Indian J. Hort. 68(3), September 2011: 399-407

Effect of organic sprays on storage behaviour of seed potatoes

G. Ravichandran*, N. Natarajan, K. Manorama and K. Vanangamudi****
Central Potato Research Station, Muthorai, The Nilgiris 643 004, Tamil Nadu

ABSTRACT

Organic agriculture promoting biodiversity, involving biological cycles and enhancing biological activities has established as an accepted production system in India. *Panchagavya*, a preparation from five products of cow, which is used in traditional medicine extensively, has a significant role in providing resistance to pest and diseases and in increasing the overall yield. Studies were conducted at Central Potato Research Station, Muthorai on storage behaviour of seed tubers by applying *panchagavya* both in the storage and in the field. Applying 3% *Panchagavya* solution on organically grown potato by spraying at 15 days interval and soaking its produce in the same solution before storage proved to be advantageous as it reduced the weight loss, delayed the sprouting and reduced the sprout growth leading to improved storability of seed potatoes. Minimal sprout weight was observed in *panchagavya* spray at 15 days interval on recommended cultural practice crop. From histological studies, it was observed that, by spraying *Panchagavya* at 15 days interval, there was improvement in number of phellem layers, number of crystals in phellem cells and scattered starch granules throughout the parenchyma, which reduced the rate of transpiration. Field performance of stored tubers in the subsequent season indicated that spraying *panchagavya* at 15 days interval in the field and soaking the tubers in 3% *panchagavya* solution before storage produced higher small and seed sized tuber number and yield.

Key words: *Panchagavya*, seed potatoes, weight loss, phellem, parenchyma cell, storage.

INTRODUCTION

Organic agriculture is environment friendly ecological production system that promotes and enhances biodiversity, biological cycles and biological activities. Organic farming system is not new in India and is being followed from ancient time. It is a method of farming system which primarily aimed at cultivating the land and raising crops in such a way as to keep the soil alive and in good health by use of organic wastes (crop, animal farm and aquatic waste) and other biological material along with beneficial microbes (biofertilisers) to release nutrients to crops for increased sustainable production in an eco-friendly, pollution-free environment. Seed is the single most important factor for successful crop production programme and potato is no exception to this universal truth. In potato production, the cost towards seed amounts to almost 50% of the total cost of cultivation (Garg, 3), because of high seed rate (2-3 t ha^{-1}) that is due to its bulky nature (Singh and Naik, 17). As per the guidelines of International Federation on Organic Agriculture Movements, organically produced seed is mandatory for organic agriculture (Naidu, 10). Production of organic seed is a very vital part in organic production systems. Availability of quality seed is the major problem with respect to potato production both in organic and inorganic systems. Moreover, the farmers do not have the practice of storing their own produce in normal storage for the next season as seed due to lack of sufficient technical knowledge about the seed potato storage.

Organic agriculture is beneficial not only in terms of cost of production but also the quality of harvested produce with reference to residue accumulation of harmful chemicals. Mere hot water treatment and biocontrol agent (*Debaryomyces hansenii*) saved the fruits from post harvest decay and maintained the quality of peach fruit (Mandal *et al*. 4). Application of GA_3 increased the yield and yield attributing characters in coriander (Panda, 12).

Panchagavya, an organic input, can act as a growth-promoter and immunity booster. It has a significant role in providing resistance to pests and diseases and in increasing the overall yield. *Panchagavya* was the most cost-effective growth-promoter followed by *Amrit Pani* (are traditional to Indian Ayurvedic systems) and *Bokashi* (a technology or EM = Effective microorganisms technology was first developed in Japan) and recommended the use of *Panchagavya* as an organic growth-promoter for small and marginally profitable vegetable-crop farmers (Bindumathi Mohan, 1). Several authors have reported that the *Panchagavya* spray enlarges the seed size (Beaulah, 2; Selvaraj, 16; Somasundaram, 18) in different crops but in potato it was not tested so far. Hence, in the present investigation, an attempt was made to produce potato seeds organically by using *Panchagavya* and to enhance the storability of these organically produced seeds by treating them with the same product.

