Biological Forum – An International Journal **13(3): 631-636(2021)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Impact of Geospatial conditions and Time of Panicle Emergence on the Postharvest Defects and Qualities of Mango var. Alphonso

Prathiksha[1*], Krishna H.C.[2], Vasudeva K.R.[3], Ramegowda G.K.[4], Hanumantharaya B.G.[5], Bhuvaneswari S.[6], Anil Kumar S.[7] and Rakshitha R.S.[1]

[1]*Ph.D. Scholar, Department of Postharvest Technology, College of Horticulture, Bengaluru, (Karnataka), India.*
[2]*Associate Professor, Department of Postharvest Technology, College of Horticulture, Bengaluru,*
[3]*Professor, Department of Postharvest Technology, College of Horticulture, Bengaluru, (Karnataka), India.*
[4]*Assistant Professor, Department of Agricultural Entomology, College of Horticulture, Mysuru, (Karnataka), India.*
[5]*Assistant Professor, Department of Horticulture, UAS, GKVK, Bengaluru, (Karnataka), India.*
[6]*Senior Scientist, Division of PHT & Agricultural Engineering, IIHR, Bengaluru, (Karnataka), India.*
[7]*Assistant Professor, Scientist (SS & AC), ICAR-KVK, Tamaka, Kolar, (Karnataka), India.*

(Corresponding author: Prathiksha)*
(Received 14 June 2021, Accepted 20 August, 2021)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Mango varieties are susceptible to different postharvest defects like spongy tissue, anthracnose, fruit fly and stem end rot and their intensity depends on growing conditions and locations. Limited information is available on the influence of locations on these defects. In this study, different geospatial parameters *viz.* altitude, temperature, rainfall, humidity, soil nutrients were analyzed to assess their impact on the quality and postharvest defects in mango var. Alphonso. Panicles were tagged thrice with an interval of 10 days at different locations *viz.* Bengaluru, Chikkaballapura, Hogalgere and Ramanagara (about 228km distant from each other). Mangoes were harvested and quality was analyzed. Results revealed that, fruits from Hogalgere were free from fruit flies but had highest incidence of spongy tissue (20.9%). The fruits from Chikkaballapura had highest fruit fly infestation (30%). Anthracnose infection was highest in fruits from Bengaluru (11.9%). Stem end rot was highest in fruits from Ramanagara (26.6%). The fruits from Ramanagara exhibited highest respiration rate (66.01mg $CO_2Kg^{-1}h^{-1}$) with minimum shelf life (13 days). Thus the impact of geospatial conditions and the time of panicle emergence determine the quality and shelf life of the fruits, so that location specific management practices are standardized.

Keywords: Altitude, geospatial, mango quality, postharvest defects, respiration.

INTRODUCTION

There are many reasons why fruits experience stress and the quality is deteriorated. The geospatial conditions pose a striking effect on postharvest quality of fruits and the adverse conditions during the growth and development of the fruits ultimately make them highly perishable. These conditions include altitude, temperature, rainfall, humidity, nutrient status of the soil, etc. together which contribute to the overall quality and shelf life of the fruits (Ahmad and Siddiqui, 2016). Also the time of panicle emergence is important for the overall quality since the early, mid and late emerged panicles experience different conditions during the development in spite of being in same orchard or even on same tree (Ambuko *et al*., 2017). However fruits picked too early or too late are more prone to physiological disorders rather that fruits picked at right stage of maturity (Kader, 2002). Nevertheless, these conditions are interrelated which have a wholesome effect. An estimate suggests that about 4.58-15.88 per cent of total fruits and vegetables production is lost in between harvest and final consumption (Anon., 2019). Mango is a seasonal fruit and requires specific conditions for flowering and fruit development (Jameel *et al*., 2018). Therefore, geospatial conditions play pivotal role and needs to be studied in depth. This experiment was conducted to comprehend the impact of geospatial conditions and panicle emergence on occurrence of postharvest qualities and defects in mango var. Alphonso.

