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Impact of organic amendments and inorganic fertilizers on post harvest storage life and organoleptic quality of tomato under eastern Himalayan region

Ranjit Chatterjee[1☼], Paul PK[2]

1. Assistant Professor, Depot. of Vegetable and Spice Crops, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India
2. Associate Professor, NIFTEM, Sonipat, Haryana, India

☼***Corresponding author:*** Assistant Professor, Depot. of Vegetable and Spice Crops, UBKV, Pundibari, W.B. ,India, Email : ranchat22@gmail.com

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ABSTRACT

A study was conducted to assess the impact of different nutrient combination of field tomato on post harvest storage life and organoleptic quality of fresh fruits. Fourteen different treatment combinations comprising two organic manures (Farmyard manure and vermicompost), inorganic fertilizers and biofertilizer in different levels were laid out in RBD with three replications during 2005-06 and 2006-07 at UBKV, Pundibari, Coochcbehar,West Bengal, India. The findings indicated that the nutrient schedule of the crop significantly influenced the physiological loss in weight (PLW) of tomato fruits as well as organoleptic quality and rotting level of fruits. The nutrient schedule comprising of higher amount of organic amendments and reduced amount of chemical fertilizers have shown promising performance over chemical fertilizers alone. The nutrient schedule comprising of 75% inorganic fertilizers along with higher dose of vermicompost (4 t ha^{-1}) in conjugation with biofertilizer emerged as potential nutrient source for improving post harvest storage life of fresh fruits. The same treatment also enhanced the organoleptic quality and lessens the rotting percentage of fruits.

Key words: Tomato fruits, Organic amendments, Physiological loss in weight (PLW) and organoleptic quality

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1. INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is one of the most popular vegetable crops worldwide. It is valued for is distinctive flavour and versatile culinary use. Ripe fruits are either consumed fresh or utilized in preparation of a number of processed products like puree, ketch up, sauce etc. Tomato fruits contain more than 92% water and are highly perishable in nature. Water loss during storage rapidly deteriorates the quality of fruits and makes it more susceptible to microbial spoilage. The post harvest storage losses emerging serious threat for growers, traders, retailers and consumers. The shelf life of tomato is influenced by a number of factors, of which nutritional status of the soil plays significant role in regulating the storage life of the fruits. Indiscriminate use of chemical fertilizers without addition of sufficient amount organic matter in soil deteriorates the fruit quality and shelf life of the fruits (Yadav et al. 2004). Several research works suggested that higher amount of organic amendments particularly vermicompost, cow dung manure and biofertilizer along with reduced level of inorganic nitrogen can enhance the fruit yield, quality and post harvest life of tomato fruits (Kumaran et al.1998; Patil et al. 2004). Vermicompost, a organic manure obtained in the form of casting of ingested biomass by earthworm after undergoing physical, chemical and microbial transformations. Besides macro and micronutrients it also contains humic acids, plant growth promoting substances like auxins, gibberellins, and cytokinins (Krishnamoorthy and Vajrabhiah, 1986), N-fixing and P-solubilizing bacteria, enzymes and vitamins (Ismail, 1997). The water soluble components of vermicompost such as humic acid, growth regulators, vitamins, micronutrients and beneficial microorganism increases the availability of plant nutrients, results in increased growth, higher yield and better quality produce (Atiyeh et al. 2002). In addition to vermicompost, farmyard manure and biofertilizer also plays a vital role as organic amendments for sustainable soil health and crop growth (Mali et al. 2005). However information regarding the type of organic amendments, their optimum dose as well as their interaction effect in combination with inorganic fertilizers on post harvest storage life and organoleptic quality aspects of tomato fruits are scanty under moist humid climate of eastern Himalayan region. Keeping in view the rich nutritional quality of tomato the present study was formulated to determine the impact of different nutrient combination on post harvest life and organoleptic quality of fresh tomato fruits.

