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Research Article

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Evaluation of Genetic Variability and Phenotypic Correlation in WorldVeg Tomato (*Solanum lycopersicum* L.) Genotypes in Bagmati Province, Nepal

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Abstract

This study was conducted to investigate the genetic variability and correlation between phenotypic traits in WorldVeg tomato genotypes in Nepal. Nine indeterminate tomato genotypes (eight WorldVeg and one commercial open-pollinated variety) were studied at the National Horticulture Research Center (NHRC), Khumaltar in a randomized complete block design (RCBD) with three replications during 2021–2022. Analysis of variance (ANOVA) revealed that genotypes showed significant genetic differences in all the plant and fruit traits except fruit firmness. AVTO1306 produced the maximum fruit yield (5.1 kg plant^{-1}), followed by AVTO0301 (2.9 kg plant^{-1}). The analysis of genetic variability showed that magnitude of phenotypic coefficient of variation (PCV) was greater than the genotypic coefficient of variation (GCV) for all the traits. Higher PCV values were observed in the titrable acidity (61.7%), number of fruit plant^{-1} (44.3%), fruit firmness (41.9%) and fruit diameter (41.8%), whereas higher GCV values were found in the titrable acidity (41.8%), plant height (36.9%) and late blight (30.2%). Late blight (LB), plant height and fruit yield plant^{-1} showed high heritability values indicating that these traits are more reliable for effective selection and enhancement in tomato breeding lines.

Keywords : Fruit yield, Heritability, Indeterminate, Open pollinated, Phenotypic coefficient

Introduction:

The tomato (*Solanum lycoperiscum* L.), a member of the Solanaceae family, is the world's second important vegetable crop after potatoes. According to FAOSTAT (2022), it is the world's most processed vegetable. Tomato consumption has increased worldwide due to its better nutritional value and taste. China is the world's greatest producer of tomatoes with a productivity of 48.0 mt ha^{-1} (FAOSTAT, 2022). It is grown all over Nepal and is the third most important fresh vegetable after cauliflower and cabbage (MoALD, 2021). MoALD (2021) is reported that tomatoes are grown on 22,600 ha of land, with the total production of 0.43 million mt. The majority of tomatoes are consumed in the Central Development Region of Nepal and the average annual national consumption is estimated to be 11.9 kg person^{-1} (Ghimire et al., 2017). Tomato farming provides a higher economic and commercial benefits to growers and contributes to reduce the poverty of the country.

In Nepal, tomato is widely cultivated crop and well-adapted in wide ranges of environment. Generally, it is cultivated at open field, but it has been cultivated in the plastic tunnels in urban and peri-urban regions in recent years. Till now, more than 30 tomato varieties are registered for commercial production (CPDD, 2021), but various biotic and abiotic stresses are limited tomato production. Most of the registered tomato varieties are F_1 hybrids and have been developed in countries abroad particularly in India, Japan and Korea (Gotame et al., 2021a). In Nepal, the average productivity of tomato is 19.1 mt ha^{-1} of tomato which is lower than that of India (25.0 mt ha^{-1}). One of the major reasons of low productivity in tomato is LB, a serious fungal disease. Tomato varieties are likely to lose their LB resistance due to many biotic and abiotic factors. Besides, hybrids seeds are unaffordable and inaccessible to growers as compared to open-pollinated (OP) variety. Additionally, OP varieties; Pusa Ruby, Monprecos, Roma and NCL-1 are now obsolete and unsuccessful to meet changing needs of the growers (Shrestha, 2022). Therefore, it is imperative to introduce and evaluate the exotic tomato OP germplasms in order to select elite genotypes for cultivation as well as breeding lines for the variety development in future.

