Effect of foliar spray of NPK, Borax, $ZnSO_4$& $MgSO_4$ on storage of Strawberry (*Fragaria annanassa* Duch.) cv. Winter Dawn

Abstract

This study identified the synergistic effect of NPK, Borax, $ZnSO_4$ and $MgSO_4$ with different concentrations on the postharvest quality and shelf life of strawberry stored at ambient conditions. This study was conducted in completely randomized Block design. Strawberry fruits were treated with different concentration of NPK, Borax, $ZnSO_4$ and $MgSO_4$ and stored at ambient temperature for 4 days. Changes in fruit's physiological loss of weight, firmness, total soluble solid, titrable acidity, and ascorbic acid were periodically recorded. The results indicated that the treatment T8 (NPK @0.5% + Borex @0.25% + $Znso_4$ @0.25%+ $Mgso_4$ @0.25%) significantly reduced the decrease of physiological loss of weight, total soluble solids, titrable acidity, ascorbic acid, reducing sugar, non- reducing sugar and total sugar content. The results showed that treatment T8 (NPK @0.5% + Borex @0.25% + $Znso_4$ @0.25%+ $Mgso_4$ @0.25%) is the most effective treatment for improving the postharvest quality and prolong the shelf life of strawberry when stored at ambient condition.

Key words: Strawberry, NPK, $Znso_4$, Mgso4, Ambient condition

INTRODUCTION

The strawberry (*Fragaria ananassa*), is a member of the Rosaceae family within the *Fragaria* genus (Hancock, 1999). Its basic chromosomal number is (x=7), making it an octoploid (8x) in nature. The domestic strawberry (*Fragaria x ananassa* Duch.) was first produced in France during the 17th century from the hybridization of two American species, *F. chillioensis* Duch. and *F. verginiana* Duch.(Yadav *et al.,* (2020). According to botany, it is an aggregation fruit that naturally perishes quickly. It is essentially a short-day, herbaceous perennial plant. The strawberry offers the fastest return in the least amount of time when compared to all other berries (Boriss *et al.,* 2006). It is an important fruit crop whose cultivation has ample scope near the big cities and fruit preservation factories. Considerable variation exists in various cultivars which can be exploited for the benefit of fruit growers in subtropical/temperate areas. Among the most significant soft fruits, strawberries (*Fragaria* × *ananassa* Duch.) are grown for commercial purposes in the following states: Maharashtra, Haryana, Punjab, Uttar Pradesh, Himachal Pradesh, Uttarakhand, Jammu and Kashmir, Meghalaya, and West Bengal (Singh *et al.,* 2006). The genus *Fragaria* includes 17 diploid species triploid, hexaploid and octoploid in nature. Asia's second-largest economy is that of India in terms of its GDP or gross domestic product. The GDP of the agriculture sector is significantly influenced by the horticulture sector. India's agricultural exports, both domestically and internationally, are heavily reliant on horticultural commodities and products. India's most important fruit is the strawberry, a food product of horticulture. Because it has shallow roots, it needs fertilizers more frequently to support healthy plant development and fruit production (Kachwaya and Chandel, 2015). Goswami *et al.,* (2012) reported that application of ZnSo4 at the rate of 0.04% significantly reduced the physiological loss in weight and increase the shelf life of guava. Kharwade *et al.,* (2018) observed that the application of NPK (19:19:19) with ZnSo4 @0.5% and Boric acid @0.3% significantly increase the shelf life and reduce the physiological loss in weight of guava under storage condition. Kumar *et al.,* (2011) observed that the Borax @0.25% with GA3 significantly increased the shelf life, minimum physiological losses, Total soluble solids, Titrable acidity, total sugar and ascorbic acid during storage in guava. Hence the present experiment entitled on "Effect of foliar spray of NPK, Borax, and ZnSO4 & $MgSO_4$ on storage of Strawberry (*Fragaria ananas* Duch.) cv. Winter Dawn".

