IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 11, Issue 8 Ver. I (August 2018), PP 06-10
www.iosrjournals.org

Influences of Phosphorus And Potassium on Nutritive Value And Shelf Life of Sub-Tropical Strawberry

M. J. Rezowana[1], H. Sultana[1], M. M. Hossain[1], A. J. M. S. Karim[2], E. Kayesh[1]And M. S. Biswas[1*]

[1](Department of Horticulture, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur 1706, Bangladesh)
[2](Department of Soil Science, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur 1706, Bangladesh)
[*]Corresponding author:M. S. Biswas (sanaullah@bsmrau.edu.bd)

Abstract: *An adequate management of nutrient elements is crucial to guarantee plant growth and development as well as for longer shelf life of fruit. The present experiment was conducted to observe the response of various combinations ofphosphorus (P) and potassium (K)fertilization on the nutritional quality and shelf life of sub-tropical strawberry.The first part of the experiment for nutritive value was designed in Randomized Complete Block Design (RCBD) including seven combined doses of P and K fertilizer (viz., T_1 - P_0 K_{100} kg/ha, T_2 - P_{25} K_{100} kg/ha, T_3 - P_{50} K_{100} kg/ha, T_4 - P_{75} K_{100} kg/ha, T_5 - P_{50} K_0 kg/ha, T_6 - P_{50} K_{50} kg/ha and T_7 - P_{50} K_{150} kg/ha)with three replications.In the second part, the shelf life was evaluated byfactorialCompletely Randomized Design (CRD) with three replications. The results revealed that under fresh condition, the maximum amount of β-carotene (15.13 IU/100 g), TSS (13.16 %), K (0.85 %), reducing sugar (6.18 g/100 g) and total sugar (8.57 g/100 g) was recorded in T_7. The highest amount of non-reducing sugar (2.51 g/100 g) and P (0.08 %) were found in T_4andascorbic acid (55.94 mg/100 g) in T_3. In terms of shelf life and packaging conditions, treatment T_4 showed the longest shelf life (25.33 days) compared to others at 4^0C with polyethylene package. Therefore, P_{50} K_{150} kg/ha (T_7) showed better performance for most of the nutritive values and P_{75} K_{100} kg/ha (T_4) was better for enhancing shelf life of strawberry. However, further investigation is necessary to determine whether non-reducing sugar or P content are related to extended shelf life of strawberry.*

Keywords: *Strawberry, phosphorus, potassium, nutritional value, shelf life*

Date of Submission: 20-07-2018 Date of acceptance: 04-08-2018

I. Introduction

Strawberry (*Fragariaxananassa*D) is one of the most popular delicious fruits under the family Rosaceae consumed worldwide. The fragrantly sweet juiciness and deep red color of strawberry can brighten up both the taste and aesthetics of any meal. It is highly valued as a dessert fruit eaten as raw or used in making juice, desserts, jam, syrup, wine and ice cream. Nutritionally strawberry is considered to be a potential source of vitamins, fiber, protein and minerals such as phosphorus, potassium, calcium, iron and sodium [1]. The world strawberry production reached 4.5 million tons in 2012, being the USA, Mexico, Turkey, Spain, Egypt, Russia, South Korea, Japan, Poland and Germany the main producers [2].In Bangladesh, it is a newly introduced crop but commercial cultivation has already been started.A small scale research and development in the public and private sector has been started for quality production and shelf life. Therefore, extension of strawberry farming in the farmer's level can bring a new horizon to the agriculture sector of Bangladesh.

It is well proved that growth, yield and quality of plants are greatly influenced by availability of a wide range of nutrients in the soil. After nitrogen, phosphorus is the second most frequently limiting macronutrient for plant growth. Phosphorus is a key element in plant structure as well as a catalyst in numerous biochemical reactions in plants [1].It has beneficial effect on root development, growth and also hastens maturity as well as improves quality of crop produce [3]. Potassium has been described as the 'quality element' and highly demanded by the crop for directly favoring fruit quality and increasing the contents of total soluble solids and ascorbic acid, besides improving aroma, taste, color and firmness of fruits [4]. Strawberry is one of the most sensitive plants in horticultural production and fruits have a very short shelf-life and senescent period due to their high degree of perishability and infection caused by several pathogens that can rapidly reduce fruit quality [5]. Hence, an adequate amount of phosphorus and potassium is required to provide high-quality postharvest attributes needed for longer shelf life. Considering the above facts, the present study was therefore, undertaken toobserve the influence of phosphorus and potassium fertilization on the nutritive value and shelf life of sub-tropical strawberry.

