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Influence of Lag Time Between Harvest and Pre-Cooling on Physiochemical Properties of Grapes (*Thompson seedless*) During Cold Storage

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ABSTRACT

The on farm precooling of grapes with air velocity of 1.5 m/s and temperature of 2°C was carried out. The effect of cooling time delay on 'a' value of colour during storage period the grapes was increased from the initial value of -13.40 to -11.74 in immediately precooled and -14.06 to -8.12 precooled after 12 h and -12.62 to -6.38 non precooled during 40th day of storage. Immediately precooled grapes shows the less PWL percentage of 4.57 and 23.10 in precooled after 12 h. The spoilage of grapes reaches 100% in control sample whereas immediately precooled grapes shows lowest spoilage percentage of 8.32%. The highest firmness value of 9.17 N was found immediately precooled and 6.62 N in precooled after 6 h. The highest total sugar content of 218.20 was found during 25th day of storage in control decreased to 212.67 g/l in 40th day of storage. The lowest pH value of 3.28 was non precooled control grapes. TSS of grapes after storage was increased to 10.41 in immediately precooled and 7.94 °B in precooled after 12 h.

Key words *On-farm precooling, Grapes (Thompson Seedless), Forced air precooling, Physicochemical parameters.*

India is the second largest producer of fruits and vegetables with 76.4 million tonnes and 156.3 million tonnes respectively and about 13% of the world's production of fruits and vegetables is done in India. About 30% of fruits and vegetables grown in India are wasted annually due to the non-availability of handling and storage facilities (National Horticultural database, 2014). As the maintenance of market quality is of vital importance to the success of the horticultural industry, it is necessary not only to cool the product but to cool it as quickly as possible after harvest.

Precooling is key component of a cold chain and helps in the preservation of quality for perishable fresh produce in postharvest systems. Precooling is defined as the removal of field heat from freshly harvested produce in order to slow down metabolism and reduce deterioration prior to transport or storage. One important factor which is often under emphasized while considering the cooling of horticultural products is the lag time between harvesting and the commencement of pre cooling (Nunes *et al*., 1995). It is essential to ensure proper pre cooling operations at field level for proper functioning of the cold chain. For this purpose, on farm pre cooling unit should be developed.

Grapes (*Vitis vinifera*) are an important fruit crop in India. Grapes are the third most widely cultivated fruit after citrus and banana. Globally grapes production contributes to about 16 % of the total fruit production. India produced 1878 thousand tonnes during 2008 which was about 2.77 % of the total world production (National Horticultural database, 2014). Even though the grape production in India is high its contribution to the export market was less due to lack of cold chain management and improper on farm precooling facilities.

MATERIALS AND METHOD

Experiment Procedure for On Farm Pre Cooling of Grapes

The precooling unit was installed in farmer's field (Madampatti village) in Coimbatore district, India and the experiments was carried out during the month of September and November 2014. Ibrahim Dincer, 1995 states that weight loss due to transfer of moisture was more while precooling grapes with 3 m/s air velocity and 1.5 m/s air velocity has optimum rate of cooling with less moisture loss. The matured Thompson seedless grapes bunches was harvested from the field and immediately precooled with different time lag. To evaluate the effect of cooling time delay on

Table. 1. ANOVA for main effects and associated interactions on physicochemical parameters of grapes

Variables	df	'a' value of colour		Physiological loss in weight%		Spoilage %,		Firmness,N		Total sugars, g l-1		pH value		Total soluble solids °B	
		F	*P*	F	*P*	F	*P*	*F*	*P*	F	*P*	F	*P*	F	*P*
TOT	134	1.68		199.62		215.42		17.45		5.71		6.93		4.38	
Trt	44	3.07	NS	605.90	0.00**	654.03	0.002**	51.12	0.005 **	15.34	0.001 **	19.07	0.119 NS	11.32	0.147 NS
Err	90	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
T	4	4.89	0.003 **	2371.67	0.00 **	2102.05	0.000**	153.02	0.000 **	8.60	0.000 **	15.56	0.000 **	16.28	0.000 **
S	8	7.03	0.00 **	1099.10	0.00 **	1254.92	0.000**	188.59	0.000 **	71.49	0.000 **	80.74	0.000 **	8.41	0.000 **
TS	32	1.85	0.04 *	261.88	0.00 **	316.56	0.000**	4.02	0.000 **	2.15	0.017 *	4.09	0.000 **	11.42	0.000 **
Err	90	1.00		1.00		1.00		1.00		1.00		1.00		1.00	