Materials and methods

The present experiment entitled that "Effect of foliar spray of NPK, Borax, and ZnSO4& $MgSO_4$ on storage of Strawberry (*Fragaria ananas* Duch.) cv. Winter Dawn was carried out during the period 2022-23 to 2023-24 at Main Experimental Station of Fruit Science orchard and 27-27 fruits of each treatment (9 treatment) and each replication (three replications) was bring from the orchard for analysis of each parameters was done in the PG laboratory of fruit Science, College of Horticulture and Forestry, A.N.D.U.A. & T., Kumarganj, Ayodhya 224229 (UP) at ambient temperature (28-32ºC temperature and 70-75% Relative humidity). NPK, Borax, $ZnSO_4$& $MgSO_4$ were applied as foliar spray during the evening time by Randomized Block Design.

To determine the weight loss of the fruit during post-harvest storage, both treated and control fruit were weighted at different sampling intervals of 1, 2, 3 and 4 days after harvesting of the fruit. Then weight loss was calculated as the difference between initial fruit weight and the fruit weight at the time of measurement and expressed in percentage.

$$PLW\ (\%) = \frac{\text{Initial fruit weight} - \text{weight of fruit on observation day}}{\text{initial fruit weight}} X\ 100$$

The total soluble solids (TSS) of dragon fruit were directly measured with the help of Hand Refractometer (range 0-32°Brix at 20°C). A drop of juice was used to measure the TSS and values were expressed in Brix for each treatment.

For Titrable acidity measurement Standard N/10 NaOH solution and phenophthalein as an indicator were used to determine the titrable acidity of strawberry fruit juice until faint pink colour appeared (AOAC, 1990).

Ascorbic acid content of the fruits was measured by volumetric method using 2, 6-dichlorophenol indophenols dye according to the procedure suggested by Rangana (1977) and expressed in mg/100g pulp.

$$\boldsymbol{Vitamin\ -C}\ (\boldsymbol{mg/100g}) = \frac{\boldsymbol{Titre\ value} \times \boldsymbol{Dye\ factor} \times \boldsymbol{Volume\ made\ up}}{\boldsymbol{Weight\ of\ aliquaot\ taken} \times \boldsymbol{weight\ of\ the\ sample\ taken}}$$

The reducing sugars were estimated by Shaffer Somogyi method as described by Rangana (1977) and expressed in per cent. To determine the reducing sugar, 10g of fruit was macerated with small amount of distilled water, filtered in 100 ml of volumetric flask and volume was maintained with distilled water. 5 ml sample was taken with 5 ml each of Fehling Solution 'A' and 5 ml Fehling Solution 'B' in 100 ml conical flask and titrated the solution against 1 % glucose while boiling and checked by methylene blue indicator. The end point was marked by the appearance of brick red color.

$$\boldsymbol{Reducing\ sugar}\ \% = \frac{(\boldsymbol{Blank\ titre\ value} - \boldsymbol{sample\ titre\ value}) \times \boldsymbol{volume\ made\ up}}{\boldsymbol{weight\ of\ aliquot\ taken} \times \boldsymbol{weight\ of\ sample\ taken}} \times \boldsymbol{100}$$

The content of non- reducing sugar in dragon fruit samples was calculated using the following formula (Ranganna, 1986).

***Non-reducing sugars (%)* =** *Total invert sugar sugars (%)-Reducing sugar (%) x 0.95*

Total sugars (%):

The sum of reducing and non-reducing sugars was expressed as total sugars.

***Total sugars (%)* =** *Reducing sugar (%) + non-reducing sugars (%)*

Statistical analysis

The data noted from each replication of each treatment from the experiment were analyzed by SAS 9.1 statistical software.

Result and Discussion

Physiological loss in weight (%)

A perusal data of Table no. 1 revealed that physiological loss in weight increased with the advancement of day of the storage during both the years (2022-23 and 2023-24). Minimum physiological loss of weight (0.62%) was observed in treatment T8 (NPK @0.5% + Borex @0.25% + $Znso_4$ @0.25%+ $Mgso_4$ @0.25%) which was statistically at par with T7 (NPK 0.5% + Borex 0.25%+$Znso_4$ 0.25%) 0.65%, on the 1st day of storage. However, maximum physiological loss of weight (8.80%) was observed in treatment T9 (control) followed by the T1 (NPK @0.5%) 8.66% on 4th day of storage during the year 2022-23. Similarly, during 2023-24 minimum physiological loss of weight (0.63%) was observed in treatment T8 (NPK @0.5% + Borex @0.25% + $Znso_4$ @0.25%+ $Mgso_4$ @0.25%) which was significantly at par with T7 (NPK 0.5% + Borex 0.25%+$Znso_4$ 0.25%) 0.64%, on the 1st day of storage. However, maximum physiological loss of weight (3.87%) was observed in treatment T9 (control) which was significantly at par with T1 (NPK @0.5%) 8.68% on 4th day of storage during the year 2023-24. Tripathi *et. al.,* (2019) reported that NPK significantly reduced the physiological loss of weight. Goswami et al., (2012) observed that application of ZnSo4 significantly reduced the physiological loss in weight.

