

# Growth, Yield and Keeping Quality of Tomato Cultivars at Central mid-hills of Nepal

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## Abstract

Tomato seedlings of seven tomato cultivars with Dalila and Srijana as check were transplanted on March first week, 2020 at Khumaltar. Crop geometry was maintained with the 70X60 cm in three replications and fertilized with 150:120:100 NPK kg + 20-ton FYM per hectare. The main objective of this study was to evaluate and select high yielding, good keeping quality with preferred characters at open field conditions for central mid-hills. Observation was recorded on vegetative, insect pest and disease, keeping quality, Ascorbic acid content and yield attributing parameters. Among the tested cultivars 13X7 showed superior performance that was late blight resistant (2.3), early days to flowering (17), higher number of fruits per plant (5.9), superior yield (55.17 t/ha) and 2404 gm per plant, consumers and farmers preferred, and medium; in fruit size, TSS (5.6), Ascorbic acid content (292 mg/100 g). It has superior keeping quality; least shrinkage (2.3), significantly higher marketable fruit weight remain percentage (74.9) and least rotten percent (15.2) at 24 days after storage (DAS). The next superior cultivar is Srijana which has late blight (2.7), days to flowering (21), higher number of fruits per cluster (7), superior yield (65.78 t/ha) and 2763 gm per plant, consumers and farmers preferred, medium; fruit size, TSS (4.9), Ascorbic acid content (128 mg/100g), and superior keeping quality; less shrinkage (2.7), higher marketable fruit weight remain percent (76.6) and less rotten percent (17.1) at 24 DAS. These two cultivars are recommended for cultivation in central mid-hills of Bagmati Pradesh in open field conditions.

**Keywords:** Cultivar, disease, high yielding, open pollinated, open field

## Introduction

Tomato the most popular home garden and the world's second most consumed vegetable after potato (Ebert, 2020). It known as the world's most widely grown and processed (FAOSTAT, 2017). Nepal area under tomato cultivation is around 21,981 ha with a total

production of 410,721mt with average yield of 19mt/ha (MoALD, 2018). In the Bhaktapur district, tomato production is 4908mt in the area of 239ha land and productivity is 21mt/ha. In the Kathmandu district, tomato production is 5656mt in the area of 352ha land and productivity is 16mt/ha. In the Lalitpur district, tomato

production is 7141mt in the area of 623ha and with a productivity of 11mt/ha (MoALD, 2018).

Any change in the amount or quality of any after-harvest product that prevents or reduces the intended consumption of the product or decreases its value is a post-harvest loss (Kiaya, 2014). After production, management, collection, storage, packaging, transport, and marketing are of the post-harvest activities (Mrema & Rolle, 2002). Acceleration of deterioration can be due to high temperature, low humidity, incorrect atmosphere, and physical damage in the transportation process as well as in storage (Gorny, 2001). Fresh fruits and vegetables, including tomatoes, are projected to have postharvest losses of 5 to 25 percent in developed countries and 20-50% in developing countries (Kader et al., 1985). Around 20-50% of tomato fruit harvested for consumption has been estimated to be wasted due to microbial spoilage and other damage incurred during transit by volatile stresses, rough loading, and unloading (Aworth, 1985).

The estimated postharvest loss of fruit and vegetable in Nepal lies in the range of 20-50 percent (Gautam & Bhattarai, 2006). It is very difficult to increase a 10% yield but easy to reduce 10% loss without bringing additional land for production (Gautam & Bhattarai, 2006).

Tomato crops in open field at mid-hills have peak harvesting period before monsoon when prices are very low but later after initiation of monsoon prices increase tremendously. If peak time harvested tomato could be stored for longer period, it extends the use and fetches the good price.

The main objective of this study was to evaluate and select tomato cultivar having high yield, good keeping quality with preferred characters at open field condition for central mid-hills.