Genetic diversity in the population is crucial for tomato selection and breeding. Phenotypic evaluation in conventional breeding is based on morphological and agronomic traits (Frankel, 1984). According to Kumar et al. (2013), PCV and GCV are essential metrics for determining the variability in population. In addition, heritability and genetic advance help to determine the influence of environment in expressing the traits and the extent to which improvement is possible after selection (Robinson et al., 1949). Moreover, yield is a complex trait that is linked to many other traits. The correlation coefficients between the traits that influence fruit yield aids in identifying the most significant characteristic that can be used as selection criteria. There have been prior researches (Saha et al., 2010; Islam et al., 2012; Kumar et al., 2013; Al-Ballat and Al-Araby, 2020) on genetic variability, heritability, genetic advance and correlation in plant, and fruit yield traits in different countries. However, studies on plant and fruit yield traits, their genetic variability, and traits association particularly on WorldVeg tomato genotypes under Khumaltar conditions have not been studied yet. Therefore, the objectives of this study were to evaluate genetic variability and phenotypic traits association of WorldVeg tomato genotypes under mid-hill conditions of Nepal.

Materials and Methods:

Experimental site and plant materials

This study was carried out in the research field of National Horticulture Research Center (NHRC) (latitude 27° 38.9113' N and 85° 19.5152' E longitude, altitude of 1, 275 m above sea level, asl) (NHRC, 2019). The soils of experimental site had silty clay loam with pH 5.98 (Rawal et al., 2022) and the climate of the region was warm-temperate types. Seeds of eight indeterminate tomato genotypes (AVTO0301, AVTO1306, AVTO1314, AVTO1315, AVTO1718, AVTO1907, AVTO1912 and AVTO1915) were received from the World Vegetable (WorldVeg) Center, Taiwan in 2020, whereas seeds of Pusa Ruby, a commercial variety was used as check.

Experimental design and plant cultivation

Plug trays containing 50 cells (5 × 10 cells) were filled with compost-mix and 50 seeds of each ten genotypes were sown in the first week of February, 2022. At each genotype, 35-days-old seedlings were transplanted on March, 2022 at the spacing of 75 cm × 60 cm. Each genotype consisted of two rows with 10 seedlings with a 4.5 m^2 plot (1.5 m × 3.0 m). The experiment was laid out in RCBD, replicated thrice. The rates of farm yard manure (FYM) and fertilizers were applied at each plot were 25 mt ha^{-1} and 200N:150 P_2O_5:120 K_2O kg ha^{-1}, respectively. Each plot was fertilized with the FYM (1.1 kg), urea (46% N, 138.04 g) di-ammonium phosphate (DAP, 18% N and 46% P_2O_5, 146.9 g) and muriate of potash (MoP, 60%, 90.0 g). The entire amount of FYM, P_2O_5 and K_2O, and half of the N were applied before one-week of the seedlings transplanting, and the remaining half amount of the N was splitted and applied equally at 30 and 60 days after transplanting (DAT). Multiplex, a balanced fertilizer (Agriplex Pvt. Ltd., India) was sprayed (2 ml l^{-1} water) on the leaves at two to three times during the cropping season. Cultural practices were followed based on the recommendation of Gautam et al. (2021).

Data collection

Phenotypic traits were recorded on randomly selected five plants from each plot. Days to 50% flowering (DTF) was recorded when half of plants in a plot began to bloom. Likewise, days to 50% fruiting (DTFR) was measured when half of the plants started to fruit set. Plant vigor was recorded at the flowering stage using a scale of 1 to 5, where: 1 = very week, 2 = week, 3 = medium or normal growth; 4 = vigorous and 5 = very vigorous (Gotame et al., 2019). Plant height (cm) was measured from joint of the stem and root to terminal portion of the stem using a meter scale at 50% fruit maturing stage. LB disease was observed using a scale of 1 to 5, where: 1 = healthy plants (highly resistant), 2 = 25% of the plants infected (resistant), 3 = 50% of the plants infected (moderately resistant/or tolerant) 4 = 75% of the plants infected (susceptible) and 5 = entire plants' infected (highly susceptible). Fruit yield plant^{-1} was calculated by adding the weight of the fruits from each of the three random fruit harvests on five plants. Weights of five individual fruit were taken using an electronic digital balance and averaged. The number of fruits plant^{-1} was recorded in each harvest separately and determined based on number of total fruits and number of plants harvested. The weights of five individual fruit were measured and averaged. A digital Vernier caliper (150 mm, Model: DC-515) was used to measure fruit diameter and fruit pericarp thickness (FPT). A hand-held digital penetrometer (Lutron Model, FR-5120) having cylindrical stainless steel (5.84 mm, diameter) was used to measure the firmness of the fruit. Puncture tests were made on three equatorial sides of the same fruit. Total soluble solid (TSS) content (°Brix) of the fruits was determined by digital refractometer (Model, ATAGO, Tokyo, Japan). The refractometer was cleaned with distilled water after use and dried with blotting paper for every reading in order to avoid contamination. The extracted tomato juice was diluted to 1:50 ratios and measured with a Pocket Brix-Acidity Meter (Model: PAL-BX|ACID F5 Cat. No.7100) in order to determine the titrable acidity (TA). It was done by placing one to two drops of diluted juice on the prism surface and expressed as percentage.