2. MATERIALS AND METHODS

The field experiment was conducted at the experimental field of UBKV, Pundibari, CoochBehar, West Bengal (89^o23′53″ E longitude and 26^o19′86″ N latitude) during winter season (November to March) of 2005-2006 and 2006-2007. The soil was well drained sandy loam having pH of 5.74, organic carbon content 0.85% and available N, P_2O_5, K_2O, were 155.85 kg ha^{-1}, 20.23 kg ha^{-1} and 125.90 kg ha^{-1}, respectively. The treatment consisted of 14 combinations of different nutrient sources and was laid out in randomized block design with three replications. The treatments were

Table 1

Effect of different nutrient sources on post harvest storage life of tomato fruits (pooled mean of 2 years)

Treatments	Initial fruit wt (g)	Physiological loss in weight (%) Storage interval (days)				
		2	4	6	8	10
T_1-100% RDF (100 : 60 : 60 kg N P K ha^{-1})	41.27	3.74	7.38	×	×	×
T_2-100% RDF + 6 t ha^{-1} FYM + biofertilizer	48.51	3.39	6.17	11.43	×	×
T_3-100% RDF + 2 t ha^{-1} VC + biofertilizer	51.17	2.96	5.27	10.39	×	×
T_4-100% NPK +3 t ha^{-1} FYM+1 t ha^{-1} VC+ biofertilizer	50.21	3.34	5.94	11.62	×	×
T_5 -75% RDF + 6 t ha^{-1} FYM	45.34	2.93	5.38	7.46	11.29	×
T_6 -75% RDF + 6 t ha^{-1} FYM + biofertilizer	46.83	2.91	5.11	7.28	10.76	×
T_7 -75% RDF + 2 t ha^{-1} VC	47.36	2.87	4.97	7.03	10.51	×
T_8 -75% RDF + 2 t ha^{-1} VC + biofertilizer	49.57	2.63	4.61	6.74	9.76	×
T_9-75%RDF+3t ha^{-1} FYM+1 t ha^{-1}VC/ha+ biofertilizer	47.91	2.76	4.89	6.87	10.39	×
T_{10} -75% RDF + 12 t ha^{-1} FYM	51.86	2.56	3.96	6.63	8.37	11.43
T_{11}-75% RDF +12 t ha^{-1} FYM + biofertilizer	53.41	2.39	3.84	6.31	8.17	10.86
T_{12} -75% RDF + 4 t ha^{-1} VC	56.12	2.09	3.49	5.79	7.42	10.24
T_{13}-75% RDF + 4 t ha^{-1} VC + biofertilizer	59.48	1.72	3.18	5.12	6.97	9.31
T_{14}-75%RDF+6 t ha^{-1} FYM+2xt ha^{-1} VC + biofertilizer	57.64	2.23	3.71	6.06	7.78	10.49
S.Em (±)	1.80	.10	.27	0.39	0.47	0.59
CD (P=0.05)	5.09	.27	.78	1.14	1.37	1.73

R.D.F.-Recommended dose of fertilizer; FYM: Farmyard manure; VC-Vermicompost; S.Em-Standard error of the mean; CD-Critical difference

selected for sole and combined application of varied levels of vermicompost and farmyard manure (FYM) along with 100% and 75% of recommended dose of inorganic fertilizers in presence and absence of biofertilizer. The combinations were T_1-100% Recommended dose of fertilizer (RDF) (100:60:60 kg N P K ha^{-1}); T_2-100% RDF + 6 tonnes FYM ha^{-1} + biofertilizer; T_3-100% RDF + 2 tonnes vermicompost ha^{-1} + biofertilizer ; T_4-100% RDF + 3 tonnes FYM ha^{-1} + 1 ton vermicompost ha^{-1} + biofertilizer ; T_5 -75% RDF + 6 tonnes FYM ha^{-1} ; T_6 -75% RDF + 6 tonnes FYM ha^{-1} + biofertilizer ; T_7 -75% RDF + 2 tonnes vermicompost ha^{-1} ; T_8 -75% RDF + 2 tonnes vermicompost ha^{-1} + biofertilizer ; T_9 -75% RDF + 3 tonnes FYM ha^{-1} + 1 ton vermicompost ha^{-1} + biofertilizer ; T_{10} - 75% RDF + 12 tonnes FYM ha^{-1} ; T_{11}-75% RDF +12 tonnes FYM ha^{-1} + biofertilizer ; T_{12}-75% RDF + 4 tonnes vermicompost ha^{-1} ; T_{13}-75% RDF + 4 tonnes vermicompost ha^{-1} + biofertilizer and T_{14} -75% RDF + 6 tonnes FYM ha^{-1} + 2 tonnes vermicompost ha^{-1} + biofertilizer. Tomato seedlings (cv. Pusa Ruby) were transplanted in 3.75 m × 3.75 m plots with a spacing of 75 cm within and between rows. Vermicompost and farmyard manure were applied to the respective plots at the time of transplanting. *Azophos*, *Azotobacter* and phosphate solubilizing bacteria containing biofertilizer were applied as seedling root dipping (250 g litre^{-1} water) just before transplanting. Full dose of phosphorus and potash along with half nitrogen were applied as basal and rest nitrogen was top dressed at 30 days after transplanting. The crop was raised adopting standard cultural practices. To analyse the post harvest life and organoleptic quality parameters ripe fruit were randomly selected during second harvest from each plots and stored under ambient condition with proper ventilation. The average room temperature and relative humidity were 21^{o}C and 82%, respectively. The post harvest storage life of fresh fruits was recorded up to ten days. The physiological loss in weight and rotting percentage of fruits were recorded at two days intervals and were estimated by using following formula