## Materials and methods

Twenty days old seedlings of seven advanced tomato genotypes were transplanted in the open field with a spacing of 60 x 60 cm in 3 replications. The standard recommended dose of fertilizers (150:120:100 NPK kg/ha + 15-ton (FYM/ha) was applied and fungicide was sprayed only two times. Observation on vegetative, insect pest and disease, keeping quality, Ascorbic acid content and yield attributing parameters were recorded.

### **Rotten (%)**

Fruits were evaluated visually for symptoms of rotten at the end of each storage interval. Samples having diseased symptoms were counted.

$$\text{Rotten (\%)} = \frac{\text{Number of rotten fruits}}{\text{Number of total fruits}} \times 100$$

### **Ascorbic acid**

The ascorbic acid of ripe fruits was measured by volumetric method as per the reference from Sadasivam and Manickam (1991). Following formula was used to calculate the ascorbic acid content.

$$\begin{aligned} \text{Amount of ascorbic acid (mg/100 g sample)} \\ = \frac{0.5 \text{ mg} \times V_2 \text{ mL} \times 12 \text{ mL} \times 100}{V_1 \text{ mL} \times 5 \text{ mL} \times \text{wt. of sample}} \end{aligned}$$

Where, V<sub>1</sub> = amount of dye consumed during the titration

V<sub>2</sub> = amount of dye consumed when the supernatant was titrated with 4% oxalic acid

### **Shrinkage**

Shrinkage of the fruit was measured using 1 to 5 hedonic scales, 1 for no shrinkage and 5 for highly shrinkage fruits. The panelist of 10 scientist and technical officer was involved in scoring the shrinkage of the fruit on the last day of storage.

### Freshness

Fruits were evaluated visually for freshness at the end of each storage interval. Samples having less freshness were counted.

$$\text{Freshness (\%)} = \frac{\text{Number of fresh fruits}}{\text{Number of total fruits}} \times 100$$

## Results and discussion

### Vegetative and Disease parameter

Result showed that among the tested cultivars 9331 had good plant uniformity (4.7). Cv. 9331, 1455, and Srijana were most vigorous (4.7). The highest plant height was measured in Srijana (127 cm) followed by 9331 (112 cm). 13X7 was least affected (2.3) and 9708 was most affected (5.7) by late blight disease (Table 1).

**Table 1.** Vegetative and disease parameter of tomato genotypes at Khumaltar

S.N.	Cultivars	Plant uniformity (1-5 scale)	Plant vigor (1-5 scale)	Plant height (cm)	Growth habit	Late-blight (1-9)
1	13X7	3.3	3.3	106	SD	2.3
2	1418	3.7	4.0	56	D	4.3
3	9708	3.7	4.0	53	D	5.7
4	9331	4.7	4.7	112	ID	4.7
5	1455	4.0	4.7	107	ID	3.3
6	Srijana	4.0	4.7	127	ID	3.3
7	Dalila	3.0	3.3	79	D	6.7
	CV%	14.21	13.23	10.29		21.07
	F-test	*	*	**		**
	LSD <sub>0.05</sub>	0.95	0.96	16.71		1.62

Uniformity and vigor: 1: Poor, 5: Excellent Disease: 1: None, 9: Dead,

Growth habit: D: Determinate, SD: Semi-determinate, ID: Indeterminate

### Yield attributing characters

13X7, 1418, 9708, 9331 and 1455 bear earliest flowers at 17DAT (Days After Transplanting). The highest Number of flowers per cluster (9.0) was in Srijana followed by 13X7 (8.2) and the least was observed in 1418. The highest Number of fruits per cluster (7.0) was in Srijana and the lowest was seen in 9708 (4.3). The highest fruit yield was obtained from Srijana (72.44 t/ha) followed by 13X7 (55.17 t/ha) and Dalila (46.50 t/ha) whereas the least yield was recorded from

9708 (22.38 t/ha). Significant differences were observed among the studied tomato genotypes indicating genetic variability among selected genotypes. This result was in conformity with the results found by Enojike and Emuh (2015) and Atugwn and Unguru (2011) who reported that differences in growth and yield characters could be attributed to variation in genetic constitution that they expressed. The least weight loss was recorded in Cv. 1418 (3.8%) after 24 days storage in ordinary room condition followed by Srijana (6.2%). This difference

in weight loss could be due to variation in the pericarp thickness, thin pericarp aggravating weight loss and rate of respiration among the varieties and transpiration loss. This finding was in line with the results of (Shena and Tariq, 2007). The highest Freshness fruit weight of

remaining tomatoes 24 DAS was obtained in Srijana (83.8%) followed by 13x7 (82.9%) and the least Freshness fruit % wt remaining was in 1455 (25.6) (Table 2).