physiochemical quality during storage period the grapes are precooled with different time lag from harvest such as (T1) precooled immediately after harvest, (T2) harvested grapes are kept in field under atmospheric condition and then precooled with time lag of 6 h, (T3) precooled after time lag of 12 h from harvest, (T4) directly stored in cold storage without precooling treatment after lag of 24 h from harvest, (T5) stored in ambient condition.

After different precooling treatments the grapes are placed in crates and stored inside the cold storage maintained at 4°C and 85% RH and the control sample was placed in ambient condition continuously throughout the storage period. The samples were taken once in five days for various physicochemical characteristics of grapes such as 'a' value of colour, Physiological loss in weight (PLW), Spoilage %, Firmness, Total sugars (g l-1), pH value, Total soluble solids (TSS).

Physicochemical parameters of grapes

Physiological loss in weight (PLW)

The initial and final weights of the leaves were recorded and the percentage loss in weight was calculated as given below (Mathad, 2003).

$$\text{Physiological loss in weight (\%)} = \frac{\text{Initial weight - Final weight}}{\text{Initial weight}} \times 100 \quad \text{——— (1)}$$

Spoilage %

Percentage of loss due to spoilage % of grapes during storage was calculated using the following formula:

$$\text{Weight loss due to spoilage (\%)} = \frac{\text{Weight of spoiled grape}}{\text{Initial weight}} \text{ X } 100 \quad \text{————(2)}$$

Colour – 'a' value

Colour flex meter (Make: Hunter Lab, Model: 45°/0°) was used for the measurement of colour. It works on the principle of collecting the light and measures energy from the sample reflected across the entire visible spectrum. The 'a' coordinate measures red when positive and green when negative.

Firmness, N

The texture of different precooled grape was determined using the texture analyzer (M/s. Stable micro system, USA Model – Texture Expert Version 1.22). The force required for penetration of the sample at a set depth of 5 mm was found out using the Penetration rig (4mm cylinder probe) type of probe and measure force in compression.

Total sugar content

Total sugar content was estimated by Phenol Sulphuric Acid Method described by Sadasivam and Manicham (1992).The amount of total sugars present in the sample expressed in mg/100g of the fresh weight was estimated using the standard

graph and calculated using following formula:

$$\text{Total sugar (mg/100g of sample)} = \frac{\text{Concentration from standard graph of glucose}}{\text{Aliquot taken for estimation}} \times 100 \times \frac{100}{\text{(weight of sample)}} \times \frac{1}{1000} \quad \text{——(3)}$$

pH value

The pH value was determined by using a digital pH meter (Systronics µpH system 361, Ahmedabad, India). Ten to fifteen grape fruits were selected randomly and pulped using mixer grinder for measuring pH.

Total soluble solids (TSS)

Small samples of the fruit pulp were filtered through muslin cloth and the drop of filtrate was taken to determine the total soluble solids (TSS) using a digital hand held pocket refractrometer (ATAGO, Co Ltd, Japan) and TSS was expressed as °Brix (Ranganna, 1986).

Statistical Analysis

Statistical analysis was carried out to study the effect of different parameters on all the dependent variables. Based on the effect of lag time before precooling on the respiration rate and physiochemical quality have been estimated with the help of statistical analysis using AGRES.

RESULTS AND DISCUSSION

Changes in 'a' value of grapes during storage

The 'a' value of grapes shows increasing trend in all the pre-cooling treatments during storage. The 'a' value was increased from the initial value of -13.40 to -11.74 in T1 treatment, -14.55 to -11.63 in T2 treatment, -13.09 to -10.35 in T3 treatment, -14.06 to -8.12 in T4 treatment and -12.62 to -6.38 in T5 during 40th day of storage. The effect of different precooling treatments (T) and the storage days (S) were found to be significant at 1% and the interactions were found to be significant at 5% level. The lowest 'a' value of -14.55 was found during 1st day of storage in T2 treatment. Therefore the change in colour was less in immediately pre-cooled samples than all other pre-cooling treatments.

