Int.J.Curr.Microbiol.App.Sci (2020) *9*(2): 2281-2290

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 9 Number 2 (2020)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2020.902.258

Response of Different Sources of Potassium on Biochemical Quality of Litchi cv. Deshi

Karanjeev Kumar, Kumari Madhumala*, Sanjay Sahay and Feza Ahmad

Department of Fruit and Fruit Technology, BAU Sabour Bhagalpur, India

**Corresponding author*

Keywords

Litchi, Marble, Stone, Sugar, Anthocyanin

Article Info

Accepted:
15 January 2020
Available Online:
10 February 2020

A B S T R A C T

Litchi (*Litchi chinensis* Sonn.) recognized as "Queen of the fruits". It is an important sub- tropical evergreen fruit crop belongs to the family Sapindaceae. The present investigation was carried out during the year 2019. Ten years old uniformly grown "Deshi" litchi plants established at Bihar Agricultural University Sabour Fruit Research Station, were sprayed with K_2SO_4 and KCl @ 0%, 1% and 2% at two different stages i.e. Marble and Stone hardening stage. The plants treated with potassium as foliar feeding significantly improved fruit quality characteristics viz. TSS, TSS/acid ratio, total sugars, reducing sugar, ascorbic acid were also enhanced with marble and stone hardening stage with sprays of different concentrations of potassium fertilizers over untreated trees. Anthocyanin content higher with K_2SO_4application at stone hardening stage. So, it is concluded that K_2SO_4 @1% and 2% at stone hardening stage significantly improved total sugar, reducing sugar and anthocyanin litchi cv. Deshi.

Introduction

Litchi (*Litchi chinensis* Sonn.) recognized as "Queen of the fruits". It is an important sub-tropical evergreen fruit crop belongs to the family Sapindaceae. It is native of south China and was introduced in India by the end of 17th century to explore the possibilities of litchi cultivation in India due to available of conducive temperature and climatic requirements. Litchi crop is widely distributed in the tropics and warm subtropics of the world. It is a highly perishable nature and is used in the form of fresh fruit and value added products i.e. RTS, squash, dry nut etc. It also contains 40-90 mg vitamin-C/100 g edible portion, 0.9% protein, 0.3% fat, 0.42% pectin and 0.7% minerals (Ca, P, Fe). Its skin is rich in insoluble fiber which prevents rectum cancer, diabetes. Wang *et al.*, (2010) reported that water soluble alcohol extracted from litchi skin significantly inhibited in vitro growth of human hepatoma cells and suppressed cancer development particularly effective in the breast cancer. Its skin also contains free radical scavenging compounds like ascorbic acid, carotenoids, polysaccharides (Yang *et al.,* 2006) and phenolic substances flavonoids (flavonols and anthocyanins) and phenolic acids.

In India litchi fruit production 497 MT and productivity 7.02 MT/ha is obtained from an area of 78 thousand ha (Anonymous 2017). Major growing state are Bihar, West Bengal, Assam and Jharkhand and to a small extent to a Tripura, Punjab, Uttarakhand and Odisha. It is cultivated on 32 thousand ha area with annual production of 300 MT and productivity 9.37 thousand MT/ha in Bihar state (Anonymous 2017) and approximately 90 percent of the total area under litchi cultivation is mainly Champaran, Siwan, Darbhanga, Purniya, Bhagalpur, Saharsa, Araria, Munger, Mdhubani, Madhepura and Begusarai. Litchi has ensure high economic productivity and retain the optimum nutrients in the soil at the desired level correct doses of manures and fertilizers must be applied on the basis of long term fertilizer experiments and choose of reliable diagnostic tools (Bhargava *et al.,* 1993). It is postulated that 10 MT litchi fruits annually remove nearly 67 kg N, 16 kg P_2O_5 and 73 kg K_2O from the soil. It is therefore essential that litchi trees should be supplied with adequate nutrients for fruit production as limited supply of macro and micro nutrients in the soil is responsible for poor fruit yield and quality (Menzel and Simpson 1987). Yang *et al.,* (2015) conclude that fruit potassium fertilizer (40%) should also be applied during the fruit enlargement period to promote litchi fruit expansion and to improve litchi yield and quality.

