

1. TOMATO (*Solanum lycopersicum* L.)

1.1 MAINTENANCE OF GENE POOL

139 genotypes of both determinate (65) and indeterminate (74) types of local and exotic origins were sown for the purpose of maintenance. The nursery of indeterminate genotypes was sown on 19.10.2016 and transplanted on 15.12.2016 whereas; the nursery of determinate genotypes was sown on 19.10.2016 and transplanted on 08.12.2016. The plot size was kept as 4.0 × 1.5 m and 7.0 × 1.25 m for indeterminate and determinate genotypes respectively. The detailed below entries were maintained during the year:

Table-1 Maintenance of Tomato Germplasm Lines / Varieties (2016-17)

DETERMINATE					
S. No.	Entry	S. No.	Entry	S. No.	Entry
1	09065	23	13230	45	Legend
2	10114	24	13232	46	LITTH-559-17-5-1-2 (Det)
3	10139	25	13234	47	LO-2752
4	10142	26	13239	48	LO-2752-Rio Fuego-33-1-5-6
5	10143	27	13240	49	Nadir
6	10160	28	16241	50	Nagina
7	10170	29	16242	51	Naqeeb
8	10173	30	16243	52	NB-242
9	10178	31	16244	53	NB-326
10	13189	32	16245	54	NTH-242
11	13198	33	16246	55	Pakit
12	13202	34	16247	56	Polar Baby
13	13205	35	16248	57	QF-Red-Rio Fuego-2-1-5-4-7
14	13209	36	16249	58	Rio Grande
15	13210	37	16250	59	Rocky (Akbar)
16	13213	38	16251	60	Roma
17	13215	39	16252	61	Saad-49
18	13216	40	3001 (Akbar)	62	UAF-2
19	13218	41	Big Beef	63	UC-134
20	13220	42	Glacier	64	Yaqui-5-1
21	13225	43	Grushovka	65	Zarnitza
22	13229	44	Jaguar		
INDETERMINATE					
S. No.	Entry	S. No.	Entry	S. No.	Entry
1	08502 (P.L)	26	Dona	51	Punjab Gaurav
2	08503	27	Grightmire's Pride	52	QF Red
3	08504	28	H. Gold-11-2-2-7	53	Red Cherry
4	08505	29	Independence Day	54	Russian Big Roma
5	08506	30	Kornesevsije	55	Sahel-2-3-2

6	08510	31	LA-2530	56	Sahel-4-11-9-5-10-1
7	08533	32	LITTH-539-4-8-4-4-1-1	57	Sahel-4-11-9-5-6-1
8	08543	33	LITTH-539-4-8-4-4-1-2	58	Salar-11-8-2-1-7
9	08581	34	LITTH-539-4-8-5-1-9	59	Salar-16-8-6-1-7
10	08582	35	LITTH-539-4-8-6-3-9	60	Salar-16-8-9-4-7-2
11	08585	36	LITTH-539-4-8-7-6-9	61	Salar-16-8-9-4-7-2-4
12	08586	37	LITTH-539-4-8-8-4-9	62	Salar-16-8-9-4-7-2-7
13	08588	38	LITTH-559-17-5-1-2	63	Salar-16-8-9-6-1-7
14	08589	39	LITTH-566-3-3-2-10	64	Salar-16-8-9-6-2-10
15	08590	40	LITTH-682-11-9-8-2	65	Salar-16-8-9-6-2-4
16	08591	41	LITTH-682-1-2-4-7	66	Salar-6-8-4-1-5-9
17	16241 (Ind)	42	LITTH-682-4-5-1-9	67	Soberano-6-4-1-8
18	Amish Red	43	Marion	68	Soberano-6-4-2-4
19	Bloody Butcher	44	Matina	69	Soberano-6-4-2-8
20	Boxcar Willie	45	NSX-6658	70	Soberano-6-4-7
21	Bulgarian Triumph	46	NSX-6658/59-Bulk	71	Soberano-6-4-9
22	Caspian Pink	47	NSX-6658-SPS-1	72	Sunset's Red Horizon
23	Cherry (Dr. Noor)	48	NSX-6658-SPS-2	73	UAF-1
24	Creole	49	Nyagous	74	Wisconsin-55
25	Debarao	50	Orange Roma		

1.2 HYBRIDIZATION

A. CROSSING WORK TO CREATE GENETIC VARIABILITY

To develop high yielding tomato varieties possessing tolerance against biotic and abiotic stresses, nursery of 20 parents each of indeterminate and determinate types was sown on 19.10.2016 and 20.10.2016 respectively. Indeterminate type was transplanted on 15.12.2016 whereas; determinate type was transplanted on 08.12.2016 in crossing blocks to create genetic variability for the selection of desired progenies as well as for heterosis studies. Crosses were attempted to produce F₀ hybrid seed suitable for open field and under tunnel cultivation. The detail of successful cross combinations is presented in table below.

Table-2 List of tomato crosses (F₀) made during 2016-17

INDETERMINATE						DETERMINATE					
S. No.	Hybrid	S. No.	Hybrid	S. No.	Hybrid	S. No.	Hybrid	S. No.	Hybrid	S. No.	Hybrid
1	Saandal F ₁	30	LITTH-878	59	LITTH-907	1	Ahmar Hybrid	30	LTH-446	58	LTH-476
2	LITTH-691	31	LITTH-879	60	LITTH-908	2	LTH-287	31	LTH-448	59	LTH-477
3	LITTH-710	32	LITTH-880	61	LITTH-909	3	LTH-297	32	LTH-449	60	LTH-478
4	LITTH-765	33	LITTH-881	62	LITTH-910	4	LTH-324	33	LTH-451	61	LTH-479
5	LITTH-778	34	LITTH-882	63	LITTH-911	5	LTH-365	34	LTH-452	62	LTH-480
6	LITTH-779	35	LITTH-883	64	LITTH-912	6	LTH-379	35	LTH-453	63	LTH-481
7	LITTH-795	36	LITTH-884	65	LITTH-913	7	LTH-385	36	LTH-454	64	LTH-482

8	LITTH-796	37	LITTH-885	66	LITTH-914	8	LTH-390	37	LTH-455	65	LTH-483
9	LITTH-809	38	LITTH-886	67	LITTH-915	9	LTH-405	38	LTH-456	66	LTH-484
10	LITTH-818	39	LITTH-887	68	LITTH-916	10	LTH-410	39	LTH-457	67	LTH-485
11	LITTH-833	40	LITTH-888	69	LITTH-917	11	LTH-416	40	LTH-458	68	LTH-486
12	LITTH-836	41	LITTH-889	70	LITTH-918	12	LTH-417	41	LTH-459	69	LTH-487
13	LITTH-844	42	LITTH-890	71	LITTH-919	13	LTH-418	42	LTH-460	70	LTH-488
14	LITTH-845	43	LITTH-891	72	LITTH-920	14	LTH-419	43	LTH-461	71	LTH-489
15	LITTH-852	44	LITTH-892	73	LITTH-921	15	LTH-421	44	LTH-462	72	LTH-490
16	LITTH-855	45	LITTH-893	74	LITTH-922	16	LTH-422	45	LTH-463	73	LTH-491
17	LITTH-859	46	LITTH-894	75	LITTH-923	17	LTH-427	46	LTH-464	74	LTH-492
18	LITTH-860	47	LITTH-895	76	LITTH-924	18	LTH-429	47	LTH-465	75	LTH-493
19	LITTH-861	48	LITTH-896	77	LITTH-925	19	LTH-431	48	LTH-466	76	LTH-494
20	LITTH-862	49	LITTH-897	78	LITTH-926	20	LTH-435	49	LTH-467	77	LTH-495
21	LITTH-867	50	LITTH-898	79	LITTH-927	21	LTH-436	50	LTH-468	78	LTH-496
22	LITTH-870	51	LITTH-899	80	LITTH-928	22	LTH-437	51	LTH-469	79	LTH-497
23	LITTH-871	52	LITTH-900	81	LITTH-929	23	LTH-438	52	LTH-470	80	LTH-498
24	LITTH-872	53	LITTH-901	82	LITTH-930	24	LTH-440	53	LTH-471	81	LTH-499
25	LITTH-873	54	LITTH-902	83	LITTH-931	25	LTH-441	54	LTH-472	82	LTH-500
26	LITTH-874	55	LITTH-903	84	LITTH-932	26	LTH-442	55	LTH-473	83	LTH-501
27	LITTH-875	56	LITTH-904	85	LITTH-933	27	LTH-443	56	LTH-474	84	LTH-502
28	LITTH-876	57	LITTH-905	86	LITTH-934	28	LTH-444	57	LTH-475	85	LTH-503
29	LITTH-877	58	LITTH-906			29	LTH-445				

B. PRODUCTION OF INDETERMINATE TOMATO HYBRID SEED SUITBLE FOR HIGH TUNNEL CULTIVATION

Two (2) indeterminate tomato parental lines were sown on 17.10.2016 and transplanted on 07.12.2016 on an area of twenty five (25) Marlas. Only one cross combination was attempted to produce the seed of approved indeterminate tomato hybrid namely Saandal F₁. A total of 2.0 kg of indeterminate tomato hybrid seed suitable for high tunnels cultivation was produced for general cultivation in Punjab.