**Table 2.** Yield performance of tomato genotypes at Khumaltar

S.N.	Cultivars	Days to flowering	No. of flowers /cluster	No. of fruits /cluster	Yield (t/ha)	Weight loss % (24 DAS)	Remain Freshness fruit % wt (24 DAS)
1	13X7	17	8.2	5.9	57.24	9.8	82.9
2	1418	17	5.6	4.7	28.07	3.8	57.7
3	9708	17	6.5	4.3	23.17	11.5	49.8
4	9331	17	6.5	4.9	41.33	12.2	27.9
5	1455	17	7.1	5.3	41.11	9.5	25.6
6	Srijana	21	9.0	7.0	65.78	6.2	83.8
7	Dalila	22	7.7	6.0	46.50	11.7	80.6
	CV%	3.59	14.22	15.09	23.99	57.14	33.31
	F-test	**	*	*	**	ns	**
	LSD <sub>0.05</sub>	1.17	1.82	1.46	18.48		34.57

### Consumer and Farmer response

Based on the size, consumer preferred 9708 (3.3) variety the most followed by 1418 (3.0). 13X7, 1418, Srijana, and Dalila were equally preferred (4.7) according to the shape. Each of the cultivars had similar mean preference on the basis of the color. Consumer response was the highest (4.0) for 13X7, 1418, and Srijana for the Freshness of the tomato. Farmer preferred 13X7, 9331 and Srijana (4.3) according to the plant appearance. On the basis of marketability, 13X7, 1418, 9331, Srijana, and Dalila had more response (4.0). 1455 and 9708 had the most excellent response from the farmer for insect resistance. Cultivars 9708 and 1455 (3.7) were found to be more disease resistant according to farmer's response and Dalila was least preferred (2.7) (Table 3).

**Table 3.** Consumer and farmer response of seven tomato at Khumaltar

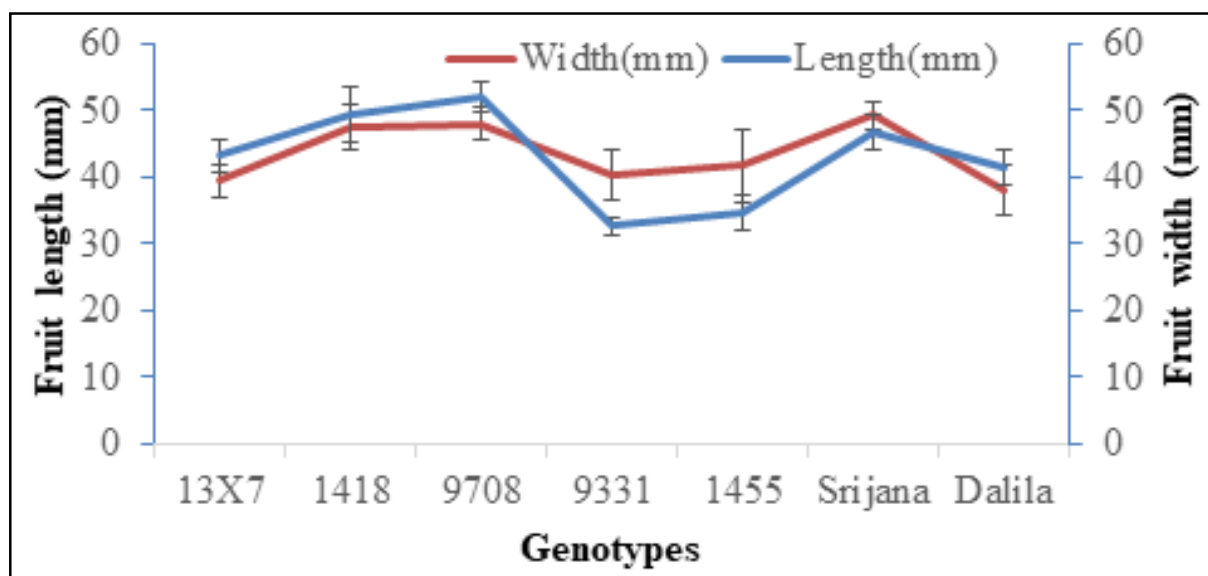
Cultivars	Consumer response <sup>x</sup>				Farmers response <sup>x</sup>			
	Size	Shape	Color	Freshness	Plant appearance	Marketability	Insect	Disease
13X7	2.7	4.7	5	4.0	4.3	4.0	4.0	3.0
1418	3.0	4.7	5	4.0	2.3	4.0	4.0	3.3
9708	3.3	4.3	5	3.3	2.3	3.3	4.6	3.7
9331	2.3	4.3	5	3.3	4.3	4.0	3.4	3.3
1455	2.3	3.0	5	3.0	4.0	3.3	4.6	3.7
Srijana	2.7	4.7	5	4.0	4.3	4.0	4.0	3.3