Likely Menzel and Kirby (2001) also reported that potassium enhances cell hydration and its deficiency causes tissue dehydration and act as the main osmotic solute in the plants for stomata functions. Potassium is involved in the translocation of sugars, formation of carbohydrates and regulates root hydraulic conductivity and provides resistance against pest, diseases, drought and stress (Imas and Bansal, 1999). Southwick *et al.,* (1996) suggested that potassium intake from foliar feeding is more efficient than soil application. Litchi cv. Rose Scented under Uttrakhand conditions Kumar Kumar (2004) confirmed that three pre harvest foliar sprays of “Multi-K” (1.0 %) @ 15, 30 and 45 days after fruit set considerably produced fruits with higher TSS (18.0%), total sugars (12.4%), TSS/acid blend ratio (28.6), juice%, ascorbic acid content (34.9 mg / 100 g pulp) and lower (0.63%) acid than the control. Two pre-harvest foliar sprays of Polyfeed (19:19:19) onlitchi plants at the interval of 15 and 45 days after fruit set effectively produced fruits with maximum fruit weight, aril weight, juice%, TSS, total sugars, reducing sugars, TSS/acid ratio, sugar/ acid ratio and ascorbic acid and minimum acidity content (Singh *et al.,* 2007).

Materials and Methods

The material and methods employed during the investigation are described here under. The present studies were carried out on 10 years old fully mature uniform healthy plants of litchi cultivar “Deshi” planted at 10.0 m x 10.0 m. The uniform cultural practices were given to all the plants as per recommendation of Package and Practices for Fruit Crops of Bihar Agricultural University Sabour. The experiment was layout by Factorial Randomized Block Design (FRBD) and plants were (in addition to soil application of recommended doses of fertilizers) sprayed with different concentrations 0%,1%, and 2% (D_0, D_1, and D_2 respectively) of K_2SO_4(48%) and KCl (60%) (K_1, K_2respectively) at two different sub treatments stages i.e. Marble stage (S_1) and Stone hardening stage (S_2). Each treatment was replicated three times. The plants were sprayed with hand operated Knapsack sprayer during early morning hours after dissolving calculated dose of respective treatment.

Total soluble solids (TSS)

The total soluble solids of each sample fruit was estimated using digital hand held Refractometer at 20ºC and the results were expressed as degree brix (ºBrix).

Titrable Acidity (%)

Titrable acidity was determined using titration method (Rangana, 2010). For this 2 g of fruit sample was weighed and added to 50 ml distilled water. This was thoroughly mixed and then filtered. The filtered sample was titrated against 0.1 N NaOH using a few drops of 1% phenolphthalein solution as indicator. The observed titre value was used for calculating acidity and the results were expressed as (%).

Acidity (%)=

$$\frac{0.0067 \times \text{Volume of NaOH used}}{\text{Volume of juice taken}} \times 100$$

TSS/Acid ratio

TSS/acid ratio was calculated by dividing the value of total soluble solids with that of the corresponding total titrable acidity.

Total sugars(%)

The estimation of total and reducing sugars was done by using method suggested by Lane and Eynon (AOAC, 1990).

Ascorbic acid content (mg/100 g)

Ascorbic acid was quantitatively determined by 2, 6-dichlorophenol indophenol dye method as described by Jones and Hughes (1983) with slight modifications.

Total Anthocyanin (mg/100g)

Ten gram of the sample was crushed with 10ml of ethanolic HCl with the help of pestle and mortar and transferred into 50 ml conical flask using 10 ml ethanolic HCl for washing. The solution was stored overnight afterwards solution was filtered with Whatman No.1 filter paper. Final volume was made up to 100 ml and stored in dark for 2hs. Absorbance was recorded at 535 nm.