Table No. 1: Effect of foliar spray of NPK, Borax, $ZnSO_4$ and $MgSO_4$ on physiological loos of weight of Strawberry (*Fragaria ananas* Duch.) cv. Winter Dawn during storage.

Treatment	2022-23					2023-24				
	1st Day	2nd Day	3rd Day	4th Day	Mean	1st Day	2nd Day	3rd Day	4th Day	Mean
T1- NPK @0.5%	0.72ab	1.77a	3.93a	8.66a	**3.77**	0.74ab	1.79a	3.95ab	8.68ab	**3.79**
T-2 NPK @1.0%	0.71b	1.69b	3.72b	8.27b	**3.59**	0.72bc	1.71b	3.74bc	8.29bc	**3.61**
T-3 NPK @1.5%	0.65cd	1.54c	3.41cd	7.50e	**3.27**	0.64e	1.52c	3.40ef	7.50e	**3.26**
T-4 NPK @1.0% +Borex @0.25%	0.66c	1.57c	3.45cd	7.67de	**3.33**	0.69d	1.59c	3.48def	7.69de	**3.36**
T-5 NPK @1.0% +Znso$_4$ @0.25%	0.67c	1.65b	3.56cb	7.92cd	**3.45**	0.69cd	1.67b	3.59cde	7.94cd	**3.47**
T-6 NPK @1.0% + Mgso$_4$ @0.25%	0.72ab	1.68b	3.64b	8.05bc	**3.52**	0.72bc	1.69b	3.66cd	8.07cd	**3.53**
T-7 NPK @0.5% + Borex @0.25%+Znso$_4$ @0.25%	0.65cd	1.53c	3.37d	7.49e	**3.26**	0.64e	1.52c	3.35f	7.48e	**3.24**
T-8 NPK @0.5% + Borex @0.25% + Znso$_4$ @0.25%+ Mgso$_4$ @0.25%	0.62d	1.51c	3.33d	7.47e	**3.23**	0.63e	1.52c	3.34f	7.48e	**3.24**
T-9 (Control)	0.75a	1.80a	4.03a	8.80a	**3.84**	0.77a	1.81a	4.07a	8.83a	**3.87**
Mean	**0.68**	**1.63**	**3.60**	**7.98**		**0.69**	**1.64**	**3.62**	**7.99**	
LSD (0.05%)	**0.034**	**0.07**	**0.18**	**0.33**		**0.03**	**0.08**	**0.21**	**0.42**	

Table No. 2: Effect of foliar spray of NPK, Borax, $ZnSO_4$ and $MgSO_4$ on total soluble solids of Strawberry (*Fragaria ananas* Duch.) cv. Winter Dawn during storage.

