International Journal of Agricultural and Applied Sciences, December 2022, 3(2): 108-113
https://www.agetds.com/ijaas
ISSN: 2582-8053
https://doi.org/10.52804/ijaas2022.3220

Research Article

OPEN ACCESS

Effect of pre-sowing treatment of chemicals on sprouting of newly harvested potato at Kavre, Nepal

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(**Received:** 19/08/2022; **Revised:** 18/11/2022; **Accepted:** 29/11/2022)

ABSTRACT
The experiment was carried out to study the effect of different chemical treatments on the sprouting of newly harvested potato tuber at Banepa, Kavrepalanchowk, Nepal. The experiment was carried out in CRD (Completely Randomized Design) in a room with seven treatments and four replications. Janakdev variety of potato was treated with seven different treatments i.e., control, cytokinin (2ml/lit, 3ml/lit), hydrogen peroxide (20mM, 40mM), and gibberellic acid (40 ppm, 50ppm). The research was conducted from March to June 2022. Different chemicals with different concentrations were used in this experiment. Tubers were soaked in treatment solution for 2 hours, allowed to dry in shade, and kept in a dark room on plastic trays. The dormancy breakage, first emergence of sprout, number of sprouts per tuber, and sprout length per tuber were recorded and analysed. Among the different chemical treatments used in the experiment, gibberellic acid 50 ppm showed the first emergence of sprout at 13.38 days compared to the control (28.28). It has decreased the dormancy period by 31.96 days compared to the control. Also, 50 ppm gibberellic acid showed the highest number of sprouts per tuber and sprout length per tuber in comparison to other treatments followed by 40 ppm gibberellic acid. In the overall result, it is found that an increase in the concentration of different treatments increases the sprout's number and decreased the dormancy period. However, an increase in concentration increases the sprout length in GA3 but decreases the sprout length in cytokinin and hydrogen peroxide.
Keywords: Concentration, Dormancy, Gibberellic acid, Security.

INTRODUCTION

After reaching physiological maturity, the potato (*Solanum tuberosum* L.) seeds may enter a state of deep dormancy, during which potato seeds do not germinate after planting. Even when placed under optimum germination conditions, tubers do not sprout during the physiological stage of dormancy (Sonnewald & Sonnewald, 2014). Depending on genotype and pre- and post-harvest circumstances, the dormancy duration ranges from 2 to 3 months. For farmers to be able to preserve their produce for the desired period under conventional storage conditions or in refrigerated infrastructure, it should be assessed before releasing any variety (Mani, Bettaieb, Doudech, & Hannachi, 2014).

Potato (Solanum tuberosum L.) is considered the most important crop of food security and one of the fourth most important crops after wheat, rice, and maize in the world. It is an important cash crop to address food insecurity and reduce poverty among smallholder farmers in a developing country like Nepal (Timsina, Kafle, & Sapkota, 2011). According to Sapkota & Bjaracharya (2017), potato cultivation is popular among farmers due to its wider adaptability, high yield potential, and high demand which contribute about 6.57 and 2.17% to AGDP and GDP respectively. It also serves as a healthy replacement for most cereal crops and provides more calories, vitamins, and nutrientsper area of land sown than other staple crops (Nunn & Qian, 2011). Potato tuber contains 70-80% water, 20.6% carbohydrate, 2.1% protein, 0.3% fat, 1.1% crude fibre, and 0.9% ash (Gemmechu, 2017).

Even in the best sprouting conditions (darkness, 15 to 20 °C, relative humidity of around 90%), dormancy is a physiological state characterized by a period during which autonomous sprout growth does not occur. Dormancy is recognized as the time between tuber initiation and the beginning of sprouting. Postharvest dormancy is employed for practical purposes because the dormancy period is difficult to determine (Virtanen, Haggman, Tegefu, Valimaa, & Seppanen, 2013) and is defined as the period from dehaulming to the time when 80% of tubers shows sprouts at least 2 mm long (Pande, PC, Singh, Pandey, & Singh, 2007).

