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Impact of cutting and chemical treatments to seed potato on crop establishment and yield

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Abstract
An experiment was undertaken at Odisha University of Agriculture and Technology, Bhubaneswar, Odisha to study the effect of variety, cutting and chemical treatments to seed potato on sprouting and development as well as consequential productivity of potato. The experiment included three important potato varieties suitable for Odisha (Kufri Jyoti, Kufri Surya and Kufri Ashoka), two types of seed material, that is, whole or cut seed potato, and six chemical treatments to seed potato. In general, seed weight of cut pieces was 29.35% less than that of whole tubers. Overall desiccation of seed tuber was also higher in cut potato as compared to the whole ones ranging from 290.67% in Kufri Ashoka to 439.51% in Kufri Surya. In cut pieces, Boric acid treatment resulted significantly more desiccation than rest of the chemical treatments. The survival of plants at 45 days after planting was the lowest with Boric acid treatment after cold storage. However, Boric acid treatment before cold storage to whole / cut tubers (cut after removal of treated tubers from cold store) resulted highest tuber yield in all the varieties. After cold storage, Mancozeb treatment to potato tubers resulted higher survival of plants and better yield than boric acid treatment. The variation in yield due to variety, type of seed tuber (whole /cut), chemical treatment and their interaction was found significant.

Keywords: seed potato, variety, cut, whole, chemical treatment

Introduction
Potato is usually propagated through seed tubers. Since seed (tuber) is the costliest input and accounts for about 40% of the production cost, farmers use either small whole tubers or cut the big tubers into pieces for planting. Generally, seed treatment with fungicides is done after the tubers are cut longitudinally with each piece containing 2-3 eyes (Kumar *et al*., 2013) [8]. Manipulation of the size of seed tuber piece is considered as a management tool for profitable Potato farming (Rykbost and Locke, 1999) [13]. Each cut piece must have at least one or two eyes, from which sprouts come out. Seed size and number of eyes per tuber affects plant growth and tuber yield (Nolte *et al*., 2003) [12]. Size of seed tubers used by farmers varies. Generally, 20-40g seed tubers are planted whole. Big tubers of 50 gm or more weight are cut into two or more pieces before planting. Since number of eyes per tuber has a direct relationship with surface area, big size seed tubers generally produce more shoots per plant and ultimately higher yield. Cutting of seed tubers is usually done before they sprout so that sprouts are not damaged. Use of cut tubers by farmers helps in reducing the amount of seed tuber required and there by the seed cost.

Many potato farmers of Odisha use cut seed tubers. To reduce the cost of cultivation of potato, they cut seed tubers into 2-4 pieces before planting. Some farmers treat these pieces with fungicide while others do not. Due to improper seed treatment or no treatment before planting, tubers rot in the field and give a poor plant population. Even sprouts coming out from untreated cut or whole tubers become susceptible to diseases afterwards and exhibit poor growth. Low plant stand is the major problem in farmers' fields where cut seed tubers are used which in turn, reduces yield. The effect of chemicals used for seed treatment has not been properly studied on the growth performance of emerging plants. Keeping these points in view, the present investigation was carried out to develop appropriate technology for getting adequate plant population and expected tuber yield even after using cut seed tubers. The experiment was carried out with three important potato varieties suitable for Odisha (Kufri Jyoti, Kufri Surya and Kufri Ashoka) and two types of seed material, that is, whole or cut seed potato. Different chemical treatments were imposed to examine their effect on the whole or cut planting materials of three varieties.

Materials and Methods

Experimental site: The experiment was conducted in the research farm of AICRP on Potato, Odisha University of Agriculture and Technology, Bhubaneswar during rabi 2018-19 located at 20°15' N Latitude and 85°52' E longitude with an altitude of 25.5m above MSL. The climate is warm and moist with hot humid summer and mild winter. Potato was cultivated after the harvest of rice crop. The soil was red lateritic with sandy-loam texture and a pH of 5.4. The mean monthly temperature and relative humidity during crop season is mentioned in Table 1.

Table 1: Weather condition during crop growing season.

