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Effect of organic farming practices on post harvest storage life and organoleptic quality of yellow onion (*Allium cepa*)

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ABSTRACT

An experiment was conducted during 2002–04 at Coimbatore to study the post-harvest storage life and organoleptic quality of onion (*Allium cepa* L.) The results revealed that the total storage loss of stored yellow onion bulbs increased steadily as the period of storage was extended. The organic treatment combination of M1S2 (3% panchakavya + 50% farmyard manure + 50% poultry manure) registered the lowest total loss 42.65 and 45.78% in 'Phule Suvarna' during crop I and crop II respectively at 120 days after storage. The inorganic treatment consisting of 100% recommended dose of NPK fertilizers (M4S10) significantly varied from organic treatment and exhibited the highest total losses in both crops. A similar kind of response was observed in sprouting and rotting per cent also. With respect to organoleptic quality, all organically nourished treatments, particularly poultry manure combination were superior, imparted better taste, flavour and texture and had higher score than inorganic fertilizer treatments. Overall acceptability was not significantly different among various treatment combinations and these attribute was acceptable in all treatments.

Key words: Growth stimulants, Onion, Organic manures, Organoleptic quality, Storage life

Onion (*Allium cepa* L.) is the most important cultivated bulb vegetable crop commercially grown in India. The post–harvest storage losses pose serious problem for onion growers and traders. It is estimated that around 2.0 million tonnes of onion is stored every year. Of this approximately 0.5 million tonnes of onion is lost due to several storage losses. Annual storage losses of onion have been estimated to be more than 50% on different accounts during storage and handling. These losses comprises physiological loss of weight, ie moisture losses and shrinkage (30–40%), rotting (10–12%) and sprouting (8–10%) The storability of onion is influenced by several factors such as varieties, nutrient management, pre- and post-harvest sprays and storage environment (Tripathi and Lawande 2006).Among the nutrient management practices, organic farming improves the quality of the produce combined with higher nutritive value and better storage-life than those grown conventionally with mineral fertilizers. Several research workers reported that organically produced vegetables are considered wholesome and valuable and it is also believed that the post harvest losses of such vegetables are considerably lower as compared to conventionally grown vegetables. (Nirmala 1996, Prasanna and Rajan 2001). In onion, this kind of information on organic farming using different kinds of organic manures and organic growth stimulants are very meager and scanty. Keeping this point in view, an experiment was conducted to investigate the post- harvest storage life and organoleptic quality aspects of onion under organic and inorganic farming system.

MATERIALS AND METHODS

The experiment was carried out at College Orchard-Vegetable Block of Tamil Nadu Agricultural University, Coimbatore during winter (*rabi*) season of 2002–03 and 2003–04 and experiment was laid out in split plot design with 40 treatment combinations replicated twice. 'Phule Suvarna'variety was used. The bulbs are medium to big size having yellow colour suitable for export market. The soil was sandy loam in texture with *p*H 7.8, organic carbon 0.57%, available nitrogen 220 kg/ha, and available phosphorus 22.1 kg/ ha and available potassium 447 kg/ ha. Before raising onion, nutrient-stabilizing crop maize (*Zea mays* L.)was taken in prepared ridges and furrows for exploiting residual nutrients status of the existing field. After harvesting of maize, onion crop was planted in the ridges and furrows at a spacing of 30 cm×15 cm.The crop was grown fully organically without using any chemicals. All organic manures were

