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Evaluation of fourteen promising tomato lines (*Solanum lycopersicum* L.) as hybrids parent candidates

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Abstract

The demand for tomato fruit has increased along with the human population. The increasing income of peoples also affect the demand orientation for high nutrition content and the shortage of resources is the obstacle for future tomato farming. Breeding tomato has been intended to create a new cultivar with high yield and quality. Previously, there were fourteen selected promising lines with high fruit firmness and yield components resulting from plant breeding program. Therefore, further steps need to be evaluated regarding yield potential and the plant quality. This study aimed to identify fourteen promising lines of high yield and high quality and compared to commercial varieties. Fourteen tomato accessions were evaluated by three control varieties. The accessions and controls varieties were assigned in a randomized completely block design (RCBD) with three replications. Data collections were analyzed using Analysis of variance (ANOVA) and continued with Duncan Multiple Range Test (DMRT) analysis with α=5%. Path analysis showed that the selection criteria for selecting high yield of tomato lines were fruit length, pulp thickness, fruit weight/plant, and flowers number per bunch. There were five lines of fourteen accessions which had high yield potential and four tomato lines which had worth considering fruit size and fruit firmness. These lines contained high potential characters to be used as breeding materials for improvement of hybrid.

INTRODUCTION

Tomatoes included as the most important food in the world, so the consumption and production of tomatoes in Indonesia has ever reached the second largest (FAO, 2016) and sixth largest position (BPS, 2020). The data of tomato consumption in United States a year was reported 14.6 kg tomato/person as the second most consumed fresh vegetable approximately 5,6 kg/person in 2019 (USDA, 2020). Tomato can be consumed in fresh condition, like pickles, preserves, or after-cooking consumption, or consumed in processed food as in sauce, paste, ketchup, powder, soup, and canned fruits.

The increasing income of peoples affect the demand orientation for high nutrition content and the shortage of resources is the obstacle for future tomato farming (Springmann et al., 2018). Tomato contains many compounds such as phenolic, carotenoids (lycopene, carotene), vitamins (C and A) and glycoalkaloids. The tomato compounds functionate as antioxidant, anti-mutagenic, anti-proliferative, anti-inflammatory and anti-atherogenic activities so it could be functional foods and useful as ingredient or vegetable (Chaudhary et al., 2018).

Erika et al. (2020) showed that the use of tomato biodiversity in organic is able to produce high yields of fruit per unit area in high nutritional content. It is implied the breeding program could improve the fruit quality and tomato yield. The tomato breeding aims to achieve high yield and high quality as well as tolerance

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to biotic and abiotic stress to ensure global food security and food quality (Choudhary, 2022). A breeder should generate a wide range of diversity from morphological and fruits characters (weight and size, shape and color) in breeding activities.

Breeding process is usually initiated with selection of the existing genotypes as parents and the selected genotypes are hybridized to combine a desirable trait (Bertan et al, 2017). Genetic gain of yield and quality of tomato is the achievement of the breeding program. Morphological traits/features are the most common selection criteria and are intended to estimate the genetic variability (Osei et al., 2014; Ngezahayo et al., 2020) because morphological traits are more practical and easier to be implemented in data collection. Morphology is also as result of genotype and environment interaction, and is cheaper compared to molecular and biochemical markers (Bernousi et al, 2011).

Tomatoes have an increasingly important economic value in recent decade. Unfortunately, in Indonesia, the land area of tomato production experienced static state in three years (2018–2020) of 54.158–57.303 ha (Badan Pusat Statistik, 2022). Thus, the breeding program for improving the yield potential and yield quality was carried out by Plant Breeding Laboratory in Faculty of Agriculture by means of conventional breeding using pedigree selection in segregation population until F5. Several selected lines showed high yield, round-shape fruit, and high fruit firmness (non-ripening fruit) so it has potentials as variety candidate or as parents to produce hybrid variety. Therefore, further evaluation of morphological characters of these lines in the advance generation with more uniform genotype in each line is highly needed. It is aimed at finding the outstanding performance of lines especially high yield potential lines that could be used as varieties candidate and breeding materials for developing tomato hybrids. In Indonesia most commercial seeds of tomato are hybrids, so the development of pure lines varieties are able to help farmers in cheaper cultivation cost.