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

$$\text{Rotting (\%)} = \frac{\text{Number of rotten fruits}}{\text{Total fruits}} \times 100$$

To study organoleptic quality, the ripe fruits were evaluated by a panel of 10 trained judges using 9 point hedonic scale (Heintz and Kader, 1983). Hedonic scale 9: like extremely; 8: like very much; 7: like moderately; 6: like slightly; 5: neither like nor dislike; 4: dislike slightly; 3 : dislike moderately ; 2: dislike; 1: dislike extremely. For acceptability scoring, judges were asked to consider the visual colour, fruit freshness, firmness and presence/absence of defects in the fruits. The data collected from the investigation were analyzed statistically by using complete randomized design as per method suggested by Panse and Sukhatme (2000). The significance of the mean difference between the treatments was determined by computing the standard error and critical difference.

3. RESULTS AND DISCUSSION

3.1. Physiological loss in weight (%)

The observation recorded on physiological loss in weight (PLW) of tomato fruits (Table 1) showed that different nutrient source have significant effect on post harvest behaviour of the tomato fruits. However the PLW was increased as the period of storage advanced for all the treatments due to active physiological processes like transpiration, respiration and ethylene production. A comparative study among different nutritional source used for tomato production revealed that the PLW was increased rapidly for the treatments containing 100% chemical fertilizers (T_1 to T_4) where as the rate was slow for 75% inorganic fertilizers combination (T_5 to T_{14}). The highest PLW loss on 2nd and 4th day was recorded by the fruits grown with sole 100% chemical fertilizers viz. 3.74% and 7.38%, respectively. On the 6th day of storage the fruits from sole 100% chemical fertilizers become unacceptable. An increase PLW could be due to rapid loss of moisture and drastic reduction in firmness. In case of tomato fruits, collected from the treatments T_5 to T_9, the acceptable limit was till 8th day but beyond that the firmness decreased and fruits became unacceptable. Incorporation of higher amount of organic amendments (Farmyard manure and vermicompost) in combination with 75% inorganic fertilizers (T_{10} to T_{14}) significantly reduced the PLW loss and increased the fruit acceptability beyond 10th days of storage. On 10th day, the lowest PLW of fruits (9.31%) was recorded by the treatment that received 75% inorganic fertilizers and vermicompost (4 t ha^{-1}) in conjugation with biofertilizer (T_{13}). The result showed that fruits grown with lower amount of chemical fertilizers and higher amount of vermicompost and biofertilizer have recorded minimum PLW and longer shelf life. This may be due to reduced respiration and evapo-transpiration. Whether the phenomena of thicker skin or lower water content and higher pulp content of the fruits have direct role in improving the storage life of fruits need to be investigated in details. In case of the fruits that received sole 100% chemical fertilizer showed the maximum PLW and minimum storage life of fresh fruits. The excessive chemical fertilizers and easily available nutrients might have encouraged rapid loss of moisture and reduced the shelf life

Table 2
Effect of different nutrient sources on percent rotten fruits of tomato (pooled mean of 2 years)