A dormancy duration provides information on how long a potato will be stored before starting to sprout. The

period of dormancy affects how to choose types for short- or long-term storage, when to use products to prevent sprouting, and how to sell the potatoes. When sprouting starts, harmful quality issues include altered glucose status, an increase in respiration rate, further weight loss, and problems with storage management like blocked airflow emerge. Depending on the season and target seed market, seed manufacturers may need to speed up or slow down sprout development (Salimi, Afsari, Hosseini, & Struik, 2010). Tuber dormancy is an adaptation of potato ontogeny providing for the successful reproduction of Solanum tuberosum species. For industrial purposes, it is preferable to keep potatoes in storage for a long time, but overly prolonged dorman cy hinders seed tuber sprouting. (Bajji, Mahmoud , Frederic , Jorge , Rojas , & Patrick , 2007). So, for seed potato multiplication, rapid post-harvest disease testing, and early production in the field or greenhouse breaking of tuber dormancy are highly important (Coleman, 1983).

Sprouts begin to grow vigorously after emerging from dormancy, with the development of roots at their bases. At this point, tubers change from being a storage organ to a source of nutrients and energy for sprouts that are still developing (Struik, Lommen, Haverkort, & Storey, 2007). To terminate premature dormancy and induce sprouting there are diverse ranges of physical, chemical, and hormonal treatments (Shuttle J. C., 2007). Chemicals such as hydrogen peroxide, cytokinin, gibberellic acid, etc. are used for initiating sprouts. Ascorbate peroxidase and glutathione peroxidase will take over to ensure the metabolism of hydrogen peroxide and, consequently, release dormancy when catalase is suppressed by the application of hydrogen peroxide, which makes the intracellular hydrogen peroxide longer available for them than for catalase. (Bhate & Ramasama, 2009). Shuttle (2004) observed that in comparison to the end of dormancy, sprout growth was more impacted by endogenous gibberellin content. Hemberg (1985) mentioned that exogenous cytokinin can be used to break potato tuber dormancy, and endogenous cytokinin levels rise before dormancy termination.

MATERIALS AND METHODS

Experimental site and duration:

The research was conducted in Banepa Municipality of Kavre district, Nepal. It lies between 27.63 ºN latitude and 85.52 ^{0}E and is located at a height of <300 m to 3000 m (Distancesto, 2022). It covers 1.73% of the total area of Nepal and has an area of 1396 sq. km. The annual rainfall is about 2,500 mm and temperatures vary from 7 ºC to 27 ºC. The research was conducted from March to June 2022.

Experimental treatments and design:

There were 7 treatments using different concentrations of control, Cytokinin (2ml/lit and 3ml/lit), Hydrogen peroxide (20 mM and 40 mM), and Gibberellic acid (40 ppm and 50 ppm). 1 kg of tubers per experimental unit was used. The experiment was laid out in a Completely Randomized Design (CRD) with three replications. Tubers were kept for sprouting at room temperature in CRD. Altogether there were 21 experimental units.

Sample collection and preparation of chemical treatments:

The tubers required for the research experiment were collected locally from Panauti municipality, Kavrepalanchowk which were harvested at Chaitra 10, 2078. Janakdev variety was taken for the study purpose as this variety was extensively cultivated by the farmers of this region. Medium-sized tubers (25-35 gram) were selected for research purposes after proper grading and removing the soil and dirt from them. The treatments were prepared by dissolving the respective concentration of chemicals in the lukewarm water except for Gibberellic acid. Gibberellic acid was first dissolved in the locally available alcohol and then mixed with water. The tubers were first washed with tap water and dipped in the chemical treatments for two hours. In the case of control, tubers were dipped in lukewarm water for two hours. After two hours, the tubers were dried and kept in a dark room for the remaining days for observation.

Data observation:

Five tubers were randomly selected from each plot and data was collected at 15 days intervals. The parameters of the research were days to the first emergence of sprouts, days to dormancy breakdown, the number of sprouts per tuber, and sprout length per tuber.

Statistical analysis:

The data recorded throughout the experimental period were tabulated in Ms-Excel and subjected to R state software for statistical analysis. Data were subjected to one-way treatment analysis of variance (ANOVA) and significant mean differences were compared by using Duncan's Multiple Range Test (DMRT) at 0.05 percent level of significance.