Yield is included as quantitative trait so numerous genes contribute to its performance (Liu et al., 2020). Direct selection to high yield should be avoided because of the profound environmental effect on quantitative traits. Indirect selection by yield components that have significantly correlation to yield should be considered (Board et al., 2003). Correlation analysis was performed to know the relationship between the traits in tomato plants. Souza et al. (2012) stated that tomato breeding programs have been focused on creating cultivars with desirable traits particularly the characters which are related to fruit yield and fruit quality. As a result, the information regarding the correlations between traits of interest is very important. Selection through a particular trait may either increase or reduce the expression of other traits, depending on the genetic correlation between them.

This study aimed to evaluate fourteen tomato lines compared to commercial varieties as standard variety for morphological characters including high yield and good quality.

MATERIALS AND METHODS

Experimental procedure

This study was carried out in the Green House, Faculty of Agriculture, Universitas Gadjah Mada for seed germination and planting tomato seedlings. However, the cultivation was carried out at the Horticultural Seed and Agribusiness Development and Promotion Center, Department of Agriculture in Sleman District, Special Region of Yogyakarta, Indonesia. This area has an elevation of 700 asl and temperature average of 25–26^{o}C. Fourteen tomato lines owned by Faculty of Agriculture, Universitas Gadjah Mada, and three commercial tomato varieties were used as plant materials (Table 1). Marta is a tomato hybrid produced by East-West Seed Indonesia, Tora is owned by IPB University, and Kaliurang is a local cultivar generated by Horticultural Seed and Agribusiness Development and Promotion Center, Department of Agriculture in Sleman District.

These lines and control varieties were arranged in RCBD with three replications. Ten plant samples per genotype were observed per replication. Thus, each block consisted of 30 tomato plants planted in the field covered with mulch and using a space of 40 cm × 40 cm. Tomato seeds were shown in the trays consisting of soil media and enriched with organic fertilizer 1:1 (w/w). These seedlings were transplanted in the field for 24 days after germination. After transplanting to the field, the cultivation process included watering, fertilizing, pruning, pest, and disease controlling, and harvesting.

Data collection

Ten plant samples per accession were observed per replication for the number of flowers per bunch, harvest age (the day after transplanting), number of fruits per bunch, fruit set (%), number of locules in fruits, fruit thickness (cm), fruit firmness (N), fruit weight (g), fruit weight per plant (kg), and yield potential (tons.ha^{-1}). The data were analyzed using variance (ANOVA) and continued by post hoc analysis using Duncan Multiple Range Test (DMRT) with α=5%. The correlation and path analysis were performed using R software statistics.

RESULTS AND DISCUSSION

Quantitative characters

The data of fruit diameter, fruit locules, fruit firmness, fruit thickness, and fruit weight are presented in Table 2. This result showed that tomato lines MA 131-6-3 and MA 131-6-1 had a higher value of fruit diameter of 6.29 cm and 6.18 compared to the commercial varieties (Tora and Marta) of 4.85 and 5.42, but these lines had no significant difference of fruit diameter compared to Kaliurang variety (6.12). This is because Kaliurang had a round flattened fruit shape, causing

Table 1. Accessions and control varieties as planting materials

No	Accession numbers/varieties	No	Accession numbers/varieties
1.	MA 131-18-2	10.	MA 131-16-3
2.	MA 131-18-1	11.	MA 131-16-4
3.	MA 131-22-1	12.	MA 131-1-1
4.	MA 131-22-2	13.	MA 131-11-1
5.	MA 131-22-5	14.	MA 131-6-3
6.	MA 131-16-2	15.	MA 131-6-2
7.	MA 175-1-2	16.	MA 131-6–1
8.	Marta	17.	Tora
9.	Kaliurang		

Table 2. Fruit diameter, fruit locules, fruit firmness, fruit thickness and fruit weight of tomato lines and commercial varieties