*Corresponding author's E-mail: gravi1000@gmail.com
**Tamil Nadu Agricultural University, Coimbatore 641 003, Tamil Nadu

MATERIALS AND METHODS

Field trials were conducted at Central Potato Research Station, Muthorai, located at an elevation of 2140 m above MSL at 11° 24' North latitude and 74° 4' East longitude. The normal rainfall of the location is 1300 mm, received in 85 rainy days and it is well distributed during both South West and North East monsoons. The mean maximum and minimum temperatures of the region range between 15 and 23°C and 6 and 13°C respectively. The climate of the region is moist subhumid type (Manorama, 7). The soil type of experimental site is sandy clay loam with a pH range of 4.7 to 5.0, 0.1 dSm^{-1} EC and high in available nitrogen, low in available phosphorus and high in available potassium. The genetically pure seed tubers of potato cv. Kufri Giriraj obtained from the Central Potato Research Station, Muthorai (PO). The Nilgiris constituted the study material for the present investigation. Kufri Giriraj is released by CPRI, Shimla in 1998 for North and South Indian hills with a yield potential of 25 t ha^{-1}. It was introduced to Nilgiris during 2001. It is a medium dormant variety and resistant to late blight disease. The experiment was conducted during summer seasons of 2004 and 2005 with six treatments of organic spray of *Panchagavya* on genetically pure seed tubers of potato cv. Kufri Giriraj. It is a medium dormant variety and resistant to late blight disease. The treatments were P1: Seed tuber soaking in *panchagavya* (3%) + spraying *panchagavya* (3%) at 8 days interval (12 sprays), P2 : Seed tuber soaking in *panchagavya* (3%) + spraying *panchagavya* (3%) at 15 days interval (6 sprays), P3 : Only spraying *panchagavya* (3%) at 8 day interval (12 sprays), P4 : Only spraying *panchagavya* (3%) at 15 days interval (6 sprays), P5 : Recommended cultural practices + spraying *panchagavya* at 15 days interval (6 sprays), P6 : Recommended cultural practices (control). The spray of *panchagavya* started when the plant attained three leaf stage. For the treatments P1 to P4, only FYM was applied @12.5 t ha^{-1}, inorganic fertilizers were not applied. Similarly, no inorganic insecticides and fungicides were sprayed to control pests and diseases. The design of the trial was RBD with a gross plot size of 3 × 2 m^2 and a net plot size of 2 × 1.6 m^2. Spacing was 50 cm × 20 cm. During 2004, the crop was planted on 24th April and harvested on 8th September. Similarly, during 2005, it was planted on 29th April and harvested on 12th September.

At harvest, six kilograms of the harvested potato tubers was taken from each treatment (six treatments) and divided in to two parts of 3 kg each. The first part of 3 kg from the treatment 1 to 5 was given with soaking 3% *panchagavya* solution for 20 min. and the second part was kept as such. A part of the control treatment was soaked with water for 20 min. and another part was not given any soaking. There were 12 treatments. The tubers after treatments were stored in open racks for 6 ½ (from 30-9-2004 to 24-4-2005; 03-09-2005 to 25-04-2006) months and at the end of storage, the following parameters were studied.

Observations on tuber weight loss, sprouted tubers, rotted tubers, weight loss of rotted tubers, sprout weight (average of 10 tubers), sprout length and per cent damage by insects.

The methodology developed by Johnson (6) was followed to study the structural changes in the seed tuber skin in the control and the first two well performed treatments of the experiment by microtome sectioning of tuber skin. The stored tubers from 12 treatments were evaluated for field performance in the subsequent season (summer 2005 and 2006) by planting them in two rows of 20 tubers each. Observations were recorded on number and yield of different sized tubers.