Month	Mean monthly temperature (°C)		Mean monthly Relative humidity (%)		Rainfall (mm)
	Min	Max	Min	Max	
November	18.76	39.71	54.48	89.11	55.2
December	14.47	28.16	48.67	91.96	36.3
January	11.96	28.05	35.57	92.43	0.0
February	16.01	33.74	28.28	92.0	0.0

Planting materials & chemical treatments: The planting material used in the present investigation was derived from 3 important potato varieties grown in Odisha such as Kufri Jyoti, Kufri Surya and Kufri Ashoka. In all the 3 varieties, seed tubers were used either whole or after cutting into pieces (half). The chemical treatments include the following:-

T_1 – 3% Boric acid treatment (30 minutes) to whole tubers before cold storage (Big tubers of this treatment are cut into approx. 20g pieces by sterilized knife without further treatment).

T_2 – Boric acid treatment to tubers 2 days after removal from cold storage (30 minutes). (3% for whole tubers and 2% for cut tubers).

T_3 – 0.25% Mancozeb treatment to tubers 2 days after removal from cold storage for 10 minutes.

T_4 – 3% Boric acid +0.03% Imidacloprid treatment to tubers for 30 minutes (2 days after removal from cold storage).

T_5 – 0.25% Mancozeb +0.03% Imidacloprid treatment to tubers for 10 minutes (2 days after removal from cold storage).

T_6 – Untreated control.

Sixty seed tubers were used per treatment in three replications to measure different attributes.

Design of Experiment

The experiment was performed in spilt plot design with three factors such as variety, seed type and chemical treatment. However, analysis for whole and cut seed types in each variety was also made in Randomised Block design (RBD) to depict variation among treatments.

The seed tubers were planted during 3rd week of November. The soil was applied with 10 tonnes FYM and 75:80:100 kg N, P_2O_5 and K_2O per ha at the time of planting and 75 kg N/ha after 21 days followed by earthing up. Seed tubers were planted at 60cm row spacing and 20cm within a row. Standard cultural practices had been followed for raising the crop.

Data analysis

Observations were recorded on (1) Weight of seed tuber under each treatment; (2) Percentage desiccation of seed tubers at 12 days after treatment (recorded at the time of planting); (3) Survival percentage of plants at 45 days after planting; (4) Marketable tuber yield (tonnes/ha).

The experimental data was analyzed following Gomez and Gomez (1976).

Results and Discussion

Seed weight: The seed tuber weight was comparatively less due to use of cut pieces in all the three varieties although it was marginally higher than whole potato in two treatments of Kufri Ashoka. The mean seed tuber weight with whole tubers in Kufri Jyoti, Kufri Surya and Kufri Ashoka was found to be 26.21g, 30.04g and 17.86g, respectively (Table 2-4).

Table 2. Effect of different treatments on potato cv. Kufri Jyoti

Treatment	Seed tuber weight (g) (Whole tuber / cut piece)			% desiccation of seed tubers at 12 days after treatment			Survival % (active plants) at 45 DAP			Marketable tuber yield (t/ha)		
	Whole	Cut	%(+/-)*	Whole	Cut	%(+/-)*	Whole	Cut	%(+/-)*	Whole	Cut	%(+/-)*
T_1	25.75	19.79	-23.15	5.2	12	130.77	87.5	75	-14.29	13.06	14.76	13.02
T_2	25.67	14.79	-42.38	6.3	52	725.40	83.3	33.3	-60.02	12.36	4.03	-67.39
T_3	27.29	17.46	-36.02	5.2	16	207.69	58.3	70.8	21.44	8.96	11.95	33.37
T_4	25.92	15.83	-38.93	7.1	60	745.07	83.3	12.8	-84.63	13.92	5.3	-61.93
T_5	26.79	19.08	-28.78	4.7	15	219.15	66.7	62.5	-6.30	8.99	9.29	3.34
T_6	25.81	19.29	-25.26	6.1	15	145.90	60.9	41.7	-31.53	9.25	8.08	-12.65
Mean	26.21	17.71	-32.43	5.77	28.33	390.99	73.33	49.35	-32.70	11.09	8.90	-19.75
C.D(0.05)	NS	2.02		1	3.72		8.04	4.87		1.21	0.46	
SE(+m)	0.799	0.63		0.31	1.16		2.52	1.53		0.38	0.14	
CV (%)	5.28	6.2		9.4	7.12		5.95	5.36		5.93	2.78	

* % increase (+) or decrease (-) in weight of cut type over whole seed tuber

T_1 – 3% Boric acid treatment (30 minutes) to whole tubers before cold storage (Big tubers of this treatment are cut into approx. 20g pieces by sterilized knife without further treatment).

T_2 – Boric acid treatment to tubers 2 days after removal from cold storage (30 minutes). (3% for whole tubers and 2% for cut tubers).