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applied on equivalent weight of recommended dose of N fertilizers (150 kg /ha) and biofertilizers (*Azospirillium,* phosphobacteria 10 kg each/ha and VAM 560 kg/ha) were applied commonly to all the treatments. Three per cent concentration of all organic growth stimulants (Panchakavya – an organic product consisting of 5 products , viz cowdung, cow urine, cow milk, cow curd and ghee. Humic acid are the major extractable component of soil humic substances obtained from Margo biocontrol lab, Coimbatore. Tender coconut was collected from University Coconut farm, Coimbatore) were sprayed at critical stages of onion bulb crop, like 30, 45 and 60 days after planting. Plant protection measures were taken by using biopesticides and botanicals. The crop was harvested at 120 days after transplanting and 50% of the leaf showing yellowing, senescence of leaves and neck fall. The entire plants were uprooted and the bulbs were separated from the stem by cutting the stem 1 to 2 cm, above the bulb. The bulbs were cured in shade for 10–15 days to remove the field heat and excess moisture. At the time of harvest, neck thickness of the onion bulbs were determined by using digital vernier calipers measured at the collar region of the bulb and the mean value was expressed in centimeters. For dry matter, 5 randomly selected bulbs in each treatment were uprooted and then kept in an oven at 70°C for complete drying. The dry weight of bulb was recorded using an electronic balance and expressed in per cent. Bulb K content was analyzed by acid digestion method. All the cured bulbs from the respective treatments were taken for storage study. The moisture content of the onion bulbs at the time of storage was ranged from 85.7 to 86.3 % and bulk density after curing ranged from 530 to 545 kg/m^3. The bulbs harvested from the first and second crop were stored under ambient conditions with proper ventilation and storage observations (physiological loss in weight sprouting, rotting and total losses) were recorded periodically from 30, 60, 90 and 120 days after storage and mean data were prepared. The physiological loss in weight (PLW) was calculated by using following formula.

$$\text{PLW (\%)} = \frac{\text{Initial weight} - \text{final weight}}{\text{Initial weight}} \times 100$$

$$\text{Sprouting (\%)} = \frac{\text{Initial bulbs} - \text{no. of sprouted bulbs}}{\text{Total bulbs}} \times 100$$

$$\text{Rotting (\%)} = \frac{\text{Total bulbs} - \text{no. of rotted bulbs}}{\text{Total bulbs}} \times 100$$

Total loss was calculated in per cent by sum of physiological loss of weight (%), sprouting loss (%) and rotting loss (%) and the mean total loss was also expressed in per cent. The mean monthly temperature (minimum and maximum in °C) and relative humidity (minimum and maximum) were recorded (Fig 1). For evaluation of organoleptic quality, the selected bulbs from each treatment were washed thoroughly to remove all inert and dirt materials

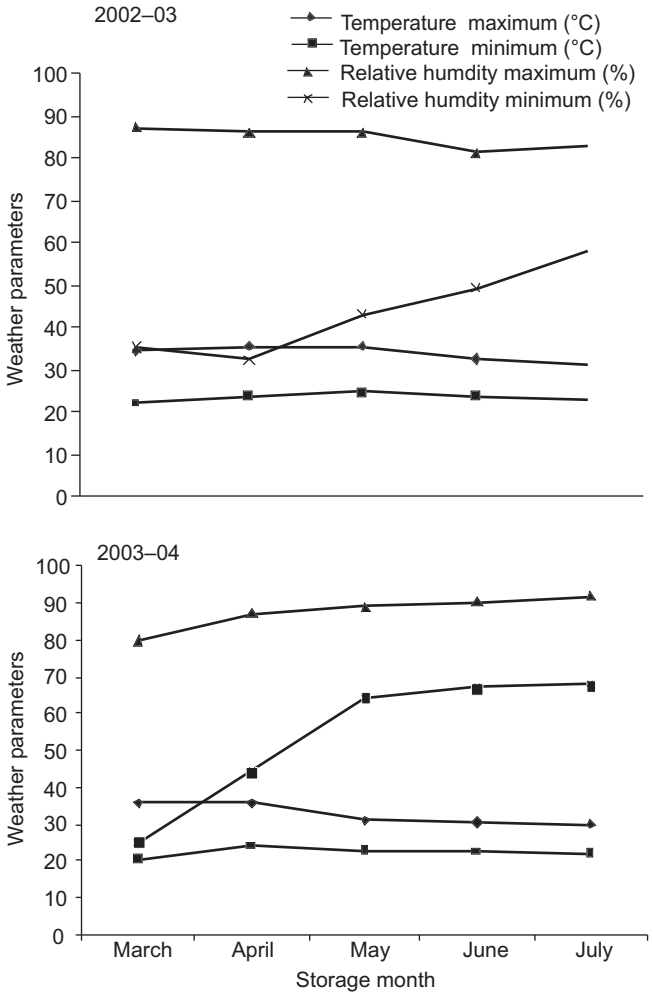

Fig 1 Onion storage environment weather parameters

from the skin. After the removal of skin, bulbs were sliced properly and smeared with salt and pepper powder and kept in bowl to test their organoleptic quality using nine point hedonic scales by untrained judges from various peer groups and ages. The organoleptic traits were colour and appearance, falvour, texture, taste and overall acceptability and corresponding scores are 1, dislike extremely; 2, dislike; 3, dislike moderately; 4, dislike slightly; 5, neither like nor dislike; 6, like; 7, like moderately; 8, like very much; and 9, like extremely. The collected data were statistically analyzed according to the methods suggested by Panse and Sukhatme (1995).