MATERIAL AND METHODS

The experiment was conducted during 2018-19 in four different locations *viz.* Bengaluru, Chikkaballapura, Hogalgere and Ramanagara with distinct geospatial parameters having altitudes of 930, 865, 836 and 747 m mean sea level respectively. The panicles were tagged at each location at different intervals using different colored tags *i.e.* white, yellow and pink for early, mid and late emerged panicles respectively as and when they emerged at an interval of 10 to 15 days and they were harvested when they reached optimum mature stage (Table 1).

Table 1: Panicle emergence, tagging and fruit growth and development of mango var. Alphonso at different locations.

	Tagging	Harvesting	DAP	DAF	Tagging	Harvesting	DAP	DAF
	Bengaluru				Chikkaballapura			
First tagging	27/12/18	11/05/2019	**136**	**101**	20/12/18	07/05/2019	**139**	**104**
Second tagging	08/01/19	20/05/2019	**132**	**98**	07/01/19	18/05/2019	**131**	**96**
Third tagging	20/01/19	31/05/2019	**132**	**98**	21/01/19	29/05/2019	**129**	**94**
	Hogalgere				Ramanagara			
First tagging	25/12/18	27/05/2019	**153**	**119**	08/12/18	16/04/2019	**130**	**95**
Second tagging	31/12/18	27/05/2019	**148**	**113**	23/12/18	28/04/2019	**126**	**91**
Third tagging	06/01/19	27/05/2019	**141**	**106**	10/01/19	10/05/2019	**120**	**85**

DAP: Days after panicle emergence; DAF: Days after flowering

The mango var. Alphonso fruits were harvested at optimum maturity, sorted and disinfected with 200 ppm sodium hypochlorite. Further, fruits were pre-cooled; de-sapping carried out by trimming the stalk to 0.6-1.0 cm and kept in de-sapping tray for about 4 hours at room temperature. Fruits were ripened using portable ethylene gas can (Make: Chemtron, Model: Ripelene-6) in ripening chamber at room temperature (28ºC). These fruits were used for the experiment and completely randomized design was used to analyze the results.

The major postharvest defects were spongy tissue, anthracnose, fruit fly and stem end rot. During the storage, the incidence of all of these defects were recorded by counting of infected/infested fruits in numbers during storage and expressed in percentage.

Physiological loss in weight (PLW %) of the fruit was recorded using 10mg precision electronic weighing balance (Make: Sartorius Germany, Model: GE812) before storage. Thereafter, the weights were recorded at 3 days interval during storage and the per cent cumulative PLW was calculated using the standard

Respiration rate (mg CO_2 $kg^{-1}h^{-1}$): The fruits of known volume were enclosed in a hermetic container for specified time and head space gas concentration of CO_2 was measured by an auto oxygen/carbon dioxide analyzer (Make: Quantek, Model: 902D Dual track) and direct reading was noted down from the instrument screen and was calculated using the following formula.

$$\text{Respiration rate (mg kg}^{-1}\text{ h}^{-1}) = \frac{2 \times \%\ CO_2 \times \text{Container volume (ml)} \times 60}{\text{Fruit weight (kg)} \times \text{Enclosing time (min)} \times 100}$$

RESULTS AND DISCUSSION

Spongy tissue: The mango variety Alphonso is very susceptible to spongy tissue and the main reason is extremely high temperature, late harvest, low calcium in soil and the heat waves from the soil. The fruits from Ramanagara were harvested during April and early May and they remained on the tree for a shorter period of time. Also the root zone in orchard in Ramanagara was covered by abundant mulching. The fruits had no incidence of spongy tissue (Fig. 1) as it experienced early harvest and lower temperature (36ºC). Contrarily, in the absence of mulch, the high temperature (39ºC) and heat waves damaged the protoplasm of the cells accompanied by inactivation of enzymes amylase and invertase (Katrodia and Sheth 1989) which was the case in Hogalgere as the trees in Hogalgere had no mulching. Hence, they had the highest incidence of spongy tissue (18.6%).

Also, the incidence was higher in the fruits from third week of panicle emergence. It might be due to extremely high temperature in the month of May and depletion of calcium in the soil. Raja, (2009) reported that fruits harvested in late May are more prone to spongy tissue and similar results were reported by Dutta and Majumdar (2012); Ram *et al.,* (2020).