The statistical analysis of the experimental data was done by the method of analysis of variance as suggested by Panse and Sukhatme (13). Statistical significance was tested by 'F' value at 0.05 level of probability and whenever the 'F' value was significant, critical difference was worked out at 0.05 level of probability.

RESULTS AND DISCUSSION

When *panchagavya* spray was given in potato seed production, it was observed that the application of *panchagavya* 3% solution by spraying at 15 days interval on field crop of potato is advantageous as it resulted in better performance both in terms of seed as well as total tuber yield (Table 1). The increased yield may be a result of a combination of effects of using just the required quantities of nutrients, growth-promoters, along with the judicious use of *panchagavya* as bio-pesticide. Similar types of results were also reported by Ramesh (14) in other crops and Banumathi Mohan (1) in brinjal.

When these tubers were stored in the store with and without soaking them in the respective treatments of *panchagavya* solution, the weight loss of tubers in storage was very high in control (20.1%). Minimal loss was recorded in *panchagavya* (3%) spray on the crop at 8 days interval. When *panchagavya* (3%) was sprayed at 15 days interval and soaking treatment was given before storage, there was a significant reduction in the per cent weight loss during storage (Table 1). Significant influence of *panchagavya* spray treatments

in the field was recorded with respect to tuber rottage in the store. In recommended cultural practice, from pooled data, a per cent loss of 1.3 was recorded and it was 0.17 per cent when 3% *panchagavya* was sprayed at 15 days interval on recommended cultural practices followed crop. In rest of the treatments the rottage was nil (Table 1).

No significant differences in per cent sprouted tubers were recorded either due to field treatments or due to storage treatments. Control recorded very long sprout and shorter sprout length was recorded in spraying *panchagavya* on recommended cultural practices followed crop at 15 days interval and it was followed by spraying *panchagavya* at 15 days interval alone (Fig.1). Respiration and transpiration are the main sources of weight loss in storage. Tuber wounds are one of the causes for respiration. Cow's *ghee* had been used in ancient and medieval times (Kautilya 321-296 BC and Someshwara Deva 1126-AD) for managing seedling health which is reported by Nene (9). The properties of ghee reported by them contained vitamin A, vitamin B, calcium, fat, etc and also rich in glycosides, which protect the wounded portion from infection. Hence, it may be one of the reasons for reduced weight loss. However to find out the scientific base for differences in per cent weight loss, length of sprout and per cent rotted tubers in *panchagavya* treatments a histological study was conducted.

Transverse section of tuber skin showed differences in thickness of phellem and arrangement of starch granules between different *panchagavya* treatments and control. In control, six layers of phellem (epidermal) cells followed by single layer of phellogen and two layers of phelloderm were observed. Next to this, presence of cortical parenchyma having large chambers containing starch granules and star type of crystals was observed. In *panchagavya* treatment of soaking in 3% solution before planting and spraying at 15 days interval followed by soaking the tubers in 3% *panchagavya* solution before storage, six to nine layers of phellem was observed. Parenchyma cells were large and the star type of crystals were one or two inside the phellem cells. Starch granules were medium in size, and observed in bundles in cortical parenchymatic cells.

By spraying *panchagavya* at 15 days interval and soaking the tubers before storage, the tuber skin developed six to nine layers of phellem. Parenchyma cells were large, crystals were more in phellem cells. The starch grains were scattered throughout the parenchymatic cells. From histological studies, it was observed that, by spraying *panchagavya* at 15 days interval, there is an improvement in number of phellem layers and more number of crystals in phellem cells and scattered starch granules throughout the parenchyma were observed (Plate 1), which reduced the rate of transpiration in this treatment. The reduction in transpiration was helpful in improving the storability by reducing weight loss, delaying sprouting and reducing the sprout growth.

