Journal of Agriculture and Natural Resources (2021) 4(1):256-264
ISSN: 2661-6270 (Print), ISSN: 2661-6289 (Online)
DOI: https://doi.org/10.3126/janr.v4i1.33280

Research Article

Growth and yield performance of different open pollinated tomato genotypes in Terai region of Nepal

Tek Prasad Gotame[1*], Surendra Lal Shrestha[1], Sujata Poudel[1] and Jiban Shrestha[2]

[1]Nepal Agricultural Research Council (NARC),National Horticulture Research Centre, Khumaltar, Lalitpur, Nepal
[2]Nepal Agricultural Research Council (NARC), National Plant Breeding and Genetics Research Centre, Khumaltar, Lalitpur, Nepal
[*]Correspondence: gotame@gmail.com
*ORCID: https://orcid.org/0000-0003-0041-1363
Received: June 22, 2020; Accepted: November11, 2020; Published: January 01, 2021

ABSTRACT

Tomato is one of the major vegetable crops in Nepal. The productivity of tomato in Nepal is very low due to lack of high yielding, disease and pests resistant varieties.The objective of this experiement was to evaluate the performance of open pollinated tomato genotypes. Ten open pollinated tomato genotypes were evaluated at on-station research field of Regional Agricultural Research Station, Parwanipur, Bara in the winter seasons of 2015 and 2017, and seven tomato genotypes were evaluated at farmers' fields of Bara and Parsa districts, Nepal in the winter seasons of 2017 and 2018. These experiments were carried out in randomized complete block design with three replications. Results of the on-station experiments showed that HRDTOM084 produced the highest yield (29.1 t/ha in 2015 and 28.5 t/ha in 2017) and showed consistant performance over the two seasons. It was the superior genotypein terms of yield and yield attributing traits. Tomato genotypes HRDTOM011, HRD109, HRDTOM080 and HRDTOM086 were found vigorous with a score value 5 in 1 to 5 rating scale. The results of the farmers' field experiment showed that HRDTOM084 and HRDTOM085 were found more productive and high yielding compared to other genotypes. The highest yield was produced in HRDTOM084 with a mean of two season yield 49.85 t/ha followed by HRDTOM085 with a mean of two season yield 47.42 t/ha).These genotypes showed moderate resistance to late blight and septoria leaf spot with a score value of 2.3 in 1-5 rating scale. Therefore, HRDTOM084 and HRDTOM085 were the most productive and gave higher yield compared to others. Hence, these two tomato genotypes can be used by tomato growers under field conditions in Terai region of Nepal.

Keywords: Open pollinated**,** Plant vigour, Tomato genotypes, Terai region

Correct citation: Gotame, T. P., Shrestha, S.L., Poudel, S., & Shrestha, J. (2021). Growth and yield performance of different open pollinated tomato genotypes in Terai region of Nepal. *Journal of Agriculture and Natural Resources*, *4*(1), 256-264.
DOI: https://doi.org/10.3126/janr.v4i1.33280

INTRODUCTION

Tomato (*Solanum lycopersicum* L. 2n=2x=24) is one of the most widely grown vegetables in tropics and subtropics and second most produced vegetables after potato in the world (FAOSTAT, 2018). The total area under tomato cultivation is 4,848,384 ha with 182,301,395 tones of production and productivity of 37.6 t/ha (FAOSTAT, 2018). It is one of the major high

