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AUGMENTED BLOCK DESIGN FOR EVALUATING ROUND AND OBLONG FRUIT SHAPE ADVANCED LINES OF INDETERMINATE TOMATO (*SOLANUM LYCOPERSICUM* L.)

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Abstract

The availability of productive genetic resources after going through hybridization, could further bridge up the hybrid and line development in tomato. Normally the plant material in F_7 attains a good level of homzygosity with respect to the traits on which their selection is made. The evaluation of the best advance lines is relatively a crucial task in view of low seed availability for its testing for basic morphological and yield attributes. 123 round and 116 oblong fruit shape advance lines were evaluated for this purpose in Augmented Block Design with 04 set of check hybrids and 04 set of OPVs. Maximum value of coefficient of variability (CV) was observed for fruit yield in both of round (30.76 %) and oblong (24.98 %) fruited advance lines which indicated the presence of variants in terms of yield. The analysis of variance revealed significant sum of squares of means for all the traits for different sources of variation. The treatment effects both unadjusted and adjusted for both of round and oblong fruited lines were found significant for number of clusters per plant, number of fruits per plant and fruit yield. Similarly, the mean squares due to tests versus checks were found highly significant for all the traits indicating thereby the superiority of tests entries over the checks in both of the trials of round and oblong fruit morphologies. 20 round fruited advance lines yielding from 42.41 to 64.35 t/ha were found at par to the check Saalar-F_1 (59.08 t/ha). 03 oblong fruited advance lines yielding from 79.53 to 116.67 t/ha showed significantly maximum fruit yield from the high performing check of Sunder-F_1 (60.43 t/ha), while 18 other oblong fruited advance lines yielding from 44.60 to 68.47 t/ha were found at par with the high performing check Sunder-F_1 (60.43 t/ha). The advance lines either superior or at par to the checks may be brought forward for further testing by increasing their seed for their subsequent screening and evaluation.

Key words: *Solanum lycopersicum* L., Indeterminate, Genetic variability, Augmented block Design, Advance lines and F_7 generation.

Introduction

Tomato is an important vegetable crop grown in Pakistan. Its consumption is on the second place after potato. Pakistan is the 33rd tomato producing country of the world. Fresh tomato of worth US$8.8 billion was exported globally, while gross export of tomato and its products over a worth of US$13 billion had been made. Mexico is the leading country in the world for tomato exports followed by Spain. United States of America is the top fresh tomato exporting country in the world followed by Belgium and Russia (Anon., 2020). In Pakistan, tomato is grown in winters/off-season crop under tunnel structure called indeterminate and in open fields during summers called determinate. The off-season/indeterminate tomato crop covered an area of 48.49 thousand hectares with a production of 580 thousand tonnes (Anon., 2020-21). The domestic tomato production and yield can be improved through the evolution of high yielding tomato hybrids and varieties. Only a few but expensive indeterminate tomato hybrids of multi-national companies are being marketed in the country. Public sector has also played its role in the development of competitive indeterminate tomato hybrids.

There is a need of development of high yielding and improved tomato hybrids and varieties. Being self-pollinated crop it is comparatively easy to conserve the seed resources than that of any cross pollinated crop. The identification and conservation of productive lines may also lead to a good level of self-sufficiency. The narrow genetic base is one of the main reasons hampering the process of development of new hybrids and varieties (Noor *et al*., 2020). As tomato is not native to our region so the low availability of the germplasm resources has led to narrow down its genetic base. Exploitation of genetic variability through heterosis and hybridization is the ultimate source of generating variability in the indeterminate tomato which may lead to boost up the tomato production in the country. Hybridization would be a feasible option in the first step for the development/evolution of best performing lines which might be used in the second step for hybrid development.

The evaluation of plant material in F_7 or later generations is of fundamental importance. The evaluation of advance material in advanced segregating generations is difficult to handle (Fehr, 1987; Saba *et al*., 2017). There is often a problem of insufficient quantity of seeds to commence replicated experiments. The best solution of evaluating a large number of advance materials is through Augmented design (Federer *et al*., 2001). The design proposed was found time and money saving.

An Augmented design was therefore followed to assess the morphological performance of a large array of advance plant material of indeterminate tomato in round and oblong fruit morphologies in F_7 along with the standard genotypes. The comparison of the advance lines was made not only with the potential varieties but also with the high performing indeterminate tomato hybrids. The high performing advance material could evaluated/screened with respect to the performance of the standards which could result in the development of the best lines which might be further useful as potential open pollinated varieties as well as potential parents for opening the new window for the constitution of hybrids.

Material and Methods

The studies pertaining to exploration of genetic variability in indeterminate tomato were conducted at the Vegetable Crops Research Programme, Horticultural Research Institute, National Agricultural Research Centre, Islamabad during 2020-21.

Plant material: The plant material comprised of round fruited and oblong fruited advance lines in F_7 with 08 checks (04 hybrids + 04 OPVs). The detail of the plant material under study is given in (Table 1).

Nursery sowing, transplantation and planting geometry: The nursery of segregating generation of round fruited (123) and oblong fruited (116) advance lines in F_7 with 08 checks (04 hybrids + 04 OPVs) were sown on 15 cm raised beds on the 22nd of October, 2020. The raised beds were manually ploughed and upper surface of 2-3 cm was top dressed with compost and FYM in the ratio 1:1. Each single plant selection was sown on separate 1.5 cm deep furrow/row and a thin layer of media (FYM: Compost) in a ratio of 1:1 was placed on the seed. The beds were irrigated with hand shower so as to moisten the seed sown without disturbing its orientation. The seedling beds were covered with plastic sheet at night in order to maintain the temperature at night. Manual weeding and hoeing of nursery beds was also done to accelerate the seedling emergence process. The seedlings were emerged by the second week of November, 2020. The seedlings were transplanted under plastic tunnel on 14th of December, 2020 with a the plant to plant and row to row distances 50 cm and 1 meter respectively. Farm yard manure @ 30,000 kg $ha^{-1}$and NPK @ 150:75:75 kg ha^{-1} was applied. All of P and half of N & K were pragmatic at soil preparation and remaining half of Nitrogen & potash was applied in five equivalent dosages after one month of transplanting, at two weeks interval (Farooq *et al*., 2013). Insecticides (Permethrin or Cypermetherin mixed with Chloropyrephos) were applied to combat against the insect pests attack. The plants were staked under the plastic tunnel with jute treads. In the next step, all of the plants were tagged by mentioning the individual numbers. The pruning of plants was also done to maintain plant vigorsity.