Dalila	2.7	4.7	5	3.7	4.0	4.0	4.0	2.7
CV%	14.9	10.19		16.74	14.90	15.85	17.67	21.48
F-test	ns	**		ns	**	ns	ns	ns
LSD <sub>0.05</sub>	.76	.805		-	.97	-	-	-

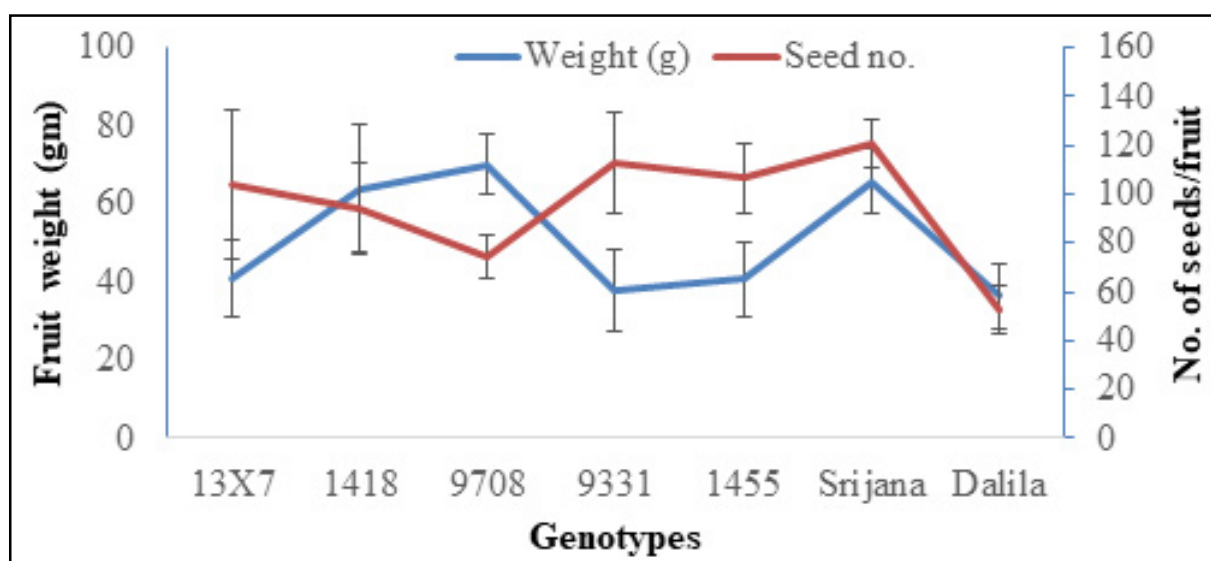
X 1: unacceptable, 5: excellent

**Fruit Characteristics**

The highest mean fruit weight (70.1gm) and length (52.2 mm) was found in 9708, width in Srijana (49.3 mm). Cultivar 1418 had the greatest Pericarp thickness (6.8mm) followed by 9708 (6.1mm) and Srijana (6.0 mm). Srijana had the most numbers of seed (120) whereas Dalila had the least (52.5). The superior TSS was found in cultivar 9331 (7.3) while greatest Ascorbic acid contains was found in 1455 (400 mg). The cultivar 1455 (3.4) had the most preferred taste followed by 1418 and Dalila (3.2).