Treatment	**2022-23**					**2023-24**				
	1^{st} Day	**2^{nd} Day**	**3^{rd} Day**	**4^{th} Day**	**Mean**	**1^{st} Day**	**2^{nd} Day**	**3^{rd} Day**	**4^{th} Day**	**Mean**
T1- NPK @0.5%	7.90bc	8.27de	8.50cd	5.53de	**7.55**	7.92cd	8.34cd	8.54cd	5.56c	**7.59**
T-2 NPK @1.0%	8.38ab	8.73cd	8.93bc	5.97cde	**8.00**	8.39bc	8.80bc	9.02bc	6.07bc	**8.07**
T-3 NPK @1.5%	8.80a	9.13bc	9.33ab	6.36abc	**8.40**	8.76ab	9.13b	9.28b	6.40b	**8.39**
T-4 NPK @1.0% +Borex @0.25%	8.68a	8.99bc	9.19abc	6.22bc	**8.22**	8.72b	9.00b	9.27b	6.31b	**8.32**
T-5 NPK @1.0% +$Znso_4$ @0.25%	8.52ab	8.83bc	9.02bc	6.08bcd	**8.11**	8.60bc	8.90b	9.10bc	6.16b	**8.19**
T-6 NPK @1.0% + $Mgso_4$ @0.25%	8.73a	9.05bc	9.22abc	6.32bc	**8.33**	8.80ab	9.10b	9.20bc	6.29b	**8.34**
T-7 NPK @0.5% + Borex @0.25%+$Znso_4$ @0.25%	8.96a	9.27ab	9.46ab	663ab	**8.58**	8.90ab	9.24ab	9.40ab	6.60ab	**8.53**
T-8 NPK @0.5% + Borex @0.25% + $Znso_4$ @0.25%+ $Mgso_4$ @0.25%	9.46a	9.62a	9.96a	7.00a	**9.01**	9.47a	9.65a	10.00a	7.04a	**9.04**
T-9 (Control)	7.58c	7.93e	8.11d	5.41e	**7.25**	7.60d	8.00d	8.18d	5.49c	**7.31**
Mean	**8.55**	**8.86**	**9.08**	**6.17**		**8.57**	**8.90**	**9.11**	**6.21**	

LSD (0.05%)	**0.75**	**0.48**	**0.79**	**0.65**		**0.73**	**0.45**	**0.71**	**058**	

Table No. 3: Effect of foliar spray of NPK, Borax, $ZnSO_4$ and $MgSO_4$ on titrable acidity of Strawberry (*Fragaria ananas* Duch.) cv. Winter Dawn during storage.

Treatment	**2022-23**					**2023-24**				
	1st Day	**2nd Day**	**3rd Day**	**4th Day**	**Mean**	**1st Day**	**2nd Day**	**3rd Day**	**4th Day**	**Mean**
T1- NPK @0.5%	0.76b	0.79ab	0.80ab	0.83ab	**0.79**	0.78ab	0.80ab	0.81a	0.84ab	**0.80**
T-2 NPK @1.0%	0.73bc	0.78b	0.76bc	0.83b	**0.77**	0.73c	0.77bc	0.75bc	0.82bc	**0.76**
T-3 NPK @1.5%	0.72bc	0.76bc	0.74cd	0.79c	**0.75**	0.73c	0.75cd	0.73cd	0.80cd	**0.75**
T-4 NPK @1.0% +Borex @0.25%	0.74bc	0.78b	0.76bc	0.81bc	**0.77**	0.73c	0.79ab	0.75bc	0.82abc	**0.77**
T-5 NPK @1.0% +$Znso_4$ @0.25%	0.75b	0.79ab	0.77abc	0.82bc	**0.78**	0.74c	0.78bc	0.77b	0.80bc	**0.77**
T-6 NPK @1.0% + $Mgso_4$ @0.25%	0.75bc	0.79ab	0.76bc	0.83b	**0.78**	0.75bc	0.79ab	0.75bc	0.82bc	**0.77**
T-7 NPK @0.5% + Borex @0.25%+$Znso_4$ @0.25%	0.68d	0.72cd	0.71de	0.78cd	**0.72**	0.69d	0.73d	0.72de	0.79de	**0.73**
T-8 NPK @0.5% + Borex @0.25% + $Znso_4$ @0.25%+ $Mgso_4$ @0.25%	0.64e	0.70d	0.69e	0.75d	**0.69**	0.63d	0.69e	0.68e	0.74e	**0.68**
T-9 (Control)	0.80a	0.83a	0.81a	0.87a	**0.82**	0.80a	0.82a	0.81a	0.86a	**0.82**

Mean	**0.73**	**0.77**	**0.75**	**0.81**		**0.73**	**0.77**	**0.75**	**0.81**	
LSD (0.05%)	**0.03**	**0.04**	**0.04**	**0.03**		**0.03**	**0.03**	**0.02**	**0.03**	

Table No. 4: Effect of foliar spray of NPK, Borax, $ZnSO_4$ and $MgSO_4$ on ascorbic acid of Strawberry (*Fragaria ananas* Duch.) cv. Winter Dawn during storage.