RESULTS AND DISCUSSION

The physiological loss of bulb weight (PLW) was influenced by different organic and inorganic treatments and the data are presented in Table 1.The PLW in stored bulbs increased steadily as the period of storage was extended at ambient storage conditions. The highest storage loss was recorded at 120 days after storage. In onion storage, generally bulbs undergo loss in weight owing to physiological changes

Table 1 Effect of organic farming practices on post harvest storage life and oreganoleptic quality of onion after 120 days of storage

Treatment	'Phule Suvarna'									
	2002–03					2003–04				
	M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean
					Physiological loss in weight (%)					
S1	28.7	29.0	29.2	29.5	29.1	29.0	29.2	29.5	29.8	29.4
S2	26.5	27.0	27.8	28.0	27.3	27.1	27.5	27.8	28.1	27.6
S3	29.1	29.4	29.6	29.9	29.5	29.7	30.0	30.5	30.7	30.2
S4	28.1	28.5	29.0	29.5	28.8	28.6	29.0	29.5	29.8	29.2
S5	28.5	28.9	29.3	29.6	29.1	29.0	29.3	29.6	30.2	29.5
S6	28.6	29.0	29.5	29.7	29.2	29.2	29.5	29.8	30.6	29.8
S7	27.1	27.5	27.8	28.0	27.6	28.3	28.6	29.2	29.7	29.0
S8	27.5	27.9	28.2	28.6	28.1	28.0	28.9	29.1	29.8	29.0
S9	27.1	27.6	28.0	28.5	27.8	27.9	28.3	28.6	29.0	28.5
S10	37.0	37.4	38.1	38.4	37.7	39.0	39.3	40.0	40.3	39.7
Mean	28.8	29.2	29.7	30.0	29.4	29.6	30.0	30.4	30.8	30.2
	M	S	M at S		S at M	M	S	M at S		S at M
CD(P=0.05)	NS	0.636	1.475		1.271	NS	0.750	1.477		1.299
					Sprouting (%)					
S1	12.2	12.4	12.6	12.8	12.5	13.8	13.9	14.0	13.7	13.9
S2	11.5	11.6	11.8	12.0	11.7	13.0	13.2	13.5	13.6	13.3
S3	12.4	12.5	12.7	12.9	12.6	13.9	14.0	14.2	14.2	14.1
S4	12.2	12.3	12.5	12.7	12.4	13.8	14.0	14.0	14.2	14.0
S5	12.5	12.6	12.7	12.8	12.7	14.0	14.2	14.1	14.3	14.2
S6	12.4	12.4	12.5	12.6	12.5	13.9	14.2	14.3	14.4	14.2
S7	11.8	11.9	12.0	12.2	12.0	13.7	13.9	14.0	14.2	14.0
S8	11.4	11.4	11.6	11.9	11.6	12.8	13.0	13.7	13.9	13.4
S9	11.6	11.5	11.8	12.0	11.7	13.3	13.5	13.8	14.0	13.7
S10	12.8	13.0	13.2	13.5	13.1	14.3	14.5	14.2	14.4	14.4
Mean	12.1	12.2	12.3	12.5	12.3	13.7	13.8	14.0	14.1	13.9
	M	S	M at S		S at M	M	S	M at S		S at M
CD (P=0.05)	0.016	0.021	NS		NS	NS	0.024	NS		NS
					Rotting (%)					
S1	5.65	5.71	5.79	5.83	5.75	6.54	6.57	6.66	6.15	6.48
S2	4.65	4.82	4.95	5.17	4.90	5.68	5.82	5.91	6.00	5.85
S3	5.95	6.05	6.17	6.22	6.10	7.12	7.22	7.31	7.45	7.28
S4	5.50	5.78	5.83	5.91	5.76	6.78	6.84	6.90	7.00	6.88
S5	5.78	5.91	5.96	6.05	5.93	7.10	7.15	7.21	7.35	7.20
S6	5.65	5.77	5.85	5.93	5.80	6.10	6.23	6.35	7.15	6.46
S7	5.65	5.82	5.90	5.97	5.84	6.45	6.55	6.65	6.78	6.61
S8	4.87	4.91	4.95	5.07	4.95	5.95	6.09	6.25	6.58	6.22
S9	5.10	5.22	5.31	5.47	5.28	6.27	6.31	6.41	6.49	6.37
S10	7.12	7.15	7.21	7.25	7.18	8.13	8.21	8.25	8.85	8.36
Mean	5.59	5.71	5.79	5.89	5.75	6.61	6.70	6.79	6.98	6.77
	M	S	M at S		S at M	M	S	M at S		S at M
CD (P=0.05)	0.032	0.093	0.179		0.186	0.035	0.094	0.181		0.187
					Total loss (%)					
S1	46.55	47.11	47.59	48.13	47.35	49.34	49.67	50.16	49.65	49.71
S2	42.65	43.42	44.55	45.17	43.95	45.78	46.52	47.21	47.70	46.80
S3	47.45	47.95	48.47	49.02	48.22	50.72	51.22	52.01	52.35	51.58
S4	45.80	46.58	47.33	48.11	46.96	49.18	49.84	50.40	51.00	50.11
S5	46.78	47.41	47.96	48.45	47.65	50.10	50.65	50.91	51.85	50.88
S6	46.65	47.17	47.85	48.23	47.48	49.20	49.93	50.45	52.15	50.43
S7	44.55	45.22	45.70	46.17	45.41	48.45	49.05	49.85	50.68	49.51
S8	43.77	44.21	44.75	45.57	44.58	46.75	47.99	49.05	50.28	48.52