Planting geometry and design: The advance lines/test entries of both of the round and oblong fruit shaped morphologies were laid in Augmented block design with 08 checks and in 06 blocks. The plot size of 1.2 × 1.0 m was maintained. The plant to plant and row to row distances were kept as 50 cm and 75 cm respectively. In each of the blocks the checks were randomly replicated while the test entries were transplanted in their own order.

Field evaluation at maturity: At maturity, the data on number of clusters per plant, number of fruits per cluster, number of fruits per plant and fresh fruit yield was recorded.

Statistical data analysis: The data regarding all traits measured at plant maturity was analyzed using analysis of variance technique (Steel *et al*., 1997) using MSTATC. Augmented design was performed in R3.61 software. Augmented design was used to evaluate 123 round and 116 oblong fruit shaped advance lines as outlined by Federer (1956 and Federer *et al*., 2001).

Results

Preliminary evaluation of advance lines in F_7 generation: There were about 123 round fruit shape and about 116 oblong fruit shape advances lines in F_7. The evaluation of this large number of advance material was not possible under simple RCBD so these were evaluated making use of Augmented Design.

a) **Descriptive statistics of round and oblong fruit shape advance lines and checks (Hybrids & OPVs):** 123 test entries/advances lines of round fruit shape along with 8 checks were assessed under augmented block design The descriptive statistics related to important yield traits have been given in the (Table 2).

Table 2 describes the real performance picture of the genotypes assessed against the certain set of traits. In the whole round fruit shape populations; the mean value for number of clusters per plant was 6.62 ± 1.77, number of fruits per cluster (5.47 ± 1.63), number of fruits per plant (35.84 ± 8.92) and fruit yield (34.54 ± 13.15). However, the range of number of clusters per plant remained between 3.5 to 12.5, number of fruits per cluster (3.54 to 9.65), number of fruits per plant (20 to 72.50) and for fruit yield from 18.73 to 64.35 t/ha. Maximum value of coefficient of variability (CV) was observed for fruit yield (30.76 %) which indicated the presence of variants in terms of yield in the round shape advance lines followed by number of fruits per cluster (24.29 %), number of clusters per plant (22.57 %) and least for number of fruits per plant (19.55).

Table 1. Resource plant material for study.

S. No.	Plant material	Source	Design
1.	(04) F_1 Indeterminate tomato hybrids*	VRI-AARI Faisalabad	Augmented Design
2.	(04) OPVs of Indeterminate tomato**	VRI-AARI Faisalabad	Augmented Design
3.	(116) Oblong fruit shaped advance lines (F_7)	Locally developed	Augmented Design
4.	(123) Round fruit shaped advance lines (F_7)	Locally developed	Augmented Design

OPVs = Open Pollinated Varieties; RCBD = Randomized Complete Block Design; VRI-AARI = Vegetable Research Institute, Ayul Agricultural Research Institute

*Saandal (F_1), Saalar (F_1), Sunder (F_1) & Surkheil (F_1)

**Prescot, Martina, Debora & Money Maker

Table 2. Descriptive statistics of the evaluating traits of 131 round fruit shape genotypes of indeterminate tomato.

Trait	Mean ± S.E	Range	CV (%)
Number of clusters per plant	6.62 ± 1.77	3.5-12.5	22.57
Number of fruits per cluster	5.47 ± 1.63	3.54-9.65	24.29
Number of fruits per plant	35.84 ± 8.92	20-72.50	19.55
Fruit yield (t/ha)	34.54 ± 13.15	18.73-64.35	30.76

Table 3. Descriptive statistics of the evaluating traits of 124 oblong fruit shape genotypes of indeterminate tomato.

Trait	Mean ± S.E	Range	CV (%)
Number of clusters per plant	6.96 ± 1.68	3.0-11.0	20.78
Number of fruits per cluster	5.48 ± 1.34	2.63-9.41	20.56
Number of fruits per plant	37.56 ± 9.98	10.53-70.0	21.94
Fresh yield (t/ha)	40.17 ± 11.92	18.83-116.67	24.98

116 test entries/advances lines of oblong fruit shape along with 8 checks were assessed under augmented block design. The advance lines were evaluated for number of clusters per plant, number of fruits per cluster, number of fruits per plant and fruit yield (t/ha). The descriptive statistics related to these traits have been given in the (Table 3).

Table 3 describes the real performance picture of the genotypes assessed against the certain set of traits. In the whole oblong fruit shape populations; the mean value for number of clusters per plant was 6.96 ± 1.68, number of fruits per cluster (5.48 ± 1.34), number of fruits per plant (37.56 ± 9.98) and fruit yield (40.17 ± 11.92). However, the range of number of clusters per plant remained between 3.0 to 11.0, number of fruits per cluster (2.63 to 9.41), number of fruits per plant (10.53 to 70.0) and for fruit yield from 18.83 to 116.67 t/ha. The recorded values of CV (%) were a bit on higher side which indicated the existence of variability among the genotypes. Maximum value of coefficient of variability (CV) was observed for fruit yield (24.98%) which indicated the presence of variants in terms of yield in the oblong shape advance lines followed by number of fruits per plant (21.94%), number of clusters per plant (20.78%) and least for number of fruits per cluster (20.56%).

b) **Analysis of variance of Augmented block design for round and oblong fruit shape advance lines:** Analysis of variance for round fruit shape advance lines (Table 4) revealed significant mean squares for the entire traits block wise by ignoring the treatments. However, means squares were found non-significant for number of clusters per plant and fruit yield except for number of fruits per cluster and number of fruits per plant block wise by eliminating the treatments. However, the blocking effect showed significant results for number of fruits per cluster and number of fruits per plant. The treatments differ significantly for number of clusters per plant, number of fruits per plant and fruit yield except for number of fruits per cluster by eliminating and ignoring block effects. The effect of checks (OPVs & hybrids) vary significantly for number of fruits per cluster, number of fruits per plant and fresh yield except for number of clusters per plant. However, for the test treatments/ advance lines, all the traits were found as non-significant. The interaction of test treatments and checks showed highly significant differences for all the traits including the yield as evident from Table 4.