Physiological loss in weight (PLW) of grapes during storage

Physiological weight loss percentage was estimated once in 5 days throughout the storage period in which the control sample (T5) shows the highest physiological weight loss percentage of 58.17 during 40th day of storage. T1 treatment shows the less PWL percentage of 4.57 followed by 6.10 in T2, 11.13 in T3 and 23.10 in T4 respectively during 40th day of storage. The effect

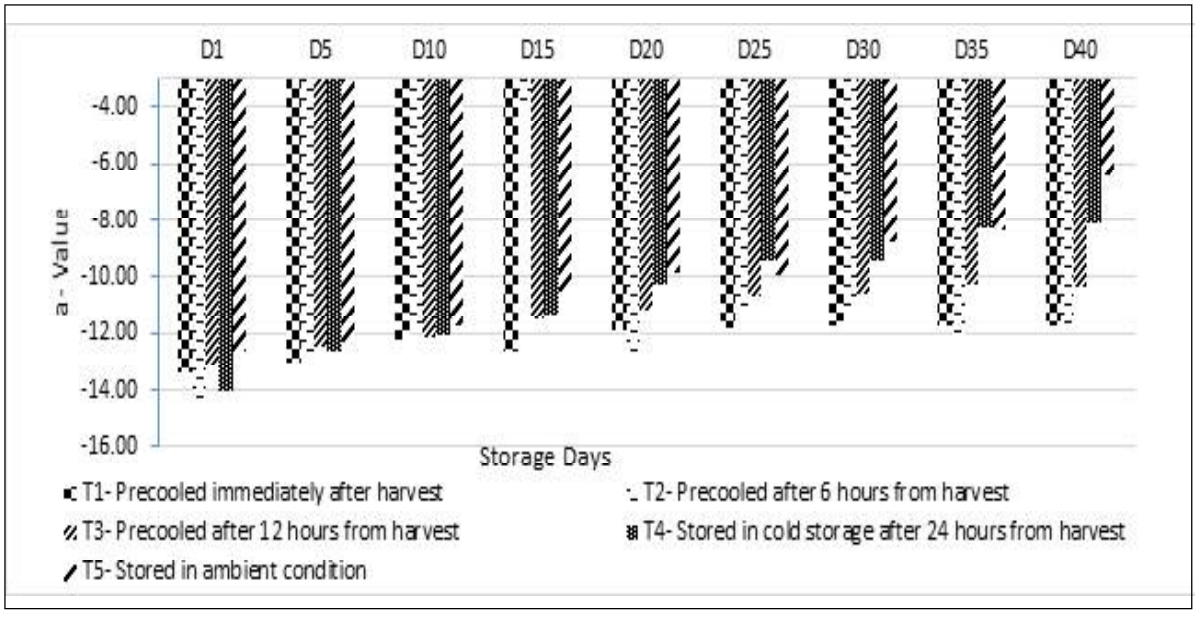

Fig. 1. Changes in colour – 'a' value of grapes during storage period

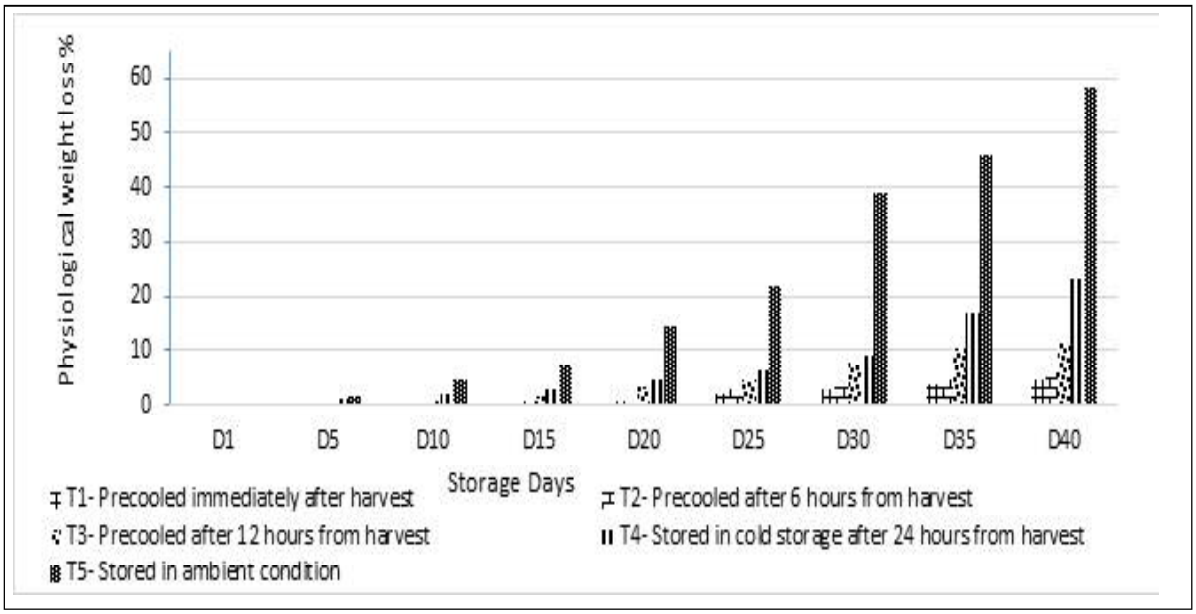

Fig. 2. Physiological loss in weight percentage of grapes during storage period

of different precooling treatments (T) and the storage days (S) and the interactions were also found to be significant at 1% level. Arin and Akdemir, (2004) also found similar results during storage of precooled grapes.

Spoilage percentage of grapes during storage

Spoilage percentage increased in all the treatments throughout the storage period. The spoilage of grapes after 40th day of storage reaches 100 % in control sample whereas the treatment T1 shows lowest spoilage percentage of 8.32% followed by 9.75% in T2, 15.38% in T3 and 44.27% in T4 respectively. The effect of different precooling treatments (T) and the storage days (S) and the interactions were also found to be significant at 1% level. During 20th day of storage there was no spoilage found in T1, T2 and T3 whereas it was 12.67% in T4 and 15.30% in T5.

Changes in firmness (N) value of grapes during storage

The firmness of grapes was decreasing in all the treatments during the storage period. The initial firmness was found to be 14.435, 13.97, 14.76, 14.18 and 13.87 N in T1, T2, T3, T4 and T5