ISSN: 2661-6270 (Print), ISSN: 2661-6289 (Online)
DOI: https://doi.org/10.3126/janr.v4i1.33280

value-added vegetables in the tropical and subtropical regions and also an important source for essential nutrients and vitamins (Panthee *et al*., 2020). Tomato is the third largest vegetable crop in Nepal in term of production. It covers 22566 ha with a total production of 406434 tone and productivity of 18.01t/ha (MoALD, 2019) which is low as compared to other countries. Tomato has been accepted as remunerative crops by the farmers of Nepal; however, availability of reliable varieties is very less (Shrestha & Sah, 2014). It has been observed that many promising local selections and introduced genotypes of tomato are popular in small areas. Use of hybrid varieties is increasing every year even in remote areas (Rawal *et al*., 2017). The productivity of tomato is greatly influenced by various biotic and abiotic stresses. However, tomato varieties, which are grown in Nepal are vulnerable to specific pests and disease. Due to the lack of abiotic and biotic stress tolerant tomato cultivars in Nepal, the productivity is low. For example, in India, the productivity of tomato in open field condition is 25 t/ha, in China, it is 48 t/ha and the world average is 37.6 t/ha which is not comparable with Nepal's national productivity (19.01 t/ha) (FAOSTAT, 2018). Various factors such as use of improved varieties, proper management, quality of seed, awareness about improved production technologies affect the production of tomato. Shrestha and Sah (2014) reported that one of the major contributing factors of low productivity of tomato is the lack of high yielding varieties under rice-based cropping system in the Terai region. The officially released open pollinated varieties of tomato; namely Pusa Ruby, Monoprecos, Roma and NCL-1 are not successful to meet the various changing needs of growers and consumers in one hand and on the other, they have not been properly maintained resulting in degeneration and deteriotion in their original characters. It also seems that the released varieties are also likely to break down their performance due to a number of biotic and abiotic stresses.

Shrestha *et al*. (2014) evaluated commercial hybrid and OP cultivars of tomato for central Terai region and found that hybridHRDTOM005 x HRDTOM010 produced the highest yiled (30.64 t/ha) followed by Makis (28.90 t/ha) and Srijana (28.87 t/ha). These cultivars produced 47.0%, 38.7%, and 38.5% more yield as compared to commercial hybrid variety such as Manisha (20.84 t/ha). Bari-4 and CL-1131 showed superior performance and therefore recommended for cultivation in central Terai (Shrestha & Sah, 2014).Gurung *et al.* (2020) evaluated hybrids developed by Horticulture Research Division, Khumaltar at RARS, Parwanipur conditions and found that Srijana produced the highest yield (50.54 t/ha).

Rawal *et al*. (2017a) evaluated open pollinated tomato genotypes in mid-western Terai region and found that the highest yield produced by STM-10 (45.47 t/ha)and this genotype was found to be tolerant tolate blight (2.67 score out of 1-5 scale). Similarly hybrid HRA20 x HRD2 produced the highest yield (118.88 t/ha) and showed resistant to the late blight disease (1.0) and therefore recommended OP genotype STM-10 and hybrid HRA20 x HRD2 for mid-western region of Nepal (Rawal *et al*., 2017a). Rawal *et al*. (2017b) evaluated AVRDC lines for mid-western Terai conditions and found that CLN3552B produced the highest fruit weight (102 g fruit^{-1}), while highest fruit yield was obtained in CLN3669A (41 t/ha) along with resistant to late blight and tomato yellow leaf curl virus.

Similarly, Shrestha *et al.* (2017) evaluated OP genotypes and found that STM-03 (34.74 t/ha), and STM-08 were the superior in both the Terai and mid-hill conditions with a vigorous growth, higher yield, less pest and disease susceptible and therefore recoomended for central and mid-western Terai region of Nepal.

ISSN: 2661-6270 (Print), ISSN: 2661-6289 (Online)
DOI: https://doi.org/10.3126/janr.v4i1.33280

There are many hybrid varieties already registered through private seed business companies in Nepal but they are not consistent in their performance across the agroecological region and over the seasons (Shrestha *et al*., 2017). Therefore, there is great necessity to develop tomato varieties to replace the imported hybrid seeds for rice-based cropping system in Terai region. Considering the lack of appropriate tomato cultivars, this experiment was carried out to identify suitable variety of tomato. The objective of this study was to evaluate and select potential tomato genotypes suitable for cultivation in the central Terai region of Nepal.