RESULTS AND DISCUSSION

Days to the first emergence of sprouts:

Table 1 shows the effect of treatment with various concentrations of different chemicals on days to the first emergence of sprouts of potato tuber. The experiment showed that there is a significant effect of treatment with various concentrations of chemicals over control on the days of the first emergence of sprouts. Minimum days to the first emergence were observed in Gibberellic acid at 50 ppm (13.38) followed by Gibberellic acid at 40 ppm (14.45). Gibberellic acid was followed by cytokinin with 3ml per lit and 2 ml per lit (16.60 and 17.83 respectively) and Hydrogen peroxide with 20 mM and 40 mM (18.63 and 19.67 respectively). The experiment showed the maximum number of days to the first emergence in the control (28.28). From the overall result, it can be concluded that Gibberellic acid gives better efficiency for the days to the first emergence of sprouts than other treatments and control throughout the observation. The result is in agreement with the finding of other researchers Rahman, Haque, Karim, & Ahmed, (2006), Virtanen, Haggman, Tegefu, Valimaa, & Seppanen,

(2013), Shibairo, et al., (2006). Rahman, Haque, Karim, & Ahmed, (2006) had shown that the increasing concentration of GA3 resulted in a decrease in the number of days to 50% sprouting. Therefore, the results suggest that GA3 should be used for the termination of dormancy and promotion of sprouts of potato seed tubers. In absence of GA3, cytokinin followed by hydrogen peroxide can be used to break down the dormancy and initiation of sprouts.

Table 1. Effect of different chemical doses on days of the first emergence of sprouts on potato tuber

Treatment	Days of the first emergence of sprout
Control	28.28[a]
Cytokinin (2ml/l)	17.63[d]
Cytokinin (3ml/l)	16.60[e]
Hydrogen peroxide(20mM)	19.67[b]
Hydrogen peroxide(40mM)	18.63[c]
Gibberellic acid (40ppm)	14.45[f]
Gibberellic acid(50ppm)	13.38[g]
LSD	0.37
SEM (+-)	0.122
F-Probability	<0.001
CV%	1.22
Grand mean	17.38

Note: CV=Coefficient of variation, LSD=Least Significant Difference, SEM=Standard Error of Mean. This means in the column with the same letter (s) in superscript indicates no significant difference between treatments.

Days to dormancy breakdown:

The results from this experiment revealed that the application of different concentrations of various chemicals shows significant differences in the number of days for breaking the dormancy of potato tuber compared to the control as shown in Table no. 2. The minimum days to break the dormancy was observed in 50 ppm Gibberellic acid with (32.42) which was followed by 40 ppm Gibberellic acid (36.92). The maximum days to break the dormancy of potato was observed in control (64.38). The result of this research regarding days for breaking the dormancy is by the finding of Asalfew (2016) and Shibairo, et al (2006) whom they reported that dipping treatment of 40 and 50 ppm reduced dormancy period by 18 days and 20 days, respectively. This finding is in line with Turnip, Siregar, & Damanik (2020) who stated that the soaking of the potato tuber seeds with cytokinin solution 45 days after harvesting time fastened the dormancy release time by 12.58 days compared to the time without soaking the potato tuber seeds with cytokinin solution. In addition, compared to the control, hydrogen peroxide enhanced the proportion of sprouting tubers (Mani, Bettaieb, Doudech, Hannachi, Mariem, & Mariem, Effect of hydrogen peroxide and thiourea on dormancy breaking of microtubers and field-grown tubers of potato, 2013).

Table 2. Effect of different chemical doses on days of dormancy breaking of sprouts on potato

Treatment	Days for dormancy breakdown
Control	64.38[a]
Cytokinin (2ml/l)	48.37[d]
Cytokinin (3ml/l)	44.53[e]
Hydrogen peroxide(20mM)	55.30[b]
Hydrogen peroxide(40mM)	53.32[c]
Gibberellic acid (40ppm)	36.92[f]
Gibberellic acid(50ppm)	32.42[g]
LSD	0.39
SEM (+-)	0.13
F-Probability	<0.001
CV%	0.46
Grand mean	47.89

Note: CV=Coefficient of variation, LSD=Least Significant Difference, SEM=Standard Error of Mean. This means in the column with the same letter (s) in superscript indicate no significant difference between treatments.