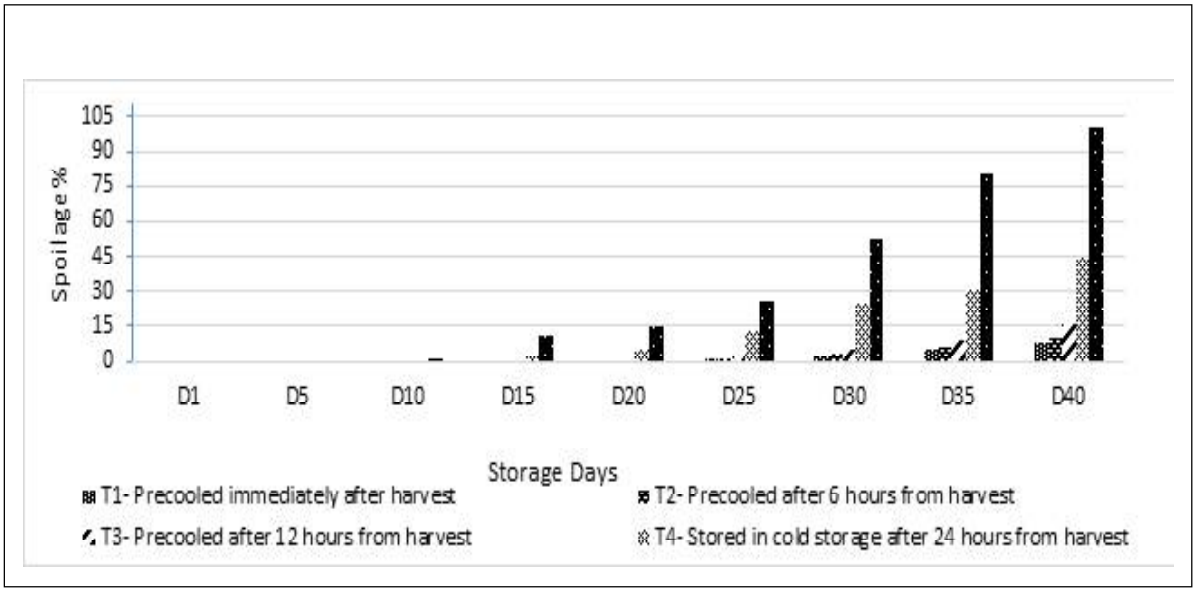

Fig. 3. Spoilage percentage of grapes during storage period

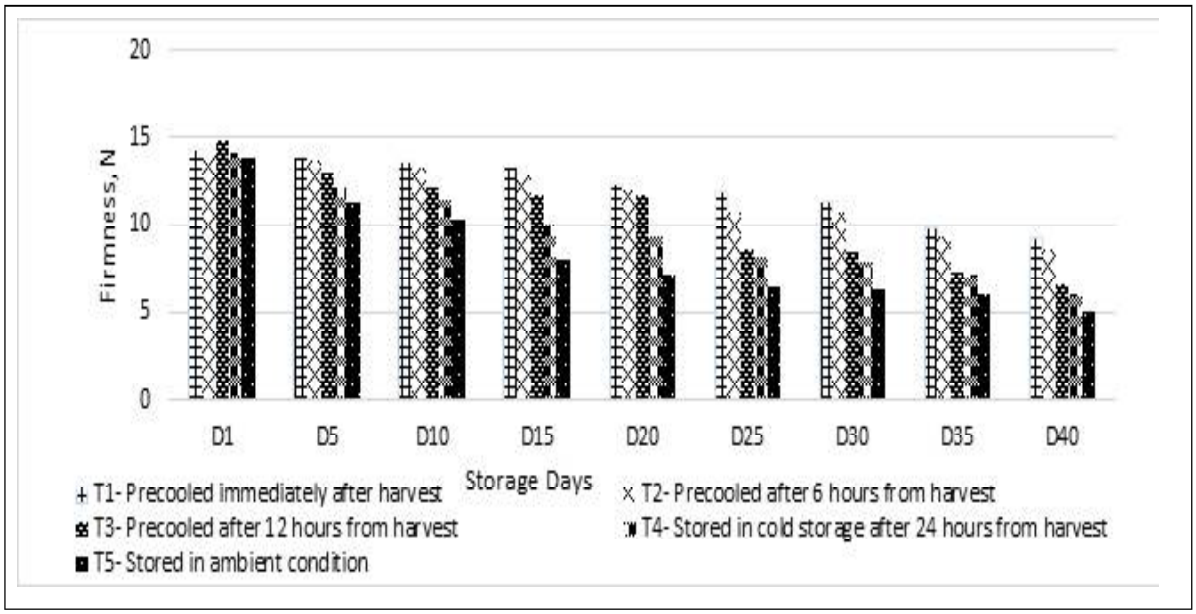

Fig. 4. Changes in Firmness of grapes during storage period

respectively. The lowest firmness value of 5.04 N was found during 40th day of storage under ambient condition (T5). The highest firmness value of 9.17 N was found in T1 treatment followed by 8.57 N in T2 6.62 N in T3 and 6.09 N in T4 respectively. The decrease in firmness value was very less in T1 when compared to all other treatments during 40th day of storage. The effect of different precooling treatments (T) and the interactions were also found to be significant at 1% level.

Changes in total sugars (g l -1) of grapes during storage

During storage period the total sugar content was increasing in all the treatments. Initially the total sugar content in different pre-cooled samples were 195.54, 190.83, 190.80, 191.53 and 193.53 g/l in T1, T2, T3, T4 and T5 respectively. The final total sugar content after 40th days of storage was 214.57, 220.30, 218.20, 214.93 and 212.67 g/l in T1, T2, T3, T4 and T5 respectively. The