II. Meterialsand Methods

The experiment was conducted at the farm and laboratory of the Department of Horticulture, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur-1706.Seven different doses of triple super phosphate (TSP) and muriate of potash (MP) representing the treatments (T_1 - P_0 K_{100} kg/ha, T_2 - P_{25} K_{100} kg/ha, T_3 - P_{50} K_{100} kg/ha, T_4 - P_{75} K_{100} kg/ha, T_5 - P_{50} K_0 kg/ha, T_6 - P_{50} K_{50} kg/ha and T_7 - P_{50} K_{150} kg/ha) of the experiment were used in the experiment as the source of P and K nutrients, respectively.Thefield experiment was designed in accordance withRandomized Complete Block Design (RCBD) and the laboratory experiment was designed with factorial Completely Randomized Design (CRD) with three replications. Freshly harvested strawberry fruits were sampled for nutritional quality assessment.Then the fruits were packed with polyethylene pack and plastic punnet and kept at different temperature (room temperature, refrigerated condition at 4^0C and moderate condition at 12^0C)keeping the packs unsealed for shelf life determination.During investigation different fruit quality parameters were evaluated. Ascorbic acid content (mg/100g) in fruit was determined by titration method described by [6]. β-Carotene content (mg/100g) was measured spectrophoto-metrically and calculated by the following formula [7]:

$$\beta\text{-Carotene (mg/100g)} = 0.216(OD_{663})+0.452(OD_{453})- 1.22(OD_{645}) - 0.304(OD_{505})$$

Where, OD indicates optical density.

Total soluble solids (TSS)content of strawberry fruit pulp was determined by hand refractometer (Model: Atago N1, Japan). Reducing, non-reducing and total sugar content (g/100 g) in fruit were measured according to [8] using Bertrand A, Bertrand B and Bertrand C solutions.Total calcium (Ca), iron (Fe), phosphorus and potassium content (%) were determined using the method described by [9].Shelf life (days) of strawberry fruits under different temperatures (4^0C, 12^0C, Room temperature) and packaging conditions (polyethylene pack and plastic punnet) were measured by initiation of any objectionable symptom (like microbial infection, colour change, objectionable odor etc.) which was observed by eye estimation. Analysis of variance (ANOVA) of the measured parameters was performed and the treatment means were compared using Least Significant Difference (LSD) at 1% or 5% level of probability.

III. Results And Discussion

Nutritional value of strawberry fruit

The application of different doses of phosphorus and potassium in combination brought about significant variation regarding free ascorbic acid, β-carotene content and total soluble solids of strawberry fruit (Table 1). Free ascorbic acid content of strawberry fruit ranged between 45.75 and 55.94 mg/100g. Among the entries, the treatment T_3 secured the highest position with maximum amount of free ascorbic acid (55.94 mg/100g) and it was minimum (45.75 mg/100g) in T_1. In a study, [10]reported to have the highest 60 mg ascorbic acid among 23 strawberry cultivars which more or less supported the above findings. The highest content of β-carotene (15.13 IU/100g) was recorded in the treatment T_7 followed by the treatment T_4 while the lowest (9.64 IU/100g) was found in the treatment T_5 which was statistically identical to the treatment T_1. Variations in β-carotene was mainly due to inherent characteristics of the genotype, climatic and environmental factors. Similar trend was found in terms of TSS of strawberry fruit.

Table 1. Effects of different doses of phosphorus and potassium fertilizer onascorbic acid, β-carotene content and TSS of freshly harvested strawberry fruit

Treatments	Ascorbic acid (mg/100g)	β-carotene (IU/100g)	Fruit TSS (%)
T_1	45.75 e	10.27 ef	10.08 ef
T_2	49.11 cd	12.6 cd	11.0 cd
T_3	55.94 a	13.34 bc	11.84 bc
T_4	52.67 b	14.21 ab	12.15 b
T_5	48.47 d	9.64 f	9.41 f
T_6	51.02 bc	11.62 de	10.48 de
T_7	49.99 cd	15.13 a	13.16 a
Level of Significance	**	**	*
CV %	1.81	5.07	3.06

Means bearing the same letter(s) in a column do not differ significantly at 1% or 5% level of probability by LSD
* indicates significant at 5% level of probability
** indicates significant at 1% level of probability

The result revealed that the treatments exerted significant influence on the reducing, non-reducing and total sugar content of the fruit (Table 2). The highest amount of reducing sugar (6.18 g/100g) and total sugar (8.57 g/100g) was found in the treatment T_7 whereas the treatment T_5 had the lowest reducing (3.38 g/100g) and total (5.38 g/100g) sugar content which was statistically identical to T_1. In case of non-reducing sugar, maximum amount (2.50 g/100g) was recorded in the treatment T_4 and it was the minimum (1.91 g/100g) in the treatment T_1. The variation in non-reducing and total sugar content was might be due to climatic and genetic factors.