MATERIALS AND METHODS

Site characteristics

The experiments were conducted at Regional Agricultural Research Station (RARS), Parwanipur, Bara, Nepal in the winter season from September to April of 2015/16, 2017/18 and 2018/19. The RARS is situated between 84° 15' to 86° 15' east longitude and 26° 15' to 26° 45' north latitude with the elevation of 115 m-asl having subtropical climate (Gotame *et al*., 2020).The meteorological data for cropping season was recorded from the meteorological station of RARS, Parwanipur, Bara, Nepal. The average maximum and minimum mean daily temperature was 29.8°C and 19.6°C, respectively. Similarly average relative humidity was 50.4% and mean rainfall was 35.5 mm during thegrowing period. The soil structure of on-station was angular blocky, dark grayish brown (10YR 4/2) in color, silt loam in texture. The soil was moderately acidic in pH (5.67±0.09), low in organic matter (0.74±0.04%) (Khadka, *et al*., 2018).

Experiment details

Two sets of experiments were carried out; one at on-station and another at farmer's field of RARS, Parwanipur during the winter session of 2015, 2017 and 2018 in randomized complete block design (RCBD) with three replications. There were ten genotypes evaluated for yield and yield attributing characters includiung pressure of disease resistant at on-station while seven genotypes including one check variety were evaluated at farmers field conditions under rice-based cropping system in winter of 2017 and 2018 (Table 1).

Table 1. Tomato genotypes evaluated at on-station and on-farm, RARS, Parwanipur

SN	Genotypes evaluated at on-station, 2015	Source of collection	Genotypes evaluated at on-station, 2017	Source of collection	Genotypes evaluated at on-farm, 2017 and 2018
1	HRDTOM011	India	HRDTOM011	India	HRDTOM011
2	HRD109	Nepal	HRD109	Nepal	HRDTOM035
3	HRDTOM035	AVRDC	HRDTOM035	AVRDC	HRDTOM083
4	HRDTOM078	SAARC	HRDTOM078	SAARC	HRDTOM084
5	HRDTOM080	SAARC	HRDTOM080	SAARC	HRDTOM085
6	HRDTOM083	SAARC	HRDTOM083	SAARC	HRDTOM086
7	HRDTOM084	SAARC	HRDTOM084	SAARC	Pusa Ruby (check)
8	STOM 05	SAARC	HRDTOM085	SAARC	
9	STOM 06	SAARC	HRDTOM086	SAARC	
10	Pusa Ruby (check)	Nepal	Pusa Ruby (check)	Nepal	

The seed sowing was done on second week of September and 25 days old seedlings were transplanted in the field with the spacing of 60 cm × 60 cm geometry. The plot size was 3 m x 1.2 m with 3.6 m^2 area at on-station experiment while the plot size was 3 m x 1.8 m with 5.4 m^2 area at on-farm conditions. There were 5 plants per row and 2 rows at on-station and 3 rows per plot at on-farm were maintained. Therefore the total plants were 10 and 15 per plot at on-station and on-farm respectively. The standard recommended dose of fertilizers (150:120:100 NPK kg/ha + 15 t FYM/ha) was applied. The fertilizer per plant was 1.08 kg FYM, 10.15 g urea, 14.08 g DAP and 4.8 g of MoP.

Observations

Plant height (cm)

Plant height was measured in randomly selected 5 plants at 50% fruits maturity stage in indeterminate type and 50% flowering stage in determinate type. It was measured in the main stem from the soil surface to tip of the axis, but not the tip of the leaf.

Plant vigour

Vigor was recorded at 50% flowering stage using a 1 to 5 rating scale according to the method described by Gotame *et al*. (2019) as follows.