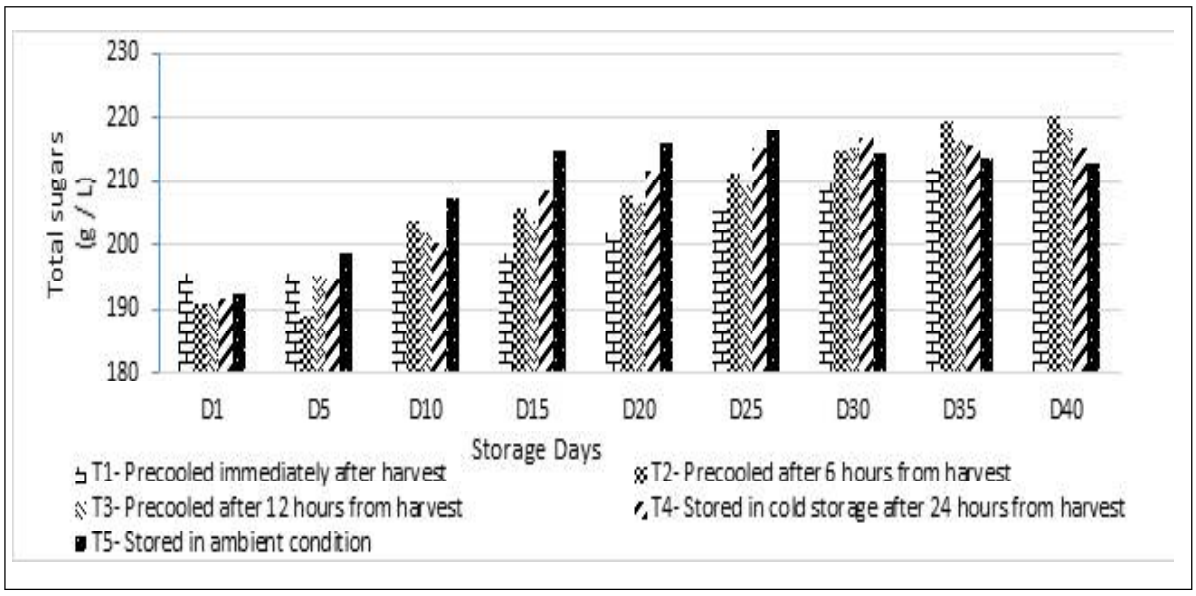

Fig. 5. Changes in total sugars content of grapes during storage period

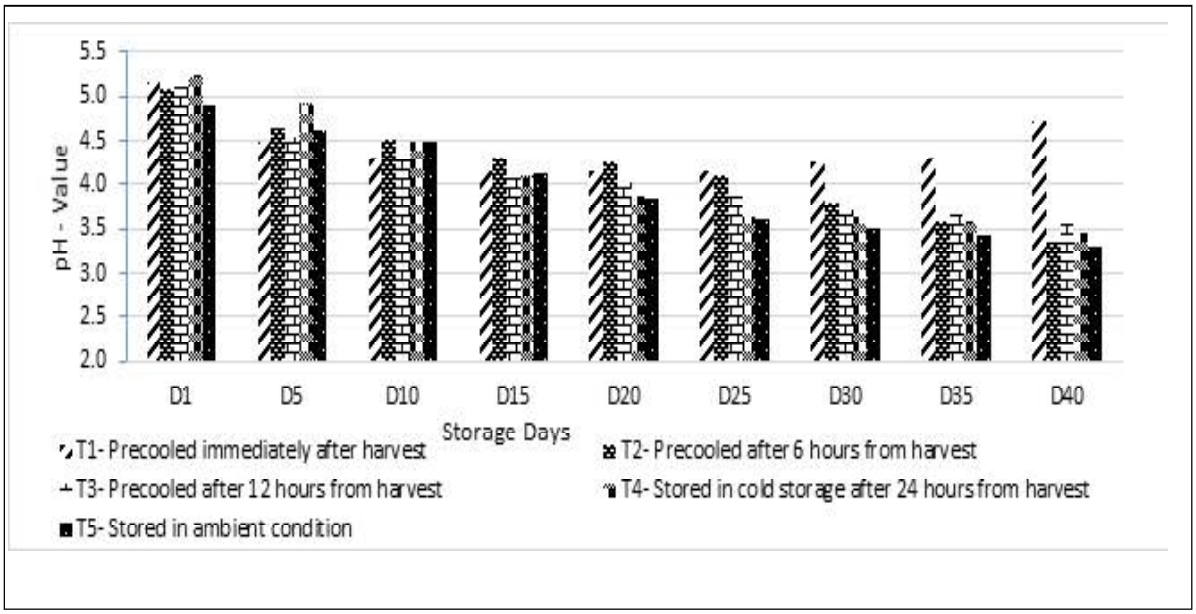

Fig. 6. Changes in pH value of grapes during storage period

effect of different precooling treatments (T) and the storage days (S) were found to be highly significant at 1% level and the interactions were found to be significant at 5% level.