Number of sprouts (sprout density):

Table no.3 shows the effect of treatment with various concentrations of different chemicals on the number of sprouts per tuber. At 15 DAT, the highest numbers of sprouts were observed in 50 ppm Gibberellic acid (6.83) and the minimum number of sprouts was observed in control (0.00). At 30 DAT, the maximum number of sprouts per tuber was observed in 50 ppm Gibberellic acid (7.33) which is at par with 40 ppm Gibberellic acid (6.50). The minimum number of sprouts per tuber was observed in the control (2.16). At 45 DAT, the highest number of sprouts was observed in 50 ppm Gibberellic acid (7.50) which was at par with 3ml/lit Cytokinin (6.83) followed by 40 ppm Gibberellic acid (6.50). At 60 DAT, the number of sprouts per tuber was found to be significantly higher in 50 ppm Gibberellic acid (8.17). At 75 DAT, the maximum number of sprouts was observed in 50 ppm Gibberellic acid (8.33) and the minimum number of sprouts was observed in control (5.50) and 20mM Hydrogen peroxide (5.50). At 90 DAT, the highest number of sprouts was observed in 50 ppm of Gibberellic acid (10.00). Similarly, the minimum number of sprouts was observed in control (6.00) which is at par with 20mM Hydrogen peroxide (6.17). These results are in agreement with the result of Shibairo, et al. (2006) who reported that higher concentrations of GA3 produce more sprouts. Similarly, the result is by the result of Turnip, Siregar, & Damanik, (2020) and Mani, et al. (2013) who reported that the number of sprouts increased with hydrogen peroxide than in the control.

Sprout length per tuber:

Table no. 4 shows the effect of treatment with various concentrations of different chemicals on sprout length per tuber on potato. The experiment showed that different concentrations of Gibberellic acid, Cytokinin, and Hydrogen peroxide had a significant effect on sprout

length over control. According to observations made on 30 DAT, 50 ppm Gibberellic acid produced the longest sprouts (1.51). The minimum length of sprouts (0.20) was produced by the control. At 45 DAT, the highest length of sprouts per tuber(2.20cm) was obtained in 50 ppm Gibberellic acid, and the lowest length of sprouts (0.58 cm) was observed in the control. Similarly, in 60 DAT Gibberellic acid produce the longest sprouts i.e., 3.25 cm, and the shortest sprouts were seen in control i.e.,0.77 cm which was at par with the concentration of Cytokinin and Hydrogen peroxide. At 75 DAT and 90 DAT, the maximum length of sprouts was observed in 50 ppm Gibberellic acid 3.83 cm and 4.20 cm respectively followed by 40 ppm Gibberellic acid 2.58 cm and 3.00 cm. The minimum length of sprouts was produced by control on both of the days of observation. At 75 DAT, the control produced 0.95 cm and at 90 DAT, it produced 1.20 cm. These findings are similar to the result of Rossouw (2008) who indicate that a lower concentration of cytokinin (0.5BA treatment) resulted in more sprout growth (14.6 mm) than a higher concentration of cytokinin (1BA) resulted in less sprout growth (8.4 mm). The result thus obtained is in accordance with Soares, et al., (2021) who stated that the menthol and H2O2 + menthol treatments result in smaller sprouts but the isolated application of H2O2 stimulated sprout growth.

Table 3. Number of sprouts per tuber induced by different chemical doses on potato tuber