- 1= Poor (all plants were small, few leaves, week plants, very thin stems, and light green color)
- 2 = Weak (75% of the plants were small or all plants were shorter than average plant height, plants had few leaves, thin stem and light green color)
- 3= Medium (the intermediate or average growth)
- 4= Vigorous (75% of the plants were taller than average, robust with foliage of dark green color, thick stems, and leaves were well developed)
- 5= Excellent (all plants were taller than average, ground entirely covered by foliage, plants were robust, with a thick stem and abundant foliage of dark green color)

Disease score

The disease was scored during flowering and at peak harvesting time. The number of plants infected with late blight and septoria leaf spot (plants showing symptoms) against the total number of plants per plot was recorded. Scoring was done using a 1 to 5 scale as described by Gotame *et al*. (2019) as follows.

Plant status	Score (1-5)
Healthy plants	= 1
About 25% of the plants infected	= 2
About 50% of the plants infected	= 3
About 75% of the plants infected	= 4
The entire plants' infected/collapsed	= 5

Yield and yield attributing characters

Fruit yield (kg/plot)

Marketable fruits from nonmarketable fruits were separated from each plot and in every harvest date. The total marketable yield was obtained by adding the yields of individual harvest date per plot. The yield per plot (kg/plot) was converted into tons per hectare. The number of plants harvested per plot were recorded and adjusted yield (kg/plot) was calculated based on actual number of plants per plot while harvesting i.e.10 plants at on-station and 15 plants at farmer's field trial (FFT).

Fruit weight (g)

Average fruit weight (g) was weighted from 10 randomly selected marketable fruits per plot. The weight was recorded two times, one at third and second at fifth harvest lot.

Journal of Agriculture and Natural Resources (2021) 4(1):256-264
ISSN: 2661-6270 (Print), ISSN: 2661-6289 (Online)
DOI: https://doi.org/10.3126/janr.v4i1.33280

Number of fruits per plant

Number of fruits per plant was recorded in each harvest date separately and cumulative number of fruits were obtained by adding after the last harvest.

Statistical analysis

The experimental data were processed by using MS Excel 2016 and analyzed by using MSTAT C. Two-way ANOVA was used to analyze the difference between the means observed on yield and yield attributing characters, and disease score. Normality was checked using histogram before analysis. Mean comparison was carried out at $P < 0.01$, and $P < 0.05$ level of significance (Gomez & Gomez, 1984; Shrestha, 2019).

RESULTS AND DISCUSSION

Plant height and plant vigour

In our study, significant differences were observed both in plant height and vigour in tomato genotypes (Table 2 and 3). The highest plant height was found in HRD109 (110.9 cm in 2015 and 151.5 cm in 2017) which was followed by HRDTOM011 (97.7cm in 2015 and 143.5 cm in 2017). The highest vigorous plant was found in HRDTOM011, HRD109, HRDTOM080 and HRDTOM086 (Table 3). Kallo *et al*. (1998) and Manoj & Ragav (1998) also reported differences in plant height among cultivars/hybrids of tomato.

Plant height is a quantitative trait controlled by several genes. Plant height can be influenced greatly by genotype and environment (Gotame *et al*., 2020). The reason for higher in plant height in HRD109 and HRDTOM011 could be due to the genetic variations exited in the genotypes.

Yield and yield attributing traits from on-station trial

There were significant differences in number of fruits per plant, fruit yield per plant, fruit length, fruit width and yield in tomato genotypes (Table 2). These results are in close conformity with the findings of Jaha and Krishi (2001) who reported variation among the cultivars of tomato for the number fruits per plant.The number of fruit was found the heighest in HRD109 (89 per plant) which was followed by HRDTOM011 (65 per plant) in 2015 while it was the highestin HRDTOM011 (64 per plant) followed by HRDTOM084 (53 per plant).

The yield was the highest in HRDTOM109 (37.16 t/ha) followed by HRDTOM83 (31.5 t/ha) and HRDTOM084 (28.5 t/ha) respectively in 2015 (Table 2) while in 2017, the yield was the heighest in HRDTOM084 (28.5 t/ha) followed by HRDTOM085 (19.9 t/ha) (Table 3). However, average fruit weight was higher in HRDTOM083 (91.7 g) followed by HRDTOM085 (65.3 g) respectively (Table 3). Yield, a complex character, is governed by a large number of factors viz genotype, environment and crop management. Yield in each genotype is a result of the cumulative effect of different yield attributing characters (Gotame *et al*., 2020). Hence, HRDTOM084, HRDTOM085 and HRDTOM086 were found superior genotypes and were tested at farmers field conditions at the outreach sites of the RARS, Parwanipur in the winter of 2017 and 2018 respectively.