(continued...)

(Table 1. concluded...)

	M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean
S9	43.80	44.32	45.11	45.97	44.80	47.47	48.11	48.81	49.49	48.47
S10	56.92	57.55	58.51	59.15	58.03	61.43	62.01	62.45	63.55	62.36
Mean	46.49	47.09	47.78	48.40	47.44	49.84	50.50	51.13	51.87	50.84
	M	S	M at S		S at M	M	S	M at S		S at M
CD (*P*=0.05)	0.483	0.573	1.524		1.345	0.566	0.453	1.484		1.306
	Organoleptic quality (overall acceptability)									
S1	7.10	7.50	6.80	7.20	7.15	7.20	7.60	7.90	8.10	7.70
S2	7.60	8.00	7.00	7.00	7.40	7.50	7.50	7.60	7.90	7.63
S3	7.50	7.90	7.10	7.90	7.60	7.00	7.40	7.50	7.50	7.35
S4	7.00	7.20	7.50	7.10	7.20	7.40	7.10	7.00	8.00	7.38
S5	7.20	7.00	7.60	7.05	7.21	7.60	7.00	7.80	8.50	7.73
S6	7.30	7.60	7.00	7.60	7.38	7.30	7.00	7.20	7.10	7.15
S7	7.00	8.10	7.20	7.30	7.40	7.20	7.20	7.30	7.00	7.18
S8	7.80	8.00	7.50	7.80	7.78	7.10	7.20	7.00	7.90	7.30
S9	7.10	7.10	7.00	7.70	7.23	7.00	7.60	7.80	7.80	7.55
S10	7.00	7.00	7.10	7.20	7.08	6.90	7.00	7.30	6.90	7.03
Mean	7.26	7.54	7.18	7.39	7.34	7.22	7.26	7.44	7.67	7.40
	M	S	M at S		S at M	M	S	M at S		S at M
CD (*P*=0.05)	NS	NS	NS		NS	NS	0.066	NS		NS

M1, Panchakavya; M2, humic substances; M3, coconut water; M4, control; S1, farmyard and neem cake 50%; S2, farmyard and poultry manure 50%; S3, farmyard and pressmud 50%; S4, farmyard and vermicompost 50%; S5, farmyard and digested coirpith 50%; S6, poultry manure and neem cake 50%; S7, poultry manure and pressmud 50%; S8, poultry manure and vermicompost 50%; S9, poultry manure and digested coirpith 50%; S10, control inorganic farming

like sprouting, rotting, rooting and desiccation. The major storage loss of onion is mainly due to PLW, sprouting and rotting.