Statistical analysis

After processing the data in MS Excel (version 16.0, Microsoft, Redmond, WA, USA), R program, version 4.2.2 [R Core Team (2022), R: A language and environment for statistical computing, Vienna, Austria. UR https:///www.R-project.org/] was used to estimate one-way analysis of variance (ANOVA), genetic variability and phenotypic correlation coefficients of the traits.

Results and Discussion:

Plant and fruit yield traits

Genotypic differences on plant and fruit yield traits are presented in Table 1. DTF was significantly ($P<0.05$) different, but DTFR showed highly significantly ($P<0.01$) differences among the genotypes. Plant vigor was significantly ($P<0.05$) different, ranged from 4 to 5 scales. The variation in plant vigor may be caused by genetic trait (Gotame et al., 2021b). Plant height and LB showed highly significant ($P<0.01$) differences. The highest plant height (299.5 cm) was measured in AVTO0301, followed by AVTO1315 (299.3 cm) and the lowest was measured in AVTO1314 (111.8 cm). A prior study was also reported in genotype-specific variation in plant height (Olakojo et al., 2014). Plant height is a quantitative characteristic that is influenced by numerous genes, and genetic trait may be cause of observed variation in plant height. Variation in plant height among tomato genotypes have also been reported in a previous study (Gotame et al. 2021b). AVTO0301, AVTO1315 and AVTO1306 showed resistant (2 in 1 to 5 scale) to LB disease. Dufera (2014) reported the genetic variability for LB among tomato genotypes in field conditions. Genotypes differed significantly ($P<0.05$) on the number of fruit plant^{-1} and it was the highest (47.0 plant^{-1}) in AVTO0301, which was statistically similar to AVTO1306 (37.0 plant^{-1}), AVTO1315 (35.0 plant^{-1}), AVTO1718 (33.0 plant^{-1}), and AVTO1912 (30.0 plant^{-1}). There was a significant ($P<0.01$) variation in total fruit

Table 1: Plant and fruit yield traits of the WorldVeg tomato genotypes evaluated at NHRC, Khumaltar, Nepal, 2021-2022

Genotypes	Days to 50% flowering, days	Days to 50% fruiting, days	Plant vigor (1–5)	Plant ht. (cm)	LB disease (1–5 scale)	Fruit/ plant (no.)	Fruit yield (kg plant-1)
AVTO0301	27.0±1.2y	54.0±0.6	5.0±0.0	299.5±17.5	2.0±0.3	47.0±12.3	2.9±1.0
AVTO1306	46.0±2.0	62.0±1.5	5.0±0.3	169.2±11.7	2.0±0.6	37.0±3.5	5.1±1.0
AVTO1314	36.0±2.6	63.0±2.9	5.0±0.6	111.8±8.9	4.0±0.3	22.0±3.1	1.4±0.1
AVTO1315	41.0±3.1	61.0±2.6	5.0±0.9	299.3±12.4	2.0±0.0	35.0±23.4	2.8±1.9
AVTO1718	45.0±5.0	64.0±3.1	4.0±0.8	163.9±27.3	3.0±0.3	33.0±3.5	2.6±0.9
AVTO1907	32.0±1.5	60.0±0.6	4.0±0.3	113.6±13.1	4.0±0.3	28.0±8.5	2.6±1.0
AVTO1912	39.0±1.5	62.0±3.2	3.0±0.0	158.5±13.0	3.0±0.3	30.0±13.7	0.6±0.2
AVTO1915	36.0±2.0	59.0±3.8	5.0±0.5	175.2±38.6	3.0±0.5	27.0±9.8	2.4±0.6
Pusa Ruby (Check)	41.0±17.0	64.0±1.5	4.0±0.3	168.8±37.5	4.0±0.5	13.0±7.5	0.7±0.1
Mean	38.30±6.1	60.93±3.1	4.37±0.7	184.40±69.3	2.90±0.9	30.2±9.6	2.35±1.4
F-Test	*	**	*	**	**	*	**
LSD (0.05)	10.46	4.25	0.88	37.41	0.49	16.89	1.40
CV (%)	15.7	4.0	11.7	11.7	9.4	35.4	36.4