Fruit fly: Among the four locations, only fruits from Chikkaballapura and fruits from later emerged panicles in Bengaluru experienced fruit fly infestation (*Bactrocera dorsalis* Hendel.). There was no infestation in the fruits from Hogalgere and Ramanagara and early emerged panicles in Bengaluru (Fig. 1). This may be due to fact that, these locations experienced early summer rains prior of mango harvest. Early summer rain is the prerequisite for fruit fly pupa to emerge out of soil as flies and to invade fruits (Verghese *et al.,* 2002).

First week emerged panicle fruits had relatively lesser fruit fly incidence than late emerged panicle. The fruit fly incidence increases delay in maturity (Kwasi, 2008). Availability of the ripe and near ripe mango stage is very much essential for egg laying, larval development, pupation and adult vigor (Rattanapun *et al.,* 2009). Besides rainfall for fruit fly emergence, higher relative humidity ensures favorable conditions for hatching of the egg and pupation. The fruits from Hogalgere and Ramanagara had no incidence of fruit flies and cause is the lack of these favorable conditions for the pest to establish and perpetuate.

Anthracnose: Anthracnose (*Colletotrichum gloeosporiodes* Penz.) causes black spots and is one of the wide spread diseases occurring in mango var. Alphonso which appeared in both field and storage period. Developing fruits are infected in the field but infections remain quiescent until the onset of ripening, when anthracnose lesions develop (Arauz, 2000; Sivakumar *et al.,* 2011).

In this experiment, anthracnose was observed in the fruits from all the locations (Fig. 1). The fruits from first week of panicle emergence showed lesser incidence than fruits obtained from subsequent emerged panicle. There was no infection in the first and second week emerged panicles in Chikkaballapura but was it was higher in the fruits from third week of panicle

emergence in Bengaluru (11.9%) and Hogalgere (11.6%). This was due to favorable environmental condition such as frequent rain fall, high RH and moderate temperature (24 to 32ºC) in the later stages of fruit development. These conditions favor growth of fungus which ultimately leads to decay of fruits during storage period. Dutta and Majumdar (2012); Dodd *et al.*, (1991) conveyed the similar result.

Stem end rot; Stem end rot is caused by *Lasiodiplodia theobromae* (Pat.). Pathogen enters the fruit through the stem end and the pericarp darkens near the base of the pedicel. Later affected area enlarges to form a circular black patch which under humid atmosphere extends rapidly and turns the whole fruit into complete black within 2 to 3 days and causes the spoilage of fruits.

In this study, stem end rot was noticed in fruits from all the locations throughout the storage period irrespective of panicle emergence, whereas, fruits from early emerged panicle had lesser incidence than late emerged panicle of mango var. Alphonso during the storage period (Fig. 1). The infection ranged from 2.8 per cent in first week emerged panicles from Chikkaballapura to 25.60 per cent in Ramanagara fruits, where panicles emerged at third week. Favorable environmental condition such as frequent rain fall, high RH and moderate temperature were responsible for the infection and similar result was conveyed by Dutta and Majumdar (2012).