Total anthocyanin(mg/100g) =

$$\frac{\text{OD} \times \text{dilution} \times \text{total volume made up}}{\text{Weight of sample} \times e} \times 100$$

Where e = 98.2 (absorbance of a solution containing 0.1 mg/ml anthocyanin)

Results and Discussion

Litchi fruit acidity has been reduced with the foliar application of potassium sulphate as compared to potassium chloride. As far as dose of potassium is concerned, the percentage of acidity increases with the increase in potassium dose.

However, the potassium application at stone hardening stage favour in reduction of total acidity in litchi fruits. The minimum fruit acidity was observed in control followed by 1% and 2%. The lowest (0.31%) fruit acidity was noted with the application of 600 g K_2O in two splits at 15 days after fruit set and 30 days before flowering in litchi cultivar “Bombai” as reported by Pathak and Mitra (2010).

The maximum TSS was found in K_2SO_4 @2% applied at marble stage. The increase in TSS content with potassium application due to synthesis of more carbohydrate and its translocation from leaves to fruits.

S. No.	Treatment symbol	Treatment detail
1	$S_1K_1D_0$	Potassium sulphate @ 0% at Marble stage
2	$S_1K_1D_1$	Potassium sulphate @ 1% at Marble stage
3	$S_1K_1D_2$	Potassium sulphate @ 2% at Marble stage
4	$S_1K_2D_0$	Potassium chloride @ 0% at Marble stage
5	$S_1K_2D_1$	Potassium chloride @ 1% at Marble stage
6	$S_1K_2D_2$	Potassium chloride @ 2% at Marble stage
7	$S_2K_1D_0$	Potassium sulphate @ 0% at Stone stage
8	$S_2K_1D_1$	Potassium sulphate @ 1% at Stone stage
9	$S_2K_1D_2$	Potassium sulphate @ 2% at Stone stage
10	$S_2K_2D_0$	Potassium chloride @ 0% at Stone stage
11	$S_2K_2D_1$	Potassium chloride @ 1% at Stone stage
12	$S_2K_2D_2$	Potassium chloride @ 2% at Stone stage

Table.1 Meteorological data (2018-19)

Months	Temperature(^{0}C)		Relative Humidity (%)		Wind Speed (Km/hr)	Rainfall (mm)
	Max.	Min.	7.00 am	2.00 pm		
Oct. 2018	31.27	19.75	89.58	72.84	2.46	2.53
Nov. 2018	29.56	12.85	88.37	61.27	0.00	1.89
Dec. 2018	24.21	7.44	89.26	59.65	0.36	2.57
Jan. 2019	23.01	5.63	89.58	54.23	0.14	3.59
Feb. 2019	25.18	10.08	88.04	60.75	1.51	4.76
March 2019	30.47	15.44	83.42	62.32	0.04	2.98
April 2019	33.56	21.46	77.93	57.20	1.27	3.21
May 2019	38.78	24.28	75.74	50.42	1.97	2.55
Average	29.51	14.62	85.24	59.83	0.97	3.01

Table.2 Main effect of foliar application of different sources of Potassium, doses and stages with respect to TSS, Acidity, Ascorbic acid on litchi cv. Deshi

Treatments	TSS (°Brix)	Acidity (%)	TSS/Acidity	Ascorbic acid (mg/100 g)
Source of Potassium (Main effect)				
Potassium sulphate(K_1)	18.62	0.48	39.21	38.81
Potassium chloride(K_2)	18.23	0.60	30.78	40.43
SE m ±	0.21	0.01	0.57	0.47
CD(P=0.05)	NS	0.02	1.67	1.39
Dose of potassium (Main effect)				
@ 0%	17.29	0.48	36.46	41.38
@ 1%	18.77	0.57	34.55	39.23
@ 2%	19.22	0.58	33.97	37.65
SE m ±	0.26	0.01	0.70	0.58
CD(P=0.05)	0.76	0.02	2.05	1.70
Stage of application (Main effect)				
Marble stage (S_1)	18.51	0.58	32.91	38.46
Stone hardening stage (S_2)	18.42	0.51	37.07	40.78
SE m ±	0.21	0.01	0.57	0.47
CD (P=0.05)	NS	0.02	1.67	1.39