Treatment	**2022-23**					**2023-24**				
	1st Day	**2nd Day**	**3rd Day**	**4th Day**	**Mean**	**1st Day**	**2nd Day**	**3rd Day**	**4th Day**	**Mean**
T1- NPK @0.5%	53.14de	51.68c	50.12c	48.11de	50.76	53.17d	51.69c	50.12cd	48.12de	**50.77**
T-2 NPK @1.0%	53.64de	52.18c	50.61c	48.58de	**51.25**	53.65d	52.18c	50.64cd	48.58de	**51.26**
T-3 NPK @1.5%	56.20abc	54.71ab	53.09ab	50.37abc	**53.59**	56.18abc	54.71ab	53.04ab	50.36abc	**53.57**
T-4 NPK @1.0% +Borex @0.25%	54.34cde	52.94bc	51.38bc	48.97cd	**51.90**	54.37cd	52.94bc	51.38bcd	48.98cd	**51.91**
T-5 NPK @1.0% +$Znso_4$ @0.25%	54.78bcd	53.38abc	51.82abc	49.40abcd	**52.34**	54.81abcd	53.39abc	51.82abc	49.45abcd	**52.36**
T-6 NPK @1.0% + $Mgso_4$ @0.25%	54.53cde	53.07bc	51.50bc	49.07bcd	**52.04**	54.55cd	53.10bc	51.54bcd	49.14bcd	**52.08**
T-7 NPK @0.5% + Borex @0.25%+$Znso_4$ @0.25%	56.51ab	55.02ab	53.44ab	50.60ab	**53.89**	56.48ab	55.00ab	53.30ab	50.56ab	**53.83**

T-8 NPK @0.5% + Borex @0.25% + $Znso_4$ @0.25%+ $Mgso_4$ @0.25%	56.84a	55.35a	53.75a	50.78a	**54.18**	56.85a	55.38a	53.76a	50.79a	**54.19**
T-9 (Control)	52.84e	51.37c	49.77c	47.27e	**50.31**	52.85d	51.39c	49.48d	47.29e	**50.25**
Mean	**54.75**	**53.30**	**51.72**	**49.24**		**54.77**	**53.31**	**51.67**	**49.25**	
LSD (0.05%)	**1.88**	**2.16**	**2.19**	**1.62**		**2.06**	**2.06**	**2.11**	**1.51**	

Table No. 5: Effect of foliar spray of NPK, Borax, $ZnSO_4$ and $MgSO_4$ on reducing sugar of Strawberry (*Fragaria ananas* Duch.) cv. Winter Dawn during storage.

Treatment	**2022-23**					**2023-24**				
	1st Day	**2nd Day**	**3rd Day**	**4th Day**	**Mean**	**1st Day**	**2nd Day**	**3rd Day**	**4th Day**	**Mean**
T1- NPK @0.5%	3.78ef	4.02de	3.91ef	3.54d	**3.81**	3.84ef	4.06de	3.94ef	3.58ef	**3.85**
T-2 NPK @1.0%	3.90de	4.12cd	4.01de	3.64cd	**3.91**	3.94de	4.12cde	4.03de	3.66de	**3.93**
T-3 NPK @1.5%	4.20abc	4.41ab	4.31abc	3.93ab	**4.21**	4.20abc	4.40ab	4.29abc	3.90bc	**4.19**
T-4 NPK @1.0% +Borex @0.25%	4.14bc	4.36abc	4.25bc	3.85b	**4.15**	4.17bc	4.36abc	4.25abc	3.86bcd	**4.16**
T-5 NPK @1.0% +$Znso_4$ @0.25%	4.06cd	4.28bc	4.17cd	3.79bc	**4.07**	4.11bcd	4.27bcd	4.18cd	3.81cde	**4.09**
T-6 NPK @1.0% + $Mgso_4$ @0.25%	4.03cd	4.23bcd	4.14cd	3.75bc	**4.03**	4.04cde	4.25bcd	4.15cde	3.76cde	**4.05**

T-7 NPK @0.5% + Borex @0.25%+ $Znso_4$ @0.25%	4.33ab	4.56a	4.41ab	4.04a	**4.33**	4.32ab	4.57a	4.43ab	4.05ab	**4.34**
T-8 NPK @0.5% + Borex @0.25% + $Znso_4$ @0.25%+ $Mgso_4$ @0.25%	4.38a	4.59a	4.48a	4.09a	**4.38**	4.40a	4.61a	4.51a	4.16a	**4.42**
T-9 (Control)	3.63f	3.84e	3.72f	3.35e	**3.63**	3.66f	3.87e	3.76f	3.36f	**3.66**
Mean	**4.05**	**4.26**	**4.15**	**3.77**		**4.07**	**4.27**	**4.17**	**3.79**	
LSD (0.05%)	**0.21**	**0.24**	**0.19**	**0.18**		**0.22**	**0.26**	**0.23**	**0.23**	

Table No. 6: Effect of foliar spray of NPK, Borax, $ZnSO_4$ and $MgSO_4$ on non-reducing sugar of Strawberry (*Fragaria ananas* Duch.) cv. Winter Dawn during storage.