Analysis of variance for oblong fruit shape advance lines as shown in Table 5 revealed significant mean squares for only fruit yield block wise by ignoring treatments and for number of fruits per plant and fruit yield by eliminating blocks. Significant mean squares for all of the traits in all of the treatments by ignoring/eliminating block effect were recorded except for number of fruits per cluster. The effect of checks (OPVs & hybrids) vary significantly for number of fruits per cluster, number of fruits per plant, number of clusters per plant and fresh yield. However, for the test treatments/advance lines, all the traits were found as non-significant except for fruit yield. The interaction of test treatments and checks showed significant differences for all the traits including the yield as evident from (Table 5). However, there might be a chance of some extra ordinarily performing lines.

Table 4. Mean squares of augmented design for 131 round fruit shape genotypes of indeterminate tomato including checks (Hybrids & OPVs).

Source of variation	df	NCl/Pl	NF/Cl	NF/Pl	FY (t/ha)
Blocks (ignoring treatments)	5	6.077*	6.090*	578.5***	263*
Treatments (eliminating blocks)	130	2.245*	2.31	195.4***	156.6*
Treatments: Checks	7	1.001	10.91***	592.0***	360.3*
Blocks (eliminating treatments)	5	2.87	5.98*	532***	244
Treatments (ignoring blocks)	130	2.37*	2.31	197***	157*
Treatments: Tests	122	2.11	1.05	83	104
Treatment: Tests Vs Checks	1	43.22***	96.49***	11324***	5244***
Error	35	2.40	2.01	61	132

NCl/Pl = Number of clusters per plant; NP/Cl = Number of fruits per cluster; NF/Pl = Number of fruits per plant; FY = Fruit yield (t/ha)

Table 5. Mean squares of augmented design for 124 oblong fruit shape genotypes of indeterminate tomato including checks (Hybrids & OPVs).

Source of variation	df	NCl/Pl	NF/Pl	NF/Cl	FY (t/ha)
Blocks (ignoring treatments)	5	4.004	150.8	0.535	246.1*
Treatments (eliminating blocks)	123	2.751*	147.0*	1.825	225.7**
Treatments: Checks	7	5.886*	779.5***	6.80***	632.1***
Blocks (eliminating treatments)	5	3.993	208.3*	2.017	310.4*
Treatments (ignoring blocks)	123	2.751*	144.7*	1.765	223.1**
Treatments: Tests	115	2.504	81.0	1.253	186.3*
Treatment: Tests Vs Checks	1	9.22*	3021***	25.45***	1589.3***
Error	35	2.152	76.0	1.372	108.4

NCl/Pl = Number of clusters per plant; NF/Pl = Number of fruits per plant; NF/Cl = Number of fruits per cluster; FY = Fruit yield (t/ha)

Table 6. Performance of round fruit indeterminate tomato genotypes (131) including checks (Hybrids & OPVs).

S.No.	Name	NCl/Pl	NF/Cl	NF/Pl	FY (t/ha)
1.	07- 08 32-8/12-8(6) M.N.F, Good R	6.00	5.17	31.00	***64.35***
2.	04- 08 27-1/15-8(1) Good R	***8.33***	4.80	40.00	***64.27***
3.	07- 08 32-8/3(7)(5) Good R	***8.00***	9.06	***72.50***	***61.17***
4.	07- 08 10-4/2-1(4) Good R	***8.50***	7.59	***64.50***	***59.90***
5.	07- 08 32-8/2(5)(2) V. Good R	***8.50***	4.59	39.00	***59.63***
6.	Saalar F_1	***7.42***	9.65	***71.17***	***59.08***
7.	07- 08 9-7/8(8)(2) EX-R	5.50	8.64	47.50	***57.78***
8.	Sahil 32-5-14/7(4) Good R	**12.50**	5.30	***66.25***	***57.18***
9.	07- 08 32-8/2(5)(4) Good R	***9.00***	7.22	***65.00***	***54.31***
10.	04- 08 27-2/2(8) (1) Good R	***7.67***	6.00	46.00	***54.01***