Table.2 Interaction effect of foliar application of different sources of Potassium, doses and stages with respect to TSS, Acidity, Ascorbic acid on litchi cv. Deshi

Interaction effect		TSS(°Brix)	Acidity(%)	TSS/Acidity	Ascorbic acid (mg/100 g)
Interaction effect (K X D)					
Potassium sulphate (K_1)	@0%	17.47	0.45	38.95	41.57
	@1%	19.64	0.48	42.11	37.86
	@2%	18.76	0.52	36.55	37.01
Potassium chloride (K_2)	@0%	17.11	0.51	33.96	42.39
	@1%	17.90	0.67	27.00	40.60
	@2%	19.67	0.64	31.39	38.30
SE m ±		0.37	0.01	0.99	0.82
CD(P=0.05)		1.08	0.03	2.89	NS
Interaction effect (K x S)					
Potassium Sulphate (K_1)	Marble(S_1)	18.63	0.51	36.69	36.24
	Stone(S_2)	18.S62	0.45	41.72	41.98
Potassium Chloride (K_2)	Marble(S_1)	18.39	0.65	29.14	40.67
	Stone (S_2)	18.06	0.56	32.43	40.18
SE m ±		0.30	0.01	0.81	0.67
CD(P=0.05)		NS	NS	NS	1.97
Interaction effect (S x D)					
Marble stage (S_1)	@0%	16.97	0.46	37.56	40.46
	@1%	18.51	0.66	28.04	39.25
	@2%	20.05	0.63	31.82	35.66
Stone hardening stage (S_2)	@0%	17.61	0.50	35.35	43.50
	@1%	19.03	0.52	38.78	39.21
	@2%	18.38	0.50	37.09	39.65
SE m ±		0.37	0.01	0.99	0.82
CD(P=0.05)		1.08	0.03	2.89	NS

Table.3 Main effect of foliar application of different sources of Potassium, doses and stages with respect to TS, RS, NRS, Anthocynin in litchi cv. Deshi

Treatment	Total sugar (%)	Reducing sugar (%)	Non Reducing sugar (%)	Anthocynin (mg/100 g)
Source of Potassium (Main effect)				
Potassium sulphate(K_1)	15.62	11.44	3.97	32.43
Potassium chloride(K_2)	15.03	11.11	3.72	31.64
SE m ±	0.17	0.11	0.04	0.36
CD(P=0.05)	0.50	0.31	0.10	NS
Dose of potassium (Main effect)				
@ 0%	15.52	10.70	4.58	30.03
@ 1%	15.35	11.81	3.36	32.51
@ 2%	15.11	11.32	3.59	33.56
SE m ±	0.21	0.13	0.04	0.44
CD(P=0.05)	NS	0.38	0.13	1.29
Stage of application (Main effect)				
Marble stage(S_1)	15.10	10.91	3.98	31.29
Stone stage(S_2)	15.55	11.65	3.71	32.78
SE m ±	0.17	0.11	0.04	0.36
CD (P=0.05)	NS	0.31	0.10	1.05

Table.4 Interaction effect of foliar application of different sources of Potassium, doses and stages with respect to TS, RS, NRS, Anthocyaninin litchi cv. Deshi