Changes in pH value of grapes during storage

The initial pH value of grapes was found to be 5.17, 5.08, 5.12, 5.23 and 4.91 in T1, T2, T3, T4 and T5 respectively. The lowest pH value of 3.28 was found during 40th day of storage under the ambient condition (T5) and the highest pH value was found in T1. The decrease in pH value was low in T1 with 4.71 followed by 3.36 in T2, 3.57 in T3 and 3.44 in T4 respectively. The effect of different precooling treatments (T) and the storage days (S) and the interactions were also found to be significant at 1% level.

Changes in total soluble solids (TSS) of grapes during storage

In T4 treatment the TSS was in increasing trend up to 30th day and then it shows a slight decrease in TSS due to increase in spoilage percentage. Initial TSS content of grapes in T1, T2, T3, T4 and T5 was 9.60, 9.60, 9.88, 9.73 and 10.11 °B respectively. The final TSS of grapes after 40th days of storage was increased to 10.41, 10.29,

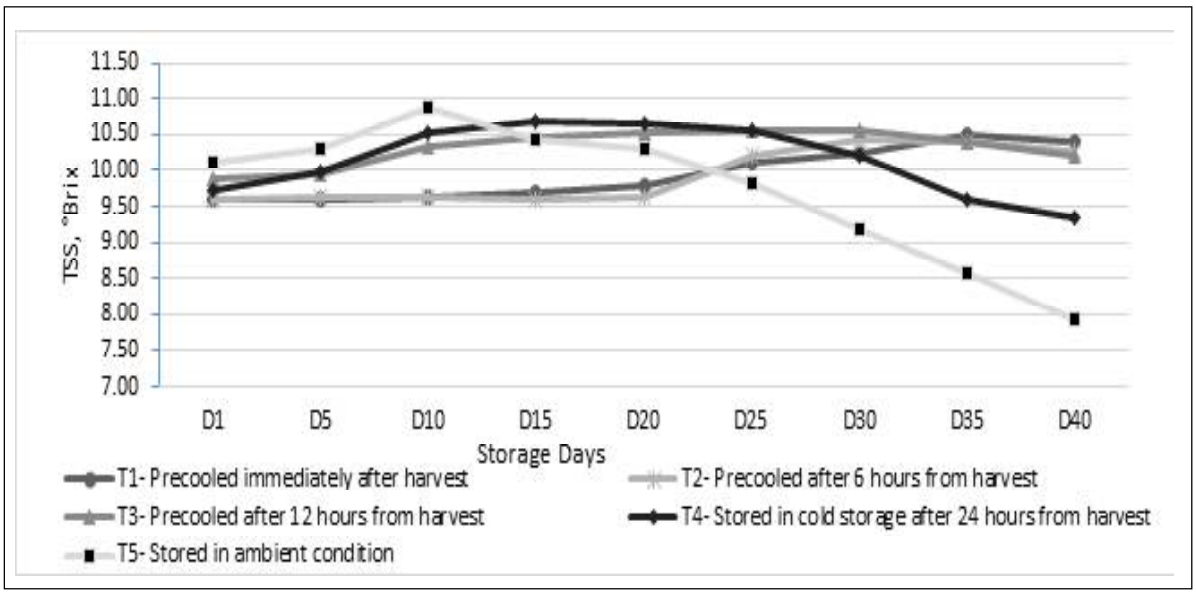

Fig. 7. Changes in total soluble solids of grapes during storage period
NS- Non Significant, **- Significant at 1% level, *- Significant at 5% level.

10.21, 9.35 and 7.94 °B in T1, T2, T3, T4 and T5 respectively. The effect of different precooling treatments (T) and the storage days (S) and the interactions were also found to be significant at 1% level.

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