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ORGANIC SYSTEM BASED EVALUATION OF TOMATO (SOLANUM LYCOPERSICUM) FOR PARTICIPATORY PLANT BREEDING IN BANGLADESH

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Abstract: For Participatory breeding program FGD and online survey was conducted with stakeholders to identify key plant traits and a total 32 diverse set of tomato germplasm was evaluated under organic management using Augmented design to better understand horticultural constraints and identify adapted germplasm for further development. Stakeholders rated a greater number of fruits per plant, nutrition color (lycopene, β carotene), flavor, virus resistances, stronger root, storability as their top breeding priority, safety was the prior quality characters of tomato. The ANOVA indicated significance difference among genotypes, the result indicated the existence of high morphological variation in tomato genotypes grown in organic system based condition. Yield per plant showed significant variation with the quality parameter like lycopene and β-carotene. To screen out suitable cultivars through multivariate analysis and genetic diversity in tomato genotypes based on 17 characters was estimated using Mahalanobis's D^2statistics. Eight different homozygous divergent genotypes were selected from five different clusters using variance ranking among genotypes within cluster.

Introduction: Plant breeding was strongly oriented towards creating cultivars that were highly productive and suitable for machine-harvesting in large-scale, high-external-input farming systems. It is estimated that more than 95% of organic agriculture is based on crop varieties that were bred for the conventional high-input sector with selection in conventional breeding programmes and lack important traits required under organic and low-input production conditions (Lammerts van Bueren et al. 2011). Participatory plant breeding is an ideal approach for developing new cultivars optimally adapted to regional and organic production systems originated in developing countries for marginal highly heterogeneous lands and growers often lack access to agrochemical inputs that optimize productivity of cultivars. Tomato (Solanum lycopersicum) is an important vegetable sources of health benefit substance like; lycopene, carotene, vitamins (vitamin C), minerals, flavonoids and phenolic acid. Absence of suitable cultivar to grow organically, small farmers are suffering from poor crop growth, severe attack of pest and diseases especially, virus, thereby, serious yield and economic damage. Participatory breeding programs generally include three steps: identifying stakeholders needs, selecting suitable material to test with stakeholders and experimenting on growers' fields.

Material and methods: A survey was designed using the tools FGD and online among the tomato stakeholders including's growers, health conscious consumers, extension personnel DAE & NGO, organic tomato sellers using 13 questions, using a on-line tool SurveyMonkey (SurveyMonkey.com). Thirty-two tomato genotypes were included in this research work collected from AVRDC, Tennessee State University, USA, Olericulture Division, Joydebpur, Gazipur after consultation with public tomato breeders. Seeds were sown in pot containing a organic mixture. Organic microbial consortiums (BARI IMO 1 and BARI IMO 2) were sprayed on seedlings to protect the seedling from pathogen and enhanced the growth other necessary care were taken for seedling regularly. Seedlings were planted in a organic field developing since 2006 and Augmented Design was applied in this experiment where the genotypes were randomly allotted in each block in both years. The field was fertilized by 10 t / ha manure and 100 g BAOFER per pit. The observation were recorded on 8 randomly selected plants in each replication for each accession on 17 quantitative characters i.e., 50% plant flowering, 1st harvest/days, last harvest/days, plant height (cm), single fruit wt.(g), No. of fruit/plant, fruit length(cm), fruit breadth (cm), fruit shape, No. of locule, °brix, pericarp thickness, yield/plant (g), root length (cm), SPAD value (by a SPAD 502, Minolta, Japan) for estimating the nitrogen according to Cerovic et al., 2012, lycopene and β carotene were measured according to Tilahun et al, 2018 by recording the color at full ripen stage with a color meter (Cr 400, Minolta, Japan). R-3.1.1 statistical program was used in all statistical analysis.