Panchagavya was found to have the properties of both fertilizer as well as bio pesticide (www.cowindia.org, 5). The damage due to insects was reduced in all panchagavya treatments than recommended cultural practices followed crop but not to the level of significance. Soaking treatment was proved beneficial by reducing insect damage in store by 48.6 per cent over no soaking. Soil drenched with *Maha Panchagavya* slurry 10 per cent successfully controlled the wilt of tomato (Mishra, 8) and it was found to be superior to carbendazim in reducing the plant disease index and increased the vigour of the plant and fruit yield of tomato (Reddy and Padmodaya, 15). *Maha Panchagavya* was found to activate soil and to protect plants from diseases (Upendra, 19).

The field performance of the seed tubers which were grown organically and stored with different treatments of *panchagavya* was evaluated to study the effect of these treatments in the subsequent crop. The results indicated that the tubers which were grown with *panchagavya* spray at 15 days interval in the field either with or without soaking before storage performed equally well with reference to the total yield (Table 2). But, the total yield of this treatment was significantly superior over control (recommended cultural practice) both under soaking and non soaking conditions. However, the seed tuber yield (10.75 t/ha) as well as number (Table 2) was significantly superior under soaking than non soaking of this same treatment. This indicates that field application followed by soaking in 3% *panchagavya* solution will result in more number of seed sized tubers and the total yield is superior to the control. This improvement in yield of this treatment over control is mainly because of its better performance in the store where it recorded lesser weight loss, lesser number of sprouted tubers and also lesser sprout weight.

Hence, it can be concluded that for seed production purpose the crop should be sprayed with 3% *panchagavya* and the resultant produce needs to be stored by soaking it in the same solution. For ware potato production the produce from spraying of *panchagavya* 3% solution at 15 days interval can be stored as such without soaking treatment.

