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# Response of calcium application on yield and skin damage of potato tubers

**Rakesh K. Dubey*, Vikas Singh, Kamala Devi and Katon Kartek**
Department of Vegetable Science, College of Horticulture & Forestry, Central Agricultural University, Pasighat 791102, Arunachal Pradesh

## ABSTRACT

**Tuberization in potato is a complex process and influenced by photoperiod, temperature and nutrition. Potato tubers have low calcium as compared to leaves and stems. Recent studies have provided evidence linking tuber quality with tuber tissue calcium concentration. There are reports on strong support indicating the involvement of calcium in tuberization. The purpose of the present study was to determine the influence of supplemental calcium on the growth, yield and skin damage of tubers. Results indicated that different levels of calcium on plant growth characteristics were significant. Total yield as well as grade-wise tuber yield were significantly higher with the application of 120 kg Ca/ha at the time of planting. Lowest skin damage in tubers were recorded with the application of 20 kg Ca/ha at planting and 20 kg Ca/ha at earthing up.**

**Key words:** Calcium, potato, plant growth, tuber yield.

## INTRODUCTION

Tuberization in potato (*Solanum tuberosum* L.) is a complex process and influenced by photoperiod, temperature and nutrition (Synder and Ewing, 12). Among the nutrients, calcium (Ca) is a common element in soil. When calcium reaches the root surface it is taken up by roots and released to the xylem (Bangerth, 1; Marschner, 7). It is translocated from roots to the rest of the plant along with water by a series of cation exchange reactions. Thus, transpiring organs such as leaves accumulate adequate amounts of calcium. Potato tubers, however, are generally much lower in calcium because of low transpiration rate in these organs (Bangerth, 1; Marschner, 7; Palta, 10). Furthermore, potato tubers are surrounded by moist soil, thus reducing their water demand as compared to the above ground parts of the plants (Palta, 10). Calcium in potato tubers is taken up by functional roots present on the tubers and stolons (Kratzke and Palta, 4). The application of calcium to different parts of the plant showed a three-fold increase in calcium concentration of tubers peel and medullary tissues when calcium was placed near the stolons and tubers (Kartzke and Palta, 5). Results of the several studies indicated that source, placement and timing of calcium application are crucial to increase tuber calcium concentration (Kartzke and Palta, 5; Ozgen *et al*., 8). Tuber calcium concentration can be enhanced by the application of calcium in the tuber area during the bulking period (Gunter *et al.*, 2; Karlsson *et al*., 3; Ozgen *et al*., 8). Potato skin damage during harvesting is known to be related to calcium deficiency. The presence of skin damage tuber leads to a reduction in the commercial value of the crop as growers are penalized depending on percentage of damaged tubers. In soils, supplemental application of calcium during bulking has been shown to increase tuber calcium concentration, thereby improving overall tuber quality and reducing internal and external defects (Tzeng *et al*., 13). Therefore, the present study was undertaken to study the effect of calcium application on tuber yield and skin damage.

*Corresponding author's E-mail: rksdudey@gmail.com

## MATERIALS AND METHODS

The present investigation was conducted during the *rabi* 2009-10 at Vegetable Farm, College of Horticulture & Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh (28°04´N and 95° 22´E, elevation 153 m). The soil of the experimental field was sandy loam with pH 6.7 and initial available calcium 4.0 meq/100 g soil samples. The experimental design was a split plot fitted to Randomized Complete Block Design with seven treatment of calcium application (Gypsum as source), *viz*., T1: no application of calcium, $T_2$: 40 kg Ca/ha at planting, $T_3$: 20 kg Ca/ha at planting and 20 kg Ca/ha at earthing up, $T_4$: 80 kg Ca/ha at planting, $T_5$: 40 kg Ca/ha at planting and 40 kg Ca/ha at earthing up, $T_6$: 120 kg Ca/ha at planting and $T_7$: 60 kg Ca/ha at planting and 60 kg ca/ha at earthing up. The recommended dose of fertilizer was 100:120:100 kg N, $P_2O_5$ and $K_2O$ per hectare, respectively. Potato variety Kufri Pushkar was selected for the study with specific objectives of experiments to see effect of calcium on total yield and skin damage of tubers. The observations on