Tomato lines	Fruit diameter (cm)	Number of locules	Fruit thickness (cm)	Fruit Firmness (N)	Fruit weight (g)
MA 131-18-2	4.91±0.27 f	2.43±0.23 de	0.78±0.06 abc	41.31±5.03 cd	94.40±6.79 efg
MA 131-18-1	5.01±0.15 f	2.61±0.27 d	0.78±0.01 abc	39.88±1.75 cde	93.34±5.13 efg
MA 131-22-1	4.91±0.22 f	2.51±0.33 de	0.80±0.04 ab	41.43±2.15 cd	93.36±8.62 efg
MA 131-22-2	4.94±0.18 f	2.26±0.14 de	0.76±0.07 abcd	46.10±5.26 c	91.33±5.54 fg
MA 131-22-5	5.07±0.22 ef	2.23±0.15 de	0.78±0.03 abc	44.33±3.41 cd	98.61±4.99 def
MA 131-16-2	4.78±0.46 f	2.34±0.04 de	0.84±0.04 a	42.04±3.66 cd	83.40±8.16 fg
MA 131-16-3	4.78±0.20 f	3.60±0.24 c	0.76±0.03 abcd	43.64±0.36 cd	85.28±1.73 fg
MA 131-16-4	4.78±0.37 f	2.27±0.06 de	0.80±0.07 ab	43.74±0.33 cd	91.04±2.99 fg
MA 131-14-1	5.70±0.11 bcd	3.45±0.09 c	0.77±0.01 abcd	38.66±1.01 de	112.04±8.45 cde
MA 131-11-1	6.03±0.07 ab	5.02±0.42 a	0.70±0.03 bcde	34.51±0.23 e	129.82±8.94 abc
MA 131-6-3	6.29±0.10 a	3.60±0.39 c	0.67±0.02 def	67.30±1.39 a	138.40±2.52 ab
MA 131-6-2	5.93±0.08 abc	4.16±0.29 b	0.56±0.13 f	59.49±7.61 b	122.67±22.55 bc
MA 131-6-1	6.18±0.08 a	4.81±0.35 a	0.68±0.06 cde	56.66±0.59 b	145.97±17.26 a
MA 175-1-2	5.60±0.21 cd	3.40±0.30 c	0.71±0.10 bcde	59.85±1.39 b	112.50±9.47 cde
Tora	4.85±0.09 f	2.55±0.29 de	0.62±0.03 ef	44.10±0.74 cd	77.37±14.18 g
Kaliurang	6.12±0.22 a	4.53±0.58 ab	0.62±0.03 ef	43.28±4.68 cd	121.75±16.17 bc
Marta	5.42±0.21 de	2.03±0.06 e	0.84±0.03 a	45.00±6.09 cd	113.92±6.15 cd
	CV = 4.08%	CV = 9.37%	CV = 7.94%	CV = 7.58%	CV = 9.87%

Remarks: Numbers followed by the same letters are not significantly different at DMRT at α=5%.

a high fruit diameter. However, tomato lines of MA 175-1-2, MA 131-14-1, MA 131-6-2 and, MA 131-11-1 had a smaller fruit diameter than the Kaliurang commercial variety but it was higher than Marta and Tora. This is because Marta had an oval fruit shape, while, Tora had a small fruit with round shape.

Tomato lines that had a higher number of locules were MA 131-11-1 and MA 131-6-1. These lines had a significantly different number of locules compared to the commercial varieties at values of 5.02 and 4.81. However other lines had fruit locules at average 2 and 3. This is in line with the study by Mu et al. (2017) which described that the number of locules was linked with fruit dimension and size.

Pericarp thickness data explained that tomato lines MA 131-16-4, MA 131-22-1, MA 131-18-1, MA 131-22-5, MA 131-18-2, MA 131-14-1, MA 131-16-3, and MA 131-22-2 did not have the significant different value of fruit thickness compared to Marta at average 0.76–0.8 cm. However, these lines had higher pericarp thickness than Tora and Kaliurang. The pericarp thickness affected the fruit firmness. Ma et al (2014) showed the inhibition of fruit ripening was affected by the *SlNAC1* through ethylene synthesis and carotenoid accumulation. The expression of *SlNAC1* decreased the fruits firmness and the pericarp thickness.