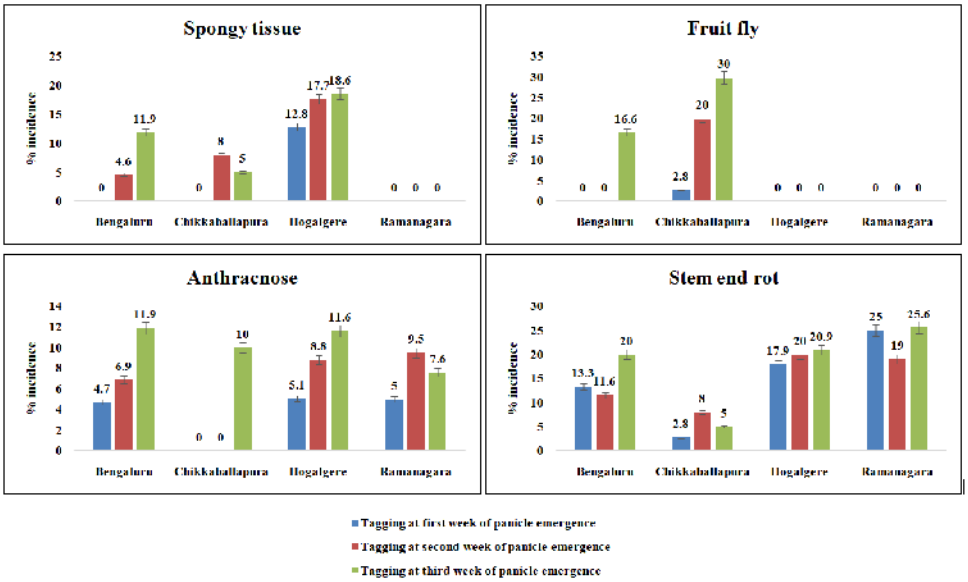

Fig. 1. Incidence of postharvest defects in mango var. Alphonso as influenced by geospatial variation and panicle emergence (%).

Incidence of spongy tissue.

Incidence of anthracnose.

Incidence of fruit fly.

Incidence of stem end rot.

Fig. 2. List of postharvest defects encountered during storage of mango var. Alphonso.

Physiological loss in weight (PLW %): The continuous process of respiration and transpiration in the fruits during storage is the main cause for the physiological loss in weight (Table 2). This process was higher in the fruits from Ramanagara since they experienced relatively higher prevailing temperature during harvesting and storage as compared to fruits from other locations. Also moisture content in the storage conditions influence the respiration and PLW in the fruits. The fruits from Ramanagara experienced lower relative humidity (50.38%) as compared to the fruits from other locations. The fruits from Hogalgere were harvested late and the storage temperature was relatively low (27°C) and the relative humidity was high during the storage of these fruits (63.27%). Also the fruits had higher amount of dry matter experience lesser loss in weight. Therefore the fruits from Hogalgere had the lowest physiological loss in weight. Similarly the fruits from first week of panicle emergence exhibited the lowest PLW. Similar results were reported by Burdon *et al.,* (2004); Spadaro *et al.,* (2010).

Table 2: Effect of geospatial variations and panicle emergence on physiological loss in weight (%) of mango var. Alphonso during storage

		Day 3	Day 6	Day 9	Day 12	Day 15
Factor I	L_1	2.48	3.10	6.29	9.95	14.34
	L_2	2.13	2.46	6.27	10.39	14.11
	L_3	2.24	2.79	5.02	6.79	8.44
	L_4	2.26	2.90	9.96	15.66	17.01
	S. Em. (±)	**0.12**	**0.25**	**0.46**	**0.60**	**0.70**
	CD (5%)	**NS**	**NS**	**1.39**	**1.81**	**2.12**
Factor II	T_1	2.60	3.03	7.50	11.41	14.49
	T_2	2.13	2.67	6.33	10.04	13.58
	T_3	2.35	2.73	6.82	10.65	10.10
	S. Em. (±)	**0.18**	**0.22**	**0.41**	**0.53**	**0.61**
	CD (5%)	**NS**	**NS**	**NS**	**NS**	**1.83**
Interaction						
L_1 T_1		1.98	3.52	7.09	10.30	14.55
L_1 T_2		1.86	2.28	4.33	7.78	11.25
L_1 T_3		2.18	3.51	7.45	11.80	17.21
L_2 T_1		2.22	2.58	6.86	10.56	13.38
L_2 T_2		2.45	2.45	6.25	10.14	14.77
L_2 T_3		2.66	2.34	5.69	10.45	14.18
L_3 T_1		1.80	3.42	5.78	7.66	7.79
L_3 T_2		1.82	2.65	4.67	6.51	8.35
L_3 T_3		1.85	2.29	4.62	6.21	9.01
L_4 T_1		2.88	2.61	10.28	17.12	22.06
L_4 T_2		2.75	3.28	10.07	15.72	19.95
L_4 T_3		2.80	2.79	9.52	14.15	19.65
S. Em. (±)		**0.42**	**0.43**	**0.81**	**1.05**	**1.22**
CD (5%)		**NS**	**NS**	**2.43**	**3.16**	**3.67**