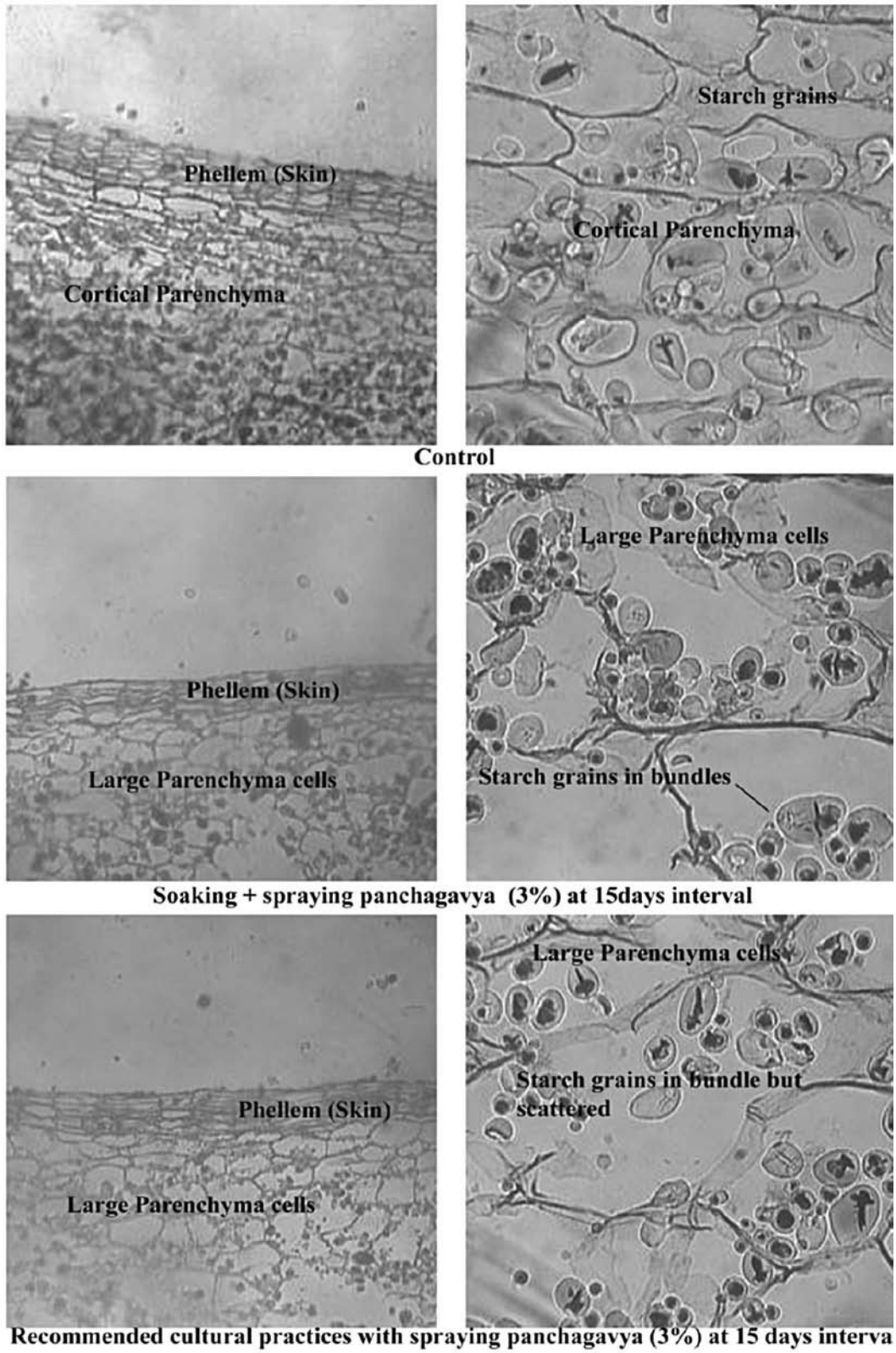

Fig. 1. Changes in the tuber skin of stored tubers that were harvested from *Panchagavya* foliar spray and soaked in *Panchagavya* and stored under normal condition - Transverse section.

Table 1. Effect of *panchagavya* foliar spray on the yield in the field and soaking of resultant tubers with *panchagavya* on tuber weight loss (%), rotted tubers (%) and weight loss of rotted tubers (%) in storage.

Treatment	Total tuber number ('000 ha^{-1})	Total tuber yield (t ha^{-1})	Weight loss (%)		Mean	Rotted tubers (%)		Mean
			Soaked	Control		Soaked	Control	
Soaking in *panchagavya* (3%) + spraying *panchagavya* (3%) at 8 days interval	422	17.56	19.81 (24.58)	19.89 (23.39)	19.85 (22.24)	0.00 (0.39)	0.00 (1.44)	0.00
Soaking in *panchagavya* (3%) + spraying *panchagavya* (3%) at 15days interval	442	18.68	18.57 (23.31)	20.78 (26.08)	19.68 (24.70)	0.00 (1.75)	0.00 (3.04)	0.00
Spraying *panchagavya* (3%) at 8 days interval	495	20.94	16.25 (25.09)	15.00 (27.34)	15.63 (25.67)	0.00 (0.39)	0.00 (1.32)	0.00
Spraying *panchagavya* (3%) at 15 days interval	575	28.69	15.83 (24.50)	19.22 (26.24)	17.53 (23.30)	0.00 (1.73)	0.00 (2.68)	0.00
Recommended cultural practice with spraying *panchagavya* (3%) at 15 days interval	534	26.53	16.22 (24.07)	18.11 (22.09)	17.17 (23.08)	0.00 (0.39)	0.33 (0.39)	0.17
Control (Recommended cultural practice)	469	23.34	19.78 (24.07)	20.33 (26.08)	20.06 (25.08)	0.67 (1.97)	2.00 (4.10)	1.33
Mean	490	22.62	17.74	18.89		0.11	0.39	
CD ($P \leq 0.05$) Treatment	60.47**	3.30**		4.3			0.13**	
Soaking				NS			NS	
Treatments × soaking				NS			NS	