Firmness is an important fruit attribute correlated with shelf life and capability in distance transport (Lun et al., 2013) and contributes to fruit quality. Tomato lines MA 131-6-3, MA 175-1-2, MA 131-6-2, MA 131-6-1, and MA 131-22-2 had a significant value of fruit firmness compared to the commercial varieties at values of 67.30 N, 59.85 N, 59.49 N, 56.66 N, and 46.10 N. This fruit firmness was higher than that in tomato Mutant yf t1 discovered by Li et al. (2019) which showed higher firmness than the wild type. The higher firmness in Mutant yf t1 indicated the loss or decrease of YFT1 function so it changed the pericarp cell structure, chemical components, hydrolase activities as result of the expression of genes encoding these hydrolases. Lunn et al. (2013) found out the SlRab11a expression was the most powerful in the fruit development indicating important status in cell wall deposition. Thus, the impact was that the pectin in the cell wall was lower than the wild type. The fruit shelf-life could be changed by altering cell wall deposition rather than cell wall hydrolytic enzymes. Genetically, according to Wiguna et al. (2021) the fruit shelf-control bye additive gene action.

Fruits vary widely in size, shape, and color (Schwarz et al., 2018). Data of fruit weight presented in Table 2 showed the range of fruit weight of 83.40–145.97 g.

Table 3. Number of flowers per bunch, number of bunches per plant, and fruit set

Tomato lines	Number of flowers per bunch	Number of fruits per bunch	Fruit set (%)
MA 131-18-2	9.90±2.04 a	7.80±1.31 ab	82.90±2.90 abcd
MA 131-18-1	9.23±1.17 ab	7.10±0.72 abcd	71.64±8.43 ef
MA 131-22-1	9.53±1.62 ab	7.20±0.72 abc	79.94±8.80 bcde
MA 131-22-2	9.43±1.50 ab	7.93±2.01 ab	86.58±5.78 abcd
MA 131-22-5	9.30±1.23 ab	7.03±1.36 abcd	79.02±2.42 cde
MA 131-16-2	8.87±1.88 abcd	6.80±1.61 abcd	88.68±4.85 ab
MA 131-16-3	9.93±1.18 a	8.28±0.68 a	87.22±6.69 abc
MA 131-16-4	10.10±0.81 a	7.90±0.96 ab	71.59±4.43 ef
MA 131-14-1	6.87±1.96 cd	5.15±1.84 de	91.26±4.11 a
MA 131-11-1	7.70±1.56 d	5.40±1.71 cde	86.99±8.28 abc
MA 131-6-3	8.37±0.64 abcd	4.77±0.68 e	56.91±6.35 g
MA 131-6-2	8.81±1.07 abcd	6.00±1.73 bcde	60.64±2.20 g
MA 131-6-1	8.33±0.64 abcd	5.33±0.42 cde	61.18±4.47 g
MA 175-1-2	8.80±0.17 abcd	6.97±0.76 abcd	82.45±2.05 abcd
Tora	7.87±0.46 abcd	4.77±0.68 e	64.38±6.18 fg
Kaliurang	7.33±0.51 bcd	5.43±0.15 cde	71.08±3.96 ef
Marta	8.97±1.15 abc	7.00±1.32 abcd	77.71±5.14 de
	CV = 1.34%	CV = 15.81%	CV = 6.38%

Remarks: Numbers followed by the same letters are not significantly different at DMRT at α=5%.