In present experiment, a comparative study made between organic and inorganic treatments revealed that organic treatment M1S2 (3% panchakavya + 50% farmyard manure + 50% poultry manure) registered the lowest PLW, viz. 26.5 and 27.1,% in crop I (02–03) and crop II (03–04), respectively at 120 days after storage. It was significantly different from the inorganic treatment consisting of 100% recommended dose of NPK fertilizer alone (M4S10), which registered the highest PLW% in both the years at 120 days after storage. The important storage parameter like PLW have been found to be highly influenced by different organic manures and organic growth stimulant combined with biofertilizer application. It is seen from Table 1 that minimum weight or weight loss was noticed in bulbs harvested from plots which received organic nutrition of 3% panchakavya + 50% farmyard manure + 50% poultry manure (M1S2) along with biofertilizer consortium, viz. *Azsopirillum*, phosphobacteria and VAM. Over all, the weight loss increased with the extended period of storage and also due to loss of moisture content in bulbs. The bulb harvested from the crop fertilized with inorganic fertilizer alone registered the highest PLW against organic nutritioned bulbs. This can be attributed to the phenomenon of altered physiology and biochemistry of the bulb as influenced by organic sources of nutrients might have led to the reduced respiration and evapotranspiration rate, which in turn resulted in low PLW.According to Prasanna and Rajan (2001), rapid loss of harvested produce occurs when the plants are raised by supplying inorganic fertilizers.

Sprouting is one of the major causes for qualitative as well as quantitative deterioration of stored bulb onions. Sprouting of bulbs increased with the increase in storage period (Table 1). From the attempt of organic farming versus inorganic farming it is obvious that the organic farming treatment of M1S8 which consists of 3% panchakavya + 50% poultry manure + 50% vermicompost recorded the lowest sprouting loss of 11.4 and 12.8% during crop I (02–03) and crop II (03–04), respectively at 120 days after storage. The highest sprouting losses were registered (13.5 and 14.4%) in the inorganic treatment of M4S10 (control-100% recommended dose of NPK fertilizers).

When compared to organic with inorganic farming, there was no significant difference noticed in sprouting per cent. But the organic treatments recorded comparatively lower amount of sprouting than inorganic treatments. Here, it is worthy to mention the importance of nitrogen in sprouting of onion bulbs. The role of N in increasing the sprouting may be explained that auxins and cytokinins are nitrogenous compounds linked with N metabolism of plant, which result in an increased sprouting due to higher concentrations of growth promoters than growth inhibitors. According to Woldetsadik *et al*. (2003) and Kumar *et al.* (2006), higher sprouting with higher fertility level might be due to the fact