1.3 STUDY OF FILIAL GENERATIONS

To advance the generations of indeterminate type, the nursery of different segregating generations was sown on 19.10.2016 and transplanted on 16.12.2016 under tunnels for the selection of high yielding lines possessing tolerance against biotic and abiotic stresses in different plot sizes according to the availability of seed. Similarly, the nursery of different segregating generations of determinate type was sown on 21.10.2016 and transplanted on 03.12.2016 in open field. The desired progenies/ lines were selected and the detail of generations/ no. of selected progenies is given below:

Table-3 Study/ Selection of Progenies from Filial Generations (2016-17)

S. No.	Cross	Single Plant Progenies Selected
a) INDETERMINATE TYPES		
F₂ Generations		
1	08504 × Legend	1
2	08503 × 08582	1
3	08589 × 08581	1
4	08590 × 08504	1
5	08587 × AUT-309	1
6	08505 × 08586	1
7	08502 × 08586	1
8	Gigantesque × 08504	1
9	08594 × 08504	2
10	08517 × NSX-6658-SPS-2	1
11	08506 × Salar-16-8-9-4-7	1
12	Jaffa × Salar-16-8-9-4-7	1
13	08506 × LITTH-566-3-3-2-10	1
14	Soberano-6-4-9 × Salar-16-8-9-4-7	1
15	Debarao × LITTH-566-3-3-2-10	1
16	Pantano × Salar-16-8-9-4-7	1
17	Salar-11-8-2-1-7 (Oblong) × 08585	1
18	Salar-11-8-2-1-7 (Oblong) × Kornesevsije	1
19	NSX-6658-SPS-1 × 08543	1
20	08504 (Oblong) × H. Gold-12-2-6-1-1	1
21	08504 × LITTH-566-3-3-2-10	1
22	08504 (H. Oblong) × 08543	2
23	TAI-687/786-6-3-15-6-3 × Salar-16-8-9-4-7	1
24	Salar-11-8-2-1-7 (Oblong) × 08543	1
25	H. Gold-12-2-6-1-1 × Salar-16-8-9-4-7	1
26	H. Gold-12-2-6-1-1 × NSX-6658-SPS-2	1
27	Cherry (Delta Seed)	1
28	Sahel *	1
29	Saandal *	1
F₃ Generations		
1	08594 × 08504	5
2	08585 × 08504	1
3	08525 × 08582	1
4	08533 × 08582	1
5	08543 × QF-Red	3
6	NUYT-701 × 08543	1
7	08504 × Polar Baby	1
8	08533 × Polar Baby	2
9	08543 × Polar Baby	1
10	Anna *	1

F₄ Generations		
1	Gigantesque × 08504	4
2	Matina × 08582	3
3	H. Gold-2-2-6-1 × 08503	3
4	08543 × QF-Red	8
5	08585 × 08503	4
6	08553 × 08582	1
7	08506 × 08504	2
8	Sahel-2-3-2 × 08504	2
9	08504 × Legend	1
10	Realeza *	2
F₅ Generations		
1	08594 × 08504	8
2	08502 × 08504	14
3	Merion × 08504	1
4	Traveller-76 × 08504	2
5	Anna *	19
F₆ Generations		
1	Gigantesque × 08504	30
2	Carmello × 08504	3
3	Manapal × 08504	2
4	Merion × 08504	3
5	Anna *	5
6	Sahel *	2
F₇ Generations		
1	08553 × 08504	3
2	08542 × 08504	1
3	Soberano *	1
b) DETERMINATE TYPES		
F₂ Generations		
1	Bonita × 13225	1
2	Glacier × AUT-324	1
3	Jaguar × AUT-309	1
4	Pakit × 13225	1
5	Nadir × AUT-324	1
6	UC-134 × 10139	2
7	LO-2752-Rio Fuego-33-1-5-6 × 10139	1
8	QF-Red-Rio Fuego-2-1-5-4 × 13225	1
9	09065 × AUT-309	1
10	10114 × 10139	1
11	10137 × AUT-309	1
12	10139 × AUT-324	1
13	10170 × AUT-305	1
14	10170 × AUT-309	1
15	13205 × 13225	1

16	13205 × 10139	1
17	13213 × 13225	1
18	TAI-2120 *	1
19	14T-4770 *	2
20	SV-3466 *	2
21	CBS-292 *	1
22	GHT-1 *	1
23	Solo-1 *	1
24	Rover *	1
25	Miracle *	1
26	Novita *	1
27	Kanon *	1
28	Indigo *	2
29	Avenue *	1
30	Mehran-670 *	1
31	Qasba *	1
32	Prasun *	1
33	TAI-14-6242 *	1
34	Kanwal *	1
35	Four Season *	1
F₃ Generations		
1	AVTOV-1007 × Nadir	7
2	Grushovka × NTH-242	8
3	Rio Grande × AUT-318	9
4	Rio Fuego × CLN-1621 F	4
5	Solo-1 *	2
6	Super Sindh *	1
7	Kanon *	1
8	Kortaja *	1
9	GAR-12 *	1
10	AR-02 *	1
11	RS-1312 *	8
12	No. 99 *	1
13	HT-1570 *	1
14	RT	1
15	No. 85	1
16	T-08	1
17	T-078	1
18	DRD-8564 *	5
19	Roshan *	7
20	Shamas *	4
21	MDS Red Diamond *	5
F₄ Generations		
1	Naqeeb × Grushovka	6
2	Nadir × Grushovka	5

3	Yaqui-5-1 × Grushovka	14
4	Beaverlodge Slicer × 10184	4
5	MDS Red Diamond *	14
6	Kanwal *	9
7	GHT-2 *	6
8	HN-2855 *	2
9	Realeza *	1
10	NBH-2 *	13
11	RS-1312 *	6
F₅ Generations		
1	Forme de Coeur × 17-07	2
2	Grushovka × Napoli	2
3	AS-2565 *	8
4	Baby Red *	2
5	Amazon *	3
6	TO-1057 *	5
7	RS-1312 *	1
F₆ Generations		
1	Merion × 08504 (Det)	1
2	Pony Express *	10
3	Gemco Star *	4
4	Advanta-1242/A *	5
5	Alankar *	2
F₇ Generations		
1	AVTOV-1002 × LO-2752	60
2	LO-2752 × Yaqui-5-1	1
3	Advanta-1242/A *	1
4	Cluster-805 *	1

* Commercial Variety/ Hybrid

1.4 PRELIMINARY EVALUATION OF DETERMINATE TOMATO LINES

To evaluate the yield performance of newly selected lines from segregating generations, a trial comprising of 11 advanced lines along with three check varieties viz: Nadir, Naqeeb and Rio Grande was conducted at Vegetable Research Institute, Faisalabad. The nursery was sown on 19.10.2016 and transplanting was done on 30.11.2016 according to Randomized Complete Block Design (RCBD) with three replications in a plot size of 7.0 × 1.25 m with plant to plant distance of 50 cm. Data recorded for fruit length, fruit width, fruit weight, fruit firmness and fruit yield is presented in the table below.

Table-4 Performance of Determinate Tomato Advanced Lines in Preliminary Yield Trial at VRI, Faisalabad during 2016-17

Rank	Entry	Fruit length (mm)	Fruit width (mm)	Fruit firmness (kg/cm ²)	Fruit weight (g)	Fruit yield (t/ha)
1	16244	55.3	56.8	3.78	120.5	44.54
2	Nadir (Check)	57.6	49.0	3.92	83.6	43.51
3	16243	53.4	54.8	3.90	112.2	43.18
4	Naqeeb (Check)	58.7	50.2	3.88	82.2	39.38
5	16249	55.2	46.8	4.10	75.0	37.47
6	Rio Grande (Check)	57.5	47.1	4.06	80.9	36.91
7	16245	61.9	47.0	3.96	91.0	36.20
8	16246	53.2	41.3	3.68	61.6	34.40
9	16252	54.7	51.4	4.02	91.4	34.39
10	16248	51.3	44.5	3.86	64.8	34.35
11	16247	53.5	49.6	3.98	81.9	33.06
12	16242	50.2	47.7	3.74	74.8	24.86
13	16241	51.7	49.9	3.78	79.4	23.47
14	16251	48.9	45.6	3.70	67.1	22.79
LSD (0.05)						2.91

The perusal of table indicates that differences among means for fruit yield due to varieties were significant. Entries ranked at No. 1 & 3 were statistically at par in terms of fruit yields against the highest yielding check Nadir (43.51 t/ha). The highest fruit yield of 44.54 t/ha was produced by the entry 16244 whereas; the lowest fruit yield of 22.79 t/ha was depicted by the entry 16251.