Table 4. Harvesting age, fruit weight per plant, and yield potential

Tomato lines	Harvesting age (day after transplanting)	Fruit weight Per plant (kg)	Yield (ton. ha^{-1})
MA 131-18-2	75.33±0.58 de	2.78±0.30 ab	23.82±2.58 ab
MA 131-18-1	73.33±0.58 fg	2.46±0.27 bcd	21.10±2.28 bcd
MA 131-22-1	73.33±1.53 fg	2.20±0.22 de	18.82±1.89 de
MA 131-22-2	73.33±1.00 fg	3.06±0.22 a	26.21±1.86 a
MA 131-22-5	73.33±0.58 fg	2.89±0.13 a	24.78±1.13 a
MA 131-16-2	74.33±0.58 def	2.29±0.34 cde	19.60±2.91 cde
MA 131-16-3	73.67±1.53 efg	2.95±0.11 a	25.25±0.92 a
MA 131-16-4	74.00±1.00 def	2.66±0.04 abc	22.76±0.37 abc
MA 131-14-1	70.67±0.71 h	1.87±0.12 e	16.03±1.03 e
MA 131-11-1	72.00±0.71 gh	2.16±0.08 de	18.50±0.72 de
MA 131-6-3	84.33±2.08 a	2.44±0.10 bcd	20.89±0.89 bcd
MA 131-6-2	83.67±0.58 a	2.46±0.13 bcd	21.09±1.11 bcd
MA 131-6-1	85.00±0.58 a	2.15±0.35 de	18.44±2.99 de
MA 175-1-2	84.00±1.00 a	2.30±0.29 cd	19.71±2.46 cd
Tora	78.00±1.00 c	1.87±0.10 e	16.01±0.84 e
Kaliurang	80.00±1.00 b	2.18±0.29 de	18.71±2.51 de
Marta	75.67±1.00 d	2.77±0.32 ab	23.72±2.74 ab
	CV = 1.34%	CV = 9.26%	CV = 9.25%

Remarks: Numbers followed by the same letters are not significantly different at DMRT at α=5%.

Tomato lines of MA 131-6-1, MA 131-6-2, MA 131-6-3, and MA 131-11-1 had bigger fruit compared to the commercial varieties (Marta, Tora, and Kaliurang) at values of 145.97 g, 112.67 g, 138.40 g, and 129.82 g. However commercial varieties (Tora, Kaliurang and Marta) had smaller fruit size of 77.37 g, 121.75 g, and 113.92 g. It implies that these lines have potentials as varieties candidate or as hybrid parents. Schwars et al (2018) categorized tomato fruit size into four categories adapted from UPOV guideline: large (100–180 g), medium (70–100 g), small 20–70 g). According to these categories, tomato lines of MA 131-6-1, MA 131-6-3, MA 131-11-1, and MA 131-6-2 could be categorized as large.

Tomato lines of MA 131-16-4, MA 131-16-3, MA 131-18-2, MA 131-22-1, MA 131-22-2, MA 131-22-5, and MA 131-18-1 had significantly higher number of flowers per bunch compared to that of Tora and Kaliurang (Table 3). The number of flowers per bunch contributed to the fruit set per plant. In addition, there were 7 tomato lines (MA 131-16-3, MA 131-22-2, MA 131-16-4, MA 131-18-2, MA 131-22-1, MA 131-18-1, and MA 131-22-5) that had higher number of fruits at around 8.28, 7.93, 7.90, 7.80, 7.20, 7.10, and 7.03. The number of fruits was significantly higher than Tora and Kaliurang varieties. The number of fruits per bunch contributed to the character of yield potential. Therefore, the 7 lines of tomato were recommended to be used as parental for developing tomato hybrids with high yields.

Fruit set is the percentage of flowers that turns into fruits at each bunch. Table 3 shows the data of fruit set which indicated that tomato lines of MA 131-14-1, MA 131-16-2, MA 131-16-3, MA 131-11-1, MA 131-22-2, MA 131-18-2, MA 175-1-2, MA 131-22-1, and MA 131-22-5 had significantly higher fruit set compared to the standard varieties at values of 91.26, 88.68, 87.22, 86.99, 79.02, 82.90, 82.45, 79.94, and 79.02. This result indicated that these lines had a high yield because the fruit set contributed to the number of fruits per bunch, and this character is linked to the yield contribution.