Treatment	**2022-23**					**2023-24**				
	1st Day	**2nd Day**	**3rd Day**	**4th Day**	**Mean**	**1st Day**	**2nd Day**	**3rd Day**	**4th Day**	**Mean**
T1- NPK @0.5%	2.53de	2.68de	2.61ef	2.37f	**2.54**	2.56ef	2.72e	2.63de	2.40e	**2.57**
T-2 NPK @1.0%	2.60cd	2.76cd	2.64de	2.43ef	**2.60**	2.63de	2.75de	2.70cd	2.44de	**2.63**
T-3 NPK @1.5%	2.81ab	2.95ab	2.88abc	2.62bc	**2.81**	2.80abc	3.00ab	2.90ab	2.67ab	**2.84**
T-4 NPK @1.0% +Borex @0.25%	2.76abc	2.91abc	2.84bc	2.57cd	**2.77**	2.79bc	2.91bc	2.84b	2.62abc	**2.79**
T-5 NPK @1.0% + $Znso_4$ @0.25%	2.72bc	2.85bcd	2.78cd	2.53cde	**2.72**	2.74bcd	2.85cd	2.80bc	2.54bcd	**2.73**

T-6 NPK @1.0% + Mgso$_4$ @0.25%	2.69bcd	2.84bcd	2.76cd	2.51de	**2.70**	2..71cd	2.84cd	2.78bc	2.53cde	**2.71**
T-7 NPK @0.5% + Borex @0.25%+Znso$_4$ @0.25%	2.89a	3.04a	2.94ab	2.70ab	**2.89**	2.88ab	3.05a	2.98a	2.70a	**2.90**
T-8 NPK @0.5% + Borex @0.25% + Znso$_4$ @0.25%+ Mgso$_4$ @0.25%	2.92a	3.06a	3.00a	2.73a	**2.92**	2.93a	3.08a	3.01a	2.72a	**2.93**
T-9 (Control)	2.43e	2.57e	2.50f	2.24g	**2.43**	2.44f	2.58f	2.51e	2.25f	**2.44**
Mean	**2.70**	**2.85**	**2.77**	**2.52**		**2.72**	**2.86**	**2.79**	**2.54**	
LSD (0.05%)	**0.16**	**0.16**	**0.13**	**0.11**		**0.14**	**0.11**	**0.12**		

Table No. 7: Effect of foliar spray of NPK, Borax, $ZnSO_4$ and $MgSO_4$ on total sugar of Strawberry (*Fragaria ananas* Duch.) cv. Winter Dawn during storage.

Treatment	**2022-23**					**2023-24**				
	1st Day	**2nd Day**	**3rd Day**	**4th Day**	**Mean**	**1st Day**	**2nd Day**	**3rd Day**	**4th Day**	**Mean**
T1- NPK @0.5%	6.21cd	6.61cd	6.80cd	4.49cd	**6.02**	6.22cd	6.71cd	6.85cd	4.53cd	**5.94**
T-2 NPK @1.0%	6.71bcd	7.09bc	7.28bc	4.95bcd	**6.50**	6.73bc	7.18bc	7.38bc	5.05bcd	**6.58**
T-3 NPK @1.5%	7.15ab	7.52ab	7.70ab	5.37ab	**6.93**	7.11ab	7.48abc	7.67ab	5.40ab	**6.91**
T-4 NPK @1.0% +Borex @0.25%	7.01abc	7.36abc	7.54bc	5.20bc	**6.77**	7.04b	7.37abc	7.63abc	5.28ab	**6.83**