[y]Mean ± SD. Plant vigor (1–5); 1; very week, 2; week, 3; medium or normal growth; 4; vigorous and 5; very vigorous, LB (1–5 scale); 1; highly resistant, 2; resistant, 3; moderately resistant; 4; susceptible, 5; highly susceptible. * and **; significant at $P<0.05$ and $P<0.01$, respectively.

yield plant^{-1}. AVTO1306 gave the highest fruit yield (5.1 kg plant^{-1}) and Pusa Ruby yielded the lowest (0.7 kg plant^{-1}). The previous researchers (Sureshkumara et al., 2017; Luitel et al., 2023) have also documented the genotypic variation in tomato fruit yield.

Fruit and quality traits

The ANOVA of fruit and quality characteristics of tomato genotypes are mentioned in Table 2. The tomato genotypes showed the significant (P<0.05) differences in fruit weight. The fruits of AVTO1306 measured the highest weight (114.1 g), followed by AVTO1912 (110.9 g) and Pusa Ruby produced the lowest (55.5 g). Fruit diameter showed a highly significant (P<0.01) differences, but the fruit firmness was non-significant (P<0.05). The genotypes differed significantly (P<0.05) in FPT. The highest (6.2 mm) FPT was measured in AVTO1315, followed by AVTO1907 (6.0 mm) and the lowest (3.3 mm) was measured in AVTO0301. Variation in TSS content was highly significant (P<0.01). The highest TSS (5.3°Brix) was measured in AVTO1314 and the lowest was in Pusa Ruby (2.9°Brix). TA showed the significant (P<0.05) differences among genotypes. The fruits of Pusa Ruby were found to be more acidic (1.5%) than those of other studied genotypes. Variations were observed in FPT, TSS and TA which could potentially be related to the genetic make of the tomato genotypes. In this research, FPT ranged from 3.3 to 6.2 mm. In contrast, it was ranged from 1.4 to 4.9 mm in a study by Saha et al. (2009). Saha et al. (2009) stated that TSS varies from 2.0 to 4.0 °Brix which is similar to our results. Likewise, TA of tomato juice ranged from 0.4 to 1.5%. In contrast, Saha et al. (2009) reported that TA varies from 0.1 to 0.5%. The WorldVeg tomato genotypes had lower TSS and TA than that of commercial variety, Pusa Ruby. Anisa et al. (2022) have also mentioned the variation in fruit firmness, FPT and TSS among various tomato breeding lines.