11.	Surkhail F_1	***7.83***	7.06	***54.29***	***52.56***
12.	04- 08 27-2/2(8)(4) Good R	6.25	6.60	41.25	***51.81***
13.	Saandal F_1	***7.79***	8.03	***61.92***	***50.93***
14.	04- 08 27-2/2(8)(4) Good R	6.00	6.67	40.00	***50.04***
15.	07- 08 32-8/2(5)(6) Good R	***8.75***	5.66	49.50	***48.77***
16.	07- 08 32-8/5(5)(7) Good R	**9.50**	4.74	45.00	***47.47***
17.	07- 08 12-2/1(4)(7) Good R	**9.50**	6.39	***60.75***	***46.75***
18.	Sunder F_1	***7.50***	7.42	***55.17***	***46.52***
19.	04- 08 27-2/2(8)(5) Good R	5.25	6.90	36.25	***45.11***
20.	Martina	***7.83***	6.03	46.83	***44.05***
21.	07- 08 32-8(4) EX-R	***8.75***	5.34	46.75	***43.58***
22.	07- 08 32-8/5(5)(5) Good R	***7.75***	5.55	43.00	***43.17***
23.	07- 08 32-8/2(4)(5) Good R	***8.25***	4.67	38.50	***43.08***
24.	07- 08 35-4/4(3)(8) V. Good R	***8.50***	4.41	37.50	***42.70***
25.	Money Maker	***8.17***	5.31	41.54	***42.51***
26.	07- 08 4-2/7(4)(4) Good R	6.00	6.71	40.25	***42.41***
27.	04- 08 27-2/2(8)(2) Good R	6.25	6.64	41.50	41.95
28.	07- 08 10-10/4-6(8) R.S.M.F, Good R	***8.25***	4.58	37.75	41.77
29.	07- 08 3-11/12(6)(10) Good R	6.00	5.96	35.75	41.63
30.	07- 08 9-7/1(4)(1) Good R	6.50	6.62	43.00	41.27
31.	04- 08 27-5/16(1)(9) Good R	6.00	6.17	37.00	41.04
32.	07- 08 32-8/7(2)(9) V. Good R	***7.50***	4.67	35.00	40.84
33.	07- 08 32-3/2(1)(5) Good R	***7.00***	7.25	50.75	40.16
34.	R.K. Seed (F_2) M.N.F Good R	6.50	5.46	35.50	39.75
35.	07- 08 32-8/2(5)(2) V. Good R	***7.00***	4.75	33.25	39.71
36.	04- 08 2-2/10-5(1) Good R	**10.50**	4.79	50.25	39.70
37.	07- 08 2-2/10-5(9) EX-R	***8.50***	4.06	34.50	38.59
38.	07- 08 3-3/3-(5)(4) Good R	6.75	5.11	34.50	38.29
39.	07- 08 3-11/12(6)(3) Good R	***7.00***	4.82	33.75	37.64
40.	Debora	6.83	6.58	44.29	37.27
41.	Sahil 5-21/17(8)(2) Good R	4.00	6.25	25.00	37.25
42.	07- 08 32-8/7(2)(8) R.S.H.F (Right)	6.00	5.67	34.00	37.20
43.	07- 08 10-10/4-6(4) R.S.M.F Good R	6.50	7.31	47.50	37.04
44.	07- 08 32-8/10(3)(6) V. Good R	***7.25***	4.83	35.00	36.97
45.	Prescot	***7.92***	6.27	47.54	36.53
46.	04- 08 28-3/14-5(2) Good R	***7.50***	4.40	33.00	36.50
47.	Sahil 35-1-13/5(1) B.F.S, Good R	6.50	4.54	29.50	36.37
48.	07- 08 9-10/7(3)(9) B.F.S, Good R	4.75	5.37	25.50	36.33
49.	07- 08 32-8/2(5)(7) Good R	5.25	5.48	28.75	36.08
50.	Sahil 32-5-5/3(5) Good R	***7.50***	4.33	32.50	35.96
51.	Anna F_2 Good R	***7.50***	4.33	32.50	35.51
52.	Sahil 32-5-14/7(3) Good R	5.75	4.78	27.50	35.18
53.	04- 08 27-2/2(8)(10) EX-R	6.75	4.81	32.50	35.12
54.	07- 08 30-3/5-7(2) Good R	6.25	5.08	31.75	35.04
55.	07- 08 3-11/12(6)(6) Good R	***7.25***	4.76	34.50	34.90
56.	Sahil 5-21/14-7(1) Good R Pear shape	3.75	6.53	24.50	34.79
57.	Sahil 35-1-13/5(4) B.F.S Good R	6.50	4.77	31.00	34.71
58.	Sahil 35-1-13/5(5) B.F.S Good R	***7.50***	3.63	27.25	34.67
59.	07- 08 32-4/8-5(1) Good R	6.75	4.56	30.75	34.58
60.	04- 08 32-4/8-5(1) Good R	6.50	5.00	32.50	34.37
61.	Sahil 35-1-13/5(2)(1) B.F.S, Good	6.50	5.15	33.50	34.20
62.	04- 08 27-2/2(8)(5) Good R	6.00	5.75	34.50	34.13
63.	04- 08 27-1/15-8(3) Good R	6.75	5.59	37.75	33.97
64.	9-3/7-1(10) B.F.S EX-R	***7.50***	4.00	30.00	33.77
65.	Sahil 32-5-14/7(3) Good R	6.25	4.88	30.50	33.50
66.	04- 08 27-5/16(1)(2) Good R	4.75	7.26	34.50	33.49
67.	04- 08 2-2/15-5(3) Good R	***8.75***	4.86	42.50	32.97