** - Significant at 1% level NS - Non significant (Figures in parenthesis indicates arc sine transformation)

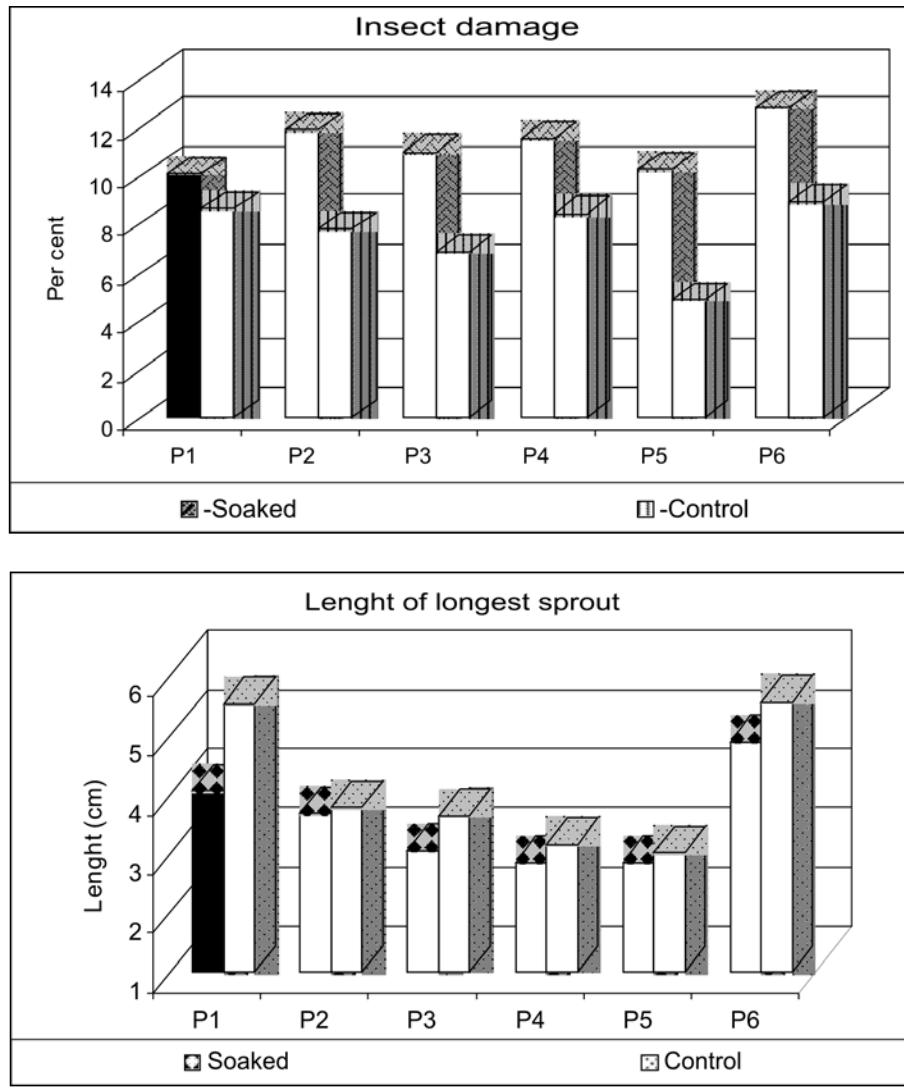

Fig. 1. Effect of field application and soaking of *panchagavya* on storage behaviour of potato seed tubers.

ACKNOWLEDGEMENTS

The authors are thankful to the Director, CPRI for providing the facilities and Dr Rajan, Technical Officer, Survey of Medicinal and Aromatic plants, Udhagamandalam for his suggestions in histological studies.

REFERENCES

1. Bindumathi Mohan, 2008. Evaluation of organic growth promoter on yield of dryland vegetable crops in India. *J. Organic System*, **3**: 23-36.

2. Beaulah, A. 2001. Growth and development of moringa (*Moringa oleifera* Lam.) under organic and inorganic systems of culture. Ph.D. thesis, Tamil Nadu Agricultural University, Coimbatore 641 003, India.