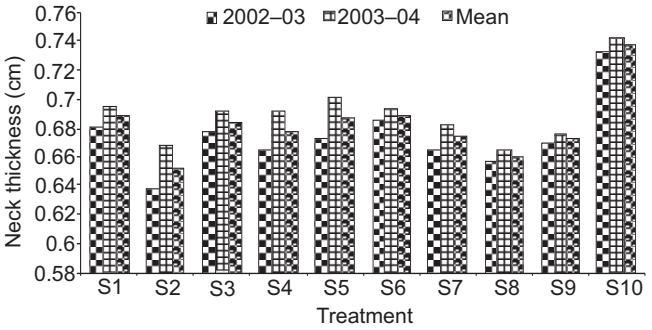

Fig 2 Bulb neck thickness (cm) influenced by organic farming practices

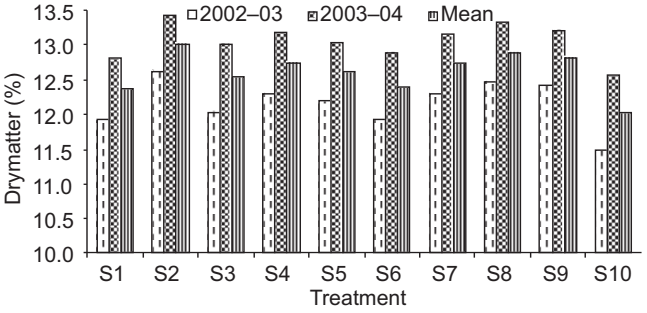

Fig 3 Bulb dry matter content (%) influenced by organic farming practices

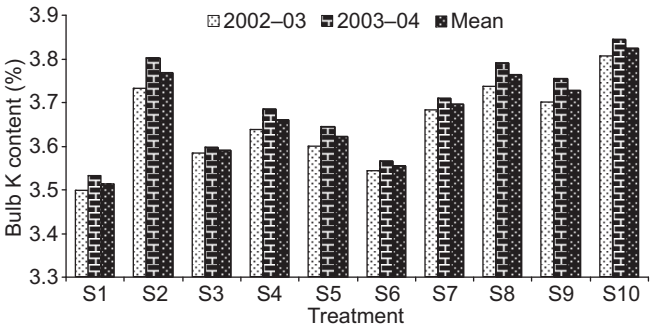

Fig 4 Bulb K content (%) influenced by organic farming practices (S1, farmyard manure and neem cake 50%; S2, farmyard manure and poultry manure 50%; S3, farmyard manure and pressmud 50%; S4, farmyard manure and vermicompost 50%; S5, farmyard manure and digested coirpith 50%; S6, poultry manure and neem cake 50%; S7, poultry manure and pressmud 50%; S8, poultry manure and vermicompost 50%; S9, poultry manure and digested coirpith 50%; S10, control inorganic farming)

that higher nitrogen availability to the crop during bulb elongation phase might be accelerated the sprouting during storage. Another possible reason is in the present experiment, organically grown onion bulbs were found to be thin necked than inorganically grown onion bulbs (Fig 2). In general, in onion storage, thin necked onion bulbs having more storage life than thick necked one (Kale *et al*.1991).Because of high fertility level, onion plants produced thick necked bulbs in inorganic treatments, which increased sprouting due to greater access of oxygen and moisture to the central growing point. These results are supported by Singh and Dhankhar (1991).

The extent of sprouting and rotting in onion during storage play a major role in influencing the keeping quality of bulbs and marketability. In general, the percentage of rotting increased as the period of storage extended. The combined application of organic manures, organic growth stimulants and biofertilizers showed their definite superiority over inorganics alone. In the present study, irrespective of nutrient regime, the rotting percentage was less accounting from 4.65 to 8.85% at 120 days after storage. It was observed that higher PLW per cent recorded in inorganic treatments consisting of 100% recommended dose of NPK fertilizers. These results are accordance with those of Gopalkrishnan and Srinivas (1990).

Similar to PLW and sprouting losses, rotting loss also increased as the storage period increased. However, here the differences among treatments were found to be significant (Table 1). The results of comparing organic versus inorganic farming treatments it is found that the organic farming treatment of M1S2 consisting of 3% panchakavya + 50% farmyard manure + 50% poultry manure recorded the lowest rotting and the highest rotting losses were recorded by inorganic treatment of M4S10 (control–100% recommended dose of NPK fertilizers) in both the years. The increase in rotting was of still higher magnitude due to shift from total organics to total inorganics.

Rotting of onion bulbs is normally met with storage due to pathogens and development of excess humidity in the storage environment. Optimum relative humidity and low temperature inhibits the growth activity of the pathogens responsible for rotting of bulbs during storage period. Overall, irrespective of treatments, rotting losses were minimum due to optimum weather parameters prevailing during storage (Fig 1). How ever, higher level of rotting per cent was observed in inorganic treatment than organic package. Owing to higher moisture content on onion bulbs (about 85%) and physiologically active growing points the bulbs were subjected to make them highly prone to shrinkage and storage rots. Moreover, higher fertility levels, particularly nitrogen makes the tissues succulent and allows greater swelling of protoplasmic colloids led to form soft bulbs which are more vulnerable to storage rots (Birajdar *et al.*1992).