**Figure 1.** Fruit length and width of different tomato genotypes



**Figure 2.** Fruitweight and no. of seeds of different tomato genotypes

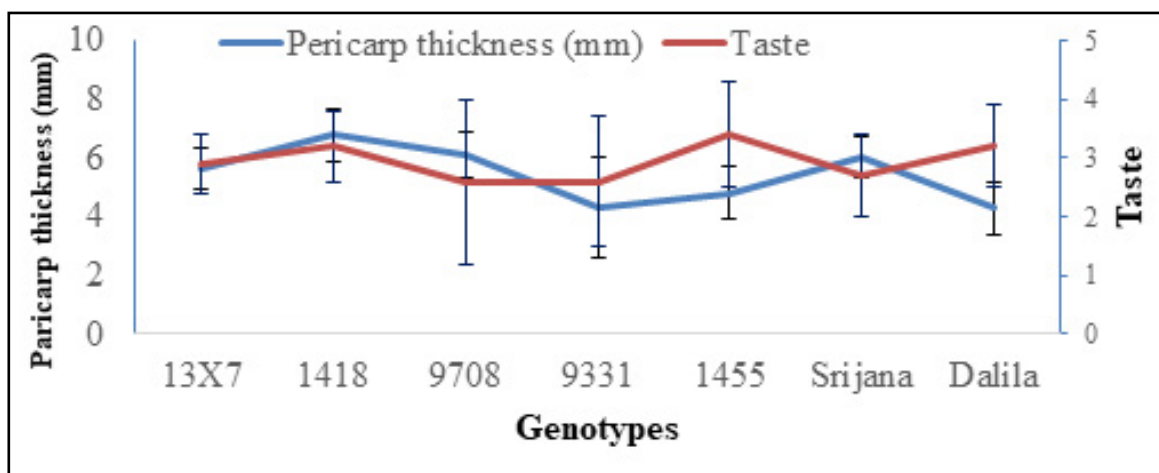


Figure 3. Fruit pericarp thickness and taste of different tomato genotypes

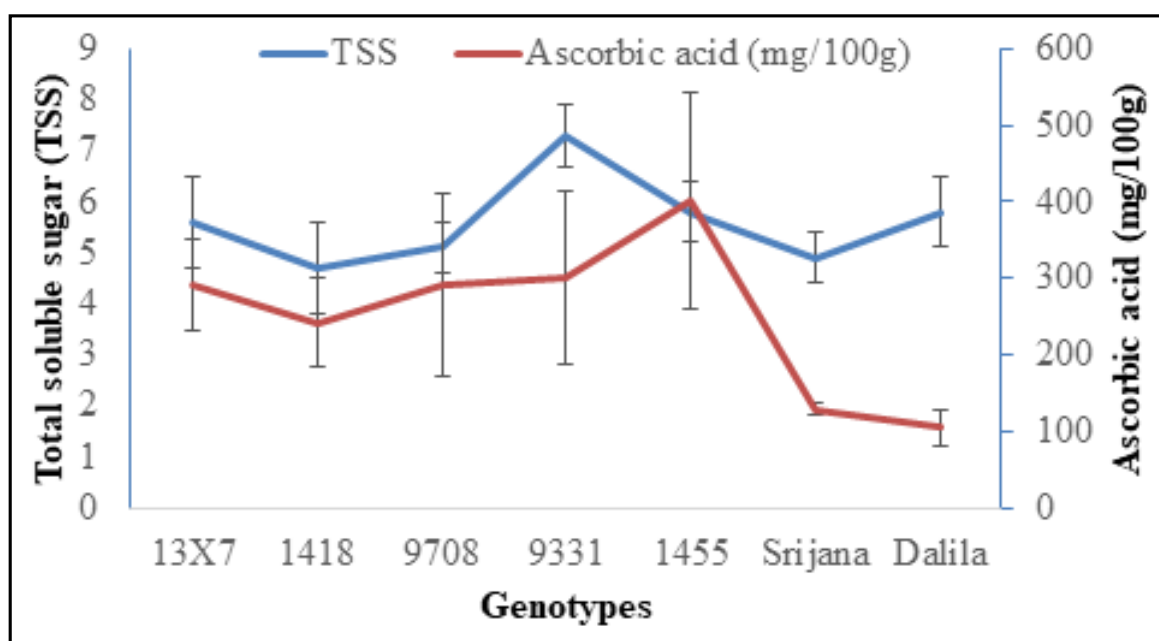


Figure 4. Total soluble sugar (TSS) and ascorbic acid contents of different tomato genotypes

### Keeping Quality

Cultivar Srijana had least rotten % (no.) (5.3) followed by Dalila (5.7) and 13X7 (6.3) on 15 days after storage. Similarly, the least rotten % (wt.) were seen on 13X7 and Dalila (5.2) followed by Srijana (10.1). The number of fruit freshness (%) were found to be highest on Srijana (94.7) followed by Dalila (94.3) and 13X7 (92.4) and according to the Freshness % weight both Dalila and 13X7 showed superior performance (94.8) on 15 days after storage. All the cultivars except 9708 had the least shrinkage status (1.0). The rotten (%) was found to be least on Srijana (16.2)