ISSN: 2661-6270 (Print), ISSN: 2661-6289 (Online)
DOI: https://doi.org/10.3126/janr.v4i1.33280

Table 2. Performance of open pollinated tomato genotypes at on-station, RARS, Parwanipur, 2015/16

SN	Genotypes	Plant height (cm)	Number of fruits/plant	Fruit yield/plant (kg)	Fruit length (mm)	Fruit width (mm)	Yield (t/ha)
1	HRDTOM011	97.7	64.8	1.97	41.7	42.2	26.95
2	HRD109	110.9	89.1	1.34	42.7	33.0	37.16
3	HRDTOM035	67.8	30.8	0.83	49.5	48.2	22.02
4	HRDTOM078	56.9	28.7	0.92	37.1	44.6	24.53
5	HRDTOM080	70.1	17.8	0.58	45.2	45.0	14.70
6	HRDTOM083	63.0	21.0	1.17	51.2	55.6	31.50
7	HRDTOM084	59.1	35.4	1.08	38.4	44.3	29.91
8	STOM05	74.5	25.1	1.01	55.0	50.3	27.26
9	STOM06	62.7	14.4	0.68	53.8	44.3	14.79
10	Pusa Ruby (check)	68.9	52.1	1.30	39.5	50.1	34.63
	CV%	9.0	34.7	23.16	7.58	9.82	20.86
	F Test	*	*	*	*	*	*
	LSD (0.05)	11.02	22.58	0.39	5.9	7.71	9.42

** Significant difference at 0.05 level of significance, CV: Coefficient of variation*

Table 3. Performance of open pollinated tomato genotypes at on-station RARS, Parwanipur conditions, 2017/18

	Genotypes	Plant height (cm)	Plant vigour (1-5 scale)^x	Disease infection (1-5 score)^y	Fruit weight (g)	Number of fruit per plant	Number of fruits/plot	Fruit yield/plot (kg)	Yield (t /ha)
1	HRDTOM011	143.5	5.0	1.3	21.6	40	384.7	2.7	7.4
2	HRD109	151.5	5.0	0.7	19.4	38	365.7	2.7	7.4
3	HRDTOM035	68.5	1.7	4.3	57.5	18	175.3	5.3	14.6
4	HRDTOM078	90.0	3.0	1.7	31.1	17	172.0	3.8	10.5
5	HRDTOM080	140.0	5.0	2.3	24.1	53	529.7	4.6	12.7
6	HRDTOM083	79.6	2.3	2.3	91.8	12	103.3	4.3	11.9
7	HRDTOM084	60.3	1.0	2.3	39.1	64	640.3	10.3	28.5
8	HRDTOM085	104.2	3.0	3.0	65.3	25	242.7	7.2	19.9
9	HRDTOM086	114.9	5.0	1.7	32.3	52	515.0	6.8	18.9
10	Pusa Ruby (check)	82.7	3.0	1.0	21.8	37	349.7	5.7	15.9
	CV%	13.60	14,8	82.3	46.1	13.1	37.32	21.3	28.5
	F Test	**	*	ns	**	**	**	*	**
	LSD (0.05)	24.17	0.861		31.97	4.52	109.11	2.16	7.21

** and ** significant difference at 0.05 and 0.01 level of significancerespectively, CV: Coefficient of variation*
^{x}1: poor, 5: excellent,^{y}1: non, 5: highly susceptible

Late blight and septoria leaf spot infection

The number of plants infected with late blight and septoria leaf spot (plants showing symptoms) against the total number of plants per plot was recorded during the winter season of 2017/18. Disease infection was found to be non significant among the genotypes (Table 3). However, it was found that HRD109 has higher resistant and HRDTOM035 was highly susceptiblewith late blight and septorial leaf spot as compared to other genotypes. Therefore, even though minimum fungicides was applied to manage diseases, the susceptibility was found to be non significant among the tomato genotypes.