T_3 – 0.25% Mancozeb treatment to tubers 2 days after removal from cold storage for 10 minutes.

T_4 – 3% Boric acid +0.03% Imidacloprid treatment to tubers for 30 minutes (after cold storage).

T_5 – 0.25% Mancozeb +0.03% Imidacloprid treatment to tubers for 10 minutes (after cold storage).

T_6 – Untreated control.

Table 3: Effect of different treatments on potato cv. Kufri Surya

Treatment	Seed tuber weight (g) (Whole tuber / cut piece)			% desiccation of seed tubers at 12 days after treatment			Survival % (active plants) at 45 DAP			Marketable tuber yield (t/ha)		
	Whole	Cut	%(+/-)*	Whole	Cut	%(+/-)*	Whole	Cut	%(+/-)*	Whole	Cut	%(+/-)*
T_1	28.00	19.88	-29.00	4.5	19	322.22	62.5	91.67	46.67	13.24	13.34	0.76
T_2	30.13	18.29	-39.30	7.2	55.6	672.22	75	45.8	-38.93	11.56	4.03	-65.14
T_3	31.67	18.50	-41.59	5.5	22	300.00	62.5	57.5	-8.00	8.13	5.19	-36.16
T_4	30.25	17.88	-40.89	6.7	51.2	664.18	77.5	45	-41.94	8.06	4.72	-41.44
T_5	30.33	19.25	-36.53	5	18.9	278.00	75	83.3	11.07	8.17	10.56	29.25
T_6	29.84	18.45	-38.17	5.7	20.1	252.63	72.3	52.4	-27.52	8.21	6.34	-22.78
Mean	30.04	18.71	-37.72	5.77	31.13	439.51	70.80	62.61	-11.57	9.56	7.36	-23.01
C.D(0.05)	NS	NS		0.75	2.21		5.07	6.87		0.79	0.5	
SE(+m)	1.1	0.57		0.24	0.69		1.59	2.15		0.25	0.16	
CV (%)	6.32	5.3		7.06	3.85		3.88	5.96		4.51	3.65	

* % increase (+) or decrease (-) in weight of cut type over whole seed tuber

Table 4: Effect of different treatments on potato cv. Kufri Ashoka

Treatment	Seed tuber weight (g) (Whole tuber / cut piece)			% desiccation of seed tubers at 12 days after treatment			Survival % (active plants) at 45 DAP			Marketable tuber yield (t/ha)		
	Whole	Cut	%(+/-)*	Whole	Cut	%(+/-)*	Whole	Cut	%(+/-)*	Whole	Cut	%(+/-)*
T_1	18.96	19.04	0.42	6.5	16.8	158.46	83.3	75	-9.96	23.99	21.34	-11.05
T_2	18.67	12.17	-34.82	8.9	62.5	602.25	70.8	20.8	-70.62	8.49	1.22	-85.63
T_3	18.17	16.88	-7.10	4.8	15.9	231.25	83.3	83.3	0.00	14.18	17.03	20.10
T_4	17.29	14.83	-14.23	9.2	39.6	330.43	87.5	45.8	-47.66	9.48	2.41	-74.58
T_5	16.88	17.71	4.92	5.6	13.2	135.71	75	75	0.00	11.74	8.16	-30.49
T_6	17.21	16.54	-3.89	6.8	15.4	126.47	78.6	49.8	-36.64	10.56	8.24	-21.97
Mean	17.86	16.20	-9.29	6.97	27.23	290.67	79.75	58.28	-26.92	13.07	9.73	-25.55
C.D(0.05)	NS	1.81		0.84	3.15		6.79	4.7		1.82	1.4	
SE(+m)	0.74	0.57		0.26	0.99		2.13	1.47		0.57	0.44	
CV (%)	7.18	6.07		6.53	6.27		4.62	4.37		7.54	7.78	

* % increase (+) or decrease (-) in weight of cut type over whole seed tuber

Similarly the mean tuber weight in cut pieces of different varieties such as Kufri Jyoti, Kufri Surya and Kufri Ashoka was found to be 17.71g, 18.45g and 16.20g, respectively. Considering the mean values of different varieties, seed weight of cut pieces was 29.35% less than that of whole tubers.

The overall reduction in seed tuber requirement has been found to range from 9.29% in Kufri Ashoka to 37.72% in Kufri Surya through use of cut pieces. This might be the main reason for use of cut pieces by potato farmers in view of high seed price.