Table 6. (Cont'd.).

S.No.	Name	NCl/Pl	NF/Cl	NF/Pl	FY (t/ha)
68.	07- 08 23-12/8(6)(8) Good R	***8.25***	4.52	37.25	32.76
69.	07- 08 32-8/2(4)(3) Good R	***7.75***	6.48	50.25	32.62
70.	04- 08 27-1/15-8(2) Good R	5.75	6.09	35.00	32.50
71.	07- 08 32-11/6(2)(8) Good R	6.00	7.17	43.00	32.42
72.	07- 08 32-8/7(2)(8) Good R	5.00	7.00	35.00	32.33
73.	07- 08 3-3/10(6)(8) Good R	6.00	5.42	32.50	32.33
74.	Sahil (F2) P5 15(2) B.F.S, Good R	5.25	5.24	27.50	32.21
75.	04- 08 27-2/6(2)(1) Good R	5.25	6.19	32.50	31.88
76.	07- 08 30-3/5-7(6) V. Good R	6.25	5.52	34.50	31.59
77.	07- 08 23-12/8(6)(10) Good R	5.50	6.27	34.50	31.37
78.	07- 08 33-3/17-(1)(6) Good R	5.00	5.90	29.50	31.17
79.	07- 08 4-3/4(6)(1) Good R	***7.75***	4.26	33.00	30.08
80.	04- 08 27-7/11(7)(6) V. Good R	6.25	5.12	32.00	29.88
81.	07- 08 27-1/13(2)(4) V. Good R	***7.00***	5.00	35.00	29.87
82.	07- 08 32-3/7-7(5) Good R	6.00	6.33	38.00	29.17
83.	07- 08 9-7/1(4)(2) B.F.S Good R	4.50	4.44	20.00	29.17
84.	07- 08 35-4/12(8)(6) Good R	5.00	5.40	27.00	29.00
85.	07- 08 32-12/6(3)(8) Good R	5.75	6.26	36.00	28.83
86.	07- 08 3-3/10(6)(3) Good R	6.00	4.42	26.50	28.75
87.	07- 08 12-2/1(4)(10) Good R	***7.00***	4.50	31.50	28.54
88.	07- 08 32-12/5(13)(9)R.S.M.F, Good R	***8.00***	4.31	34.50	28.52
89.	04- 08 32-4/8(5)(2) Good R	***7.50***	4.50	33.75	28.48
90.	07- 08 32-8/2(5)(1) V. Good R	***8.25***	3.88	32.00	28.43
91.	07- 08 32-3/5-7(3) Good R	6.25	7.36	46.00	28.33
92.	07- 08 12-2/1(4)(5) Good R	3.50	5.79	20.25	28.06
93.	04- 08 27-2/8(2)(1) Good R	***7.25***	4.66	33.75	27.94
94.	04- 08 2-2/10-5(2) Good R	5.50	6.36	35.00	27.80
95.	07- 08 35-5/11(3)(10) Good R	**9.67**	3.65	35.25	27.39
96.	Sahil 35-6-8/5(1) Good R	6.00	5.00	30.00	26.80
97.	07- 08 32-8/13-(5)(3) Good R	6.25	5.00	31.25	26.42
98.	07- 08 35-12/11-(8)(3) Good R	***7.00***	4.57	32.00	26.33
99.	04- 08 29-2/15(6)(1) Good R	6.00	5.75	34.50	26.24
100.	Sahil 5-17/20-7(4) Good R	5.50	5.23	28.75	26.13
101.	04- 08 27-2/18(5(4) Good R	6.00	5.04	30.25	26.09
102.	Sahil P5 16(5) Good R	4.00	5.31	21.25	25.59
103.	07- 08 9-7/8-8	5.25	5.24	27.50	25.58
104.	07- 08 32-12/6(3) Good R	4.75	5.79	27.50	25.31
105.	07- 08 9-7/7(5) B.F.S, V. Good R	6.25	5.16	32.25	25.10
106.	Sahil 32-5-11/7(8) B.F.S, Good R	3.75	5.33	20.00	25.04
107.	Sahil 35-1-13/15(4) B.F.S, V. Good R	6.00	6.17	37.00	24.92
108.	07- 08 4-3/4(6)(3) Good R	4.75	5.68	27.00	24.88
109.	07- 08 9-3/7-4(2) Good R	5.75	4.96	28.50	24.83
110.	07- 08 30-11/6(2)(4) Good R	5.25	5.43	28.50	24.83
111.	Sahil 35-6-10/6(4) M.N.F, Good R	5.50	4.55	25.00	24.46
112.	07- 08 9-7/1-7(6) B.F.S, M.N.F, V. Good R	6.00	5.25	31.50	24.42
113.	04- 08 27-1/11(7) UK	***7.25***	4.66	33.75	24.08
114.	07- 08 32-8/2(4)(4) Good R	5.75	5.09	29.25	24.08
115.	07- 08 4-12/15-8(2) Good R	***8.25***	3.61	29.75	23.92
116.	Sahil 32-5-11/7(10) V. Good R	6.75	4.48	30.25	23.71
117.	07- 08 9-7/3(5)(2) Good R	6.50	4.62	30.00	23.70
118.	07- 08 33-3/12(1)(2) Good R	5.50	5.05	27.75	22.98
119.	04- 08 21-7/12(4)(1) V. Good R	6.50	4.31	28.00	22.63
120.	R.K. Seed (F_2) (9) M.N.F Good R	4.00	6.25	25.00	22.53
121.	R.K. Seed (F_2) Good R	5.75	5.17	29.75	22.26
122.	07- 08 9-7/18(8)(7) Good R	5.25	5.24	27.50	21.73
123.	07- 08 32-8/5(5)(8) Good R	6.00	5.17	31.00	21.37
124.	04- 08 21-7/12(4)(1) V. Good R	5.75	5.00	28.75	21.33
125.	07- 08 9-3/7(8)(6) B.F.S Good R	6.50	4.54	29.50	21.31
126.	Sahil 32-14-1/1(4) B.F.S, Good R	5.00	5.50	27.50	21.14
127.	07- 08 32-8/10(3)(1) Good R	5.00	7.10	35.50	21.00
128.	04- 08 21-12/10-8(6) Good R	6.00	4.17	25.00	20.58
129.	07- 08 4-3/12-7(1) Good R	6.00	3.54	21.25	19.92
130.	07- 08 33-8/11-(1) Good R	5.33	5.20	27.75	18.86
131.	07- 08 35-4/12(7)(7) Good R	***8.00***	3.69	29.50	18.73
	LSD (0.05)	1.16	NS	18.10	16.69