Growth and yield performance of OP tomato genotypes at farmer's field conditions

An evaluation trial of seven genotypes of tomato were conducted at outreach sites of RARS, Parwanipur in winter season of 2017 and 2018. The tallest plant height was measured

Journal of Agriculture and Natural Resources (2021) 4(1):256-264
ISSN: 2661-6270 (Print), ISSN: 2661-6289 (Online)
DOI: https://doi.org/10.3126/janr.v4i1.33280

ingenotypes HRDTOM011 (143 cm) followed by HRDTOM086 (129 cm) where as the shortest plant (59 cm) was in HRDTOM084. In 207/18, the highest marketable fruit yield per plot (3.5 kg) was recorded in HRDTOM085 followed by HRDTOM084 (3.4 kg). Similarly, yield per hectare was highest in HRDTOM084 (25.50 t/ha) followed by HRDTOM085 (21.12 t/ha) (Table 4).

Table 4. Performance of open pollinated tomato genotypes in farmer's field conditions, 2017/18

SN	Lines	Plant height (cm)	Fruit wt (g)	No of fruits per plot	No of fruits per plant	Yield per plot (kg)	No of marketable fruit per plot	Marketable yield per plot (kg)	Number of non marketable fruits per plot	Non marketable yield per plot (kg)	Yield (t/ha)
1	HRDTOM011	143.4	18.2	597.3	60	6.7	112.0	2.0	485.3	4.6	18.49
2	HRDTOM035	64.9	35.9	273.7	28	5.5	54.0	1.9	219.7	3.6	15.31
3	HRDTOM083	85.3	33.4	70.3	9	1.5	11.3	0.4	59.0	1.1	4.26
4	HRDTOM084	58.9	18.8	748.3	75	9.2	179.7	3.4	568.7	5.8	25.50
5	HRDTOM085	95.7	30.8	348.7	35	7.6	118.3	3.5	230.3	4.1	21.12
6	HRDTOM086	128.9	21.6	509.7	51	6.6	160.7	3.5	349.0	3.1	18.21
7	Pusa Ruby	79.2	18.9	334.7	34	5.1	161.7	2.9	173.0	2.2	14.23
	CV%	6.8	20.23	16.1	15.2	11.5	12.3	55.7	14.3	38.2	36.8
	F Test	**	**	**	**	**	ns	ns	ns	*	*
	LSD (0.05)	15.10	9.2	102.1	18.5	2.1				1.90	6.2

*** Significant difference at 0.01 level of significance, CV: Coefficient of variation*

In 2018/19, the result showed that the highest number of fruit per plot was recorded in HRDTOM086 (1391) followed by HRDTOM035 (1384). The average fruit weight was the highest in HRDTOM085 (49.5g) followed by HRDTOM083(47.7 g). The highest fruit yield per plot was found in HRDTOM084 (34.72 kg) followed by HRDTOM035 (27.08 kg) and HRDTOM086 (24.12 kg). HRDTOM084 produced the highest marketable fruit yield (24.54 kg) per plot followed by HRDTOM035 (21.64 kg). Similarly, yield per hectare was recorded the highest in HRDTOM084 (74.20 t/ha) followed by HRDTOM085 (73.72 t/ha) (Table5).