**Table 1.** Initial soil fertility status of the experimental plot.

| Treatment | OC* | pH | Av. N | Av. P | Av. K |
|---|---|---|---|---|---|
| T1 | 2.0 | 6.7 | 372.0 | 39.0 | 185.90 |
| T2 | 2.1 | 6.7 | 372.0 | 39.64 | 184.90 |
| T3 | 2.1 | 6.72 | 372.0 | 39.64 | 185.92 |
| T4 | 2.0 | 6.72 | 372.0 | 39.60 | 185.92 |
| T5 | 2.1 | 6.7 | 371.5 | 39.64 | 185.92 |
| T6 | 2.1 | 6.7 | 370.5 | 39.64 | 185.92 |
| T7 | 2.1 | 6.7 | 371.5 | 39.65 | 185.92 |

OC*= Organic carbon content of soil; Av = available

Calcium application rate (ha)

1. No calcium application
2. 40 kg at planting
3. 20 kg at planting + 20 kg at earthing up
4. 80 kg at planting
5. 40 kg at planting+ 40 kg at earthing up
6. 120 kg at planting
7. 60 kg at planting+60 kg at earthing up

plant emergence, plant height, number of shoots and leaves/plant, tuber yield in different grades, total tuber yield, total number of tubers/ha, dry matter, skin damaged tuber yield and economics and return of different treatments were recorded. Analysis of complete variance and comparison of means was done according to LSD test by MSTAT-C software.

## RESULTS AND DISCUSSION

The application of gypsum as calcium source at all dozes increased plant emergence by 1.88 to 4.88%. The calcium level of 40 kg/ha at planting and 40 kg/ha at earthing up recorded maximum plant emergence (95.0) and the control (*i.e.* without calcium application) showed minimum plant emergence (90.0). However, tallest plant height (42.0) was observed with application of calcium 60 kg/ha at planting and 60 kg/ha at earthing up while highest number of shoots/plant (4.5) was recorded with the application of calcium at 40 kg/ha at planting. Further, application of 80 kg ca/ha at planting produced maximum number of leaves/plant (41.0). Similar results have been reported in investigation conducted by Gunter *et al.* (2). Maximum tuber yield of 0-25 g tubers was recorded with application of 120 kg Ca/ha at planting (3.6), while application of calcium at 20 kg /ha at planting and 20 kg/ha at earthing up produced maximum tuber yield of 25-50 g tubers (3.4 t/ha). Application of 120 kg Ca/ha at planting produced maximum yield of 50-75 g tubers (4.1 t/ha), while highest tuber yield of >75 g was recorded with application of calcium 60 kg/ha at planting and 60 kg/ha at earthing up (5.0). Maximum total tuber yield was recorded with application of calcium 120 kg/ha at planting (15.6 t/

**Table 2.** Percent emergence, plant height, number of shoots and leaves/ plant and yield of different grade tubers under different treatments.

| Treatment | Percent emergence | Plant height (cm) | No. of shoots/ plant | No. of leaves/ plant | Yield (t/ha) | | | | Total yield t/ha |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 0-25 g | 25-50 g | 50-75 g | >75 g | |
| T1 | 90.0 | 39.5 | 3.8 | 36.0 | 3.0 | 3.0 | 3.5 | 4.5 | 13.8 |
| T2 | 91.9 | 40.8 | 4.5 | 38.0 | 3.0 | 3.2 | 3.6 | 4.3 | 14.0 |
| T3 | 93.5 | 39.7 | 4.0 | 38.8 | 3.4 | 3.4 | 3.6 | 4.1 | 14.3 |
| T4 | 93.4 | 41.1 | 4.0 | 41.0 | 3.5 | 3.2 | 3.8 | 3.9 | 14.5 |
| T5 | 94.9 | 38.0 | 3.3 | 40.3 | 3.2 | 3.1 | 3.8 | 4.0 | 14.1 |
| T6 | 92.4 | 37.3 | 4.3 | 36.0 | 3.6 | 3.3 | 4.1 | 4.8 | 15.6 |
| T7 | 93.9 | 41.7 | 3.5 | 37.0 | 3.3 | 3.2 | 3.8 | 5.0 | 15.3 |
| $CD_{0.05}$ | 1.1 | 2.5 | 1.2 | 3.1 | 0.5 | 0.3 | 0.3 | 0.4 | 0.6 |
| CV% | 0.8 | 4.3 | 20.3 | 5.3 | 8.6 | 4.8 | 5.6 | 6.3 | 3.0 |