T-5 NPK @1.0% + $Znso_4$ @0.25%	6.84bc	7.02bcd	7.36bc	5.06bcd	**6.57**	6.99bc	7.27bc	7.44bc	5.14bc	**6.71**
T-6 NPK @1.0% + $Mgso_4$ @0.25%	7.05abc	7.41abc	7.58abc	5.29ab	**6.83**	7.08b	7.46abc	7.56bc	5.27ab	**6.34**
T-7 NPK @0.5% + Borex @0.25%+ $Znso_4$ @0.25%	7.35ab	7.70ab	7.86ab	5.65ab	**7.14**	7.28ab	7.66ab	7.79ab	5.63ab	**7.09**
T-8 NPK @0.5% + Borex @0.25% + $Znso_4$ @0.25%+ $Mgso_4$ @0.25%	7.87a	8.09a	8.37a	6.04a	**7.59**	7.90a	8.11a	8.40a	5.88a	**7.57**
T-9 (Control)	5.86d	6.24d	6.40d	4.34d	**5.71**	5.89d	6.31d	6.47d	4.44d	**5.77**
Mean	**6.89**	**7.22**	**7.43**	**3.22**		**6.91**	**7.28**	**7.46**	**5.18**	
LSD (0.05%)	**0.89**	**0.81**	**0.80**	**0.78**		**0.81**	**0.78**	**0.82**	**0.69**	

Changes in Titrable acidity (%)

A perusal data of Table No.3 revealed that titrable acidity increased with the advancement of day of the storage during both the years (2022-23 and 2023-24). Minimum titrable acidity (0.64%) was observed in treatment T8 (NPK @0.5% + Borex @0.25% + $Znso_4$ @0.25%+ $Mgso_4$ @0.25%) followed by the T7 (NPK 0.5% + Borex 0.25%+$Znso_4$ 0.25%) 0.68%, on the 1st day of storage. However, maximum titrable acidity (8.87%) was observed in treatment T9 (control) on 4th day of storage during the year 2022-23. Similarly, during 2023-24 minimum titrable acidity (0.63%) was observed in treatment T8 (NPK @0.5% + Borex @0.25% + $Znso_4$ @0.25%+ $Mgso_4$ @0.25%) followed by the T7 (NPK 0.5% + Borex 0.25%+$Znso_4$ 0.25%) 0.69%, on the 1st day of storage. However, maximum titrable acidity (8.86%) was observed in treatment T9 (control) which was significantly at par with T1 (NPK @0.5%) 0.84% on 4th day of storage during the year 2023-24. Kumar *et al.,* (2011) observed that the Borax reduce the losses of titrable acidity during storage.

Changes in Ascorbic acid (mg/100g)

A perusal data of Table No.4 revealed that Ascorbic acid content decreased with the advancement of day of the storage during both the years (2022-23 and 2023-24). Maximum ascorbic acid (56.84mg) were observed in the treatment T8 (NPK @0.5% + Borex @0.25% + $Znso_4$ @0.25%+ $Mgso_4$ @0.25%) which was statistically at par with T7 (NPK @0.5% + Borex @0.25%+$Znso_4$ @0.25%) 56.51mg on 1st day of the storage. However, minimum ascorbic acid (47.27mg) was observed in the treatment T9 (control) followed by the T1 (NPK @0.5%) 48.11mg on 4th day of storage during the year 2022-23. Similarly, during 2023-24 maximum ascorbic acid (56.85mg) were observed in the treatment T8 (NPK @0.5% + Borex @0.25% + $Znso_4$ @0.25%+ $Mgso_4$ @0.25%) which was statistically at par with T7 (NPK @0.5% + Borex @0.25%+$Znso_4$ @0.25%) 56.48mg and T3 (NPK @1.5%) on 1st day of the storage. However, minimum ascorbic acid (47.29mg) was observed in the treatment T9 (control) followed by the T1 (NPK @0.5%) 48.12mg on 4th day of storage during the year 2022-23. Kumar et al., (2011) observed that the Borax reduce the losses of ascorbic acids during storage.