NCl/Pl = Number of clusters per plant; NF/Cl = Number of fruits per cluster; NF/Pl = Number of fruits per plant; FY = Fruit yield (t/ha)

Table 7. Performance of oblong fruit indeterminate tomato genotypes (124) including checks (Hybrids & OPVs).

S. No.	Advance lines/Checks (Hybrids/OPVs)	NCl/Pl	NF/Cl	NF/Pl	FY (t/ha)
1.	Sahil 5-17-4(5)(3) Ob-Gd (left)	9.00	5.67	***51.00***	**116.67**
2.	Sahil 33-1-13/5(10) Ob-vg	**10.00**	5.00	***50.00***	**87.27**
3.	07-0814-8/16-8/16(4) Ob-Gd	6.00	7.33	44.00	**79.53**
4.	07-08 38-7/8(7)(2) Ob-Gd	8.00	7.25	***58.00***	***68.57***
5.	21-9/17(7) (1)	9.33	7.50	***70.00***	***66.06***
6.	04-08 4-7/7(5)(6)	7.00	7.14	***50.00***	***63.65***
7.	07-089-7/(3)5(10) Ob-Gd	8.00	6.88	***55.00***	***63.30***
8.	Sunder F_1	7.56	6.88	***50.92***	***60.43***
9.	04-0816-6/16(2)(4) Ob-Gd	6.25	6.40	40.00	***58.00***
10.	Sahil 15-13/6-4(6) B.F.S Ob-Gd	6.33	4.74	30.00	***57.94***
11.	Sahil 31-3/11-3(6) Gd -Oval	8.00	7.00	***56.00***	***57.58***
12.	Sahil 5-1/19-2(4) Ob-Gd	5.00	6.80	34.00	***57.08***
13.	Sahil 5-7/5-2(1) M.N.F Ob-Gd	6.00	7.17	43.00	***56.28***
14.	07-0810-10/11-4(3) Ob-Gd	9.67	4.66	45.00	***55.37***
15.	21-6/15-8 (3)	**10.25**	6.05	***62.00***	***55.08***
16.	Sahil 5-13/6-4(5) B.F.S Ob-Gd	4.75	6.74	32.00	***53.74***
17.	Sanadal F_1	7.42	7.42	***54.66***	***53.45***
18.	07-0810-10/11-4(7) Ob-Gd	8.33	5.04	42.00	***53.00***
19.	Surkhail F_1	8.33	6.74	***55.31***	***50.32***
20.	07-0829-8/10-4(7) Ob-Gd Pointed	7.00	5.29	37.00	***50.10***
21.	04-0821-7/10(8)(6) Ob-Gd	6.00	7.67	46.00	***49.67***
22.	Saalar F_1	8.16	7.81	***63.30***	***49.55***
23.	Sunder (F_2)(1) Ob-Gd	8.50	4.94	42.00	***49.48***
24.	9-2/9(8) (10)	7.00	6.43	45.00	***49.40***
25.	Sahil 35-1-13/5(8) Ob-Gd	6.75	5.63	38.00	***49.39***
26.	04-084-7/2(2)(1) More Cluster	5.75	5.91	34.00	48.33
27.	Prescot	7.08	5.89	40.91	46.83
28.	Sahil 8-7/16-6(3)Ob-Gd	8.50	4.71	40.00	46.58
29.	07-08 17/11/2-4(1) Ob-Gd	**10.00**	4.50	45.00	46.17
30.	07-0817-6/4(2)(1) Ob-Gd	8.75	5.94	***52.00***	46.09
31.	Sahil 5-21/22-1(2) B.F.S Ob-V.Gd	7.25	4.83	35.00	45.35
32.	07-0819/11-2(5)(1) Ob-Gd	**10.33**	4.55	47.00	44.82
33.	07-0829-8/2(1)(8) Ob-V.Gd	6.75	6.07	41.00	44.60
34.	07-084-11/12(1)(6) Ob-V.Gd	9.00	4.78	43.00	43.67
35.	Debora	8.50	4.81	39.37	43.60
36.	Sahil 5-2/17(8)(4) Ob-V.Gd	5.25	5.33	28.00	43.33
37.	Martina	7.0	5.40	37.66	42.49
38.	04-0821-3/9 (6)(3) Ob-Gd	8.00	4.50	36.00	42.43
39.	04-0832-1/3(7) (2) Ob-V.Gd VIP	5.25	6.10	32.00	41.73
40.	04-0816-6/16/(2)(3) Ob-Gd	6.75	5.93	40.00	41.67
41.	07-0832-3/7(4)(2) Ob-Gd	7.00	5.00	35.00	41.50
42.	04-0821-6/10-8(1) Ob-Gd Pointed	6.50	5.69	37.00	41.34
43.	Sahil 5-1/19-1 B.F.S; Ex-Ob	5.25	5.71	30.00	41.33
44.	Sahil 25-18/10-8(2)Ob-Gd	5.00	7.00	35.00	41.14
45.	07-089-7/4(3) B.F.S Ob-V.Gd	8.75	4.11	36.00	41.08
46.	07-083-3/10-8(10) Ob-V.Gd	7.25	5.10	37.00	41.03
47.	32-1/3-7 (2)	5.25	5.71	30.00	40.71
48.	Sahil 31-4/8-7(2) Ob-Gd	5.67	6.53	37.00	40.58
49.	04-08 32-12/4 (2) Ob/V.Gd	9.50	5.79	***55.00***	40.29
50.	4-6/8-2 (1)	9.75	4.92	48.00	40.21
51.	04-084-6/3(8)(6) Ob-Gd	6.25	6.08	38.00	39.88
52.	04-0832-1/3(8)(4) Ob-Gd	6.67	5.40	36.00	39.83
53.	Sahil 31-11/4-3(1) Ob-Gd	5.25	6.10	32.00	39.80
54.	Sahil 31-4/5-5(1) M.N.F Ob-Gd	6.50	6.92	45.00	39.77
55.	Sahil5-13/6-4(1) B.F.S Ex-Ob	6.00	5.67	34.00	39.63
56.	Sahil5-13/6-4(3) B.F.S Ex-Ob	5.25	5.71	30.00	39.55
57.	07-0829/6/8-7(5) Ob-Gd	6.00	5.50	33.00	39.22
58.	04-084-7/7(6)(6) Ob-Gd	6.50	6.77	44.00	38.95
59.	Sahil 35-1-13/5(4) Ob-Gd	6.25	5.60	35.00	38.89
60.	07-0829-8/10-4(4) Ob-Gd	8.50	4.71	40.00	38.58
61.	04-0838-7/11(1)(2) Ob-Gd	5.67	4.94	28.00	38.10
62.	07-084-11/12(1)(3) Ob-V.Gd	7.67	5.48	42.00	37.88
63.	Sahil 31-9/10-1(1) Ob-Gd	**11.00**	3.91	43.00	37.87

Table 7. (Cont'd.).