Effect on desiccation of seed tubers: Effect of chemicals on desiccation of cut tubers was much higher than that of whole tubers. Again, the variation among different treatments with respect to desiccation was found to be significant both in whole and cut seed tubers. The mean desiccation of whole and cut tubers was found to be 5.77% and 28.33%, respectively in Kufri Jyoti; 5.77% and 31.13%, respectively in Kufri Surya; and 6.97% and 27.23%, respectively in Kufri Ashoka. The increase in desiccation of cut tubers over whole tubers was found to be 391%, 440% and 291% in Kufri Jyoti, Kufri Surya and Kufri Ashoka, respectively. Among different treatments, it was observed that application of Boric acid solution to tubers after cold storage resulted maximum desiccation which is significantly much higher than rest of the treatments. Compared to pre-cold storage Boric acid treatment, desiccation was 455 %, 109 % and 280 % higher over Boric acid treatment after cold storage in Kufri Jyoti, Kufri Surya and Kufri Ashoka, respectively. Imidacloprid treatment has also been found to increase desiccation.

Effect on plant survival at 45 days: The overall survival percentage of cut seed tuber in different treatments of three varieties was less than that of whole tuber. The mean survival % of whole and cut tubers was 73% and 49%, respectively in Kufri Jyoti; 71% and 63%, respectively in Kufri Surya; and 80% and 58%, respectively in Kufri Ashoka. The survival of plants was most affected in treatments of cut potato with boric acid after cold storage (with or without imidacloprid) in all varieties. This clearly shows that treatment of cut tubers with boric acid after cold storage not only results maximum desiccation but also affects survival of sprouted seed tuber pieces in field. Maximum mortality of 87.2% was observed in cut tubers of Kufri Jyoti with Boric acid + Imidacloprid treatment. Mancozeb treatment had no such detrimental effect on survival. Although desiccation of cut tubers with Mancozeb treatment was also observed, survival of plant developed from cut tuber was better in Kufri Jyoti , similar in Kufri Ashoka and slightly less in Kufri Surya as compared to the plants developed from whole tuber. While Mancozeb treatment per se to cut tubers had no such drastic effect on plant survival, combined application of Mancozeb and imidacloprid was found to exhibit a more negative role.

Effect on marketable tuber yield: With both whole and cut tubers, highest marketable tuber yield in all three varieties occurred when 3% boric acid was applied before cold storage. Highest marketable tuber yield was observed in Kufri Ashoka both with whole seed (23.99 t/ha) and cut seed (21.34 t/ha). Whole seed tubers of Kufri Jyoti were not so affected by boric acid treatment after cold storage and exhibited tuber yield at par with that of treatment before cold storage. However, drastic reduction in tuber yield occurred with boric acid treatment after cold storage in Kufri Surya and Kufri Ashoka. In case of cut tuber treatments, lowest yield occurred in all three varieties with boric acid treatment after cold storage. Lowest tuber yield of only 1.22 t/ha was observed in Kufri

Ashoka in the treatment with Boric acid to cut tubers. This indicates that when chemical treatment is to be made after cold storage, mancozeb treatment to potato tubers is better since it resulted better survival of plants and higher yield than boric acid treatment.

Significant variation with respect to marketable tuber yield was observed among varieties, seed type (whole vs. cut) and chemical treatments as well as their interactions (Table 5).

Table 5: Interaction of varieties, seed types (whole / cut) and chemical treatments for marketable tuber yield (t/ha)

Chemical treatment	K. Jyoti		K. Surya		K. Ashoka		Mean of 3 varieties	
	Whole	Cut	Whole	Cut	Whole	Cut	Whole	Cut
T_1	13.060	14.760	13.240	13.340	23.990	21.340	16.76	16.48
T_2	12.360	4.030	11.560	4.030	8.490	1.220	10.80	3.09
T_3	8.960	11.950	8.130	5.190	14.180	17.030	10.42	11.39
T_4	13.920	5.300	8.060	4.720	9.480	2.410	10.49	4.14
T_5	8.990	9.290	8.170	10.560	11.740	8.160	9.63	9.34
T_6	9.250	8.080	8.210	6.340	10.560	8.240	9.34	7.55
Mean	11.09	8.90	9.56	7.36	13.07	9.73	11.24	8.67