* Significant at 5% ($P_{0.05}$), NS: Non significant at 5% ($P_{0.05}$); Fruits stored at ambient condition in PHT lab in Bengaluru; L_1- Bengaluru (Stored during month of May, Avg. temp.: 28.97°C, RH: 54.55%); L_2- Chikkaballapura (Stored during month of May, Avg. temp.: 28.97°C, RH: 54.55%); L_3- Hogalgere (Stored during month of June, Avg. temp.: 27.73°C, RH: 61.15%); L_4- Ramanagara (Stored during month of April, Avg. temp.: 28.31°C, RH: 53.19%); T_1- Tagging at first week of panicle emergence; T_2- Tagging at second week of panicle emergence; T_3- Tagging at third week of panicle emergence

Respiration rate: There was significant difference in respiration rate of the fruits from different locations. Respiration involves a series of biochemical changes like ethylene production and changes in structural polysaccharides causing softening of texture (Devanesan *et al.,* 2011). Lower respiration rate was recorded in the fruits from Hogalgere (Fig. 3). It also depends on the storage temperature in the location. Usually the fruits which grow under stress are immune to respiration and moisture loss (Karabacak and Karabacak, 2019). Also the fruits from late emerged panicle respire more than early emerged panicle because energy is released in a series of metabolic steps leading to breakdown of complex materials such as starch, sugars and organic acids are broken-down into simpler molecules *viz*. carbon dioxide and water and the rate of respiration of a fruit is directly proportional to shelf-life; higher the rate of respiration, lower the shelf-life.

In climacteric fruit, respiration rate shows a decreasing trend to the lowest value termed as pre climacteric minimum followed by a sharp rise in respiration rate to the climacteric peak. This sudden rise is called as respiratory climacteric followed by a decrease in respiration rate in the senescence period (Sen *et al.,* 2012). The process of respiration involves the role of many enzymes which are highly dependent on the temperature. This phenomenon was observed in the mangoes from all four locations and all the harvests.

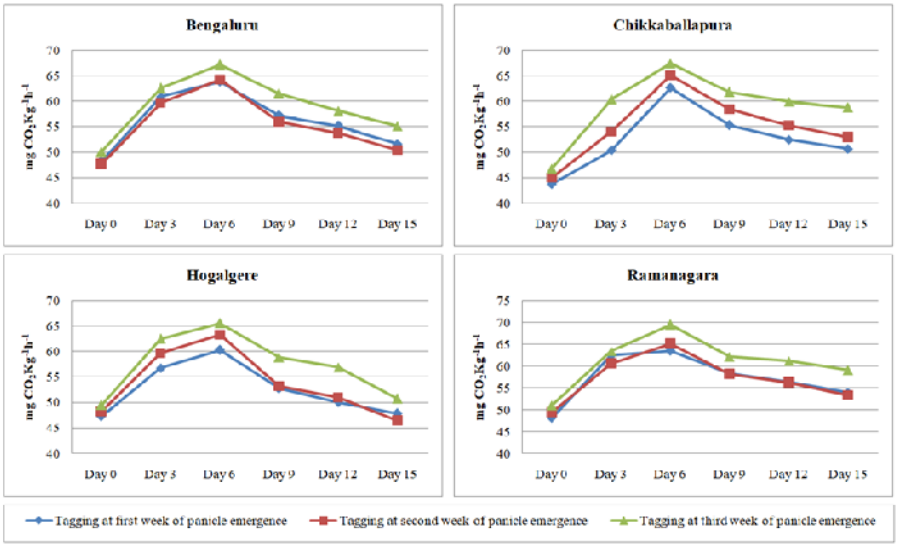

Fig. 3. Effect of geospatial variations and panicle emergence on respiration rate (mg $CO_2Kg^{-1}h^{-1}$) of mango var. Alphonso during storage.

Correlation: The different physical and physiological parameters were correlated with days after flowering and the geospatial parameters (Table 3). It was observed that days after flowering had a strong negative correlation with PLW (0.97) and respiration rate (0.97). Temperature had positive correlation with PLW (0.72) and respiration rate (0.64) but negative correlation with shelf life (0.68). The soil nutrients were correlated with physical and physiological parameters (Table 4). Nitrogen had positive correlation with PLW and respiration rate. And shelf life was positively correlated with nitrogen (0.78), phosphorus (0.62) and potassium (0.74).