S. No.	Advance lines/Checks (Hybrids/OPVs)	NCl/Pl	NF/Cl	NF/Pl	FY (t/ha)
64.	04-054-6/3(8)(10) Ob-Gd	5.50	6.18	34.00	37.83
65.	38-7/5(5) (5)	6.50	6.92	45.00	37.51
66.	07-0832-8/2(5)(9) Ob-V.Gd	8.25	2.63	21.71	37.27
67.	07-08 32-3/8(5)(9) Ob-Gd	8.25	4.61	38.00	37.24
68.	07-0838-7/11(4)(6) Ob-Gd	6.67	4.50	30.00	36.98
69.	07-0817-6/9(3)(1) Ob-Gd Pointed	8.67	4.73	41.00	36.71
70.	04-0816-8/3-2(1) Ob-Gd	5.00	5.36	26.80	35.83
71.	07-0817-16/4(7)(5) Ob-V.Gd	8.75	4.80	42.00	35.68
72.	Sahil 5-21/22-1(1) B.F.S Ob-V.Gd	6.25	5.92	37.00	35.43
73.	07-0810-4/9/6(4)(7) Ob-Gd	5.50	5.09	28.00	35.23
74.	32-6/2-5 (4)	7.75	5.03	39.00	35.00
75.	07-084-3/12-4(4) Ob-Gd	8.25	4.61	38.00	34.43
76.	04-0832-4/2-8(3) Ob-Gd	5.25	4.76	25.00	33.92
77.	Sahil 2-1/26-7 (1) B.F.S Ob-V.Gd	6.67	4.50	30.00	33.90
78.	04-0821-5/4(5)(4) Ob-pointed Gd	3.00	3.51	10.53	33.78
79.	Sahil 32-2/7(4) Ob-Gd	5.00	7.00	35.00	33.76
80.	04-0821-6/15-5(1) Ob-V.Gd	7.00	5.29	37.00	33.59
81.	21-6/15-5 (6)	**10.50**	4.10	43.00	33.46
82.	07-0833-3/12(1)(4) Gd-Round	5.00	4.40	22.00	33.38
83.	07-0832-3/7-4(2) Ob-Gd	7.25	4.83	35.00	33.33
84.	07-0838-7/7(6)(3) Ob-Gd	5.67	5.65	32.00	33.33
85.	07-0830-11/10(3)(10) Ob-Gd	6.00	4.67	28.00	33.07
86.	Sahil 31-4/5-5 (3) M.N.F Ob-Gd	6.50	7.38	48.00	33.06
87.	07-0832-3/7(4)(8) Ob-Gd	8.50	4.71	40.00	32.80
88.	Sahil 31-3/11-3(3) Ex-Ob	4.25	9.41	40.00	32.77
89.	07-0817/6/4(6)(3) Ob-Gd	6.00	6.33	38.00	32.67
90.	Sahil 35-6/12-6 (1) Ob-Gd	5.75	4.35	25.00	31.77
91.	07-0817/11-2(5)(2) Ob-Gd	7.50	3.87	29.00	31.67
92.	07-0830-8/2-7(7) Gd-Ob	6.75	4.44	30.00	31.45
93.	Sahil 31-3/11-3(8) v,Gd Oval	5.50	6.36	35.00	31.43
94.	04-082-6/2-5(6)	4.67	6.64	31.00	31.12
95.	14-16/8(6) (5)	6.33	5.05	32.00	31.09
96.	14-16/8(6) (7)	7.00	4.29	30.00	30.92
97.	07-08 29/6/8-7 (1)	6.50	6.92	45.00	30.77
98.	04-084-7/7(5)(3) Ob-V.Gd	6.25	5.43	33.92	30.28
99.	17-6/4(7) (3)	9.00	4.44	40.00	29.89
100.	07-083-3/10-8(1) Ob-Gd	8.25	4.61	38.00	29.75
101.	07-0829-8/10-4(3) Ob-Gd pointed	6.67	3.75	25.00	29.67
102.	07-08 10-4/9/6(4)(9) Ob-Gd	7.25	4.28	31.00	29.57
103.	Sahil 31-3/11-3 P-2 Gd-Oval	6.00	5.60	33.58	29.33
104.	Sahil 5-21/16(6)(1) Ob-Gd	5.50	5.45	30.00	29.21
105.	04-0832-6/2-5(3) Ob-Gd	6.25	4.80	30.00	29.00
106.	07-0812-2-1/4(3) Ob-Gd	9.00	3.56	32.00	28.28
107.	32-3/8(5) (8)	5.00	3.62	18.12	28.00
108.	Sahil 32-2-2/7(7) Ob-Gd	7.00	6.57	46.00	27.89
109.	07-08 17-6-4/(8) Ex-Ob	8.25	4.85	40.00	27.58
110.	21-6/13-8 (4)	8.00	4.18	33.47	27.25
111.	12-2-1/1 (1)	6.00	3.87	23.20	27.23
112.	07-0810-1/3 (1)(9) Ob-Gd	8.67	3.92	34.00	27.22
113.	Sahil 25-18/10-8(1) Ob-Gd	5.25	5.33	28.00	26.22
114.	04-0812-2/1(4)(2) Ob-Gd	8.50	4.00	34.00	26.20
115.	10-10/11-4 (4)	6.67	4.35	29.00	26.03
116.	Sahil 32-4/8-7(4) Ob-Gd	4.75	4.63	22.00	25.97
117.	12-2/9(6) (2)	5.75	6.26	36.00	25.73
118.	07-0812-2/9(6)(5) Ob-V.Gd	6.50	5.08	33.00	25.62
119.	Money Maker	5.42	5.52	29.09	25.37
120.	07-0829-6/4(4)(6) Ob-Gd	5.25	6.48	34.00	24.98
121.	07-0817-6/4(1) (4) B.F.S. Ob-Gd	6.00	5.00	30.00	24.37
122.	07-0838-12/11(8)(1) Gd-Round	4.00	7.00	28.00	24.27
123.	14-8/16-8 (10)	7.25	5.38	39.00	21.52
124.	07-0810-4/9/6(4)(8) Ob-Gd	6.00	7.24	43.46	18.83
	LSD (0.05)	1.41	NS	13.30	11.22

NCl/Pl = Number of clusters per plant; NF/Cl = Number of fruits per cluster; NF/Pl = Number of fruits per plant; FY = Fruit yield (t/ha)

c) **Performance of round and oblong fruit indeterminate tomato genotypes including checks in Augmented block design:** The performance of the round fruit indeterminate advance lines along with the checks is presented in the (Table 6). Significant differences between the test entries and checks were recorded except for number of fruits per cluster. Maximum number of clusters per plant (12.50) were recorded for Sahil 32-14/7(4) Good R followed by 04-08 2-2/10-5(1) Good R (10.50), 07- 08 35-5/11(3)(10) Good R (9.67), 07- 08 32-8/5(5)(7) Good R (9.50) and 07- 08 12-2/1(4)(7) Good R (9.50). All of these entries were at par to one another and have significantly high number of clusters per plant than that of the checks (shown in bold). All of the other lines shown with italic-bold were found non-significant and were at par to the checks that comes under green font colour. Maximum number of fruits per cluster were recorded for the check hybrid (Saalar F_1) with 9.65 followed by 07- 08 32-8/3(7)(5) Good R (9.06), 07- 08 9-7/8(8)(2)EX-R (8.64) and the check Saandal F_1 (8.03 All of these lines and checks were at par to one another. Maximum number of fruits per plant were recorded for 07- 08 32-8/3(7)(5) Good R (72.50) followed by the check hybrid Saalar-F_1 (71.17), Sahil 32-5-14/7(4) Good R (66.25), 07- 08 32-8/2(5)(4) Good R (65.0), 07- 08 10-4/2-1(4) Good R (64.50), check hybrid Saandal-F_1 (61.92), 07- 08 12-2/1(4)(7) Good R (60.75) and the check hybrid Sunder F_1 (55.17) & Surkhail F_1 (54.29). All of these test entries and the checks were found non-significant to one another statistically. Hence, the test entries were found at par to the standard hybrids in terms of their number of fruits per plant. Maximum fruit yield was recorded for 07- 08 32-8/12-8(6) M.N.F, Good R (64.35 t/ha), followed by 04- 08 27-1/15-8(1) Good R (64.27 t/ha), 07- 08 32-8/3(7)(5) Good R (61.17 t/ha), 07- 08 10-4/2-1(4) Good R (59.90 t/ha), 07- 08 32-8/2(5)(2) V. Good R (59.63), check hybrid Saalar F_1(59.08 t/ha) and all others highlighted with italic-bold. All of these test entries and the standards were found at par to one another.