Analysis of genetic variability

Variations for plant and fruit yield characteristics among 10 tomato germplasms are presented in Table 3. The range was maximum for plant height (217.6 cm), fruit weight (119.3 g), and number of fruit plant^{-1} (52.0). The genotypic variance of the traits was found lower than the phenotypic variance. The genotypic variance ranged from 0.1 (fruit firmness and TA) to 4,642.4 (plant height), whereas phenotypic variance ranged from 0.9 (LB) to 5,109.6 (plant height). GCV values ranged from 1.5 (fruit yield) to 41.8% (TA). Likewise, PCV values ranged from 2.3 (fruit yield) to 61.7% (TA). In this study, PCV values were higher than the GCV values indicating that the environment has influenced in the expression of traits. Deshmukh et al. (1986) suggested that PCV and GCV values below 10% are categorized as low, values between 10~20% as medium, and values over 20% as high. We found that the highest GCV was for TA (41.8%), plant height (36.9%), LB (30.2%), number of fruit plant^{-1} (22.8%) and fruit weight (20.5%), whereas medium GCV was recorded for TSS (18.9%), FPT (13.3%) and plant vigor (11.3%). In contrast, the lowest GCV values were observed in fruit yield plant^{-1} (1.5%), DTFR (4.1%) and fruit firmness (9.3%). Similarly, the highest PCV was also observed for TA (61.7%), number of fruit plant^{-1} (44.3%), fruit firmness (41.9%), fruit weight (41.8%), plant height (38.8%), LB (31.7%), TSS (26.9%), FPT (23.6%), and DTF (20.3%), whereas medium PCV was recorded for plant vigor (16.3%) and fruit diameter (14.9%), and the lowest PCV was observed for fruit yield plant^{-1} (2.3%) and DTFR (5.7%). The highest PCV and GCV values were recorded for plant height, number of fruit plant^{-1} and average fruit weight (Kumar et al., 2013) and Singh and Singh (2018), which confirms to our results. Fruit yield plant^{-1}, DTFR, LB, plant vigor and plant height showed the least differences between PCV and GCV, indicating a greater contribution

Table 2: Fruit and quality traits of the WorldVeg tomato genotypes evaluated at NHRC, Khumaltar, Nepal, 2021–2022

Genotypes	Fruit wt. (g)	Fruit dia. (mm)	Fruit firmness (kg cm$^{2-1}$)	Fruit pericarp thickness (mm)	TSS (°Brix)	TA (%)
AVTO0301	59.5±35.8[y]	46.6±4.6	3.8±1.9	3.3±2.5	3.0±1.5	0.4±0.2
AVTO1306	114.1±22.0	56.8±3.8	4.8±1.4	5.6±0.5	4.2±0.6	0.6±0.3
AVTO1314	72.2±59.1	44.1±0.6	2.6±0.3	4.6±0.4	5.3±0.3	0.6±0.3
AVTO1315	63.5±23.9	53.6±2.6	3.9±1.4	6.2±0.2	4.4±0.6	0.8±0.5
AVTO1718	91.1±9.6	48.6±5.2	4.9±2.5	5.3±0.6	4.5±0.4	1.0±0.5
AVTO1907	65.1±10.8	51.2±1.0	3.9±1.3	6.0±0.3	4.0±1.1	0.5±0.2
AVTO1912	110.9±28.2	52.1±5.3	5.4±1.8	5.9±0.6	4.8±0.2	0.7±0.2
AVTO1915	60.8±37.8	39.7±10.3	3.1±1.0	4.9±1.3	3.0±1.9	0.4±0.2
Pusa Ruby (Check)	55.5±19.5	58.5±0.9	2.7±1.3	4.8±1.5	2.9±0.1	1.5±0.6
Mean	77.60±22.6	49.90±6.0	3.92±0.9	5.18±0.9	4.02±0.8	0.70±0.3
F-Test	*	**	NS	*	**	*
LSD (0.05)	40.59	8.66	2.78	1.76	1.32	0.55
CV (%)	36.5	10.0	33.9	19.8	19.0	25.9

[y]Mean ± SD. NS, * and **; non-significant and significant at P<0.05 and P<0.01, respectively.

of the genotypic effect to the phenotypic expression of these traits. In contrast, large differences observed between PCV and GCV particularly for fruit firmness, number of fruit plant^{-1}, fruit weight and TA might be due to environmental factors that play a major role for the expression of these traits. Values of heritability are crucial to predict the anticipated advancement that selection will bring. Heritability (broad sense) ranged from 4.9 (fruit firmness) to 91.1% for LB. Singh (2001) reported that heritability values greater than 80, 60–79, 40–59 and less than 40% indicates very high, moderately high, medium and low, respectively. Accordingly, in this study, the highest heritability was observed for LB and plant height, whereas moderately high heritability was observed for fruit yield plant^{-1}. According to Fehr (1987), a trait's heritability depends on the population being studied, the environment and method being used. Al-Ballat and Al-Araby (2020) reported high GCV for average fruit weight, number of fruit plant^{-1}, and weight of fruits plant^{-1}. Fruit yield plant^{-1} had high GA (%) and fruit firmness had low GA (%). Generally, a high GCV value suggests that these traits may be improved through selection. For the traits such as fruit yield plant^{-1}, DTFR, LB, plant vigor and plant height, the differences between PCV and GCV are low. This suggests that the environment has less effect on these traits which may be improved through genetic manipulation.