Table 3: Correlation of geospatial conditions with physical and physiological parameters of mango var. Alphonso.

Variables	DAF	Altitude (m MSL)	Rainfall	RH	Temp (Max)	Temp (Min)	Physiological loss in weight	Respiration rate	Shelf life
DAF	**1**								
Altitude (m MSL)	0.33	**1**							
Rainfall	-0.11	0.64*	**1**						
RH	-0.73**	-0.89**	-0.41	**1**					
Temp (Max)	-0.54	-0.92**	-0.30	0.93**	**1**				
Temp (Min)	0.20	0.15	-0.62*	-0.20	-0.48	**1**			
Physiological loss in weight	-0.97**	-0.51	0.08	0.84**	0.72**	-0.36	**1**		
Respiration rate	-0.97**	-0.37	0.25	0.74**	0.64*	-0.44	0.99**	**1**	
Shelf life	0.98**	0.53	0.08	-0.86**	-0.68*	0.16	-0.98**	-0.94**	**1**

Table 4: Correlation of available soil nutrients with chemical and physiological parameters of mango var. Alphonso.

Variables	Available Nitrogen	Available Phosphorus	Available Potassium	Exchangeable Calcium	Exchangeable Magnesium	Physiological loss	Respiration rate	Shelf life
Available Nitrogen	**1**							
Available Phosphorus	0.62*	**1**						
Available Potassium	0.34	0.79**	**1**					
Exchangeable Calcium	0.45	0.83**	0.35	**1**				
Exchangeable Magnesium	0.21	0.66*	0.16	0.96**	**1**			
Physiological loss	-0.86**	-0.53	-0.59*	-0.10	0.18	**1**		
Respiration rate	-0.93**	-0.56	-0.51	-0.20	0.08	0.99**	**1**	
Shelf life	0.78**	0.62*	0.74**	0.14	-0.15	-0.98**	-0.94**	**1**

DAF: Days after flowering; MSL: Mean sea level; RH: Relative humidity; *: significant correlation at 5% ($P_{0.05}$); **: highly significant correlation at 5% ($P_{0.05}$)

CONCLUSION AND FUTURE SCOPE

All the postharvest defects and quality attributes have deep connection with geospatial conditions and time of harvest, hence location specific pre and postharvest practices is inevitable. Postharvest defects stem end rot and anthracnose occurred in all the locations whereas, fruit flies and spongy tissue was location specific. Harvesting at optimum maturity maintains the qualities and the fruits harvested from early emerged panicles had fewer incidences of defects than the subsequent ones. Postharvest management of fresh mangoes is a

challenging, however, understanding geospatial condition and its intricate correlation details may aid in maintaining the postharvest quality and extending the shelf life of mangoes. Long term assessment of heat units required in different locations may be calculated to aid in staggered harvesting in different locations to avoid the postharvest defects and ultimately preserving the post harvest quality and shelf life.

Acknowledgement. Authors are thankful to University of Horticultural Sciences, Bagalkot, and progressive mango grower Mr. Pranesh from Ramanagara and Department of Horticulture, Government of Karnataka for extending facilities for the research.

Conflict of Interest. Nil.

REFERENCES

Ahmad, M. S., & Siddiqui, M. W. (2016). Postharvest Quality Assurance of Fruits. *Springer*, *2*: 7-32.

Ambuko, J., Kemunto, N., Hutchinson, M., & Owino, W. (2017). Comparison of The Postharvest Characteristics of Mango Fruits Produced Under Contrasting Agro-Ecological Conditions and Harvested at Different Maturity Stages. *Journal of Agricultural Science*, *9*: 181-192.

Anonymous (2019). Annual report (2018-19), CIPHET, Ludhina.

Arauz, L. F. (2000). Mango Anthracnose: Economic Impact and Current Options for Integrated Management. *Plant Diseases*, *84*: 600–611.

Burdon, J., McLeod D., Lallu, N., Gamble, J., Petley, M., & Gunson, A. (2004). Consumer Evaluation of 'Hayward' Kiwi Fruit of Different at-harvest Dry Matter Contents. *Postharvest Biology and Technology*, *34*: 245-255.

