these small sized minitubers to produce successive disease free generations is the next most critical issue after the successful advent of the technology. Being a nascent technology, there is a severe dearth knowledge related to the management and planting of the aeroponic minitubers. Post-cold storage behavior and the effect of different harvesting periods on sprouting and emergence of minitubers of different varieties not known. Picking of aeroponic minitubers generally extends for 2-3 months, which leads to differently aged tubers kept together during storage. This in turn may affect the storage, sprouting and emergence of minitubers. There is a urgent need for standardization of protocols for minimum weight loss storage, efficient sprouting and emergence of minitubers. Keeping these issues related to the aeroponic minitubers in view, the present study on the post cold storage behavior of different varieties harvested at different time periods under two environmental conditions (natural indoor and controlled).

MATERIALS AND METHODS

An experiment was conducted at ICAR-Central Potato Research Station, Jalandhar during September to November 2016. Minitubers produced through aeroponics in month of February, March and April of 2016 were used for this study. After harvesting, treating with fungicide and greening the minitubers under artificial light, these were stored in a cold chamber at 4°C in perforated plastic bags. The minitubers harvested between 1st and 5th of each corresponding month were only considered for comparing the sprouting behavior to ensure significant age difference between harvestings. Minitubers of seven varieties (Kufri Pukhraj, Kufri Jyoti, Kufri Himalini, Kufri Badshah, Kufri Chipsona-1, Kufri Chipsona-3 and Kufri Surya) having an average weight of 2-3 g (medium size) were kept in two environments in the month of September 2016 just before planting in field. The experiment was laid as a factorial randomized block design (RBD) with 42 treatment combinations replicated three times. The two environments considered in the study include ENV1: indoor natural conditions (variable temperature (25-33°C), diffused natural light ENV2: Controlled (temperature (18-20°C, maintained in precooling chamber with artificial lights and RH. The minitubers of the three harvest months (February, March and April) and the seven varieties were placed in the two environments to compare the sprouting behaviour. Observations were recorded on percentage of minitubers showing sprouting on every alternate day, weight loss percentage, number of sprouted eyes after 30 days and percentage emergence in the net house. Weight loss was calculated by taking initial weight at withdrawal from cold store and the final weight after complete sprouting which was observed at days after withdrawal. Minitubers were planted in net house on October 16 in raised beds with spacing of 30 cm × 10 cm with sprinkler irrigation. Emergence of minitubers in net house was recorded 20 days after planting. Data was subjected to analysis of variance (ANOVA) for testing the significance of variation for different characters as described by Gomez and Gomez (1984). Mean values were calculated and compared using t-test at 5% level of significance.

RESULTS AND DISCUSSION

We investigated the weight loss pattern (**Table 1**) in both environments and found that the weight loss percentage was significantly higher in open conditions (ENV1) than the controlled temperature conditions (ENV2). The weight loss percentage in Environment 1 was 20.82 percent which is 203.06 percent higher than Environment 2 (6.87%). Regarding weight loss in different varieties the significantly higher weight loss was observed in Kufri Badshah (21.58%) followed by Kufri Pukhraj (16.09%), Kufri Jyoti (15.65%) and Kufri Chipsona-1 (15.10%) whereas minimum weight loss was recorded in Kufri Himalini (7.94%). Pande *et al.*, 2007 also observed different weight loss pattern in tubers of different varieties. Temperature, humidity and air movement have been reported to be the most important factors during storage of tubers, which are known to affect loss of moisture, development of rots, and excessive sprout growth (Harbenburg *et al.*, 1986 and Maldegem, 1999). The controlled environment ENV2 provided controlled temperatures and higher relative humidity to ensure lesser weight loss as compared to the indoor natural environment ENV1. A clear pattern for effect of harvesting time on weight loss could not be established, which may be attributed to the significant interaction between Environment × variety × month observed in this case.

Table 1. Weight loss (%) in mini-tubers of different potato varieties harvested at different intervals at two environments.

Varieties	Environment 1	Environment 2
K. Pukhraj	24.49 (5.00)	7.69 (2.92)
K. Jyoti	24.44 (4.95)	6.87 (2.79)
K. Himalini	11.21 (3.45)	4.67 (2.38)
K. Badshah	32.25 (5.73)	10.91 (3.42)
K. Chipsona-1	16.79 (4.17)	4.41 (2.31)
K. Chipsona-3	23.05 (4.86)	7.15 (2.85)
K. Surya	13.54 (3.79)	6.39 (2.65)
Mean	20.82 (4.57)	6.87 (2.76)
Factors	C.D.	SE (m)
Environment	0.14	0.05
Varieties	0.26	0.09
Intraction (Environment × Variety)	0.37	0.13