Results: The result of the study were summarized and illustrated in the fig 1 and 6 parameters scored ≥ 4.5 namely, number of fruits per plant (4.82), flavor and nutritional quality (4.79), color (4.79), safety (4.65), virus (4.61) and storability (4.50). Stronger root system, nutrient use efficiency also scored near 4.5 there this two might be considered production sustainability point of view from the growers end. The ANOVA indicated significance difference among genotypes all quantitative characters except block vs adj of fifty percent flowering (FPF), days to first harvest (DFH), days to last harvest (DLH), plant height (PH)and fruit length (FL) (Table 1). Hence, the result indicated the existence of high morphological variation in tomato genotypes grown in organic system based condition. SPAD is the indicator for chlorophyll and nitrogen contents of leaves of the genotypes differed significantly among the genotypes. Yield per plant (Table 1) showed significant variation (ranged 1.42-3.39 kg/plant) with the quality parameter like lycopene and β -carotene (Table 1). On the basis of Mahalanobis D2values, the 32 tomato genotypes were grouped into five divergent clusters, indicating adequate genetic diversity for selecting superior and diverse parents, which can be exploited for any organic breeding program. Cluster I was the largest group containing 13, followed by cluster II and V with 7 genotypes, cluster III and cluster IV containing 2 and 3 genotypes, respectively. Scattered diagram also showed 5 distinctive clustering patterns (Fig 2). The clustering pattern comprising of the 32 genotypes from different sources indicated that there was no association between eco geographical distribution of genotypes and genetic divergence. Therefore, the genotypes falling in these clusters were genetically divergent and suitable for tomato hybridization programme.Three traits , economic duration of crops, number of fruits per plant, fruit shape, °brix, and SPAD value contributed in the divergence positively while the fifty percent plant flowering, days to first and last harvest, fruit length, pericarp thickness, lycopene and B-carotene in the Z2 scores.

Table 1. Analysis of variance (ANOVA) of the variables studied at low input organic condition

Response	Mean sum square																	
	DF	FPF	DFH	DLH	PH	SFW	NFPP	FL	FB	FS	NL	TSS	PT	YPP	RL	SPAD	LYC	BC
block.unadj	6	3.2**	24.6*	14.0**	1511.3**	2479.1**	3448.7**	1.3**	2.3**	0.04**	3.2**	1.43**	0.006*	1.5*	2.3**	2.4**	2.9**	1.9**
trt.adj	33	2.9**	41.7**	82.89**	2096.6**	8253.6**	4790.0**	3.1**	5.5**	0.06**	6.1**	1.25**	0.018**	2.8**	4.3**	4.4**	13.7**	6.4**
trt.unadj	33	3.4**	43.4**	85.44**	2353.1*	8234.4**	5392.3**	3.3**	5.9**	0.06**	1.4**	1.48**	0.018**	1.5**	4.8*	4.8*	13.6*	6.5*
block.adj	6	0.34ns	15.8ns	0.00 ns	100.4ns	2584.9**	136.0**	0.25ns	0.2*	0.005ns	1.3 ns	0.17**	0.003ns	2.8**	0.16*	0.18 ns	3.2ns	1.2ns
Mean		22.8	74.8	107.31	126.9	92.87	33.3	5.1	5.3	0.99	3.7	4.43	0.46	1.4	22.1	44.1	14.2	4.4
Max.		25.0	88.0	114.00	255.6	229.3	183.1	6.6	8.9	1.78	10.6	6.96	0.62	3.4	46.9	48.0	18.9	9.3
Min.		19.1	61.0	87.00	63.0	7.98	4.0	2.4	2.1	0.66	2.0	2.33	0.28	0.3	29.3	38.3	9.3	1.8
CV (%)		8.4	8.23	9.07	33.8	60.2	102.2	21.84	29.4	22.02	52.1	22.51	18.74	61.1	19.2	4.3	19.2	41.8

DF: degree of freedom, FPF: fifty percent plant flowering, DFH: days to first harvest, DLH: days to last harvest, PH: plant height (cm), SFW: single fruit weight (g), NFPP: number of fruits per plant, FL: fruit length (cm) FB: fruit breadth, FS: fruit shape(length / breadth ratio), NL: number of locules, TSS : total soluble solids (°brix), PT: pericarp thickness RL: root length, YPP: yield per plant, LYC: lycopene, BC: β Carotene

Discussion: The survey data are not surprising given that farmers really want a greater number of fruits per plant for incremental yield, moreover, concerns about cosmetic surface blemishes are less important to customers who purchase organic produce whereas ‘‘health’’ is often noted to be the primary reason consumers buy organic food with many scientific evident proved that organic food is more nutritious (Hughner et al., 2007). Nevertheless, the relatively high importance expressed by both grower groups indicated that fruit quality traits should be an important component of fresh-market tomato breeding programs. Among agronomic traits, disease resistance ranked as one of the top breeding priorities among both grower groups. This study has revealed the existence of considerable genetic variation among the tested tomato genotypes that indicates the presence of excellent opportunity to bring about improvement. By combining the survey results with the evaluation and clustering, the genotypes AVTO 1201, BARI tomato 17, AVTO 1250, AVTO 1245, Nepal, Cherry 42, L 390, Indeterminate white might be selected for future organic system-based hybridization program.