3. Garg, V.K., Sarjeet Singh, Desh Raj and Ashwani Kumar. 2000. Effect of physio-agronomical manipulations on the number and yield of seed tubers in breeders seed in the hills. **In:** Potato, Global Research & Development – Vol. I, S.M. Paul Khurana, G.S. Shekhawat, B.P. Singh and S.K. Pandey (Eds.). CPRI, Shimla, pp. 413-18.

4. Goutam Mandal, Singh, Dinesh and Sharma, R.R. 2007. Effect of hot water treatment and biocontrol agent (*Debaryomyces hansenii*) on shelf-life of peach. *Indian J. Hort.* **64**: 25-28

Table 2. Determining the field performance of 6½ month-old tubers that was harvested from *panchagavya* foliar spraying treatment and soaking with *panchagavya* and stored in normal conditions.

Tuber number ('000 ha^{-1})

Treatment	< 30 g size tuber weight (t ha^{-1})		Mean	30 - 60 g size tuber weight (t ha^{-1})		Mean	>60 g size tuber weight (t ha^{-1})		Mean	Total tuber weight (t ha^{-1})		Mean
	Soaked	Control		Soaked	Control		Soaked	Control		Soaked	Control	
Soaking in *panchagavya* (3%) + spraying *panchagavya* (3%) at 8 days interval	4.67	2.42	3.54	7.90	7.83	7.86	5.58	6.21	5.89	18.15	16.45	17.30
Soaking in *panchagavya* (3%) + spraying *panchagavya* (3%) at 15days interval	3.74	1.70	2.72	8.62	7.58	8.10	6.72	7.15	6.93	19.08	16.42	17.75
Spraying *panchagavya* (3%) at 8 days interval	3.31	3.48	3.40	9.18	9.65	9.41	7.39	6.46	6.92	19.87	19.59	19.73
Spraying *panchagavya* (3%) at 15 days interval	4.11	5.13	4.62	10.75	10.21	10.48	8.05	7.27	7.66	22.91	22.61	22.76
Recommmended cultural practice with spraying *panchagavya* (3%) at 15 days interval	3.78	4.21	4.00	10.26	9.11	9.68	7.25	6.86	7.05	21.28	20.19	20.73
Control (Recommended cultural practices)	2.96	2.63	2.79	9.08	8.97	9.03	6.95	6.84	6.89	18.99	18.43	18.71
Mean	3.76	3.26		9.30	8.89		6.99	6.80		20.05	18.95	
CD(P<0.05) Treatments		0.45	**		0.52			NS			1.87	
Soaking		0.26	**		0.78	**		NS			2.13	
Treatments × soaking		0.63	**		NS			NS			NS	

NS - Non significant ** - Significant at 1% level Soaked = Seed soaked with *panchagavya*

Table 3. Determining the field performance of 6½ month-old tubers that was harvested from *panchagavya* foliar spraying treatment and soaking with *panchagavya* and stored in abnormal condition.

Treatment	< 30 g size tuber numbers ('000 ha^{-1})		Mean	30 - 60 g size tuber numbers ('000 ha^{-1})		Mean	>60 g size tuber numbers ('000 ha^{-1})		Mean	Total tuber numbers ('000 ha^{-1})		Mean
	Soaked	Control		Soaked	Control		Soaked	Control		Soaked	Control	
Soaking in *panchagavya* (3%) + spraying *panchagavya* (3%) at 8 days interval	162	151	156	217	170	194	202	135	169	476	406	441
Soaking in *panchagavya* (3%) + spraying *panchagavya* (3%) at 15days interval	249	100	175	216	180	198	183	121	152	550	362	456
Spraying *panchagavya* (3%) at 8 days interval	236	194	215	199	205	202	176	163	170	528	490	509
Spraying *panchagavya* (3%) at 15 days interval	257	257	257	229	208	219	189	184	187	568	551	560
Recommmended cultural practice with spraying *panchagavya* (3%) at 15 days interval	270	248	259	223	198	210	194	178	186	582	534	558
Control (Recommended cultural practices)	185	164	175	211	204	208	161	152	156	484	455	469
Mean	226	186		216	194		184	155		531	466	
CD(P≤0.05) Treatment		27.42	**		6.84			NS			54.84	
Soaking		15.84	**		14.41	**		13.13	**		43.64	**
Treatment × soaking		38.80	**		NS			NS			NS	