Changes in Reducing Sugar (%)

A perusal data of Table No.5 revealed that reducing sugar increased with the advancement of day of the storage up to 2nd day after that decreased during both the years (2022-23 and 2023-24). Maximum reducing sugar (4.59%) were observed in the treatment T8 (NPK @0.5% + Borex @0.25% + $Znso_4$ @0.25%+ $Mgso_4$ @0.25%) which was statistically at par with T7

(NPK @0.5% + Borex @0.25%+Znso$_4$ @0.25%) 4.56%, T3 (NPK @1.5%) 4.41% and T4 (NPK @1% +Borex @0.25%) 4.36% on 2nd day of the storage. However, minimum reducing sugar (3.35%) was observed in the treatment T9 (control) which was statistically at par with T1 (NPK @0.5%) 3.54% on 4th day of storage during the year 2022-23. Similarly, during 2023-24 maximum reducing sugar (4.61%) were observed in the treatment T8 (NPK @0.5% + Borex @0.25% + Znso$_4$ @0.25%+ Mgso$_4$ @0.25%) which was statistically at par with T7 (NPK @1% + Mgso$_4$ @0.25%) 4.57% on 2nd day of the storage. However, minimum reducing sugar (3.36%) was observed in the treatment T9 (control) which was statistically at par with T1 (NPK @0.5%) 3.58% on 4th day of storage during the year 2023-24.

Changes in Non- reducing sugar (%)

A perusal data of Table No.6 revealed that Non- reducing sugar increased with the advancement of day of the storage up to 2nd day after that decreased during both the years (2022-23 and 2023-24). Maximum non-reducing sugar (3.06%) were observed in the treatment T8 (NPK @0.5% + Borex @0.25% + Znso$_4$ @0.25%+ Mgso$_4$ @0.25%) which was statistically at par with T7 (NPK @0.5% + Borex @0.25%+Znso$_4$ @0.25%) 3.04%, T3 (NPK @1.5%) 2.95% and T4 (NPK @1% +Borex @0.25%) 2.91% on 2nd day of the storage. However, minimum non-reducing sugar (2.24%) was observed in the treatment T9 (control) which was statistically at par with T1 (NPK @0.5%) 2.37% on 4th day of storage during the year 2022-23. Similarly, during 2023-24 maximum non-reducing sugar (3.08%) were observed in the treatment T8 (NPK @0.5% + Borex @0.25% + Znso$_4$ @0.25%+ Mgso$_4$ @0.25%) which was statistically at par with T7 (NPK @1% + Mgso$_4$ @0.25%) 3.05% and T3 (NPK @1%) 3.0% on 2nd day of the storage. However, non-reducing sugar (2.25%) was observed in the treatment T9 (control) on 4th day of storage during the year 2023-24.

Changes in Total sugar (%)

A perusal data of Table No.7 revealed that total sugar increased with the advancement of day of the storage up to 2nd day after that decreased during both the years (2022-23 and 2023-24). Maximum total sugar (7.65%) were observed in the treatment T8 (NPK @0.5% + Borex @0.25% + Znso$_4$ @0.25%+ Mgso$_4$ @0.25%) which was statistically at par with T7 (NPK @0.5% + Borex @0.25%+Znso$_4$ @0.25%) 7.60% and T3 (NPK @1.5%) 7.37% on 2nd day of the storage. However, minimum total sugar (5.59%) was observed in the treatment T9 (control) which was statistically at par with T1 (NPK @0.5%) 5.91% on 4th day of storage during the year 2022-23. Similarly, during 2023-24 maximum total sugar (7.70%) were observed in the treatment T8 (NPK @0.5% + Borex @0.25% + $Znso_4$ @0.25%+ $Mgso_4$ @0.25%) which was statistically at par with T7 (NPK @1% + $Mgso_4$ @0.25%) 7.61% and T3 (NPK@ 1.5%) on 2nd day of the storage. However, minimum total sugar (5.61%) was observed in the treatment T9 (control) which was statistically at par with T1 (NPK @0.5%) 5.98% on 4th day of storage during the year 2023-24. Kumar *et al.,* (2011) observed that the Borax reduce the losses of Total sugar during storage.

CONCLUSION

It is concluded that the application of NPK @0.5% + Borex @0.25% + $Znso_4$ @0.25%+ $Mgso_4$ @0.25% noted significantly better results in terms of minimum physiological loss of weight, total soluble solids, titrable acidity, ascorbic acid, reducing sugar, non- reducing sugar and total sugar content. It was followed by T7 (NPK @1% + $Mgso_4$ @0.25%) 7.61%) that is significant for the storage of strawberry at ambient conditions.

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