Treatments	Percent rotten fruits (%) Storage interval (days)				
	2	4	6	8	10
T_1-100% RDF (100 : 60 : 60 kg N P K ha^{-1})	37.84	84.79	×	×	×
T_2-100% RDF + 6 t ha^{-1} FYM + biofertilizer	32.47	71.24	94.23	×	×
T_3-100% RDF + 2 t ha^{-1} VC + biofertilizer	27.61	54.53	86.78	×	×
T_4-100% NPK +3 t ha^{-1} FYM+1 t ha^{-1} VC+ biofertilizer	29.12	61.87	89.82	×	×
T_5 -75% RDF + 6 t ha^{-1} FYM	24.76	49.03	87.93	×	×
T_6 -75% RDF + 6 t ha^{-1}FYM + biofertilizer	22.67	46.21	82.74	×	×
T_7 -75% RDF + 2 t ha^{-1} VC	22.11	44.74	72.79	95.67	×
T_8 -75% RDF + 2 t ha^{-1} VC + biofertilizer	19.83	38.79	63.62	88.32	×
T_9-75% RDF +3 t ha^{-1} FYM+1 t ha^{-1}VC/ha+ biofertilizer	21.34	42.83	67.38	91.07	×
T_{10} -75% RDF + 12 t ha^{-1} FYM	16.13	41.11	63.04	88.52	95.68
T_{11}-75% RDF +12 t ha^{-1} FYM + biofertilizer	13.87	38.07	60.42	85.28	92.17
T_{12} -75% RDF + 4 t ha^{-1} VC	9.81	26.93	47.17	72.47	83.36
T_{13}-75% RDF + 4 t ha^{-1} VC + biofertilizer	8.76	21.12	39.58	64.19	78.21
T_{14}-75% RDF+6 t ha^{-1} FYM +2 t ha^{-1} VC + biofertilizer	11.67	29.86	53.85	77.39	87.89
S.Em (±)	1.47	2.14	1.72	1.41	1.64
CD (P=0.05)	4.34	6.22	4.84	4.10	4.86

R.D.F.-Recommended dose of fertilizer; FYM: Farmyard manure; VC-Vermicompost; S.Em-Standard error of the mean; CD-Critical difference

Table 3
Effect of different nutrient sources on organoleptic quality (consumer acceptability) of tomato fruits (pooled mean of 2 years)

Treatments	Consumer acceptability (%) Storage interval (days)				
	2	4	6	8	10
T_1-100% RDF (100 : 60 : 60 kg N P K ha^{-1})	7.10	5.42	×	×	×
T_2-100% RDF + 6 t ha^{-1} FYM + biofertilizer	7.46	6.34	5.08	×	×
T_3-100% RDF + 2 t ha^{-1} VC + biofertilizer	7.81	6.59	5.13	×	×
T_4-100% NPK +3 t ha^{-1} FYM+1 t ha^{-1} VC+ biofertilizer	7.64	6.41	5.03	×	×
T_5 -75% RDF + 6 t ha^{-1} FYM	7.76	6.98	6.09	5.02	×
T_6 -75% RDF + 6 t ha^{-1}FYM + biofertilizer	7.96	7.09	6.14	5.08	×
T_7 -75% RDF + 2 t ha^{-1} VC	8.26	7.41	6.48	5.22	×
T_8 -75% RDF + 2 t ha^{-1} VC + biofertilizer	8.46	7.73	6.86	5.44	×
T_9-75% RDF +3 t ha^{-1} FYM+1 t ha^{-1}VC/ha+ biofertilizer	8.31	7.54	6.64	5.36	×
T_{10} -75% RDF + 12 t ha^{-1} FYM	8.91	8.14	7.33	6.39	5.04
T_{11}-75% RDF +12 t ha^{-1} FYM + biofertilizer	9.03	8.32	7.53	6.67	5.39
T_{12} -75% RDF + 4 t ha^{-1} VC	9.23	8.52	7.65	6.73	5.47
T_{13}-75% RDF + 4 t ha^{-1} VC + biofertilizer	9.47	8.80	7.96	7.01	5.84
T_{14}-75% RDF+6 t ha^{-1} FYM +2 t ha^{-1} VC + biofertilizer	8.96	8.22	7.35	6.39	5.19
S.Em (±)	0.19	0.15	0.14	0.11	0.09
CD (P=0.05)	0.54	0.41	0.39	0.29	0.25

R.D.F.-Recommended dose of fertilizer; FYM: Farmyard manure; VC-Vermicompost; S.Em-Standard error of the mean; CD-Critical difference

of fruits. Prasanna and Rajan (2001) opined that plants raised with higher amount of inorganic fertilizers resulted in rapid loss of moisture from the surface of the fruits and subsequently results in higher PLW in fruits.