Devanesan, J. N., Karuppiah, A., & Abirami, C. K. (2011). Effect of Storage Temperatures, O_2 Concentrations and Variety on Respiration of Mangoes. *Journal of Agrobiology*, *28*(2): 119-128.

Dodd, J. C., Bugante, R., Koomen, I., Jeffries, P., & Jeger, M. J. (1991). Pre and Postharvest Control of Mango Anthracnose in the Philippines. *Plant Pathology*, *40*(4): 576-583.

Dutta, P., & Majumdar, D. (2012). Influence of Bagging on Fruit Quality and Mineral Composition of Himsagar Mango Grown in New Alluvial Zones of West Bengal. *Advances in Horticultural Sciences, 26*: 158-162.

Jameel, A., Naik, S. M. R., Madhumathi, C., Reddy D. S., & Venkataramana, K. T. (2018). Physiology of Flowering in Mango. *Journal of Pharmacognosy and Phytochemistry, 7*(6): 2375-2382.

Kader, A. A. (2002). Postharvest Biology and Technology: An overview. *Postharvest technology of horticultural crops, 3311*: 39-47.

Karabacak, C. E., & Karabacak, H. (2019). Factors Affecting Carotenoid Amount in Carrots (*Daucus carota*). *Ecological Life Sciences, 14*(2): 29-39.

Katrodia, J. S., & Sheth, I. K. (1989). Spongy Tissue Development in Mango Fruit of Cultivar Alphonso in Relation to Temperature and its Control. *Acta Horticulturae*, *231*: 827-834.

Kwasi, W. (2009). Assessment of Fruit Fly Damage and Implications for the Dissemination of Management Practices for Mango Production in the Upper West Region of Ghana. *Journal of Developments in Sustainable Agriculture*, *3*(2): 117-134.

Raja, M.E. (2009). Investigation on Causes and Correction of Spongy Tissue in Alphonso Mango (*Mangifera indica* L.). *Acta Horticulturae*, *820*: 697-706.

Ram, R.A., Rahim, M. A., & Alam, M.S. (2020). Diagnosis and Management of Nutrient Constraints in Mango. *Fruit Crops*, *12*: 629-650.

Rattanapun, W., Amornsak, W., & Clarke, A. R. (2009). *Bactrocera dorsalis* Preference for and Performance on Two Mango Varieties at Three Stages of Ripeness. *Entomologia Experimentalis et Applicata*, *131*(3): 243-253.

Sen, C., Mishra, H. N., & Srivastav, P. P. (2012). Modified Atmosphere Packaging and Active Packaging of Banana (*Musa* spp.): A Review on Control of Ripening and Extension of Shelf Life. *Journal of Stored Products and Postharvest Research, 3*(9): 122 - 132.

Sivakumar, D., Jiang, Y., & Yahia, E. M. (2011). Maintaining Mango (*Mangifera indica* L.) Fruit Quality During the Export Chain. *Food Research International*, *44*: 1254–1263.

Spadaro, D., Galliano, A., Pellegrino, C., Gilardi, G., Garibaldi, A., & Gullino, M. L. (2010). Dry Matter, Mineral Composition and Commercial Storage Practices Influence the Development of Skin Pitting Caused by *Cadophora luteo-olivacea* on Kiwifruit 'Hayward'. *Journal of Plant Pathology*, *5*: 349-356.

Verghese, A., Madhura, H. S., Kamala Jayanthi, P. D., & Stonehouse, J. M. (2002) Fruit Flies of Economic Significance in India, With Special Reference to *Bactrocera dorsalis* (Hendel). *In: Proceedings of 6th Int. Fruit fly Symposium*. May 6, South Africa. pp. 6-10.

How to cite this article: Prathiksha, Krishna, H.C., Vasudeva, K.R., Ramegowda, G.K., Hanumantharaya, B.G., Bhuvaneswari, S., Anil Kumar, S. and Rakshitha, R.S. (2021). Impact of Geospatial conditions and Time of Panicle Emergence on the Postharvest Defects and Qualities of Mango var. Alphonso. *Biological Forum – An International Journal*, *13*(3): 631-636.