1.5 SECONDARY / STATION YIELD EVALUATION OF DETERMINATE TOMATO ADVANCED LINES

An experiment comprising of eight advanced lines along with three checks namely Nadir, Naqeeb and Rio Grande was sown in nursery on 19.10.2016 and transplanted on 30.11.2016 in a Randomized Complete Block Design with three replications. The plot size was kept as 7.0 × 1.25 m with plant to plant distance of 50 cm. Data recorded for fruit length, fruit width, fruit weight, fruit firmness and fruit yield is given in the table below.

Table-5 Performance of Determinate Tomato Advanced Lines in Station Yield Trial at VRI, Faisalabad during 2016-17

Rank	Entry	Fruit length (mm)	Fruit width (mm)	Fruit firmness (kg/cm ²)	Fruit weight (g)	Fruit yield (t/ha)
1	13240	45.7	42.7	3.58	67.1	50.17
2	Naqeeb (Check)	56.7	47.1	3.86	79.5	41.02

3	Nadir (Check)	57.7	49.8	3.90	81.6	40.60
4	13239	53.6	48.3	3.98	83.7	40.39
5	10139	54.4	45.9	3.84	78.0	36.90
6	13234	55.3	44.0	3.68	78.3	36.01
7	Rio Grande (Check)	58.5	50.1	4.04	87.0	35.82
8	13230	58.3	45.4	3.50	83.9	28.80
9	13229	58.7	47.3	3.92	81.2	28.68
10	13189	55.1	48.9	3.86	79.7	27.89
11	13232	56.9	44.8	3.58	80.4	25.17
LSD (0.05)						2.62

It is evident from the above table that differences among means for fruit yield due to varieties were significant. The top ranked entry namely 13240 produced statistically significant fruit yield of 50.17 t/ha against the highest yielding check Naqeeb which depicted the fruit yield of 41.02 t/ha. The entry ranked at No. 4 performed statistically at par in terms of fruit yield against the better check Nadir. The lowest fruit yield was harvested from the entry namely 13232 (25.17 t/ha).

1.6 MULTI-LOCATIONAL / ZONAL EVALUATION OF DETERMINATE TOMATO ADVANCED LINES

To evaluate the yield performance of determinate tomato advanced lines under different ecological zones of Punjab, a trial comprising of eight (8) entries along with three checks (Nadir, Naqeeb & Rio Grande) was conducted at four different locations viz; VRI Faisalabad, VRSS Sheikhpura, VRSS Multan and VRSS Bahawalpur. The nursery of these lines was sown on 19.10.2016. The transplanting of the nursery was done according to RCBD in 3 replications and plant to plant distance was kept as 50 cm. The data recorded for fruit yield is given in tables below.

Location	Transplantation Date	Plot Size
VRI, Faisalabad	30.11.2016	7.0 × 1.25 m
VRSS, Sheikhpura	15.12.2016	7.0 × 1.25 m
VRSS, Multan	20.12.2016	7.0 × 1.25 m
VRSS, Bahawalpur	21.12.2016	7.0 × 1.25 m

Table-6 Performance of Determinate Tomato Advanced Lines in Multi-locational / Zonal Trials at VRI, Faisalabad during 2016-17

Rank	Entry	Fruit length (mm)	Fruit width (mm)	Fruit firmness (kg/cm²)	Fruit weight (g)	Fruit yield (T/ha)
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1	10139	58.0	47.5	3.86	85.2	37.70
2	Nadir (Check)	59.7	51.6	3.96	88.1	37.10
3	13198	60.2	49.7	3.84	95.4	35.76
4	10173	57.0	47.8	3.78	83.6	35.47
5	10142	59.3	51.6	3.92	98.3	34.76
6	Naqeeb (Check)	58.5	48.2	3.72	87.4	33.75
7	Rio Grande (Check)	60.8	51.4	4.02	90.7	30.71
8	13213	52.2	45.0	3.84	78.9	27.17
9	13209	50.5	42.9	3.70	77.3	25.98
10	NB-326	54.7	42.2	3.74	66.4	22.72
11	NB-242	66.6	43.0	3.66	88.0	19.41
LSD (0.05)						2.67

It is evident from the above table that differences among means for fruit yield due to varieties were significant. The entries ranked at No. 1 & 3 – 5 produced statistically at par fruit yields against the highest yielding check Nadir (37.10 t/ha). The highest and lowest fruit yields were given by the entries 10139 (37.70 t/ha) and NB-242 (19.41 t/ha) respectively.

Table-7 Performance of Determinate Tomato Advanced Lines in Multi-locational / Zonal Trials at Different Locations during 2016-17

Rank	Entry	Fruit yield (T/ha)				
		FSD	S. Pura	Multan	B. Pur	Average
1	10139	37.70	34.40	30.67	25.01	31.95
2	Nadir (Check)	37.10	33.45	29.62	23.50	30.92
3	13198	35.76	32.95	29.90	23.81	30.61
4	10142	34.76	32.32	27.81	23.60	29.62
5	Naqeeb (Check)	33.75	30.95	27.68	24.06	29.11
6	10173	35.47	29.92	28.42	22.23	29.01
7	Rio Grande (Check)	30.71	29.89	24.97	22.67	27.06
8	13213	27.17	21.01	21.73	19.24	22.29
9	13209	25.98	23.22	20.97	17.64	21.95
10	NB-326	22.72	17.41	15.71	18.40	18.56
11	NB-242	19.41	15.16	14.91	13.92	15.85
LSD (0.05)		2.67	3.31	2.19	2.04	-

It is evident from the above table that differences amongst means for fruit yield due to varieties were significant at all locations. On average basis, top ranked advanced line namely 10139 produced higher fruit yield of 31.95 t/ha against the highest yielding check Nadir which gave an average fruit yield of 30.92 t/ha. The lowest average fruit yield of 15.85 t/ha was depicted by the entry NB-242.

1.7 EVALUATION OF EXOTIC TOMATO VARIETIES/ HYBRIDS IN ADAPTABILITY TRIAL

A. DETERMINATE TYPES

Seventy nine (79) exotic determinate tomato varieties/ hybrids received from different Seed Companies were tested along with two checks namely T-1359 F₁ (exotic) and Nadir (local) in four sets for their performance in adaptability trial at Vegetable Research Institute, Faisalabad during Rabi, 2016-17. The nursery was sown and transplanted in a Randomized Complete Block Design with two replications. The recommended agronomic and plant protection measures were adopted to maintain the crop. Data recorded for fruit length, fruit width, fruit firmness, fruit weight and fruit yield is presented below.

Table-8 Performance of Exotic Determinate Tomato Varieties/ Hybrids in Adaptability Trial at VRI, Faisalabad during 2016-17
Set-1

Date of nursery sowing: 20.10.2016
Date of transplanting: 02.12.2016
Plot size: 7.0 × 1.25 m
Plant to plant distance: 50 cm

Rank	Variety/ Hybrid	Fruit length (mm)	Fruit width (mm)	Fruit firmness (kg/cm ²)	Fruit weight (g)	Fruit yield (T/ha)
1	TAI-14-6242	50.3	48.3	3.64	76.5	58.51
2	GTH-1	65.4	46.0	2.56	80.3	58.09
3	Hiker F ₁	56.5	44.9	2.86	73.1	57.07
4	CBS-292	60.7	40.3	3.32	69.7	56.86
5	TAI-2120	47.0	44.9	2.72	64.4	55.49
6	Novita	61.2	47.8	3.08	83.8	53.62
7	14T-4770	64.1	49.6	3.30	88.2	50.66
8	14T-4703	56.4	44.1	3.12	71.0	50.46
9	HT-1570 F ₁	52.3	48.3	3.04	77.0	48.59
10	T-1359 F₁ (Check)	51.2	43.4	3.12	68.1	47.43
11	TM-1826 F ₁	53.7	44.5	3.16	73.2	46.32
12	GTH-2	52.2	44.4	3.12	68.1	46.06
13	Prince	52.1	47.5	3.16	71.0	44.28
14	NSC-92 F ₁	52.6	43.7	2.84	67.6	43.69
15	Wantia F ₁	57.3	51.1	2.98	89.7	43.53
16	Super Star F ₁	56.0	49.2	3.50	78.9	41.54
17	Holland-1 F ₁	60.3	44.6	3.36	74.4	41.04
18	6484 F ₁	51.3	45.7	3.02	67.1	40.88
19	Nadir (Check)	57.8	50.1	3.18	82.6	40.19

20	Anokhi F ₁	51.3	41.4	2.80	64.5	39.49
21	Red Pearl F ₁	50.5	43.6	2.90	64.5	36.22
22	Red Wonder	57.3	47.5	3.22	82.0	35.81
23	Red Boss	49.1	41.0	2.56	61.9	34.92
LSD (0.05)						3.28

It is evident from the above table that the six entries ranked 1 – 6 produced significantly higher fruit yields than high yielding check T-1359 F₁ (47.43 t/ha). However, entries ranked from 7 – 9 and 11 – 13 remained statistically at par in comparison with high yielding check T-1359 F₁. The highest fruit yield of 58.51 t/ha was recorded in entry TAI-14-6242 while the lowest fruit yield was depicted by the entry Red Boss (34.92 t/ha).