Correlation of the traits

Results of phenotypic correlation coefficients of the 13 traits in WorldVeg tomato genotypes are given in Table 4. DTF showed significant ($P<0.05$) positive correlation with DTFR (r = 0.46), fruit diameter (r = 0.41), and FPT (r = 0.45). There was a significant ($P<0.05$) negative correlation between DTFR and plant vigor (r = −0.39), plant height (r = −0.48) and number of fruit (r = −0.56). But DTFR had significantly positively correlated with LB (r = 0.51), FPT (r = 0.43), TSS (r = 0.39) and TA (r = 0.43). Plant vigor and fruit yield plant^{-1} were significantly positively correlated (r = 0.64). In contrast, plant height had a highly significant ($P<0.01$) strong and negative correlation with LB (r = −0.79), but a significant ($P<0.05$) positive correlation with number of fruit plant^{-1} (r = 0.47). LB exhibited a highly significant ($P<0.01$) negative correlation with the number of fruit plant^{-1} (r = −0.59), and fruit yield plant^{-1} (r = −0.47). The number of fruit plant^{-1} had a highly significant ($P<0.05$) positive correlation with fruit yield plant^{-1} (r = 0.58). The association between fruit weight and fruit yield was significant ($P<0.05$) and showed a positive moderate correlation (r = 0.40). Fruit weight revealed a highly significant ($P<0.01$) positive correlation with fruit diameter (r = 0.47) and TSS (r = 0.36). Fruit weight and fruit diameter have been found to significantly positively correlated in tomato (Gotame et al. 2021a). This study showed un-correlation among

Table 3: Genetic variability of plant and fruit yield traits of the WorldVeg tomato genotypes evaluated at NHRC, Khumaltar, Nepal, 2021–2022

Traits	Mean	Range	Genotypic variance (σ2G)	Phenotypic variance (σ2P)	SE	GCV (%)	PCV (%)	Heritability h2B (%)	Genetic advance	
									GA (%)	GA% of mean
DTF	38.3	21.0–51.0	24.31	60.5	3.4	12.8	20.3	40.2	6.4	16.8
DTFR	60.9	54.0–67.0	6.2	12.2	1.4	4.1	5.7	50.5	3.6	5.9
PV	4.4	3.0–5.0	0.2	0.5	0.3	11.3	16.3	48.2	0.7	16.2
PHT	184.4	102.0–319.6	4,642.4	5,109.6	12.5	36.9	38.8	90.8	133.8	72.5
LB	3.0	1.5–4.5	0.7	0.9	0.2	30.2	31.7	91.1	1.8	59.5
FN	30.0	5.0–57.0	47.2	178.8	6.6	22.8	44.3	26.4	7.3	24.1
FY	2.4	0.4–6.2	1.5	2.3	0.5	1.5	2.3	67.5	2.1	88.8
FW	77.0	23.4–142.7	249.9	1,037.7	16.2	20.5	41.8	24.1	15.9	20.8
FD	49.9	31.0–59.6	30.2	55.3	2.8	11.0	14.9	54.7	8.4	16.8
FF	3.9	1.2–6.8	0.1	2.7	0.9	9.3	41.9	4.9	0.2	4.3
FPT	5.2	0.4–6.6	0.5	1.5	0.6	13.3	23.6	31.8	0.8	15.5
TSS	4.0	1.7–5.6	0.6	1.2	0.4	18.9	26.9	49.6	1.1	27.5
TA	0.7	0.1–2.2	0.1	0.2	0.2	41.8	61.7	44.8	0.4	56.9