Table 4 shows the data of harvesting age, fruit weight per plant, and yield potential. There were three tomato lines (MA 131-18-2, MA 131-16-2, and MA 131-16-4) that had significantly lower harvesting age than the standard varieties (Tora and Kaliurang). However, it is not significantly different from Marta. Marta is a hybrid with good plant performance produced by East-West Seed Indonesia. Therefore, this study used Marta as standard variety in order to select the best lines which could at least produce good characters like Marta so the lines can become variety candidate for non-hybrid variety or as parent in hybrid variety

Table 5. Correlation of tomato characters

Morphological characters	NL	FD	FW	FF	HE	FT	FS	FWPP	Y	NFLPB
FD	0.88*									
FW	0.83*	0.96*								
FF	0.27	0.50*	0.52*							
HE	0.50*	0.61*	0.60*	0.89*						
FT	-0.69*	-0.61*	-0.47	-0.48*	-0.67*					
FS	-0.33	-0.44	-0.43	-0.64*	-0.73*	0.63*				
FWPP	-0.55*	-0.41	-0.27	0.03	-0.21	0.39	0.19			
Y	-0.50*	-0.23	-0.08	-0.12	-0.30	0.48	0.15	0.67*		
NFLPB	-0.72*	-0.67*	-0.52*	0.09	-0.11	0.47	0.03	0.75*	0.59*	
NFPB	-0.69*	-0.73*	-0.59*	-0.26	-0.43	0.64*	0.48	0.78*	0.49*	0.86*

Remarks: (*) Indicates the significant correlation at α=5%. NL = Number of locules, FD = Fruit diameter, FW = Fruit weight, FF = Fruit firmness, HE = Harvesting age, FT = Fruit thickness, FS = Fruit set, FWPP = Fruit weight per plant, Y = Yield, NFLPB = Number of flowers per bunch, NFPB = Number of fruits per bunch.

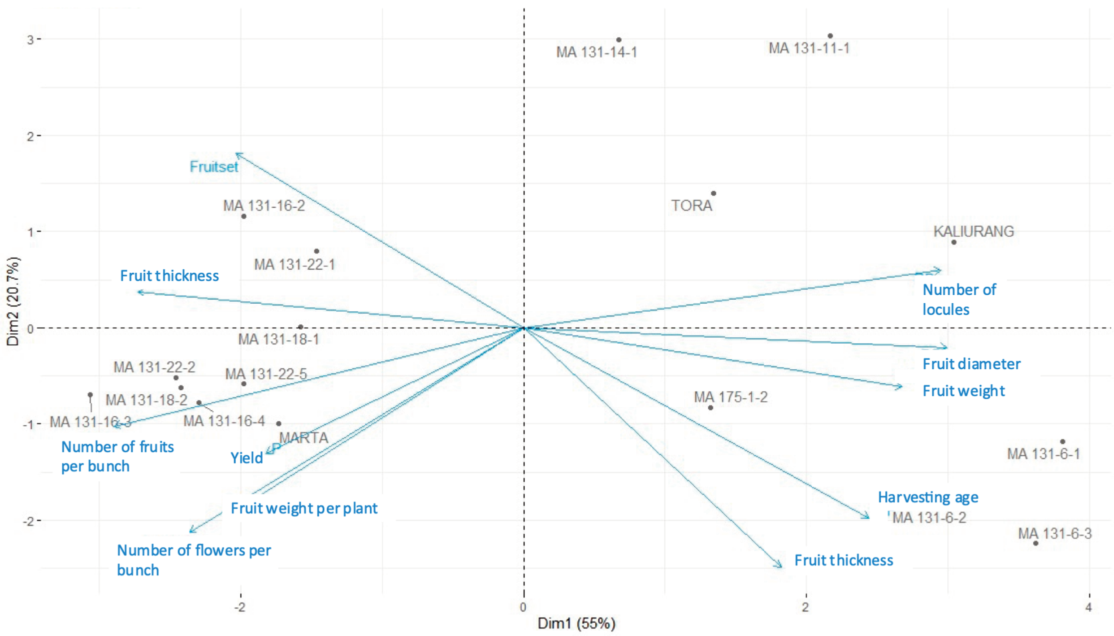

Figure 1. Path analysis of the correlation among the characters in tomato plants

Remarks: Blue lines indicate the characters, black dots represent the tomato lines/varieties, the angles formed between two lines show the correlation among characters.

production. Harvesting age genetically controlled and involved several physiological factors such as light intensity, temperature, nutrition, and other growing factors (Edmond, et al., 1975).