Table 5. Performance of open pollinated tomato genotypes in farmer's field, 2018/19

SN	Genotypes	No. of fruit/plot	Fruit yield/plot (kg)	No of fruits per plant	Non marketable fruit yield/plot (kg)	Marketable fruit yield/plot (kg)	Fruit wt. (g)	Yield (t/ha)
1	HRDTOM011	1279	21.29	128	2.66	18.63	25	58.7
2	HRDTOM035	1384	27.08	138	5.43	21.64	40.1	51.68
3	HRDTOM083	594	18.63	60	7.63	12.09	47.7	39.94
4	HRDTOM084	1606	34.72	161	10.42	24.54	32.5	74.20
5	HRDTOM085	692	15.75	70	7.05	8.73	49.5	73.72
6	HRDTOM086	1391	24.12	140	6.04	17.97	23.3	48.38
7	Pusa Ruby (check)	690	13.03	70	3.55	9.47	28.6	24.14
	CV%	20.38	23.27	11.4	25.11	22.48	14.27	22.69
	F-test	**	*	**	**	**	**	**
	LSD(0..05)	395.69	9.15	14.4	2.73	6.46	8.94	21.38

* and ** significant difference at 0.05 and 0.01 level of significancerespectively, CV: Coefficient of variation

ISSN: 2661-6270 (Print), ISSN: 2661-6289 (Online)
DOI: https://doi.org/10.3126/janr.v4i1.33280

CONCLUSION

The present study reported a considerable variability for yield due to variation in yield contributing traits among tomato genotypes. Of all genotypes, on-station research showed that HRDTOM083, HRDTOM084 and HRDTOM085 were the superior genotypes in terms of yield and yield attributing traits. While results from farmers' field trial, HRDTOM084 and HRDTOM085 were found to be high yielding compared to other genotypes. These genotypes showed moderate resistance to late blight and septoria leaf spot. Therefore HRDTOM084 and HRDTOM085 could be the superior and promising genotypes for commercialization at the central Terai region of Nepal. With the limitation of this research, we suggest to evaluate these lines for additional seasons to assure consistant performance and farmers preference before notifying in the national seed system.

ACKNOWLEDGMENTS
The authors would like to acknowledge the Nepal Agricultural Research Council, Regional Agricultural Research Station, Parwanipur, Bara, Nepal for providing financial support to carry out the research. Horticulture Research Division, Khumaltar is due acknowledged for providing tomato germplasms.

Authors' contributions
T.P. Gotame designed, executed the experiment and wrote the draft of the manuscript, S.L. Shrestha provided materials for research and finalized the manuscript, S.Poudel involved in field layout, genotype evaluation, data collection. J. Shrestha helped in data analysis and finalized the initial draft of this manuscript.

Conflict of interest
The authors declare no conflicts of interest.

REFERENCES

FAOSTAT. (2018). Food and Agricultural Organization (FAO). Food and Agricultural Organization. Retrieved from*http://www.fao.org/faostat/en/No. of data/QC*.

Gomez, K.A., & Gomez, A.A. (1984). Statistical procedures for agricultural research. 2nd edn. International Rice Research Institute, College, Laguna, pp. 680.

Gotame, T.P, Gautam, I.P., Shrestha, S.L., & Pradhan, N.G. (2019). A field guide for vegetable germplasm testing and variety registration/release. Nepal Agricultural Research Council (NARC), National Agriculture Research Institute (NARI), Horticulture Research Division (HRD), Khumaltar, Lalitpur. NARC Publication Serial No. 00669-683 (2019/20).

Gotame, T.P., Poudel, S., Shrestha, S.L., & Shrestha, J. (2020). Evaluation of yield and yield components of eggplant (*Solanum melongena* L.) genotypes in the Terai region of Nepal. *International J. Environment, 9*(2), 67-80.

Gurung, S., Adhikari, P., Giri, K., Gotame, T. P., & Shrestha, S.L.(2020). Growth and yield performance of hybrid tomato (*Solanum lycopercicum* L.) lines at Parwanipur, Bara, Nepal. *J. Agriculture and Natural Res., 3*(1), 180-189. DOI: https://doi.org/10.3126/janr.v3i1.27166.