Table-9 Performance of Exotic Determinate Tomato Varieties/ Hybrids in Adaptability Trial at VRI, Faisalabad during 2016-17

Set-2

Date of nursery sowing: 20.10.2016
Date of transplanting: 02.12.2016
Plot size: 7.0 × 1.25 m
Plant to plant distance: 50 cm

Rank	Variety/ Hybrid	Fruit length (mm)	Fruit width (mm)	Fruit firmness (kg/cm ²)	Fruit weight (g)	Fruit yield (T/ha)
1	Rover F ₁	55.6	47.3	3.32	78.7	71.54
2	Avenue F ₁	57.5	47.8	3.22	71.5	70.90
3	Miracle F ₁	55.9	46.1	3.18	72.9	66.52
4	Mehran-670	50.4	46.6	2.86	67.2	63.72
5	Rani	54.7	46.2	3.54	73.5	61.47
6	Kamaal F ₁	53.9	47.2	3.06	81.4	61.40
7	Four Seasons	53.3	43.1	3.08	64.9	59.63
8	T-1359 F₁ (Check)	51.3	42.3	3.20	63.6	59.53
9	Betsy F ₁	58.4	46.9	3.02	77.2	58.06
10	Qasba F ₁	63.1	49.5	3.04	104.6	57.96
11	Nadir (Check)	57.0	47.9	3.44	79.8	57.87
12	Indigo F ₁	54.2	48.2	3.14	74.8	56.76
13	Solo-1	64.7	54.9	3.18	109.1	56.57
14	Faris F ₁	50.5	43.7	3.36	63.3	55.42
15	TTM-502	57.0	46.6	3.08	74.3	53.82
16	Amazon F ₁	52.6	46.4	2.84	66.8	53.11
17	Kanwal	55.6	44.7	3.12	75.8	49.30
18	Samrudhi	56.2	46.5	3.28	78.3	47.38
19	Toma-2	55.3	44.7	2.96	64.0	46.26
20	Maryam F ₁	57.9	51.3	3.10	90.2	46.25

21	Rebecca F ₁	63.1	49.2	3.12	80.0	44.58
22	Nun-02281	50.8	43.8	3.16	70.5	40.94
23	TTM-503	53.1	45.3	2.98	68.1	32.68
LSD (0.05)						4.06

The above table reveals that entries ranked from 1 – 4 produced significantly higher fruits yields than the high yielding check T-1359 F₁ (59.53 t/ha). The entries ranked from 5 – 7 and 9 – 13 produced statistically at par fruit yields in comparison with high yielding check T-1359 F₁. The highest and lowest fruit yields were recorded in entries namely Rover F₁ (71.54 t/ha) and TTM-503 (32.68 t/ha) respectively.

Table-9 Performance of Exotic Determinate Tomato Varieties/ Hybrids in Adaptability Trial at VRI, Faisalabad during 2016-17 Set-3

Date of nursery sowing: 28.10.2016
Date of transplanting: 16.12.2016
Plot size: 7.0 × 1.25 m
Plant to plant distance: 50 cm

Rank	Variety/ Hybrid	Fruit length (mm)	Fruit width (mm)	Fruit firmness (kg/cm ²)	Fruit weight (g)	Fruit yield (T/ha)
1	Yaqui	61.1	51.3	3.26	97.2	71.13
2	Prasun	56.7	46.9	3.12	72.5	69.83
3	SV-3466 TE	50.5	44.6	3.40	65.9	59.64
4	Fonto	62.6	48.3	3.44	88.3	58.24
5	T-1359 F₁ (Check)	53.8	45.5	3.50	70.2	56.28
6	SV-6605 TE	57.9	48.1	3.28	79.1	56.03
7	Kanon F ₁	63.4	45.9	3.36	102.7	51.74
8	SV-8749 TE	51.4	44.2	3.60	62.4	49.93
9	Nadir (Check)	59.5	51.4	3.66	88.1	46.14
10	Chaman F ₁	60.5	50.5	3.34	88.3	41.36
11	Leader F ₁	60.4	49.8	3.46	85.4	40.98
12	Pound F ₁	57.8	50.2	3.28	87.3	38.90
13	Supremo F ₁	65.8	52.6	3.04	97.0	32.16
14	5565 F ₁	55.3	48.2	3.20	69.0	31.59
15	Red Beauty F ₁	59.7	49.2	3.28	78.1	26.91
16	Rambo F ₁	65.8	46.6	3.42	79.3	26.11
17	Capri F ₁	55.4	43.7	3.22	98.1	25.47
18	Zamora F ₁	53.8	44.7	3.04	72.2	24.85
19	Cassandra F ₁	59.9	50.5	3.36	80.8	24.60
20	Rota F ₁	65.1	49.6	3.62	85.0	23.33
21	T-100 F ₁	56.1	48.1	3.30	73.6	21.49
22	Euro F ₁	58.3	43.0	3.80	65.9	20.20

23	Neon F ₁	65.5	55.5	3.46	105.7	17.76
LSD (0.05)						4.75

The above table shows that entries ranked from 1 – 2 produced significantly higher fruit yields than high yielding check T-1359 F₁ (56.28 t/ha). However, entries ranked from 3 – 4 and 6 – 7 remained statistically at par in comparison with high yielding check T-1359 F₁. The highest fruit yield was depicted by the entry Yaqui (71.13 t/ha) whereas the lowest fruit yield was recorded in the entry Neon F₁ (17.76 t/ha).

Table-10 Performance of Exotic Determinate Tomato Varieties/ Hybrids in Adaptability Trial at VRI, Faisalabad during 2016-17 (Late Received)
Set-4

Date of nursery sowing: 08.12.2016
Date of transplanting: 07.02.2017
Plot size: 7.0 × 1.25 m
Plant to plant distance: 50 cm

Rank	Variety/ Hybrid	Fruit length (mm)	Fruit width (mm)	Fruit firmness (kg/cm ²)	Fruit weight (g)	Fruit yield (T/ha)
1	V-369 F ₁	69.8	52.4	3.30	95.3	33.26
2	Albi F ₁	54.8	46.8	3.26	74.9	29.46
3	Fulham F ₁	58.1	49.7	3.38	80.2	27.31
4	Red Cross F ₁	50.8	46.0	3.32	61.5	26.89
5	Kama F ₁	60.3	49.4	3.58	77.0	24.50
6	Marina F ₁	64.1	50.0	3.82	91.0	24.35
7	SV-0141TJ F ₁	65.6	46.8	3.72	76.9	24.02
8	13-HN-FDS-6318	59.2	49.1	3.80	81.6	23.86
9	AS-414 F ₁	56.1	49.7	3.56	75.8	23.46
10	T-1359 F₁ (Check)	50.3	44.6	3.54	62.7	22.64
11	Caporal F ₁	54.6	46.0	3.42	68.2	22.45
12	007 F ₁	50.6	45.4	3.36	65.4	22.04
13	13-9P-FDS-4777	55.5	50.4	3.70	79.1	21.18
14	Zarmatt F ₁	55.5	41.8	3.42	63.9	20.52
15	Nadir (Check)	54.3	46.3	3.70	75.6	20.25
16	Firmont F ₁	61.7	53.0	3.54	93.4	19.82
17	Red Sun F ₁	52.7	43.7	3.22	60.8	19.81
18	Nasdette F ₁	60.9	50.6	3.72	79.3	14.89
LSD (0.05)						3.60

The above table reveals that entries ranked from 1 – 4 produced significantly higher fruit yields than high yielding check T-1359 F₁ (22.64 t/ha). However, entries ranked from 5 – 9 and 11 – 17 remained statistically at par in comparison with high

yielding check T-1359 F₁. The highest and lowest fruit yields were recorded in the entries V-369 F₁ (33.26 t/ha) and Nasette F₁ (14.89 t/ha) respectively.