NS = Non significant ** = Significant at 1% level Soaked = Seed soaked with *panchagavya*

5. http://www.cowindia.org /ani, al-energy.htm, economic / ecological contribution of cattle pp. 1-7.

6. Johanson, D.D. 1960. *Plant Microtome Technique*. McGraw Hill, New York.

7. Manorama, K. 2004. Weed management in potato in Nilgiris. *Potato J.* **31**: 91-93.

8. Mishra, V.K. 2002. Efficacy of soil application of *Maha panchagavya* (MPG) on control of wilt of tomato compared to other anitifungal ingredients and fungicides. *Research Report of Bharatiya Cattle Resource Development Foundation*, Ahwinsa Bhavan, Lado Sarai, New Delhi.

9. Nene, Y.L. 1999. Seed health in ancient and medical history and its relevance to present day agriculture. **In**: S.L. Choudhary, G.S. Sharma and Y.L. Nene (Eds.) Ancient and medical history of Indian agriculture. *Proc. of the Summer School* held from 28th May to 17th June, 1999, Rajasthan College of Agriculture, Jaipur.

10. Naidu, R. 1996. International regulations on organic Agriculture. **In**: *Proc. of National Seminar on Org. Fmg & Sust. Agri., APOF*, Bangalore, pp. 162-68.

11. Natarajan, K. 1999. *Panchagavya*. *Numvazhi Velanmai*, Oct-Dec. **11**: 3-4.

12. Panda, M.R., Chatterjee, R., Pariari, A., Chattopadhyay, P.K., Sharangi, A.B. and Alam, K. 2007. Effect of growth regulators on growth, yield and quality of coriander. *Indian J. Hort.* **64**: 369-71.

13. Panse, V.G. and Sukhatme, P.V. 1985. *Statistical Methods for Agricultural Workers*. Indian Council of Agricultural Research, New Delhi

14. Ramesh, P., Singh, M. and Subbarao, A. 2005. Organic Farming: Its relevance to the Indian context. *Curr. Sci.* **88**: 561-69.

15. Reddy, H. and Padmodaya, B. 1996. **In**: High-five. *Down to Earth*, Sept. 30th 1996.

16. Selvaraj, N., Ramaraj, B., Devarajan, K., Seenivasan, N., Senthil Kumar, S. and Sakthi. E. 2003. Effect of organic farming on growth and yield of thyme. **In**: *Articles and Abstracts of National Seminar on Production and Utilization of Medicinal Plants*, 13-14 March, 2003, Annamalai University, Tamil Nadu, pp. 63.

17. Singh, S. and Naik, P.S. 1993. Rapid seed multiplication. **In**: *Advances in Horticulture*. *Vol. 7. Potato*, K.L. Chadha and J.S. Grewal (Eds.), Malhotra Publishing House, New Delhi, pp. 567-676.

18. Somasundaram, E. 2003. Evaluation of organic sources of nutrient and *Panchagavya* spray on the growth and productivity of maize- sunflower-green gram system. Ph.D. thesis, Tamil Nadu Agricultural University, Coimbatore.

19. Upendra, S., Purushothama Rao, Aruna Kumara, U.K. and Anand, A.S. 2000. **In**: *Krishi Paryoga Pariwara. A Group of Experimenting Farmers*, 9 p.

Received: August, 2009; Revised: January, 2011;
Accepted : July, 2011