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Image:

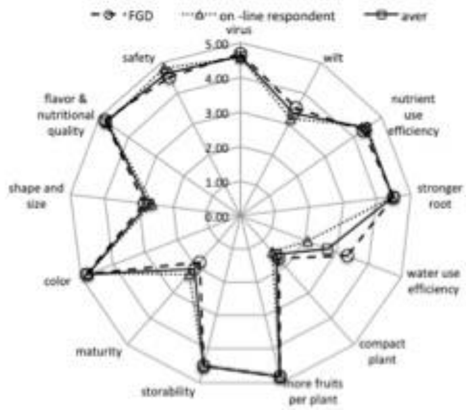

Fig. 1 PGS organic vegetable growers, extensions workers, consumer, seller and online survey respondents indicated that a specific trait was one of their three most desired traits for inclusion in a tomato breeding program

Image 2:

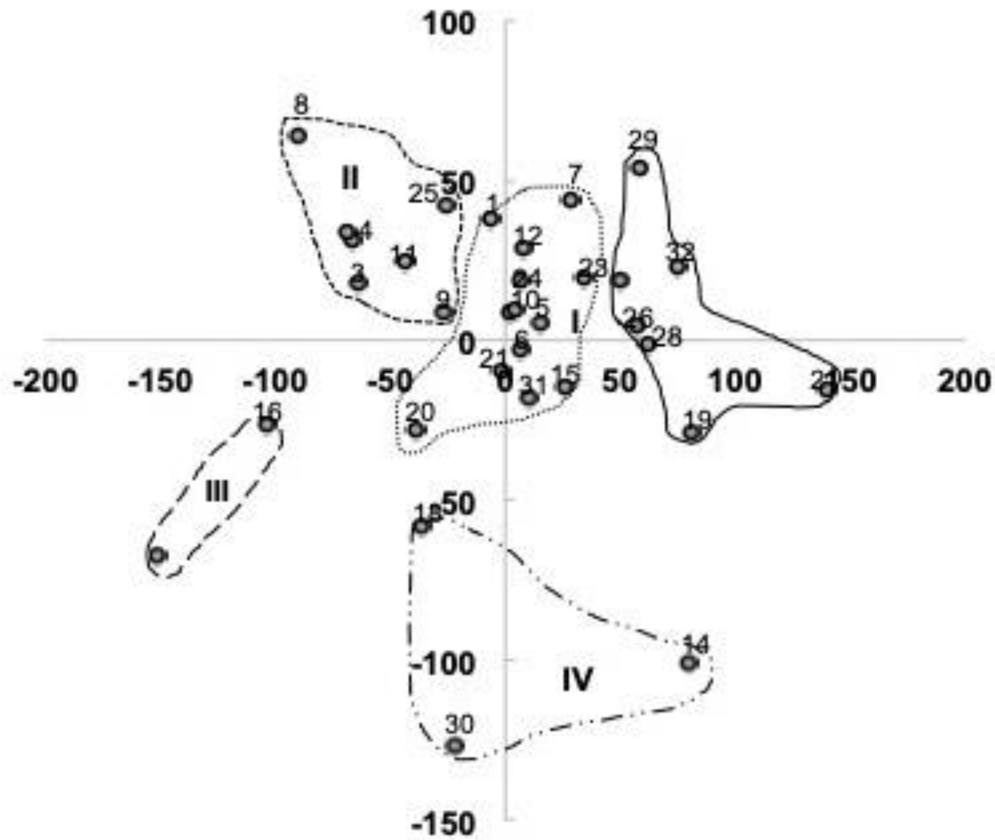

Fig 2. Clustering group of the genotypes

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