3.2. Rotting (%)

Rotting of fruit is common in tomato due to higher moisture content (around 92%) and perishable nature of the fruits. Excess humidity of storage room and development of secondary infection by microbes also encourages rotting of fruits. In general, the percentage of rotting increased with the increasing storage period. In present experiment a considerable amount of rotting (Table 2) was observed for the fruits harvested from the plant supplied with higher level of chemical fertilizers. The fruits received sole 100% inorganic fertilizers (T_1) become unacceptable on 6th days of storage due to severe rotting. Easy availability of soluble nutrients particularly nitrogen might have encouraged rapid growth of fruits in the field but reduced the dry matter accumulation that subsequently resulted in rapid loss of moisture in storage and invited microbial spoilage and rotting of fruits. Birajdar et al. (1992) stated that crops grown with higher doses of nitrogen fertilizer makes the tissues succulent and allows greater swelling of protplasmic colloids which are more vulnerable to storage rot. Chances of rotting with higher doses of nitrogen has also been reported earlier by Gopalkrishnan and Srinivas (1990) and Kumar et al.(2007) in onion. The fruits collected from the treatments T_5 to T_{14} recorded comparatively lower amount of rotting and the treatment T_{13} registered lowest rotting loss among all the treatments. High amount of vermicompsot and reduced level of chemical fertilizers in combination with biofertilizer might have made the fruits thicker, firmer and higher accumulation of dry matter and hence more résistance to shrinkage, microbial activities and rotting. The superiority of combined application of different organic amendments over sole inorganic fertilizer in reducing rotting of onion bulb has been reported by Sankar et al. (2009).

3.3. Organoleptic quality

The organoleptic evaluation or consumer acceptability score of fresh tomato fruits during storage has been presented in Table 3. The result revealed that overall acceptability rating was significantly affected by source of nutrients during cultivation and storage period of the fruits. The acceptability of tomato was higher for the fruits harvested from 75% inorganic fertilizers treatment combination (T_5 to T_{14}). Whereas it was comparatively lower for the fruits collected from the plots containing 100% inorganic fertilizers (T_1 to T_4). The acceptability of tomato fruits from the sole 100% inorganic fertilizers (T_1) drastically reduced after 2nd day of storage and it become unacceptable on 6th day of storage.

The organoleptic rating of fruits containing higher amount of organic manures (T_{10} to T_{14}) were consistently higher and remain acceptable till the end of storage period but decreased subsequently in later stages. The reduced scoring in the later stage could be attributed to over ripening, loss of texture, decrease in firmness and dull appearance of the fruits. The maximum score after 10th day of storage was recorded by the fruits harvested from the treatment containing 75% inorganic fertilizers along with higher dose of vermicompost (4 t ha^{-1}) inoculated with biofertilizer (T_{13}). An increase in organoleptic score by the organic amended plots may be due to better firmness of the fruits, delayed senescence and checking of various enzymatic and microbial activities during storage thus maintained the acceptability even after 10 days of storage. Superior organoleptic quality in presence of higher amount of organic amendments has been reported earlier by Thamburaj (1994) in tomato, Rajasekar (1995) in okra and Nirmala (1996) in cucumber.

4. CONCLUSION

The study showed that soil nutrient status particularly nutritional source have direct impact on the post harvest life of tomato fruits, The nutrient schedule comprising of higher amount of organic amendments and reduced amount of chemical fertilizers have showed promising performance for improvement the post harvest life of tomato fruits and superior organoleptic quality. The nutrient schedule comprising of 75% inorganic fertilizers along with higher dose of vermicompost (4 t ha^{-1}) in conjugation with biofertilizer emerged as potential nutrient source for improving post harvest storage life and organoleptic quality of tomato fruits.

SUMMARY OF RESEARCH

The experimental findings showed that by judicious selection of nutrient schedule comprising of higher amount of vermicompost and reduced level of inorganic fertilizers in conjugation with biofertilizer will minimize the physiological loss in weight (PLW) of fruits and improve the post harvest storage life of tomato fruits. It will also enhance the organoleptic quality and lessen the rotting percentage of fruits.

FUTURE ISSUES

The present findings of enhancing post harvest storage life of tomato fruits can be further improved by undertaking research work on storage behaviour of sole organically produced tomato. Investigations may also be carried out to judge the shelf life, organoleptic quality and rotting percentage by wrapping the fresh fruits with polythene bag and stored in normal, refrigerated (4 ^{o}C) and frozen(-18 ^{o}C) temperature.

DISCLOSURE STATEMENT

The authors declare that they have no competing interests.

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