Table 2. Effects of different doses of phosphorus and potassium fertilizer onreducing sugar, non reducing sugar and total sugar content of freshly harvested strawberry fruit

Treatments	Reducing sugar (g/100g)	Non reducing sugar (g/100g)	Total sugar (g/100g)
T_1	3.55 f	1.91 f	5.46 e
T_2	4.46 d	2.11 d	6.58 d
T_3	5.04 c	2.32 b	7.36 c
T_4	5.40 b	2.50 a	7.91 b
T_5	3.38 f	2.0 e	5.38 e
T_6	4.03 e	2.21 c	6.25 d
T_7	6.18 a	2.38 b	8.57 a
Level of Significance	**	**	**
CV %	3.16	1.42	2.29

Means bearing the same letter(s) in a column do not differ significantly at 1% level of probability by LSD
** indicates significant at 1% level of probability

Table 3 shows that different doses of phosphorus and potassium had a significant effect on the nutrient contents of strawberry. Total calcium was found maximum (0.503 %) in the treatment T_3 and minimum (0.370%) in the treatment $T_{5.}$ Treatment T_6 had the highest iron content (90.97 ppm) which performed statistically similar to the treatment T_3 (89.09 ppm) whereas T_1 had the lowest amount (78.113 ppm) which was statistically similar to T_4. Total phosphorus content in fruit ranged from 0.076% to 0.085% and among all the treatments, maximum content was recorded in T_4 (0.085 %) while the lowest was found in T_1 (0.76 %). The treatment T_7 attained the highest position with maximum amount of potassium (0.865 %) followed by T_4 and T_3 and it was recorded minimum (0.813 %) in $T_{1.}$

Table 3. Effects of various doses of phosphorus and potassium onnutrient content of strawberry fruit

Treatments	Ca (%)	Fe (ppm)	P (%)	K (%)
T_1	0.393 e	78.11 e	0.076 c	0.823 f
T_2	0.408 de	81.97 d	0.08 abc	0.834 d
T_3	0.503 a	89.09 ab	0.083 ab	0.841 c
T_4	0.479 b	79.72 de	0.085 a	0.852 b
T_5	0.37 f	84.88 c	0.078 bc	0.817 g
T_6	0.435 c	90.97 a	0.081 abc	0.828 e
T_7	0.415 d	86.82 bc	0.084 a	0.865 a
Level of Significance	**	**	**	**
CV %	1.85	1.36	2.85	0.25

Means bearing the same letter(s) in a column do not differ significantly at 1% level of probability by LSD
** indicates significant at 1% level of probability

Shelf life of strawberry fruit

Phosphorus and potassium supplementation had a significant influence on the shelf life of strawberry (Fig. 1). In room temperature, the treatment T_4had the longest (3.50 days) shelf life followed by T_3 and T_7 and shortest shelf life (1.0 day) was obtained by T_1. Shelf life was also greatly affected by various temperature changes. At 4^0C, the highest shelf life was 22.65 days while in room temperature, it was reduced to 3.7 days (Fig. 2). This finding is more or less in agreement with the findings of [11] who reported that under room temperature (RT), shelf life ranged between 1.4 to 3.5 days in different strawberry genotypes.

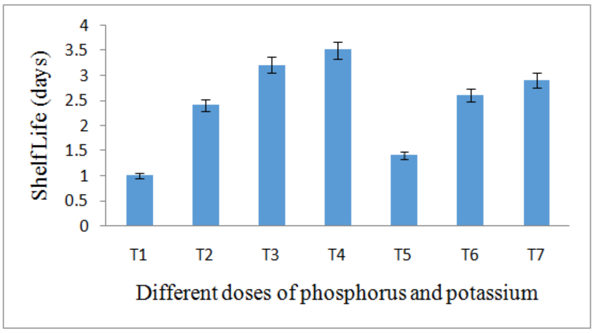

Fig. 1. Effects of various doses of phosphorus and potassium onshelf life of strawberry. Error bars indicate the SEM. Each treatment was repeated three times.