*Figures in parenthesis are arcsine transformed

Interesting results were obtained regarding number of sprouted eyes per minituber (**Table 2**). Similarly number of sprouted eyes was also not significantly influenced by the environmental conditions but showed significant varietal variation. The maximum number of sprouted eyes were observed in Kufri Chipsona-3 (4.24) followed by Kufri Chipsona-1 (3.97) and then Kufri Pukhraj (2.72) whereas minimum number of eyes were obtained in Kufri Badshah (2.00) and Kufri Surya (2.01). Similar varietal variation in number of sprouted eyes has been reported by Reeves and Hunter (1980). Different harvesting times of minitubers were also observed to affect the number of sprouted eyes per minituber, indicating the role of differently aged minitubers. February harvested minitubers were observed to show the maximum number of sprouted eyes (3.18) which were found to be statistically at par with March harvested minitubers (3.11) but significantly superior to April harvested minitubers (2.21).

Percent emergence of minitubers was observed to be significantly influenced by environments, varieties as well as harvesting times (**Table 3**). Emergence percentage depicted significantly higher variation in ENV1 (87.41%) as compared to ENV2 (81.05%) but difference is non-significant. Regarding different varieties highest emergence was recorded in variety Kufri Pukhraj (90.46%) which was found statistically at par with Kufri Chipsona 1 (90.09%), Kufri Badshah (87.32%) and Kufri Surya (85.83%). The trend is in correlation with the results obtained for the number of sprouted eyes except for Kufri Badshah which had minimum number

Table 2. Average number of sprouted eyes per minituber.

Environment	Environment 1				Environment 2			
Varieties/ Months	February	March	April	Mean	February	March	April	Mean
K. Pukhraj	1.73	2.40	1.00	1.71	4.47	3.60	3.13	3.73
K. Jyoti	2.93	2.13	2.40	2.49	2.40	2.53	2.40	2.44
K. Himalini	1.87	1.60	2.20	1.89	2.67	4.00	2.00	2.89
K. Badshah	2.27	2.07	2.00	2.11	1.80	2.27	1.60	1.89
K. Chipsona-1	4.07	3.73	2.00	3.27	6.07	4.33	3.60	4.67
K. Chipsona-3	6.87	8.00	2.80	5.89	3.87	2.27	1.67	2.60
K. Surya	2.20	1.93	2.67	2.27	1.27	2.60	1.40	1.76
Mean	3.13	3.12	2.15	2.80	3.22	3.09	2.26	2.85
Factors		C.D.			SE (m)		SE (d)	
Environment		N.S.			0.08		0.11	
Varieties		0.41			0.14		0.20	
(Environment × Variety)		0.58			0.20		0.29	
Month		0.27			0.10		0.13	
(Environment × Month)		N.S.			0.13		0.19	
(Variety × Month)		0.70			0.25		0.35	
(Environment × Variety × Month)		1.00			0.35		0.50	

of eyes, but was probably highly vigorous to show early emergence. Minimum percentage of emergence was observed in Kufri Jyoti (71.75%). February harvested minitubers showed highest emergence percentage (92.24%) which was statistically at par with March harvested minitubers but significantly higher emergence than April harvested ones. February harvested minituber showed 32.37% higher emergence than April harvested minitubers. These results are in strong concurrence with the results on variation in number of sprouted eyes of minitubers on harvesting period.

Sprouting percent was recorded on every alternate day but here we have discussed only sprouting percent at 30 days after keeping in different environments (**Fig. 1**) from the date of starting experiment the experiment (date of withdrawal from cold store). Keeping conditions were found to have significant impact on sprouting percentage of potato minitubers with significantly higher sprouting in ENV2 of 99.79 percent which is 51.54 percent higher than sprouting in Environment-1 (65.85%). As in ENV2 temperature and relative humidity are controlled which provide favourable conditions for sprouting whereas in ENV1 due to higher temperature and wider variation in relative humidity might have caused lower sprouting percent. Sprouting was also varied between different varieties and highest sprouting percent was recorded in variety Kufri Himalini (90.93%) followed by Kufri Chipsona-1 (86.67%). Minitubers harvested in the month of February (98.84%) recorded higher chitting percent as compared to March (84.46 %) and April (65.16%) harvested tuber, supporting our proposed effect of variation arising from harvesting dates. The earlier picking of minitubers in February may have led to earlier breaking of dormancy of these minitubers as compared to April harvested

Table 3. Percent emergence of minitubers in net house after 20 days.