Interaction effect		Total sugar (%)	Reducing sugar (%)	Non Reducing sugar (%)	Anthocyanin (mg/100g)
Interaction effect(K X D)					
Potassium sulphate (K_1)	@0%	15.48	11.08	4.17	30.41
	@1%	15.49	11.66	3.64	33.05
	@2%	15.90	11.59	4.09	33.84
Potassium chloride(K_2)	@0%	15.57	10.31	5.00	29.65
	@1%	15.20	11.96	3.08	31.97
	@2%	14.32	11.06	3.09	33.29
SE m ±		0.29	0.19	0.06	0.62
CD(P=0.05)		0.87	0.54	0.18	NS
Interaction effect (K x S)					
Potassium sulphate(K_1)	Marble(S_1)	15.64	11.15	4.26	31.08
	Stone (S2)	15.60	11.74	3.67	33.78
Potassium chloride(K_2)	Marble (S_1)	14.56	10.66	3.69	31.49
	Stone (S_2)	15.50	11.55	3.75	31.78
SE m ±		0.24	0.15	0.05	0.51
CD(P=0.05)		NS	NS	0.15	1.49
Interaction effect (S x D)					
Marble stage (S_1)	@0%	15.42	10.18	4.98	29.91
	@1%	15.15	11.58	3.39	31.45
	@2%	14.73	10.96	3.57	32.50
Stone hardening stage (S_2)	@0%	15.63	11.22	4.19	30.15
	@1%	15.54	12.04	3.33	33.57
	@2%	15.49	11.69	3.61	34.62
SE m ±		0.29	0.19	0.06	0.62
		NS	NS	0.18	NS

These results are corroborated with the finding of Dilmaghani *et al.,* (2005) who conclude that application of K at high rates significantly increased fruit soluble solids content in "Golden Delicious" apples and maximum TSS was found with application of 1000g K_2O per tree in "Starking Delicious" apples. Chanana and Gill (2008) observed that foliar application of K_2SO_4 substantially improved TSS and decreased the fruit acidity in "Perlette" grapes. Pathak *et al.,* (2013) also observed that higher rates of both P and K markedly reduced the fruit acidity however, increased TSS/acid ratio.

The maximum total sugar was found with K_2SO_4 @ 2% and minimum with KCl @ 2%. However, the dose of potassium did not showed any significant difference for total sugar. Application of potassium either at marble or stone hardening stage have any significant difference. The results are in accordance with the findings of Ahlawat and Yamdagini (1981) who observed that increased total sugar with potassium in guava fruits might be attributed to higher assimilating power of leaves over longer period resulting in increased availability of sugars to fruits. Potassium is known to enhance photophosphorylation and dark reaction of photosynthesis resulting in increased accumulation of carbohydrates. Similarly according to Taiz and Zeiger (2004) the efflux of sucrose to the apoplast is facilitated by potassium availability which thereby increases sugar translocation from source to sink tissues promoting their growth. Pathak and Mitra (2010) concluded the similar results that fruits from the plants receiving 800 g Potassium chloride in two splits at 15 days after fruit set and 30 days before flowering showed the maximum reducing sugar (14.65 %) content of fruit.

Various other researchers reported similar findings of increase in reducing sugar content with K application Kumar *et al.,* (2006) in "Alphonso" mango.

The ascorbic acid content of litchi fruit has positive effect by the different source of potassium, its doses and stage of application. The interaction effect does not differ for ascorbic acid. The maximum ascorbic acid was recorded with K_2SO_4 applied at stone hardening stage. Increase in ascorbic acid with potassium is connected with improved sugar metabolism. Bhat *et al.,* (2009) reported the maximum ascorbic acid content with foliar application of potassium sulphate (6.02 mg/100 g) and minimum under control (4.14 mg/100 g) in cherry cv. "Makhmali. Bhat *et al.,* (2009) further stated that increases in ascorbic acid content might be attributed to higher synthesis of some metabolites and intermediate substances which promoted the synthesis of precursor of ascorbic acid. The highest anthocyanin content was observed with K_2SO_4applied at stone hardening stage and minimum with control while as source of potassium and its concentration do not registered any significant differences. Potassium play important role in bio synthesis pathway of anthocyanin. The findings are in confirmation with the literature as suggested by Fisher and Kwong (1961) that improvement in colour was noted with application of K fertilization might be due to increased in carbohydrates accumulation in the fruits. In peaches Trevisan *et al.,* (2006) reported that soil application (1200 g of KCl + 10 g KCl) as foliar application combined with vegetative pruning improved red coloration of fruits.