Table 1 reveals that organic treatment combination of M1S2 (3% panchakavya + 50% farmyard manure + 50% poultry manure) registered the lowest total loss, viz 42.65 and 45.78%, in crop I (2002–03) and crop II (2003–04), respectively at 120 days after storage. The inorganic treatment consisting of 100% recommended dose of NPK fertilizers (M4S10) significantly varied from organic treatment and exhibited the highest total losses in both the crops (59.15 and 63.55%). Similar results also obtained by Warade *et al.* (1996) that the application of chemical fertilizers has adverse effect on total losses of onion bulbs. Organic manures applied

plots had lower per cent losses of weight when compared to inorganic fertilizer application which recorded higher per cent weight loss within a period of 4 months. Another possible reason for low storage losses in organic farming treatment may be due to more accumulation of dry matter and K content in onion bulbs.

In onion storage, higher dry matter content in bulbs always associated with lower storage and rotting losses. Dry matter or total soluble solids content may therefore be an indicator of good storability of onion during storage period. (Kale *et al.*1991, Sundaram *et al.*2002). In the present study, a significant variation was found in the amount of dry matter accumulation in organic and inorganic nutrition applied onion bulbs. The highest dry matter contents were observed in organic farming treatments (Fig 3) and the lowest dry matter content were recorded in inorganic farming treatment of 100% recommended dose of inorganic NPK fertilizers applied plots in both the years. Onions with high dry matter are firmer and hence more resistant to damage during storage and transport and, they tend to have thicker, better adhering skins and lose water less than onions which have higher water content and thinner bulbs.

Overall, the improvement in storage behaviour of onion bulbs harvested from crop subjected to organic manuring might be higher uptake of potassium nutrient from organics throughout the crop season (Fig 4). Optimum level of K helps in greater translocation of metabolites to storage organs and enhances thickening of bulbs. Thus efficient metabolism and better source sink relationship contributes on improved storage life in onion. Potash nutrition imparts sturdiness to the bulb tissues by increasing thickness of cell wall and helps in getting healthy bulbs. Further, the strong skin of bulbs guards them against decay and reduced rate of respiration during storage. The potash decreasing the sprouting during storage may be attributed to the increased concentration of inhibitors apparently by facilitating release of potassium ions from the guard cell.

The organoleptic evaluation of freshly harvested onion bulbs was taken up under different organic manures and organic growth stimulants combined with biofertilizer treatments in comparison with inorganic fertilizer application and the scores are presented in Table 1. Among different organic manures and organic growth stimulants evaluated, organoleptic attribute, overall acceptability (combined mean scores of colour, flavour, texture and taste) was not significantly different among various treatment combinations. These attributes are acceptable in all treatments.

In respect of colour, texture, taste and overall acceptability, the organic manures combination, particularly poultry manure combination had higher score than inorganic fertilizer treatments evaluated. In the present experiment also all organically nourished treatments, particularly poultry manure combination were superior and had higher score. According to earlier findings of Sankar (1998), farmyard manure application had favourable influence on organoleptic quality characters of cassava tubers which was highly acceptable, but organoleptic attributes did not show any appreciable variation. This is in line with the previous findings reported by Rajasekar (1995) in okra and Nirmala (1996) in cucumber. This makes clear that plots receiving organic amendments recorded better quality. Thamburaj (1994) noticed that increase in quality aspects of tomato with organic manures application, but difference was not significant. Organic manures combined with foliar spray of panchakavya showed delicious and an appreciable change in organoleptic attributes was observed by Somasundram (2002).

In general, farmers and consumers entertained a deep conviction that organically produced food possessed better keeping quality and organoleptic properties than conventionally produced food using inorganic fertilizers. But according to researchers, in general, sources of plant nutrients were unlikely to produce any effect on the quality of produce, but it was the imbalanced use of plant materials that affected the quality and quality alike. However it has to be kept in mind that when crops are harvested without spraying any synthetic pesticides/fungicides definitely it is going to be a pollution-free produce, free from any health hazard and also safe for environment.

It is concluded that the combined application of 3% panchakavya + 50% farmyard manure + 50% poultry manure + biofertilizers consortium, viz *Azsopirillum*, phosphobacteria and VAM along with organic way of plant protection measures were significantly improved the post-harvest storage life of onion var. 'Phule Suvarna' under organic culture. In case of organoleptic quality, all organically nourished treatments, particularly poultry manure combination were superior, imparted better taste, flavour and texture and had higher score than inorganic fertilizer treatments.

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