followed by 13X7 (17.1) and Dalila (19.3) on 24 days after storage. After 24 days of storage, Dalila had the highest number of fruit freshness (88.7) likewise, Srijana (83.8) and 13X7 (78.2) were statistically par. The highest percent of Freshness weight after 24 days of storage was found at Srijana 76.60 followed by 13X7 (74.9) and Dalila (71.4). According to the shrinkage status, 13X7, 9331, and Dalila (2.3) were found to be excellent whereas 9708 was seen to be the worst (4.0) (Table 5)

Table 5. Keeping quality of tomato genotypes in ordinary room condition at Khumaltar

Line	15 Days after storage				24 Days after storage			
	Rotten (%)	Number of fruit freshness (%)	Freshness % (wt.)	Shrinkage status (1-5)	Rotten (%)	Number of fruit freshness (%)	Freshness % (wt.)	Shrinkage status (1-5)
13X7	6.3	92.4	94.8	1.0	17.1	78.2	74.9	2.3
1418	26.6	73.4	75.3	1.0	42.2	57.8	53.3	3.7
9708	38.3	61.7	65.3	2.3	50.1	49.9	46.9	4.0
9331	38.4	61.9	65.0	1.0	72.0	28.0	23.8	2.3
1455	40.9	59.1	65.3	1.0	74.3	25.7	24.2	2.7
Srijana	5.3	94.7 a	89.9	1.0	16.2	83.8	76.6	2.7
Dalila	5.7	94.3	94.8	1.0	19.3	88.7	71.4	2.3
Mean	23.06	76.8	78.6	1.19	41.6	57.7	53.0	2.85
F-test	**	**	*	**	**	**	**	*
LSD <sub>0.05</sub>	23.4	23.14	21.04	0.38	34.61	33.79	28.6	1.027
CV%	57.03	16.96	15.04	18.33	46.76	32.90	38.31	20.21