Factors	C.D. (0.05)	SE(d)	SE(m)
Factor A (Variety)	0.454	0.164	0.116
Factor B (Seed type)	0.246	0.123	0.087
Interaction A × B	0.426	0.213	0.151
Factor C (Chem. Tr.)	0.426	0.213	0.151
Interaction A × C	0.738	0.369	0.261
Interaction B × C	0.602	0.302	0.213
Interaction A × B × C	1.043	0.522	0.369

Based on the mean values of three varieties, highest yield with both whole tuber (16.76 t/ha) and cut tuber (16.48 t/ha) was obtained through treatment of tubers with 3% Boric acid before cold storage (T_1). Interestingly, while seed tuber requirement was lowered by 23.15% and 29.0% by using cut pieces, there was increase in marketable tuber yield by 13.02% and 0.76% in Kufri Jyoti and Kufri Surya, respectively with Boric acid treatment before cold storage. This shows that treatment of Boric acid to the tubers after 10-12 days of harvest followed by cold storage, and cutting healthy seed tubers 4-5 days after removal from cold storage but minimum 2-3 days before planting can be profitably adopted for some varieties like Kufri Jyoti but in general tuber yield with cut tuber was lower than the yield with whole tuber. It must be kept in mind that since bacteria and viruses are transmitted through tuber resulting clonal degeneration, it is always essential to utilize only healthy tubers for use as seed tuber. After cold storage, when tubers are cut and treated with Boric acid, there was drastic reduction in tuber yield.

The present investigation clearly shows the effect of variety, cutting and chemical treatments on sprouting, plant development and consequential productivity. Planting of small size whole tubers is practised to reduce the wounding of seed tubers associated with cutting and handling and thereby saving labour towards both the operations. However, many of our farmers use seed potato of varying size and cut the big tubers at several locations to reduce seed cost. Since seed potatoes are rich in water (approximately 80%) and nutrients, they are prone to attack by pathogens if not properly treated before planting. Planting of healthy and properly treated seed potatoes could only give desired yield and profit to the farmers.

Planting of whole seed potatoes may be regarded as an effective cultural control technique for reducing the tuber borne diseases like soft rot, bacterial wilt, viral diseases, etc. Highest gross yield of tubers is obtained with large whole seed tubers although smaller tubers and half cut distal were economically profitable (Hossain *et. al*., 2011) [6]. For a given seed tuber size, total tuber yield increases with increase in seed rate (Khurana *et al.* 1994) [7] but for a given seed tuber rate, total seed tuber yield decreased with increase in seed tuber size. The physiological status of seed potato significantly affects emergence, stems per plant, tubers per stem and tuber yield (Struik, 2007) [15].

The cut surface of seed potato needs to heal or suberize properly before planting which requires much of space and attention. For the healing of cut seed potato, proper temperature (50°-55°F), oxygen (high airflow in storage) and relative humidity (around 90%) are to be maintained. In addition, seed and soil temperature needs to be monitored during planting. Planting of cold seed in warm and moist soil aggravates soft rot. The size of cut seed piece has significant effect on the production of number of shoots per plant and tuber yield (Sultana and Siddique, 1991) [16]. Large size seed tubers with relatively larger food reserves produce vigorous plants which establish faster and increase the efficiency of biomass partitioning to the tubers (Michael, *et al*., 2012) [11]. Potato tubers weighing > 50gm may be longitudinally cut into two pieces so that each piece had at least two prominent eyes (Singh, 1993).

Seed tubers containing at least two eyes exhibit more yield and economic return than single eye (Hoque, 2001) [5]. The emergence, growth and tuber productivity decreased with decreasing size of seed tuber planted whether cut piece or whole tubers (Mayakaduwa *et al*., 2017) [10]. The number of sprouts in a seed tuber is mostly determined by size, temperature and storage duration (Struik, 2007) [15]. Seed tubers with four to five strong sprouts are ideal for planting to obtain optimum number of shoots per hill (Beattie, 2010) [1]. Stem density has also significant effect on the number and size of harvested tubers (Harris, 1978) [4]. With the increase in stem density, number of tubers harvested also increased (Beattie, 2010) [1].

Suitability for cutting of seed tuber is also influenced by varietal characteristics including the number and the position of the eyes as well as chances of rotting (Fienie, 2016) [2].

In our study, seed potato requirement was reduced through use of cut pieces in all 3 varieties under study. After cold storage, whole or cut tubers were applied with different treatments. Somewhat bigger seed tubers were carefully cut

into pieces to form about 20g cut piece (for seed potato) and comparatively smaller tubers were used whole.