Treatment	Number of sprouts per tuber					
	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT
Control	0.00^{e}	2.16^{d}	3.50^{d}	4.17^{e}	5.50^{d}	6.00^{d}
Cytokinin (2ml/l)	5.67^{abc}	6.00^{ab}	6.33^{abc}	6.50^{bcd}	6.83^{bc}	7.66^{bc}
Cytokinin (3ml/l)	5.00^{bcd}	6.17^{ab}	6.83^{a}	7.00^{b}	7.17^{b}	7.33^{c}
Hydrogen peroxide(20mM)	4.17^{d}	4.33^{c}	5.17^{c}	5.50^{d}	5.50^{d}	6.17^{d}
Hydrogen peroxide(40mM)	4.50^{cd}	5.00^{bc}	5.50^{bc}	5.83^{cd}	6.00^{cd}	6.50^{d}
Gibberellic acid(40ppm)	6.00^{ab}	6.50^{a}	6.50^{ab}	6.83^{bc}	7.33^{ab}	8.33^{b}
Gibberellic acid(50ppm)	6.83^{a}	7.33^{a}	7.50^{a}	8.17^{a}	8.33^{a}	10.00^{a}
LSD	1.24	1.34	1.19	1.01	1.01	0.83
SEM (+-)	0.41	0.44	0.39	0.33	0.33	0.27
F-Probability	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
CV%	15.39	14.26	11.54	9.19	8.66	6.40
Grand mean	4.60	5.36	5.90	6.29	6.67	7.43

Note: CV=Coefficient of variation, LSD=Least Significant Difference, SEM=Standard Error of Mean. Means in the column with same letter (s) in superscript indicate no significant difference between treatments.

Table 4. Sprout length (cm) induced by different chemical doses

Treatment	Sprout length per tuber(cm)				
	30 DAT	45 DAT	60 DAT	75 DAT	90DAT
Control	0.20^{d}	0.58^{de}	0.77^{c}	0.95^{d}	1.20^{d}
Cytokinin (2ml/l)	0.35^{cd}	0.70^{cde}	0.90^{c}	1.23^{cd}	1.53^{c}
Cytokinin (3ml/l)	0.28^{cd}	0.50^{e}	0.77^{c}	0.98^{cd}	1.43^{cd}
Hydrogen peroxide(20mM)	0.48^{c}	0.83^{c}	1.03^{c}	1.28^{c}	1.63^{c}
Hydrogen peroxide(40mM)	0.51^{c}	0.70^{cd}	0.93^{c}	1.08^{cd}	1.50^{c}
Gibberellic acid(40ppm)	1.05^{b}	1.62^{b}	2.30^{b}	2.58^{b}	3.00^{b}
Gibberellic acid(50ppm)	1.51^{a}	2.20^{a}	3.25^{a}	3.83^{a}	4.20^{a}
LSD	0.27	0.23	0.28	0.31	0.30
SEM (+-)	0.08	0.07	0.09	0.10	0.09
F-Probability	<0.001	<0.001	<0.001	<0.001	<0.001
CV%	24.3	12.48	11.39	10.30	8.16
Grand mean	0.63	1.03	1.42	1.72	8.16

Note: CV=Coefficient of variation, LSD=Least Significant Difference, SEM=Standard Error of Mean. Means in the column with same letter (s) in superscript indicate no significant difference between treatments.

CONCLUSION

Dormant potato tuber takes more time for sprouting so, the growth phase of potato plant become longer. The result of this study indicated that, all methods of treatments have an effect on the first emergence of sprouts, days to dormancy break, number of sprouts per tuber, and sprout length per tuber. Dipping treatments with 50 ppm gibberellic acid is found to be best for breaking dormancy with more numbers of sprouts and the highest sprout length in comparison to other treatments. After Gibberellic acid (both 40 ppm and 50 ppm), cytokinin can be used for initiating sprouting but hydrogen peroxide is not found quite significant as sometimes it may be used by other for sprouting inhibitors. Therefore, gibberellic acid with 50 ppm is recommended for initiating sprouting in newly harvested potato.

CONFLICT OF INTEREST

The author here declares that there is no conflict of interest in the publication of this article.

ACKNOWLEDGEMENT

The author would like to acknowledge Prime Minister Agriculture Modernization Project (PMAMP), Agriculture and Forestry University for funding this research project.

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Citation: Neupane, S.; Sharma, S.; Sigdel, S. and Duwal, R. 2022. Effect of pre-sowing treatment with different doses of chemical on sprouting of newly harvested potato at Kavre, Nepal. *International Journal of Agricultural and Applied Sciences*, 3(2): 108-113. https://doi.org/10.52804/ijaas2022.3220