**Table 3.** Number of tubers, percent dry matter, due to calcium application tuber yield and skin damaged tubers.

| Treatment | No. of tuber (0-25 g) in '000 | No. of tubers /ha (25-50 g) in '000 | No. of tubers/ ha (50-75 g) in '000 | No. of tubers/ha (>75 g) in '000 | Total No. of tubers/ ha in '000 | Percent dry matter | Skin damaged tuber yield (t/ha) | Skin damaged tubers No./ ha in '000 |
|---|---|---|---|---|---|---|---|---|
| T1 | 138.9 | 127.3 | 115.2 | 101.5 | 482.8 | 16.4 | 0.7 | 24.3 |
| T2 | 141.2 | 132.9 | 112.5 | 107.2 | 493.8 | 15.4 | 0.6 | 26.8 |
| T3 | 127.7 | 125.4 | 113.6 | 113.0 | 479.7 | 15.7 | 0.5 | 26.2 |
| T4 | 135.8 | 125.6 | 124.8 | 111.5 | 497.7 | 17.0 | 0.7 | 26.2 |
| T5 | 139.5 | 134.5 | 129.4 | 124.2 | 527.6 | 16.1 | 0.6 | 27.2 |
| T6 | 140.6 | 134.5 | 129.8 | 114.6 | 519.5 | 15.9 | 0.6 | 28.7 |
| T7 | 142.9 | 137.5 | 123.6 | 114.2 | 518.3 | 17.3 | 0.6 | 30.5 |
| $CD_{0.05}$ | 4.3 | 4.0 | 4.1 | 3.5 | 8.6 | 0.7 | 0.1 | 2.4 |
| CV (%) | 2.1 | 2.0 | 2.3 | 2.1 | 1.2 | 2.9 | 11.7 | 6.0 |

ha). Similar response of gypsum on potato tubers was also reported by Kleinhenz *et al.* (6). However, maximum number of 0-25 and 25-50 g tubers were recorded with 60 kg Ca/ha at planting and 60 kg Ca/ ha at earthing up (142.9 and 137.5) respectively. However, application of 120 kg Ca/ha at planting produced the maximum number of 50-75 g tubers (129.8) However, maximum number of >75 g tubers and total number of tubers recorded with 40 kg Ca/ha at planting and 40 kg Ca/ha at earthing up (124.2 and 527.6), respectively. Present finding was in conformity of Ozgen and Palta (9). Maximum percentage of dry matter content was recorded with application of calcium 60 kg/ha at planting and 60 kg/ha at earthing up (17.3), while lowest skin damaged tuber yield was recorded with application of calcium 20 kg/ha at planting and 20 kg/ha at earthing up (0.5). Similar results were also reported by Gunter *et al.* (2) and Karlsson *et al*. (3). Maximum net returns was recorded with the application of calcium 120 kg/ha at planting (Rs. 1,03,900.0). In general, significant improvement in tuber calcium was recorded with all doses if its application. Results of the present study demonstrated that calcium level of 20 kg/ha at planting and 20 kg/ha at earthing up minimized the skin damage of potato tubers during harvesting. Considering the potential of potato crop in the region, the findings of the present investigation could be useful to the potato growers of the region for getting maximum tuber yield with minimum losses due to skin bruising.

## REFERENCES

1. Bangerth, F. 1979. Calcium related disorders of plant. *Ann Rev. Phytopathol*. **17**: 97-122.

2. Gunter, C., Ozgen, S., Karlsson, B. and Palta, J.P. 2000. Calcium application at pre-emergence and during bulking may improve tuber quality and grade. *HortSci*. **35**: 498.