Even whole tubers without any treatment exhibited some desiccation. Maximum desiccation in whole tubers occurred in T2 and T4 (Boric acid treatment after cold storage).

In cut pieces, Boric acid treatment was found to cause significantly higher % of desiccation than the other treatments. The survival of plants at 45 days after planting was the lowest with T2 and T4 (Boric acid treatment after cold storage). Marketable tuber yield was also the lowest in Boric acid treatments (after cold storage) to cut pieces. In contrast, Boric acid treatment to whole / cut tubers before cold storage resulted highest tuber yield in all the varieties.

In Kufri Jyoti & Kufri Surya, highest tuber yield was observed in cut potato with Boric acid treatment before cold storage. In Kufri Ashoka, use of Boric acid treated whole tubers (before cold storage) out yielded cut seed potato but both whole & cut seed potato under T1(Boric acid treatment before cold storage) out yielded rest of the treatments. After cold storage, Mancozeb treatment to potato tubers resulted better survival of plants and higher yield than boric acid treatment in all the varieties.

References

1. Beattie BM. The Effects of Seed Production Practices on the Productivity of the Succeeding ware Potato Crop. University of Tasmania 2010;31:114-119.
2. Fienie N. The Cutting of Seed potatoes, 2016. http://www.potatoes.co.za. (Accessed on 2017/04/12)
3. Gomez KA, Gomez AA. Statistical procedures for agricultural research with special emphasis on rice. International Rice Research Institute, Los Banos, Philippines 1976, 17-24.
4. Harris PM. The potato crop. Department of Agriculture and Horticulture, Reading University, London, UK 1978.
5. Hoque MA. Effect of cut seed size and spacing on the yield and profitability of potato. Annual report on post flood rehabilitation and adaptive research support project, BARI, Munshiganj, 2001, 17.
6. Hossain MS, Zakaria M, Hossain MM, Rashid MH. Effect of Seed Size and Cutting Methods on the Yield and Profitability of Potato. The Agriculturists 2011;9(1&2):54-62.
7. Khurana SC, Dhankhar BS, Shekhawat GS. Effect of seed rate and seed size on potato hybrid JH 222. In: Potato: present and future. Proceedings of the national symposium held on Modipuran during 1-3, March, 1993, 1994, 164-167.
8. Kumar P, Kumar D, Luthra SK. Potato. In: Text of Field Crops Production-Commercial Crops. (Ed. Rajendra Prasad), ICAR, New Delhi. 2013;2:469-527.
9. Kumar Parveen, Kumar Rajeev, Kumar Anivesh, Kumar D., Sandhu KS, Singh BP. Effects of seed cutting and treatment methods of potato on yield, quality and profitability of French fry variety Kufri Frysona. Annals of Agricultural Research 2015;36(3):269-274.
10. Mayakaduwa MAP, Babu AGC, Nugaliyadde MM, Peter J, Kahawandala KRSCB, Nishshanka NIJH. Performance of seed tuber pieces of potato as planting material under up country wet zone conditions. Annals of Sri Lanka Department of Agriculture 2017;19:129-138.
11. Michael TMA, Farai CM, Arnold BM, Evison B. Influence of plant population and Seed Tuber Size on Growth and Yield Components of Potato (*Solanum tuberosm*) International Journal of Agriculture and Biology. ISSN Print: 1560–8530. 2012, 545-549.
12. Nolte P, Bertram M, Mateman M, Mcintosh CS. Comparative effects of cut and treated seed tubers vs untreated whole seed tubers on seed decay, *Rhizoctonia* stem canker, growth and yield of Russet Burbank potatoes. American Journal of Potato Res 2003;80:1-8.
13. Rykbost KA, Locke KA. Effect of seed piece size on performance of three potato varieties in the Klamath Basin of Oregon. American Journal of Potato Res 1999;75:75-82.
14. Singh N. Effect of cut and whole seed tubers and seed rate on the emergence, yield and economics of potato in the Nilgiri hills. Journal of Indian Potato Association 1993;20(3-4):260-262.
15. Struik PC. Physiological age of seed tubers 2007 https://www.researchgate.net. (Accessed on 2013/03/22)
16. Sultana N, Siddique A. Effect of cut seed piece and plant spacing on the yield and profitability of potato. Bangladesh Horticulture 1991;19(1):37-43.