HRD. (2016). Annual Report 2072/73 (2015/16). Horticulture Research Division, NARC,

Journal of Agriculture and Natural Resources (2021) 4(1):256-264
ISSN: 2661-6270 (Print), ISSN: 2661-6289 (Online)
DOI: https://doi.org/10.3126/janr.v4i1.33280

Khumaltar, Lalitpur, Nepal.

Jaha, J.C., & Krishi, B. (2001). Studies on performance of different tomato hybrids in off-season under different planting methods in Terai agro-climatic zones of West Bengal. Uttar Banga Krishi Viswavidyalya, W. Bengal, India, *J. Interacademicia, 5*(2), 186-189.

Kallo, G., Chaurasia, S.N.G., Major, S., & Singh, M. (1998). Stability analysis in tomato. Vegetable Research, Ghandi Nagar, India. *Vegetable Sci., 25*(1), 81-84.

Khadka, D., Lamichhane, S., Bhurer, K., Chaudhary, J., Ali, M., & Lakhe, L. (2018). Soil fertility assessment and mapping of Regional Agricultural Research Station, Parwanipur, Bara, Nepal. *J. Nepal Agr. Res. Council, 4*(1), 33-47. DOI: https://doi.org/10.3126/jnarc.v4i1.19688.

Manoj, R., & Raghav, M. (1998). Performance of F1 hybrids and high yielding varieties of tomato under mid-west plains of Uttar Pardesh. *Progressive Hort., 30*(3), 194-197.

MoALD. (2019). Statistical Information on Nepalese Agriculture, 2017/18. Agribusiness Promotion and Market Development Directorate, DOA, Kathmandu, Nepal.

Panthee, D.R., Gotame, T.P. , Shrestha, S.L. Tiwari, K.R., & Bhandari, H.S. (2020). The current status of fruits and vegetables and their improvements. In: Rasali, D. P., Bhandari, P. B., Karki, U., Parajulee, M. N., Acharya, R. & Adhikari, R. (Eds.), Principles and practices of food security: sustainable, sufficient, and safe food for healthy living in Nepal. *Association of Nepalese Agricultural Professionals of Americas (NAPA)*, USA. Pp:245-269.

Rawal, R., Khadka, R.B., Gautam, D.M., Gautam, I.P., Mishra, K., Acedo, A.L., Hanson, P., Easdown, W., Hughes, J.A., & Keatinge, J.D.H. (2017b). Evaluation of AVRDC advanced lines of processing tomato in the mid-western plain of Nepal. *Acta Hortic., 1179*, 305-310. DOI: org/10.17660/ActaHortic.2017.1179.47.

Rawal, R., Shrestha, S.L., Gautam, I.P., & Khadka, R.B. (2017a). Evaluation of open pollinated and hybrid tomato (*Solanum lycopersicum*) genotypes for quality and yield in mid-western Terai of Nepal. In: Gautam, I.P., Shrestha, S.L., Subedi, G.D., Bhattarai, D.R., Gotame, T.P., Upadhyay, K.P. (eds), Proc. of 9th National Horticulture Workshop, May 31-June 1, 2017, NARC, HRD, Khumaltar, Lalitpur. Pp. 229.

Shrestha, J. (2019). P-value: a true test of significance in agricultural research. Retried https://www.linkedin.com/pulse/p-value-test-significance-agricultural-research-jiban-shrestha. DOI: http://doi.org/10.5281/zenodo.4030711

Shrestha, S.L., Devkota, S., Karki, M., & Singh, D. (2017). Performance evaluation of hybrid tomato cultivars in mid-hill condition of Nepal. In: Gautam, I.P., Shrestha, S.L., Subedi, G.D., Bhattarai, D.R., Gotame, T.P., Upadhyay, K.P. (eds), Proc. of 9th National Horticulture Workshop, May 31-June 1, 2017, NARC, HRD, Khumaltar, Lalitpur. Pp. 249.

Shrestha, S.L., & Sah, R.L. (2014). Evaluation of tomato cultivars for central Terai of Nepal. *Nepal J. Sci. and Tech., 15* (2),11-16.