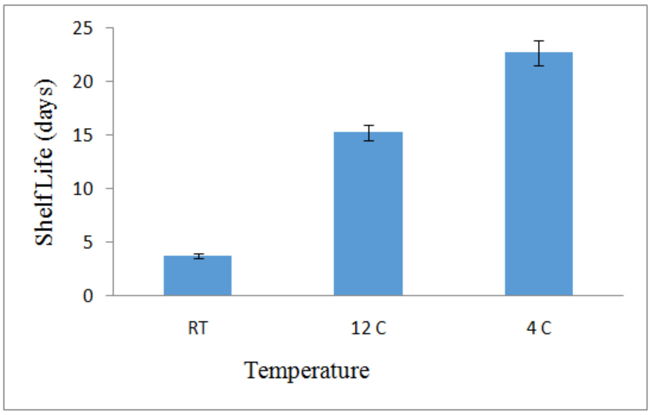

Fig. 2. Effects ofdifferent temperatures on shelf life of strawberry. Error bars indicate the SEM. Each treatment was repeated three times.

Interaction of different doses of phosphorus and potassium fertilizer and temperature had shown significant effect on the shelf life of strawberry (Table 4). Maximum shelf life (18.67 days) was obtained by the treatment T_4 and it was minimum (8.33 days) in T_1 at 12^0C. In case of 4^0C, maximum shelf life (30.33 days) was also recorded in T_4 while minimum (15 days) was found in the treatment T_1. Low temperature increases the shelf life by reducing respiration, transpiration, metabolism etc. thus in 4^0C shelf life was increased.

Table 4. Effect of various doses of phosphorus and potassium and temperature on the shelf life of strawberry

Treatments	Shelf life (days)	
	12^0C	**4^0C**
T_1	8.33 e	15 f
T_2	12.67 cd	19.33 e
T_3	16.33 b	26.67 b
T_4	18.67 a	30.33 a
T_5	11.67 d	18.33 e
T_6	14.33 bc	22 d
T_7	15.67 b	24 c
Level of Significance	**	**
CV %	6.13	3.53

Means bearing the same letter(s) in a column do not differ significantly at 1% level of probability by LSD
** indicates significant at 1% level of probability

Various doses of phosphorus and potassium fertilizer and packaging interactions demonstrated significant effects on the shelf life of strawberries (Table 5). When polyethylene is used for packing, the longest shelf life (22.33 days) was obtained by T_4 and the shortest (7.33 days) was obtained by T_1.[12]reported that, packing strawberries in polyethylene bags decreased respiration, maintained quality, and prolonged the shelf life for 20-25 days in different cultivars. In case of plastic punnet packaging, maximum shelf life (14.33 days) was observed in T_4, which was statistically similar to T_3 while it was minimum (5.67 days) in the treatment T_1 which was statistically similar to T_5. Microbial infection and water loss was higher as the plastic punnets were unsealed resulting in reduced shelf life in comparison with polyethylene packages which were slightly wrapped.

Table 5. Effect of various doses of phosphorus and potassium fertilizer and packaging on the shelf life of strawberry

Treatments	Shelf life (days)	
	Polyethylene package	**Plastic punnet**
T_1	7.33 g	5.67 e
T_2	12 e	7.67 d
T_3	18.67 b	13 ab
T_4	22.33 a	14.33 a
T_5	9.33 f	7 de
T_6	16 d	9.33 c
T_7	16.33 c	12 b
Level of Significance	**	**
CV %	5.56	6.03

Means bearing the same letter(s) in a column do not differ significantly at 1% level of probability by LSD
** indicates significant at 1% level of probability

Combined effects of fertilizer, temperature and packaging had a significant variation on the shelf life of strawberry (Table 6). The treatment T_4 had the longest (25.33 days) shelf life at 4^0C under both polyethylene and plastic punnet packaging and the shortest (1.33 days) shelf life was obtained by the treatment T_1 at room temperature (25^0C to 27^0C) under plastic punnet packaging.[13] reported to have shelf life of strawberries varied from 1.5 to 3.5 days under room temperature.