B. INDETERMINATE TYPES

One exotic indeterminate tomato hybrid received from CKD Seeds and Fertilizers, Gujranwala was tested along with two checks i.e. Sahel F₁ (exotic) and Salar F₁ (local) for their performance in adaptability trial under high tunnel at Vegetable Research Institute, Faisalabad during Rabi, 2016-17. The nursery was sown and transplanted in a Randomized Complete Block Design with five replications. The recommended agronomic and plant protection measures were adopted to maintain the crop. Data recorded for fruit length, fruit width, fruit firmness, fruit weight and fruit yield is given below.

Table-11 Performance of Exotic Indeterminate Tomato Varieties/ Hybrids in Adaptability Trial under High Tunnel at VRI, Faisalabad during 2016-17

Date of nursery sowing: 08.11.2016
 Date of transplanting: 10.12.2016
 Plot size: 4.0 × 1.5 m
 Plant to plant distance: 40 cm

Rank	Variety/ Hybrid	Fruit length (mm)	Fruit width (mm)	Fruit firmness (kg/cm ²)	Fruit weight (g)	Fruit yield (T/ha)
1	Salar F ₁ (Check)	57.2	48.6	3.94	82.3	145.22
2	Sahel F ₁ (Check)	60.6	52.0	4.06	106.7	143.20
3	Cosmic F ₁	59.2	50.1	3.90	96.2	120.43
LSD (0.05)						6.66

The above table reveals that differences among means for fruit yield due to varieties were significant. The local check Salar F₁ produced the maximum fruit yield of 145.22 t/ha whereas the exotic check Sahel F₁ produced statistically at par fruit yield of 143.20 t/ha in comparison with the high yielding check i.e. Salar F₁. The lowest fruit yield of 120.43 t/ha was depicted by the entry Cosmic F₁.

1.8 ADAPTABILITY EVALUATION OF INDETERMINATE TOMATO HYBRIDS DEVELOPED BY PARC, ISLAMABAD

Eight (8) indeterminate tomato hybrids received from PARC, Islamabad were evaluated under high tunnel along with two checks namely Sahel F₁ (exotic) and Salar F₁ (local) at Vegetable Research Institute, Faisalabad during Rabi, 2016-17. The nursery was sown and transplanted in a Randomized Complete Block Design with two

replications. The recommended agronomic and plant protection measures were adopted to maintain the crop. Data recorded for fruit length, fruit width, fruit firmness, fruit weight and fruit yield is presented below.

Table-12 Performance of Indeterminate Tomato Hybrids of PARC, Islamabad in an Adaptability Trial at VRI, Faisalabad during 2016-17

Date of nursery sowing: 03.11.2016
 Date of transplanting: 15.12.2016
 Plot size: 7.0 × 1.25 m
 Plant to plant distance: 50 cm

Rank	Variety/ Hybrid	Fruit length (mm)	Fruit width (mm)	Fruit firmness (kg/cm ²)	Fruit weight (g)	Fruit yield (T/ha)
1	Salar F ₁ (Check)	61.6	51.6	4.02	94.3	146.51
2	MGIT-02 F ₁	69.2	50.9	3.70	113.5	142.80
3	Sahel F ₁ (Check)	63.4	54.4	4.06	119.6	140.04
4	MGIT-01 F ₁	67.3	52.3	3.40	122.8	122.07
5	MGIT-08 F ₁	67.3	53.4	3.84	128.5	118.97
6	MGIT-04 F ₁	64.5	53.2	3.76	117.2	114.55
7	MGIT-06 F ₁	64.5	54.1	3.60	131.3	114.36
8	MGIT-07 F ₁	58.6	49.2	3.54	91.9	109.98
9	MGIT-03 F ₁	56.4	47.9	3.94	81.4	101.62
10	MGIT-05 F ₁	56.5	55.5	3.62	115.9	100.48
LSD (0.05)						5.65

The above table reveals that differences amongst means for fruit yield due to varieties were significant. The entry ranked at No. 2 namely MGIT-02 (142.80 t/ha) produced statistically at par fruit yield in comparison with the highest yielding check Salar F₁ (146.51 t/ha) which also the top ranked entry. The lowest fruit yield was given by the entry MGIT-05 F₁ (100.48 t/ha).

1.9 NATIONAL UNIFORM YIELD TRIAL OF TOMATO VARIETIES/ HYBRIDS

Thirteen (13) determinate tomato varieties/ hybrids received from National Coordinator (Hort.), PARC, Islamabad were evaluated in open field along with two checks namely T-1359 F₁ (exotic) and Naqeeb (local) at Vegetable Research Institute, Faisalabad during Rabi, 2016-17. The nursery was sown and transplanted in a Randomized Complete Block Design with three replications. The recommended agronomic and plant protection measures were adopted to maintain the crop. Data

recorded for fruit length, fruit width, fruit firmness, fruit weight and fruit yield is presented below.

Table-13 Performance of Determinate Tomato Varieties/ Hybrids in NUYT Trial at VRI, Faisalabad during 2016-17

Date of nursery sowing: 09.11.2016
 Date of transplanting: 02.12.2016
 Plot size: 7.0 × 1.25 m
 Plant to plant distance: 50 cm

Rank	Variety/ Hybrid	Fruit length (mm)	Fruit width (mm)	Fruit firmness (kg/cm ²)	Fruit weight (g)	Fruit yield (T/ha)
1	TOM-16002	50.6	54.3	3.58	78.3	37.64
2	TOM-16050	48.3	51.6	3.40	72.4	33.38
3	TOM-16033	44.4	45.2	3.72	60.3	30.16
4	T-1359 F₁ (Check)	51.5	42.3	3.86	60.4	26.31
5	TOM-16045	45.6	46.7	3.44	53.6	26.20
6	TOM-16014	56.9	45.1	3.54	66.4	26.15
7	Naqeeb (Check)	56.6	48.0	3.94	76.7	24.57
8	TOM-16040	36.7	41.6	3.34	48.6	20.03
9	TOM-16007	69.0	43.3	3.68	75.1	19.72
10	TOM-16024	58.3	47.7	4.18	76.8	18.68
11	TOM-16047	36.7	38.2	3.26	36.1	17.84
12	TOM-16027	42.5	41.0	3.46	44.0	17.25
13	TOM-16042	46.7	49.6	3.84	67.8	16.90
14	TOM-16019	50.7	42.2	3.76	58.9	15.56
15	TOM-16011	34.0	36.3	3.16	28.5	14.88
LSD (0.05)						3.20

The above table reveals that differences amongst means for fruit yield due to varieties were significant. The entries ranked at No. 1 – 3 produced significantly higher fruit yields than the highest yielding check i.e. T-1359 F₁ (26.31 t/ha) whereas; entries ranked at No. 5 and 6 performed statistically at par in terms of fruit yield in comparison with highest yielding check T-1359 F₁. The highest and lowest fruit yields were depicted by the entries namely TOM-16002 (37.64 t/ha) and TOM-16011 (14.88 t/ha) respectively.

1.10 EVALUATION OF LOCALLY DEVELOPED DETERMINATE TOMATO ADVANCED LINES / HYBRIDS FOR AUTUMN PLANTING

a) Determinate Advanced Lines:

To evaluate the performance of autumn sown determinate tomato advanced lines under different ecological zones of Punjab, an experiment comprising of twelve advanced lines along with three checks namely RS-1312 F₁, Kanwal F₁ and T-1359 F₁ was conducted at two different locations viz; VRI Faisalabad and BARI Chakwal. The details of the experiment are as under:

Table-14 Performance of Determinate Tomato Advanced Lines in Multilocal Trials under Tunnel at VRI, Faisalabad and in open field at BARI, Chakwal during 2016-17 (Autumn Planting)

Particulars	Faisalabad	Chakwal
Sowing date:	16.08.2016	?
Transplanting date:	13.10.2016	?
No. of Entries:	12	9
No. of Replications:	2	3
No. of Plants/ Entry:	12	11
Plant to plant distance:	50 cm	50 cm
Plot size:	3.2 × 1.7 m	7.0 × 1.25 m

Rank	Entry	Fruit yield (T/ha)		
		VRI, Faisalabad	BARI, Chakwal	Average
1	RS-1312 F ₁ (Check)	27.22	-	27.22
2	T-1359 F ₁ (Check)	21.54	15.89	18.71
3	AUT-312	18.39	13.98	16.18
4	AUT-315	19.35	12.30	15.82
5	AUT-318	18.77	11.81	15.29
6	AUT-305	17.81	10.93	14.37
7	Kanwal F ₁ (Check)	14.35	-	14.35
8	AUT-309	15.17	8.30	11.73
9	AUT-302	13.71	7.85	10.78
10	10139	10.51	-	10.51
11	AUT-324	12.87	7.54	10.20
12	AUT-330	9.65	6.97	8.31
	LSD (0.05)	2.86	1.39	-