## Conclusion

Based on the overall characters, among the tested cultivars 13X7 was found, early days to flowering, less infection with late blight and septoria disease, higher number of fruits per plant, superior yield (55.17 t/ha), 2404gm per plant, consumers and farmers preferred, and medium in fruit size, TSS (5.6), Ascorbic acid content (292 mg/100 g). It has superior keeping quality; least shrinkage (2.3), significantly higher marketable fruit weight remain percentage (74.9%) and least rotten percent (15.2%) at 24 days after storage (DAS). The next superior cultivar is Srijana which has late blight (3.3), days to flowering (21), higher number of fruits per cluster (7), superior yield (65.78 t/ha), 2763 gm per plant, consumers and farmers preferred, medium; fruit size, TSS (4.9), Ascorbic acid content (128 mg/100g), and superior keeping quality; less shrinkage (2.7), higher marketable fruit weight remain percent (76.6%) and less rotten percent (16.2%) at 24 DAS. These two varieties are recommended for cultivation in

mid-hills conditions of Bagmati Province in open field conditions.

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Declaration of conflict of interest and ethical approval

S.L Shrestha involved in designing, conducting experiment, analyzing and interpreting the results and preparing manuscript. D. Ghimire and P.P Khatwada involved in conducting study and manuscript preparation. I.P. Gautam involved in supervising the experimental work, providing guidelines for result interpretation and manuscript preparation

The authors declare no conflicts of interest regarding publication of this manuscript.

## References

- Atugwu, A. I., & Uguru, M. I. (2011). Tracking Fruit Size Increase in Recombinants Obtained from Interspecific Cross between Cultivated (*Solanum lycopersicon*) and Wild Tomato Relative (*Solanum pinpinellifolium*). *J. Plant Breed. Crop Sci.*, 4(4): 62-71
- Aworth, O.C. (1985). Preservation of Perishable Food Commodities through Processing, *Nigerian Food Journal*, 2(3), 24-44.
- Ebert, A. W. (2020). The role of vegetable genetic resources in nutrition security and vegetable breeding. *Plants*, 9(6), 736. DOI: <https://doi.org/10.3390/plants9060736>
- Enujike, E. C., & Emuh, F. N. (2015). Evaluation of Some Growth and Yield Indices of Five Varieties of Tomato (*Solanum lycopersicon*). *Glob. J. Bio-Sci. Biotechnol.*, 4(1): 21-26
- FAOSTAT. (2017). Food and Agricultural Organization (FAO). Retrieved August 25, 2019, from *Food and Agricultural Organization*. Web site: <http://www.fao.org/faostat/en/#data/QC>
- Gautam, D.M. & Bhattarai, D.R. (2006). Post Harvest Horticulture. Public Printing Press. Newplaza, Putalisadak Kathmandu, Nepal.
- Gorny, J.R. (2001). A summary of CA and MA requirements and recommendations for Freshness-cut (minimally processed) fruits and vegetables. Doi: <https://doi.org/10.17660/ActaHortic.2003.600.92>
- Kader, A.A. (1992). Post-harvest technology of horticultural crops. 2nd Ed. Univ. of California, *Div. of Agri and Natural Resources*. Public, 3311.
- Kader, A.A., Kasmire, R.F., Mitchell, F.G., Reid, M.S., Sommer, N.F., & Thomson, J.F. (1985). Post harvest Technology of Horticultural crops. *University of California. Publication*. 3311, 192-199.
- Kiaya, V. (2014). Post-harvest losses and strategies to reduce them. **Technical Paper on Postharvest Losses, Action Contre la Faim (ACF), 25.**
- MOALD, (2017/18). Statistical Information on Nepalese Agriculture. Ministry of Agriculture and Livestock Development, Singha Durbar, Kathmandu, Nepal.
- Mrema, C.G., & Rolle, S.R. (2002). Status of the postharvest sector and its contribution to agricultural development and economic growth. 9th JIRCAS International Symposium- Value Addition to Agricultural Product, 13-20.
- Shehla, S., & Tariq, M. (2007). Effects of different packaging systems on storage life and quality of tomato (*Lycopersicon esculentum*) during different ripening stages. *Journal of food safety* 9 37-44.