Table 6. Effects of fertilizer, temperature and packaging on the shelf life of strawberry

Treatments	**Polyethylene package**			**Plastic punnet**		
	4^0C	**12^0C**	**Room temperature**	**4^0C**	**12^0C**	**Room temperature**
T_1	16.67 e	12.67 f	2 e	15.33 e	8 e	1.33 g
T_2	19.33 d	16 d	4.33 d	18.33 d	10.33 d	3.33 e
T_3	23.33 b	20.33 b	7.67 ab	23.33 b	15 b	6.33 b
T_4	25.33 a	22.67 a	8.67 a	25.33 a	16.33 a	7.33 a
T_5	18.33 d	14.33 e	3.33 d	16.67 e	9.33 d	2.33 f
T_6	21 c	17.67 c	5.67 c	19.67 cd	12.67 c	4.33 d
T_7	22.33 b	19 bc	6.67 bc	21 c	13.67 c	5.33 c
Level of Significance	**	**	**	**	**	**
CV %	1.97	3.66	9.28	3.38	4.11	6.91

Means bearing the same letter(s) in a column do not differ significantly at 1% level of probability by LSD
** indicates significant at 1% level of probability

IV. Conclusion

In the present study, it can be concluded that application of phosphorus @ 50 kg/ha and potassium @ 150 kg/ha gave the highest nutritional value such as β-carotene, TSS, K content, reducing sugar, total sugar content etc. in strawberry. On the contrary, phosphorus @ 75 kg/ha and potassium @ 100 kg/ha accumulated the highest amount of non-reducing and P content, simultaneously the following treatment showed extended shelf life of strawberry.

References

[1]. Ahmad, H.,Sajjid, M., Hayat, S.,Ullah, R., Ali, M.,Jamal, A., Rahman, A., Aman,Z. and Ali,J.;Growth, yield and fruit quality of strawberry (*Frageriaananasa* Dutch) under different phosphorus levels. Research in Agriculture.2017; 2(2): 19-28.

[2]. FAO; Food and Agriculture Organization of the United Nations. FAOSTAT. 2012.(*http://faostat.fao.org/site/339/default.aspx.*)

[3]. Meena, N.K., Meena, R.K., Dhaka,R.S. and Meena, O.P.; Response of nitrogen, phosphorus and potassium levels on growth and yield of okra [*Abelmoschusesculentus* (L.) Moench] *cv*. ArkaAnamika. Int. J. Pure App. Biosci.2017; 5(4): 1171-1177.

[4]. Medeiros, R.F., Pereira, W.E., Rodrigues, R.D.M., Nascimento, R.D., Suassuna,J.F. and Dantas, T.A.G;Growth and yield of strawberry plants fertilized with nitrogen and phosphorus. RevistaBrasileira de EngenhariaAgrícola e Ambiental. 2015; 19(9): 865-870.

[5]. Gol, N.B., Patel, P.R. and Rao, T.V.R.;Improvement of quality and shelf-life ofstrawberries with edible coatings enriched with chitosan. Postharvest Biology and Technology. 2013;85: 185-195.

[6]. Pleshkov, B.P.; Practical works on plant biochemistry. Moscow, Kolos. 1976; Pp. 236-238.

[7]. Nagata, M., Dan, K. and Yamashita, I.; Simple methods for simultaneous determination of chlorophyll and carotenoiods in tomato. J. Jpn. Soc. Hortic. Sci. 1992; 61(2): 685-687.

[8]. Somogyi, M.; Notes on sugar determination. J. Biol. Chem. 1952; 195: 19-23.

[9]. Piper, C.S.; Soil and Plant Analysis. Hans Publishers, Bombay (Reprint). 1966; Pp. 368-392.

[10]. Zmuda, E., Wieniarska,J. and Szember, E.; Comparative studies on chemical composition of chosen strawberries cultivars (*Fragaria×ananassa*Duch.). Folia UniversitatisAgriculturaeStetinensis, Agricultura. KatedraSadownictwa, AkademiaRolnicza, Poland. 2004; 96: 225-230.

[11]. Rahman, M.M. and Ahmad,M.R.; Collection and evaluation of strawberry lines. Research Report on Horticultural Crops, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh. 2010a;Pp. 329-331.

[12]. Krivorot, A.M. and Dris,R.; Shelf life and quality changes of strawberry cultivars. Acta. Hortic.2002;567(2): 755-758.

[13]. Rahman, M.M. and Ahmad,M.R.; Regional yield trial of strawberry lines. Research Report on Horticultural Crops,Bangladesh Agricultural Research Institute, Gazipur, Bangladesh.2010b;Pp. 332-333.

*M. S. Biswas. ‘’Influences of Phosphorus And Potassium on Nutritive Value And Shelf Life of Sub-Tropical Strawberry." IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS) 11.8 (2018): 06-10.