It is evident from the above table that differences among means for fruit yield due to varieties were significant at both locations. On average basis, the exotic check entry RS-1312 F₁ produced higher fruit yield of 27.22 t/ha than all the entries. The lowest average fruit yield was harvested from the entry AUT-330 (8.31 t/ha).

b) Indeterminate Hybrids:

To evaluate the performance of autumn sown indeterminate tomato hybrids under tunnel an experiment comprising of nine hybrids including two checks namely Sahel F₁ and Saandal F₁ was conducted at VRI Faisalabad. The details of the experiment are as under:

Table-15 Performance of Indeterminate Tomato Hybrids under Tunnel at VRI, Faisalabad during 2016-17 (Autumn Planting)

Rank	Hybrid	Fruit yield (T/ha)
1	LITTH-804	48.55
2	Saandal F₁ (Check)	39.77
3	LITTH-888	37.10
4	LITTH-880	30.97
5	LITTH-797	27.69
6	Sahel F₁ (Check)	23.92
7	LITTH-793	23.10
8	LITTH-798	20.59
9	LITTH-796	9.56
	LSD (0.05)	4.11

The above table reveals that differences amongst means for fruit yield due to varieties were significant. The top ranked entry namely LITTH-804 produced significantly higher fruit yield of 48.55 t/ha than the highest yielding check Saandal F₁ (39.77 t/ha). However, the entry ranked at No. 3 namely remained statistically at par in comparison with the highest yielding check Saandal F₁. The lowest fruit yield was recorded in the entry LITTH-796 (9.56 t/ha).

1.11 PRELIMINARY EVALUATION OF LOCALLY DEVELOPED DETERMINATE TOMATO HYBRIDS

To evaluate yield potential and other valuable characteristics of locally developed determinate tomato hybrids, an experiment comprising of 40 hybrids along with two checks (T-1359 F₁ & Nadir) in two sets (20 hybrids and two checks in each set) was conducted at VRI, Faisalabad during Rabi, 2016-17. The nursery was sown on 19.10.2016 and transplanted on 30.11.2016 in RCBD with two replications. Plot size was kept as 7.0 × 1.25 m and plant to plant distance was maintained at 50 cm. Data recorded for fruit length, fruit width, fruit firmness, fruit weight and fruit yield are presented in table below.

Table-16 Performance of Locally Developed Determinate Tomato Hybrids in Preliminary Yield Trial at VRI, Faisalabad during 2016-17 (Set-1)

Rank	Entry	Fruit length (mm)	Fruit width (mm)	Fruit firmness (kg/cm ²)	Fruit weight (g)	Fruit yield (t/ha)
1	LTH-420	56.9	47.3	3.32	77.9	50.05
2	LTH-421	54.5	47.4	3.42	82.5	47.73
3	LTH-418	46.2	50.7	3.76	73.4	46.81
4	T-1359 F₁ (Check)	51.9	43.7	3.78	65.1	46.17
5	LTH-429	52.5	57.2	3.78	88.5	46.05
6	Nadir (Check)	59.5	48.2	3.86	82.4	45.64
7	LTH-423	54.1	47.9	3.72	73.2	44.53
8	LTH-422	61.4	50.9	3.82	90.0	43.81
9	LTH-430	60.5	52.9	3.72	96.6	43.70
10	LTH-419	57.7	47.8	3.96	75.6	40.76
11	LTH-416	52.4	46.5	3.64	75.1	40.43
12	LTH-417	45.2	40.0	3.46	51.7	39.80
13	LTH-413	52.9	41.8	3.90	53.5	37.84
14	LTH-415	56.5	44.9	3.72	64.6	36.80
15	LTH-411	47.8	50.4	3.52	85.3	36.63
16	LTH-414	61.0	50.1	3.44	86.2	35.71
17	LTH-427	58.8	53.9	2.60	93.0	34.25
18	LTH-424	62.7	50.4	3.56	84.3	31.93
19	LTH-412	40.9	37.6	3.36	47.8	27.76
20	LTH-428	49.3	42.5	3.66	58.3	27.26
21	LTH-425	57.9	48.1	3.62	62.6	26.67
22	LTH-426	35.9	36.4	2.42	34.8	24.21
LSD (0.05)						4.18

The above table reveals that differences among means for fruit yield due to genotypes were significant. The hybrid entries ranked at No. 1, 2, 3, 5 and 7 – 9 produced statistically at par fruit yields than the better check T-1359 F₁ which gave the fruit yield of 46.17 t/ha. The highest fruit yield was produced by the entry LTH-420 (50.05 t/ha) whereas; the lowest fruit yield was depicted by the entry LTH-426 (24.21 t/ha).

Table-17 Performance of Locally Developed Determinate Tomato Hybrids in Preliminary Yield Trial at VRI, Faisalabad during 2016-17 (Set-2)

Rank	Entry	Fruit length (mm)	Fruit width (mm)	Fruit firmness (kg/cm ²)	Fruit weight (g)	Fruit yield (t/ha)
1	LTH-440	51.0	42.9	3.78	68.2	55.09
2	LTH-433	53.0	42.8	3.64	63.8	53.48
3	LTH-444	54.6	46.2	3.56	74.2	52.88

4	LTH-445	50.4	45.2	3.52	69.8	50.26
5	LTH-432	49.5	45.7	3.76	62.5	50.02
6	LTH-436	60.7	49.1	3.90	100.4	49.97
7	LTH-447	50.8	41.5	3.86	59.9	49.77
8	LTH-449	45.9	41.8	3.94	57.2	48.94
9	T-1359 F₁ (Check)	51.3	42.2	3.84	62.5	48.18
10	LTH-431	41.0	43.2	3.68	54.9	48.05
11	LTH-441	52.1	43.2	3.68	72.8	47.79
12	LTH-438	58.3	46.6	3.64	79.7	47.77
13	LTH-434	44.1	45.4	3.72	60.6	47.64
14	LTH-437	55.2	45.0	3.62	77.0	44.52
15	Nadir (Check)	58.7	48.3	4.04	81.9	44.34
16	LTH-442	51.1	42.3	3.58	63.0	42.77
17	LTH-439	51.6	43.1	3.80	62.3	42.42
18	LTH-446	47.2	41.3	3.70	70.2	41.21
19	LTH-448	46.9	45.2	3.72	65.8	41.19
20	LTH-443	48.2	41.1	3.60	58.1	34.73
21	LTH-450	55.4	41.4	3.46	103.4	32.93
22	LTH-435	54.5	44.7	3.68	68.1	32.81
LSD (0.05)						3.83

The above table reveals that differences among means for fruit yield due to genotypes were significant. The entries ranked from No. 1 – 3 showed statistically significant performance in terms of fruit yields as compared with the higher check T-1359 F₁ (48.18 t/ha). However, the entries ranked from No. 4 – 8 and 10 – 14 showed statistically at par fruit yields as compared with the higher check T-1359 F₁. The highest and lowest fruit yields were depicted by the entries LTH-440 (55.09 t/ha) and LTH-435 (32.81 t/ha) respectively.

1.12 SECONDARY/ STATION YIELD EVALUATION OF LOCALLY DEVELOPED DETERMINATE TOMATO HYBRIDS

An experiment comprising of seven (7) determinate tomato hybrids and one (1) OPV along with three checks namely T-1359 F₁, Nadir and Naqeeb was conducted at VRI, Faisalabad to evaluate the yield potential and other valuable characteristics. The nursery was sown on 19.10.2016 and transplanted on 30.11.2016 in RCBD with three replications. Plot size was kept as 7.0 × 1.25 m and plant to plant distance was maintained at 50 cm. Data recorded for fruit length, fruit width, fruit firmness, fruit weight and fruit yield are presented in table below.