DTF; Days to 50% flowering, days, DTFR; Days to 50% fruiting, days, PVIG; Plant vigor (1–5), PHT; Plant height (cm), LB; Late blight (1–5), FN; Fruit plant^{-1} (no.), FYL; Fruit yield (kg plant^{-1}), FW; Fruit weight (g), FD; Fruit diameter (mm), FF; Fruit firmness (kg cm$^{2-1}$), FPT; Fruit pericarp thickness (mm), TSS; Total soluble solid (°Brix), and TA; Titrable acidity (%). SE; Standard error, GCV; Genotypic coefficient of variation, PCV; Phenotypic coefficient of variation, GA; Genetic advance fruit firmness, FPT, TSS and TA, and Saha et al. (2010) reported the similar findings in tomato. Correlation coefficients with desired traits are higher than 0.50 value helps to improve these traits through indirect selection (Lopes et al., 2002). Accordingly, the positive correlation coefficients between fruit yield plant^{-1} and plant vigor (r = 0.64) and number of fruit plant^{-1} (0.58) found in this study can be regarded as selection criteria to increase tomato fruit yield.

Table 4: Phenotypic correlation coefficients of 13 traits in WorldVeg tomato genotypes, 2021–2022

Traits	DTF	DTFR	PV	PHT	LB	FN	FY	FWT	FD	FF	FPT	TSS	TA
DTF	1.0	0.46*	−0.21	−0.03	−0.06	0.05	0.13	0.30	0.41*	0.23	0.39*	0.45*	0.36
DTFR		1.0	−0.39*	−0.48**	0.51**	−0.56**	−0.20	0.09	0.32	−0.10	0.43*	0.39*	0.43*
PV			1.0	0.25	−0.25	0.36	0.64**	−0.06	−0.10	−0.30	−0.27	−0.28	−0.02
PHT				1.0	−0.79**	0.47*	0.22	−0.11	0.06	0.06	−0.16	−0.27	−007
LB					1.0	−0.59**	−0.47*	0.06	0.04	−0.19	0.10	0.31	0.32
FN						1.0	0.58**	0.28	−0.01	0.31	0.16	−0.12	−0.08
FY							1.0	0.40*	0.09	0.08	0.03	0.04	−0.10
FWT								1.0	0.47**	0.34	0.23	0.36*	0.15
FD									1.0	0.28	0.31	0.09	0.34
FF										1.0	0.08	0.33	−0.07
FPT											1.0	0.04	0.23
TSS												1.0	0.10
TA													1.0

*and ** indicate significant at P<0.05 and P<0.01, respectively. DTF; Days to 50% flowering, days, DTFR; Days to 50% fruiting, days, PV; Plant vigor (1–5), PHT; Plant height (cm), LB; Late blight (1–5), FN; Fruit plant^{-1} (no.), FY; Fruit yield (kg plant^{-1}), FW; Fruit weight (g), FD; Fruit diameter (mm), FF; Fruit firmness (kg cm$^{2\ -1}$), FPT; Fruit pericarp thickness (mm), TSS; Total soluble solid (°Brix), TA; Titrable acidity (%).

Conclusion:

This study examined the genetic variability and phenotypic traits association among WorldVeg tomato genotypes. WorldVeg tomato genotypes showed higher number of fruit plant^{-1}, fruit yield plant^{-1}, fruit weight, FPT and TSS than that of Pusa Ruby, commercial variety. AVTO1306 showed a high yielding (5.1 kg plant^{-1}) genotype, followed by AVTO1301 (2.9 kg plant^{-1}) and these genotypes could be the most promising for tomato farming at open field condition. The results of genetic variability revealed the wide variations particularly in plant height, fruit weight, number of fruit plant^{-1}, fruit diameter and DTF. PCV values were greater than GCV values for all the traits suggesting that the environment had an impact. High heritability estimates for the LB, plant height and fruit yield plant^{-1} infers more genetic control than the environmental effect and it is suggested to use these traits as selection to increase tomato yield. Fruit yield was linked with plant vigor, LB and the number of fruits plant^{-1}; as a result, selecting for these traits can increase yield trait of the tomato genotypes.

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Declaration of conflict of interest and ethical approval:

BP Luitel involved in designing the experiment, analyzing the data and writing the manuscript. D Ghimire and B Bhusal helped to conduct the experiment and record data. TR Chapagain and YR Bhusal edited the manuscript. The authors declare no conflict of interest.

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