The performance of the oblong fruit indeterminate advance lines along with the checks is presented in the (Table 7). Significant differences between the test entries and checks were observed. Maximum number of clusters per plant (11.0) were recorded for Sahil 31-9/10-1(1) Ob-Gd followed by 21-6/15-5 (6) (10.50), 07-0819/11-2(5)(1) Ob-Gd (10.33), 21-6/15-8 (3) (10.25), Sahil 33-1-13/5(10) Ob-vg (10.0) and 07-08 17/11/2-4(1) Ob-Gd (10.0). All of these entries were found significantly on higher side than the checks marked as bold. However, the differences among them were found non-significant statistically. The differences of means were found statistically non-significant for number of fruits per cluster. Maximum number of fruits per cluster was recorded for Sahil 31-3/11-3(3) Ex-Ob with 9.41 followed by Saalar F_1 (7.81). Maximum number of fruits per plant were recorded 21-9/17(7) (1) (70.0) followed by the check hybrid Saalar-F_1 (63.30) and 21-6/15-8 (3) (62.0). The other lines ranged from 50 to 58 were found at par with the check hybrids. Maximum fruit yield was recorded for Sahil 5-17-4(5)(3) Ob-Gd (left) (116.67 t/ha), followed by Sahil 33-1-13/5(10) Ob-vg (87.27 t/ha) and 07-0814-8/16-8/16(4) Ob-Gd (79.53 t/ha) which were statistically at par to one another and vary significantly from the check Sunder F_1 (60.43 t/ha) as highlighted with bold font. All of the other test entries in italic-bold were found at par with the standard. The results showed a wide array of best performing genotypes and could be re-evaluated in secondary trial.

Discussion

The advance lines had limited quantity of seed hence, the aforementioned design made easy to evaluate a large array of advance lines in one go. The seed of the best performing advance lines was multiplied with the help of the remnant seed. The advance lines in each of the fruit shape group were evaluated separately through Augmented Design (Fehr, 1987). The advance lines of round and oblong fruit shapes were evaluated for number of clusters per plant, number of fruits per cluster, number of fruits per plant and fruit yield (t/ha). These traits hold a very important position for evaluating indeterminate tomato (Fadhilah *et al*., 2022). These traits actually contributed to the yield. The mean values were compared with the corresponding values of the standard error (Ghafoor *et al*., 2003; Shankar *et al*., 2013). For all of the traits; the value of the standard error remained lower than their corresponding means which indicated the precision of data. The recorded values of CV (%) were a bit on higher side which indicated the manifestation of variability among the genotypes as was also studied by Saba *et al*., (2017). The selection of best advance lines can be made by making use of this inference.

Analysis of variance for round fruit shape advance lines revealed significant mean squares for the entire traits block wise by ignoring the treatments which meant that sufficient variability existed in each of the blocks. The non-significance of means squares in case of round fruit shape advance lines for number of clusters per plant and fruit yield except for number of fruits per cluster and number of fruits per plant block wise by eliminating the treatments indicating the homogeneity of the blocks for number of clusters per plant and fruit yield which meant that genotypes behaved in a similar manner for these traits in all the different blocks. However, the blocking effect for round fruit shape advance lines showed significance for number of fruits per cluster and number of fruits per plant indicating towards the non-homogenous variability trend for these two traits. The effect of checks (OPVs & hybrids) vary significantly for number of fruits per cluster, number of fruits per plant and fresh yield except for number of clusters per plant which indicated that no variable difference among the checks were recorded for number of clusters per plant. However, for the test treatments/advance lines, all the traits were found as non-significant which showed that all the lines were at par to one another. The interaction of test treatments and checks showed highly significant differences for all the traits including the yield which directed towards the availability of variability between the checks and test entries as evident from Table 4. However, there might be a chance of some extra ordinarily performing lines. Analysis of variance for oblong fruit shape advance lines revealed significant mean squares only for fruit yield block wise by ignoring treatments and for number of fruits per plant and fruit yield by eliminating blocks which meant that sufficient variability existed for these traits among the blocks. Significant mean squares for all of the traits in all of the treatments by ignoring/ eliminating block effect indicated sufficient variability for these traits among the treatments except for number of fruits per cluster. The non-significance of the test treatments/advance lines for all of the traits showed that all the lines were at par to one another except for fruit yield. The interaction of test treatments and checks showed significant differences for all the traits including the yield which directed towards the availability of variability between the checks and test entries. However, there might be a chance of some extra ordinarily performing lines.

The appraisal of the round and oblong fruit indeterminate advance lines along with the checks genotypes under the same pattern was made by Saleem *et al*., (2013). Important yield attributing traits were taken into consideration for advance lines evaluation against the available checks (Ramzan *et al*., 2014; Kiran *et al*., 2017). In case of round fruit shape advance lines; maximum number of clusters per plant range from 11.40 to 12.20 were also reported by Regassa *et al*., (2012). All of the entries were at par to one another and have significantly high number of clusters per plant than that of the checks (shown in bold) and hence, were considered on the top for number of clusters per plant. Maximum number of fruits per cluster recorded for the check hybrid (Saalar F_1) followed by 07- 08 32-8/3(7)(5) Good R, 07- 08 9-7/8(8)(2)EX-R and the check Saandal F_1 were in line with the findings of Ali *et al*., (2020).

Maximum number of fruits per plant were recorded for round fruit shape advance lines and checks got similiarity trend with the findings of Ayyub *et al*., 2012. Selection on the basis of number of fruits per plant can be made for the test entries as highlighted with italic-bold in Table 7. Maximum fruit yield was recorded for the advance lines ranged from 64.35 to 59.63 t/ha). However, the studies of Regassa *et al*., (2012) reported 51 t/ha to 58 t/ha of fruit yield from tomato.

In case of the oblong fruit indeterminate advance lines, the differences of means were found statistically non-significant for number of fruits per cluster which indicated that these lines and checks were at par to one another. Maximum fruit yield from the oblong fruit shape advance lines remained from 116.67 to 60.43t/ha, which varied significantly from the check Sunder F_1 (60.43 t/ha). However, Ali *et al*., (2020) reported maximum yield of 120.72 t/ha for the hybrid (Sahil). All of the other test entries in italic-bold were found at par with the standard.

Conclusions

Out of 123 round fruit shape advance lines of indeterminate tomato; 20 round fruit shape advance lines yielding from 42.41 to 64.35 t/ha were found at par with high performing check Saalar-F_1 (59.08 t/ha) when evaluated in Augmented Design with 04 set of check hybrids and 04 set of OPVs. Out of 116 oblong fruit shape advance lines of indeterminate tomato; 03 oblong fruit shape advance lines yielding from 79.53 to 116.67 t/ha showed significantly maximum fruit yield from the high performing check Sunder-F_1 (60.43 t/ha), while 18 oblong fruit shape advance lines yielding from 44.60 to 68.47 t/ha were found at par with the high performing check Sunder-F_1 (60.43 t/ha) when evaluated in Augmented Design with 04 set of check hybrids and 04 set of OPVs. Severe wind and thunder storms in the months of February and March, 2021 also resulted in fruit drop which also affected the overall yield.

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