Environment	Environment 1				Environment 2			
Varieties/ Months	February	March	April	Mean	February	March	April	Mean
K. Pukhraj	90.54 (9.56)*	95.00 (9.80)	82.78 (9.15)	89.44 (9.49)	97.78 (9.94)	97.78 (9.94)	78.89 (8.86)	91.48 (9.57)
K. Jyoti	92.10 (9.64)	42.86 (6.51)	33.33 (5.68)	56.10 (7.28)	97.78 (9.94)	96.67 (9.88)	67.78 (8.27)	87.41 (9.36)
K. Himalini	98.89 (9.99)	97.78 (9.94)	64.44 (8.05)	87.04 (9.33)	93.33 (9.71)	84.44 (9.23)	48.89 (7.06)	75.56 (8.67)
K. Badshah	96.67 (9.88)	95.00 (9.80)	56.67 (7.34)	82.78 (9.01)	98.89 (9.99)	96.67 (9.88)	80.00 (8.99)	91.85 (9.62)
K. Chipsona-1	95.55 (9.83)	95.56 (9.83)	73.89 (8.65)	88.33 (9.43)	98.89 (9.99)	95.56 (9.82)	81.11 (9.02)	91.85 (9.61)
K. Chipsona-3	88.70 (9.47)	90.56 (9.57)	46.67 (6.73)	75.31 (8.59)	95.56 (9.83)	96.67 (9.88)	78.89 (8.92)	90.37 (9.54)
K. Surya	85.56 (9.29)	87.22 (9.38)	92.22 (9.66)	88.33 (9.44)	61.11 (7.88)	98.89 (9.99)	90.00 (9.53)	83.33 (9.14)
Mean	92.57 (9.67)	86.28 (9.26)	64.28 (7.89)	81.05 (8.94)	91.91 (9.61)	95.24 (9.80)	75.08 (8.66)	87.41 (9.36)

Factors	C.D.	SE (m)	SE (d)
Environment	0.241	0.085	0.121
Varieties	0.450	0.160	0.226
(Environment × Variety)	0.636	0.226	0.320
Month	0.295	0.105	0.148
(Environment × Month)	0.417	0.148	0.209
(Variety × Month)	0.780	0.277	0.392
(Environment × Variety × Month)	1.102	0.392	0.554

Figures in parenthesis are transformed values

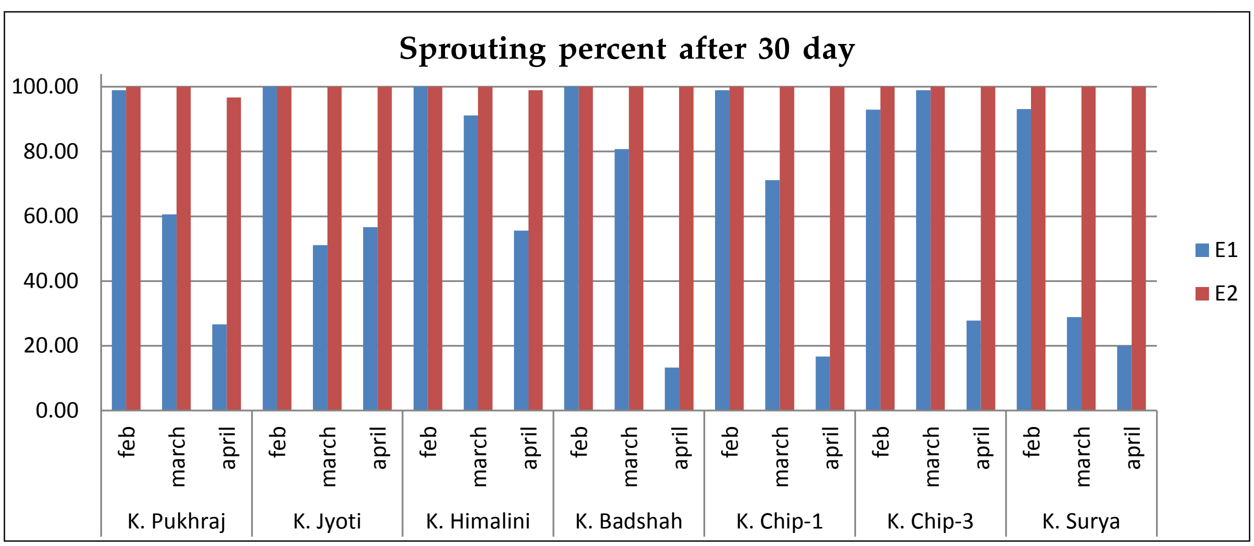

Fig. 1. Sprouting percentage after 30 days in two environments.

minitubers, thereby showing higher sprouting percentages.

CONCLUSIONS

Higher weight loss of minituber was recorded in open indoor conditions as compared to controlled environment. Minitubers are quite small in size, due to which the small weight loss reflects as a major sprouting and emergence loss in minitubers. Ensuring proper management of temperatures, light and relative humidity for sprouting of these expensive planting materials is most crucial for its optimum utilization. Sprouting percent and number of sprouted eyes were more in February harvested minitubers as compared to March harvested minitubers, which led to their higher emergence under net house planting. The variation in harvesting dates according to harvest implies that staggered sprouting and planting of aeroponic these small minitubers is required to get better response from minitubers.

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