3. Karlsson, B., Palta, J.P. and Ozgen, S. 2001. Reduction of potato tuber bruising and internal

**Table 4.** Economics and net returns of different calcium treatments on potato production.

| Treatment | Yield (t/ha) | Cost of cultivation (Rs./ha) | | | Cost (Rs./ha) | | Sale price (Rs./q) | Net returns* (Rs./ha) | B:C ratio |
|---|---|---|---|---|---|---|---|---|---|
| | | Seed | Fertilizer | Cultivation | Inputs | Produce | | | |
| T1 | 13.8 | 30,000 | 16.000 | 3,000 | 49,000 | 1,38,000 | 1,000 | 89,000 | 1.81:1 |
| T2 | 14.0 | 30,000 | 16.000 | 3,200 | 49,200 | 1,40,000 | 1,000 | 90,800 | 1.84:1 |
| T3 | 14.3 | 30,000 | 16,000 | 3,150 | 49,150 | 1,43,000 | 1,000 | 93,850 | 1.91:1 |
| T4 | 14.5 | 30,000 | 16,000 | 3,050 | 49,050 | 1,45,000 | 1,000 | 95,950 | 1.96:1 |
| T5 | 14.1 | 30,000 | 16,000 | 2,950 | 48,950 | 1,41,000 | 1,000 | 92,050 | 1.88:1 |
| T6 | 15.6 | 30,000 | 16,000 | 3,000 | 49,000 | 1,56,000 | 1,000 | 1,07,000 | 2.18:1 |
| T7 | 15.3 | 30,000 | 16,000 | 3,100 | 49,100 | 1,53,000 | 1,000 | 1,03,900 | 2.12:1 |

* Cost of produce = Cost of inputs (cultivation).

defects by supplemental calcium field application. *American J. Potato Res*. **78**: 462.

4. Kratzke, M.G. and Palta, J.P. 1985. Evidence for the existence of functional roots on potato tubers and stolons: Significance in water transport to the tubers. *American Potato J. Res.* **62**: 227-36.

5. Kartzke, M.G. and Palta, J.P. 1986. Calcium accumulation in potato tubers: Role of basal roots. *HortSci*. **25**: 1022-24.

6. Kleinhenz, M.D., Palta, J.P. and Kelling, K.A. 1999. Impact of source and timing of calcium and nitrogen on 'Atlantic' potato tuber calcium concentrations and internal quality. *J. American Soc. Hort. Sci*. **124**: 498-506.

7. Marschner, H. 1995. *Mineral Nutrition of Higher Plants*, Academic Press, London, pp. 285-99.

8. Ozgen, S., Karlsson, B.H. and Palta, J.P. 2006. Responses of potatoes (cv. Russet Burbank) to supplemental calcium applications under field conditions: Tuber calcium, yield and incidence of Internal Brown Spot. *American Potato J. Res*. **83**: 195-204.

9. Ozgen, S. and Palta, J.P. 2004. Supplemental calcium application influences potato tuber number and size. *HortSci.* **40**: 102-5.

10. Palta, J.P. 1996. Role of calcium in plant responses to stresses: Linking basic research to the solution of practical problems. *Proceedings of Colloquium: Recent Advances in Plant Responses to Stress: Bridging the Gap between Science and Technology*. *HortSci*. **31**: 51-57.

11. Simmons, K.E., Kelling, K.A., Wolkowski, R.P. and Kelman, A. 1988. Effect of calcium source and application method on potato yield and calcium composition. *Agron. J*. **80**: 13-21.

12. Snyder, R.G. and Ewing, E.E. 1989. Interactive effects of temperature, photoperiod and cultivar on tuberization of potato cutting. *HortSci.* **24**: 336-38.

13. Tzeng, K.C., Kelman, A., Simmons, K.E. and Kelling, K.A. 1986. Relationship of calcium nutrition to internal brown spot of potato tubers and subapical necrosis of sprouts. *American Potato J*. **63**: 87-97.

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