Table-18 Performance of Locally Developed Determinate Tomato Hybrids in

Secondary/ Station Yield Trial at VRI, Faisalabad during 2016-17

Rank	Entry	Fruit length (mm)	Fruit width (mm)	Fruit firmness (kg/cm²)	Fruit weight (g)	Fruit yield (t/ha)
1	LTH-405	54.2	45.6	3.40	72.4	49.07
2	T-1359 F₁ (Check)	48.2	38.8	3.80	61.2	47.66
3	LTH-379	48.0	44.4	3.68	67.9	47.08
4	LTH-371	55.6	46.0	3.86	78.6	44.49
5	LTH-365	44.4	47.1	3.56	63.5	42.27
6	Nadir (Check)	56.5	47.3	3.90	78.4	42.22
7	Naqeeb (Check)	58.4	49.7	3.74	85.3	42.01
8	10139	55.6	46.7	3.94	77.5	40.40
9	LTH-366	59.1	42.5	4.08	70.0	40.03
10	LTH-324	47.6	51.6	3.60	81.3	39.77
11	LTH-350	49.9	49.4	3.52	88.9	39.03
LSD (0.05)						3.56

The above table reveals that differences among means for fruit yield due to genotypes were significant. The hybrid entries ranked at No. 1, 3 & 4 produced statistically at par fruit yields against the higher check T-1359 F₁ (47.66 t/ha). The highest fruit yield was produced by the entry LTH-405 (49.07 t/ha) and lowest fruit yield was depicted by the entry LTH-350 (39.03 t/ha).

1.13 MULTI-LOCATIONAL / ZONAL TESTING OF LOCALLY DEVELOPED DETERMINATE TOMATO HYBRIDS

A trial comprising of eight (8) locally developed determinate tomato hybrids along with two checks i.e. T-1359 F₁ (exotic) & Ahmar F₁ (local) and two OPVs was planted to evaluate the performance at four different locations viz; VRI Faisalabad, VRSS Sheikhpura, VRSS Multan and VRSS Bahawalpur. The nursery of these hybrids was sown on 19.10.2016 and transplanting was done according to RCBD in 3 replications. The plant to plant distance was kept as 50 cm. The fruit yield data recorded at different locations is given below in table.

Location	Transplantation Date	Plot Size
VRI, Faisalabad	30.11.2016	7.0 × 1.25 m
VRSS, Sheikhpura	15.12.2016	7.0 × 1.25 m
VRSS, Multan	20.12.2016	7.0 × 1.25 m
VRSS, Bahawalpur	21.12.2016	7.0 × 1.25 m

Table-19 Performance of Determinate Tomato Hybrids in Multi-locational / Zonal Trial at VRI, Faisalabad during 2016-17

Rank	Entry	Fruit length (mm)	Fruit width (mm)	Fruit firmness (kg/cm ²)	Fruit weight (g)	Fruit yield (T/ha)
1	NBH-149	57.4	50.7	3.64	81.8	58.24
2	NBH-5	59.0	42.6	3.56	64.6	54.54
3	LTH-297	43.3	40.2	3.70	60.3	52.89
4	NBH-1	60.5	45.5	3.40	75.3	49.11
5	T-1359 F₁ (Check)	48.2	42.0	3.52	62.9	48.41
6	LTH-324	45.7	47.5	3.58	74.7	47.52
7	LTH-291	49.6	51.8	3.72	76.3	47.32
8	LTH-287	47.7	45.7	3.42	69.4	46.89
9	LTH-350	52.9	49.8	3.54	77.0	46.07
10	Ahmar F₁ (Check)	56.1	49.0	3.74	78.4	45.03
11	Nadir	57.8	49.1	3.84	80.1	42.18
12	10139	55.2	46.8	3.68	78.5	40.45
LSD (0.05)						4.64

The above table reveals that differences among means for fruit yield due to genotypes were significant. The hybrid entries ranked from 1 – 2 produced significantly higher fruit yields as compared with the highest yielding check T-1359 F₁ (48.41 t/ha). However, entries ranked at No. 3 – 4 & 6 – 9 performed statistically at par in terms of fruit yields against the highest yielding check T-1359 F₁. The highest fruit yield of 58.24 t/ha was depicted by the entry NBH-149 whereas; the lowest fruit yield of 40.45 t/ha was given by the entry 10139.

Table-20 Performance of Determinate Tomato Hybrids in Multi-locational / Zonal Trials at Different Locations during 2016-17

Rank	Entry	Fruit yield (T/ha)				
		FSD	S. Pura	Multan	B. Pur	Average
1	NBH-149	58.24	53.90	50.44	32.30	48.72
2	NBH-5	54.54	52.93	47.60	34.42	47.37
3	LTH-297	52.89	48.57	45.52	29.47	44.11
4	NBH-1	49.11	46.82	44.21	29.62	42.44
5	T-1359 F₁ (Check)	48.41	46.55	42.59	31.58	42.28
6	LTH-291	47.32	43.77	41.14	27.03	39.82
7	10139	40.45	39.79	41.05	31.03	38.08
8	Ahmar F₁ (Check)	45.03	40.04	38.36	28.08	37.88
9	LTH-287	46.89	40.74	37.71	25.24	37.65
10	Nadir	42.18	38.91	37.47	29.01	36.89
11	LTH-350	46.07	41.90	35.64	23.24	36.71

12	LTH-324	47.52	40.88	33.87	22.17	36.11
LSD (0.05)		4.64	2.57	3.07	2.29	-

It is evident from the above table that differences amongst means for fruit yield due to varieties were significant at all locations. On average basis, entries ranked from No. 1 – 4 produced higher fruit yields than the highest yielding check T-1359 F₁ which gave average fruit yield of 42.28 t/ha. The highest average fruit yield was depicted by the hybrid namely NBH-149 (48.72 t/ha) whereas; the lowest average fruit yield of 36.11 t/ha was recorded in entry LTH-324.

1.14 PRELIMINARY EVALUATION OF LOCALLY DEVELOPED INDETERMINATE TOMATO HYBRIDS

A varietal trial comprising of 42 hybrids along with one exotic check i.e. Sahel F₁ was planted in three sets (14 hybrids and one exotic check in each set) to evaluate the performance of locally developed indeterminate tomato hybrids. Nursery was sown on 17.10.2016 and transplanted on 10.12.2016 in Randomized Complete Block Design with two replications under high tunnel. The plot size was kept as 4.0 × 0.75 m while, plant to plant spacing was maintained at 40 cm. Fruit picking was started on 03.03.2017 and continued till 19.06.2017 with total number of fifteen pickings. The data recorded for fruit length, fruit width, fruit firmness, fruit weight and fruit yield is presented in table below.

Table-22 Performance of Locally Developed Indeterminate Tomato Hybrids under High Tunnel in Preliminary Yield Trial at VRI, Faisalabad during 2016-17 (Set-1)

Rank	Entry	Fruit length (mm)	Fruit width (mm)	Fruit firmness (kg/cm ²)	Fruit weight (g)	Fruit yield (t/ha)
1	LITTH-834	48.6	49.6	3.58	78.3	137.94
2	Sahel F₁ (Check)	63.2	53.9	3.94	119.7	135.49
3	LITTH-835	59.0	52.2	3.52	92.5	133.47
4	LITTH-841	52.2	45.6	3.66	71.9	130.47
5	LITTH-842	67.7	46.9	3.52	96.8	128.25
6	LITTH-832	57.9	46.5	4.12	79.6	126.00
7	LITTH-833	68.5	47.7	3.82	88.9	125.85
8	LITTH-843	62.6	47.5	3.40	87.2	125.80
9	LITTH-837	72.2	47.8	3.40	94.5	123.39
10	LITTH-838	59.7	49.4	4.02	86.7	121.33
11	LITTH-839	60.7	50.3	3.50	97.3	119.58
12	LITTH-840	59.4	50.1	3.64	91.1	116.37

13	LITTH-836	67.8	48.2	3.44	93.0	115.03
14	LITTH-830	45.9	51.8	3.90	77.1	83.56
15	LITTH-831	56.0	44.7	3.64	68.8	82.37
LSD (0.05)						7.03

The perusal of the table indicates that differences among means for fruit yield due to genotypes were significant. The hybrid entries ranked at No. 1, 3 & 4 produced statistically at par fruit yields as compared with the exotic check Sahel F₁ (135.49 t/ha). The hybrid entry LITTH-834 (137.94 t/ha) produced highest fruit yield whereas the lowest fruit yield was depicted by the entry LITTH-831 (82.37 t/ha).