References

Ahlawat, V.P. and Yamdagni, R. (1981). Effect of potassium sprays on quality of guava (*Psidium guajava* L.) cv. Sardar. AgricSci Digest 1: 213-14.

Bhargava B S, Singh H P and Chadha K L

(1993) Role of potassium in development of fruit quality. In: K L Chadha and O P Pareek (ed) Advances in Horticulture, Vol. 2 Fruit Crops. Pp. 947-60. Malhotra Publishing House, New Delhi.

Chanana Y R and Gill M I S (2008) High quality grapes can be produced in Punjab. ActaHort785:85-86.

Dilmaghni M R, Malakouti M J, Neilsen G H and Fallahi E (2005) Interactive effects of potassium and calcium on K/Ca ratio and its consequences on apple fruit quality in calcareous soils of Iran. J Pl Nut., 27: 1149-62.

Fisher E G and Kwong S S (1961) The effect of potassium fertilization on fruit quality of McIntosh apple. Proc Am SocHortSci., 78: 16-23.

Kumar A and Kumar G (2004) Effect of foliar applications of water soluble fertilizer “Multi- K” on yield and quality of Litchi cv. Rose Scented. Adv Pl Sci., 17: 519-23.

Kumar N, Selvi R, Meenakshi N, Balasubramanyan S and Ebert G (2006) Foliar application of potash (SOP) on yield and quality of fruits in mango cv. Alphonso. Intl Symp Balanced Fertilization., 2:446-48.

Menzel C M and Simpson D R (1987) Lychee Nutrition; a review. ScientHort., 31: 195-224.

Menzel K and Kirby E A (2001) Principles of Plant Nutrition. Pp 685. International Potash Institute, IPI, Bern, Switzerland

Pathak P K and Mitra S K (2010) Rate and time of potassium fertilization influence yield and quality of litchi. ActaHort863: 235-42.

Pathak P K, Majumdar K and Mitra S K (2013) Levels and time of potassium fertilization influence soil and leaf nutrient composition and its relation with yield of litchi. Indian J Hort., 69: 33-38

Singh V P, Kumar G and Singh A K (2007) Effect of water soluble fertilizer ‘Polyfeed’ on physicochemical attributes of litchi fruits cv. Rose Scented. *Prog Agric.*, **7**: 22-24.

Taiz Z and Zeiger E (2004) Plant Physiology. Pp 23-45. Porto Alegre, Artmed.

Trevisan, Senoo T, Uno T, Sasabe Y and Tada M (2006) Distinction of astringency in peach fruit using near-infrared spectroscopy. Hort Res., 6: 137-43.

Wang Y, Wang H C, Hu Z Q and Zhou Z K (2010) Litchi good for heath from skin to heart: An overview of litchi functional activities and compounds. ActaHort., 863: 644-45.

Yang S U, Xiao-Chao Zhou, Dan Gao O and Zhou K B (2015) Effects of the changes in the contents of K, Ca and Mg in pericarp on the pericarp's coloring of *Litchi chinensis* cv. Ziniangxi. J CNKI., 33:12-17.

Yang B, Wang J, Zhao M, Liu Y, Wang W and Jiang Y (2006) Identification of polysaccharides from pericarp tissues of litchi (*Litchi chinensis* Sonn.) fruit in relation to their antioxidant activities. Carbohydrate Res., 341:634-38.

How to cite this article:

Karanjeev Kumar, Kumari Madhumala, Sanjay Sahay and Feza Ahmad. 2020. Response of Different Sources of Potassium on Biochemical Quality of Litchi cv. Deshi. *Int.J.Curr.Microbiol.App.Sci.* 9(02): 2281-2290. doi: https://doi.org/10.20546/ijcmas.2020.902.258