Tomato lines that had the higher value of fruit weight per plant compared to the commercial varieties (Kaliurang and Tora) were MA 131-22-2, MA 131-16-3, MA 131-22-5, and MA 131-18-2. However, the fruit weight per plant of these lines was not significantly different from Marta's. Furthermore, the data of yield potential showed that there were four tomato lines (MA 131-22-2, MA 131-16-3, MA 131-22-5, and MA 131-18-2) that had significantly higher yield potential at around 26.21 tons.ha^{-1}, 25.25 ton.ha^{-1}, 24.78 ton.ha^{-1}, and 23.82 ton.ha^{-1} compared to the commercial varieties. This indicated that these lines are highly recommended to be selected as parents for tomato hybrids development with high yield character.

Correlation and path analysis

Phenotypic correlations are estimated directly from values measured in the field and are the result of genetic and environmental causes (de Souza et al., 2012). The correlation between tomato line characters is presented in Table 5. The results revealed that fruit weight per plant, number of flowers per bunch, and number of fruits per bunch exhibited a positive link to yield attribute. However, the positive correlation also appeared between characters of fruit firmness with fruit diameter, fruit weight, and harvesting age. This finding was in line with research result by De Souza et al., (2012) from which the positive phenotypic correlations were observed between fruit weight per plant and the traits number of fruits, fruit weight. This suggests that selecting tomato plants in a high value of fruit weight per plant, number of flowers per bunch, and number of fruits per bunch will increase yield potential. Tomato lines with a high value of fruit weight per plant, number of flowers per bunch, and number of fruits per bunch are recommended to be used as genetic resources for developing hybrids with high yield performance. These traits contributed to yield increase and should be noticed simultaneously for line selection.

Correlation data alone could not give a comprehensive result of the correlation between characters. Therefore, path analysis is highly recommended for completing the analysis (Alam et al., 2019). Path coefficient can estimate the correlation among desirable traits in tomato lines. The result of path analysis is presented in Figure 1. The figure reveals that the angles formed between two lines show the correlation among characters. The smaller the angles, the stronger the correlation between two characters of tomato plants. The opposite blue lines represent the characters with negative correlation (Cai et al., 2018).

The result indicated that the characters having small angles with the character of tomato yield were number of flowers per bunch, fruit weight per plant, and number of fruits per bunch. However, characters having small angles with fruit firmness were fruit diameter, fruit weight, and harvesting age. This result was in line with the correlation of the characters. Tomato lines having small angles with the characters of number of flowers per bunch, fruit weight per plant, and number of fruits per bunch were MA 131-22-2, MA 131-18-2, MA 131-22-5, MA 131-16-3, and MA 131-16-4. These lines had higher yield than commercial varieties. On the other hand, tomato lines having small angles with the characters of fruit diameter, fruit weight, and harvesting age were MA 131-6-2, MA 131-6-3, MA 175-1-2, and MA 131-6-1. Thus, tomato lines of MA 131-22-2, MA 131-18-2, MA 131-22-5, MA 131-16-3, and MA 131-16-4 were highly recommended to be used as plant materials for developing tomato hybrids in high yield characters. However, tomato lines of MA 131-6-2, MA 131-6-3, MA 131-6-1, and MA 175-1-2 were suggested to be included as breeding materials for developing tomato hybrids in high fruit quality.

CONCLUSIONS

MA 131-16-4, MA 131-22-5, MA 131-18-2, MA 131-16-3, and MA 131-22-2 lines were recommended as pure line varieties or parent candidates for developing tomato hybrids in high yield. The lines having good fruit quality were MA 131-6-1, MA 131-6-2, MA 131-6-3, and MA 175-1-2. The number of flowers per bunch, fruit weight per plant, and number of fruits per bunch had significant correlation with yield, while the fruit diameter, fruit weight, and harvesting age had correlation with fruit firmness.

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