Table-23 Performance of Locally Developed Indeterminate Tomato Hybrids under High Tunnel in Preliminary Yield Trial at VRI, Faisalabad during 2016-17 (Set-2)

Rank	Entry	Fruit length (mm)	Fruit width (mm)	Fruit firmness (kg/cm ²)	Fruit weight (g)	Fruit yield (t/ha)
1	LITTH-857	56.3	59.4	3.52	123.1	145.20
2	LITTH-849	47.2	56.3	3.66	93.0	144.35
3	LITTH-854	45.6	44.5	3.76	66.8	140.20
4	Sahel F₁ (Check)	65.3	54.6	3.78	122.6	137.75
5	LITTH-844	62.6	50.3	3.30	100.3	136.87
6	LITTH-845	53.2	48.0	3.62	78.6	131.48
7	LITTH-856	54.3	57.8	3.84	110.5	131.05
8	LITTH-852	52.8	46.8	3.80	74.1	130.36
9	LITTH-853	46.9	49.0	3.68	70.2	124.59
10	LITTH-855	52.4	43.8	3.42	69.6	123.62
11	LITTH-851	54.4	44.6	3.60	72.5	122.24
12	LITTH-850	51.6	43.1	3.46	75.4	116.28
13	LITTH-846	60.1	52.1	3.88	98.4	103.19
14	LITTH-847	64.5	49.3	3.46	94.7	101.96
15	LITTH-848	49.0	50.7	3.26	80.4	90.81
LSD (0.05)						5.44

The perusal of table indicates that differences among means for fruit yield due to genotypes were significant. Two top ranked entries produced statistically significant fruit yields against the exotic check Sahel F₁ (137.75 t/ha). The entries ranked at No. 3 & 5 performed statistically at par in terms of fruit yields in comparison with the highest yielding check Sahel F₁. The highest and lowest fruit yields were recorded in hybrid entries LITTH-857 (145.20 t/ha) and LITTH-848 (90.81 t/ha).

Table-24 Performance of Locally Developed Indeterminate Tomato Hybrids under High Tunnel in Preliminary Yield Trial at VRI, Faisalabad during 2016-17 (Set-3)

Rank	Entry	Fruit length (mm)	Fruit width (mm)	Fruit firmness (kg/cm ²)	Fruit weight (g)	Fruit yield (t/ha)
1	LITTH-865	45.7	57.4	3.60	100.6	159.57
2	LITTH-862	44.5	57.7	3.72	96.9	154.82
3	LITTH-861	63.2	51.1	3.86	105.2	147.30
4	LITTH-859	54.4	54.0	3.68	99.7	145.47
5	Sahel F₁ (Check)	62.3	53.8	3.94	118.1	143.97
6	LITTH-869	57.3	51.5	3.82	98.5	143.86
7	LITTH-868	50.3	50.0	4.02	80.4	143.23
8	LITTH-863	58.9	56.6	3.90	131.5	141.17
9	LITTH-860	59.4	55.8	3.78	126.1	136.65
10	LITTH-871	59.7	53.5	3.66	110.3	128.58
11	LITTH-867	64.2	53.1	3.44	120.8	128.49
12	LITTH-870	67.3	51.0	3.70	113.6	123.78
13	LITTH-866	58.9	57.5	3.48	127.0	123.52
14	LITTH-864	65.5	49.5	3.74	101.1	111.37
15	LITTH-858	49.5	48.5	3.56	81.4	90.13
LSD (0.05)						4.89

The perusal of table indicates that differences among means for fruit yield due to genotypes were significant. Two top ranked entries produced statistically significant fruit yields against the exotic check Sahel F₁ (143.97 t/ha). The entries ranked at No. 3 – 4 and 6 – 8 performed statistically at par in terms of fruit yields in comparison with the highest yielding check Sahel F₁. The highest fruit yield of 159.57 t/ha was produced by the hybrid entry LITTH-865 whereas; the lowest fruit yield of 90.13 t/ha was depicted by the hybrid entry LITTH-858 (90.13 t/ha).

1.15 SECONDARY / STATION YIELD EVALUATION OF LOCALLY DEVELOPED INDETERMINATE TOMATO HYBRIDS

To evaluate the performance of promising locally developed indeterminate F₁ tomato hybrids, a trial comprising of seven (7) locally developed hybrids along with two checks (1 exotic & 1 local) was planted at VRI, Faisalabad under high tunnel. The nursery was sown on 17.10.2016 and transplanted on 10.12.2016 in Randomized Complete Block Design with three replications under high tunnel. The plot size was kept as 4.0 × 1.50 m while, plant to plant spacing was maintained as 40 cm. Fruit picking was started on 03.03.2017 and continued till 19.06.2017 with total number of fifteen pickings.

The data recorded for fruit length, fruit width, fruit firmness, fruit weight and fruit yield are presented in table below.

Table-25 Performance of Indeterminate Tomato Hybrids under High Tunnel in Secondary / Station Yield Trial at VRI, Faisalabad during 2016-17

Rank	Entry	Fruit length (mm)	Fruit width (mm)	Fruit firmness (kg/cm ²)	Fruit weight (g)	Fruit yield (t/ha)
1	LITTH-818	53.1	52.9	3.70	103.4	147.27
2	Saandal F₁ (Check)	62.8	57.1	3.92	126.8	146.59
3	Sahel F₁ (Check)	67.2	55.6	3.80	117.4	136.23
4	LITTH-779	53.1	52.3	3.72	96.1	129.54
5	LITTH-778	53.6	53.0	3.68	93.6	113.29
6	LITTH-799	63.3	50.0	3.88	91.3	110.11
7	LITTH-809	61.6	45.9	4.06	82.0	105.84
8	LITTH-796	65.5	51.4	3.54	109.9	101.29
9	LITTH-811	58.6	52.7	3.78	97.5	93.56
LSD (0.05)						4.84

The above table reveals that differences among means for fruit yield due to varieties were significant. The top ranked entry namely LITTH-818 (147.27 t/ha) produced statistically at par fruit yield against the high yielding check Saandal F₁ (146.59 t/ha). The lowest fruit yield of 93.56 t/ha was depicted by the hybrid entry LITTH-811.

1.16 MULTI-LOCATIONAL / ZONAL TESTING OF LOCALLY DEVELOPED INDETERMINATE TOMATO HYBRIDS

A trial comprising of seven (7) locally developed indeterminate F₁ tomato hybrids along with three checks namely Sahel F₁ (exotic), Saandal F₁ (local) and Salar F₁ (local) was planted to evaluate the performance at four different locations viz; VRI Faisalabad, VRSS Sheikhpura, VRSS Multan and NIAB Faisalabad. The nursery of these hybrids was sown on 17.10.2016. Transplanting of the nursery was done according to RCBD in 3 replications and plant to plant distance was kept as 40 cm. The data for fruit length, fruit width, fruit firmness, fruit weight and fruit yield was recorded at Faisalabad location while at the rest of locations only fruit yield data was recorded. The detail is presented below in tables.

Location	Transplantation Date	Plot Size
VRI, Faisalabad	10.12.2016	4.0 × 1.50 m
VRSS, Sheikhpura	15.12.2016	2.80 × 0.85 m
VRSS, Multan	20.12.2016	2.80 × 0.85 m

NIAB, Faisalabad	02.12.2016	3.60 × 0.75 m
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Table-26 Performance of Indeterminate Tomato Hybrids under High Tunnel in Multi-locational / Zonal Trial at VRI, Faisalabad during 2016-17

Rank	Entry	Fruit length (mm)	Fruit width (mm)	Fruit firmness (kg/cm ²)	Fruit weight (g)	Fruit yield (t/ha)
1	Salar F ₁ (Check)	62.0	51.2	4.08	91.4	156.35
2	Saandal F ₁ (Check)	62.2	57.3	4.20	121.1	149.73
3	LITTH-691	69.3	48.6	4.16	98.8	144.25
4	LITTH-765	65.3	56.6	4.10	112.2	142.54
5	Sahel F ₁ (Check)	64.0	54.8	4.12	124.7	142.38
6	LITTH-682	55.1	51.1	3.90	84.6	142.14
7	LITTH-710	56.7	52.3	4.00	87.5	141.49
8	LITTH-707	57.8	52.1	4.12	95.3	118.27
9	NBH-167	64.9	54.0	3.32	106.0	93.65
10	NBH-166	67.3	51.2	3.54	103.4	86.23
LSD (0.05)						4.85

The above table reveals that differences among means for fruit yield due to varieties were significant. None of the hybrid entry produced statistically significant or at par fruit yield in comparison with the high yielding check Salar F₁ (156.35 t/ha) which is also the No. 1 ranked entry. The lowest fruit yield of 86.23 t/ha was recorded in the hybrid entry NBH-166.

Table-27 Performance of Indeterminate Tomato Hybrids under Tunnels at Different Locations in Multi-locational / Zonal Trial during 2016-17

Rank	Entry	Fruit yield (T/ha)				
		FSD	S. Pura	Multan	NIAB, FSD	Average
1	Salar F ₁ (Check)	156.35	140.34	136.97	-	144.55
2	LITTH-691	144.25	137.39	134.59	127.83	136.02
3	Saandal F ₁ (Check)	149.73	137.75	133.33	122.50	135.83
4	LITTH-682	142.14	134.24	132.49	-	135.29
5	Sahel F ₁ (Check)	142.38	136.13	134.87	124.96	134.59
6	LITTH-765	142.54	126.47	117.44	-	128.82
7	LITTH-707	118.27	121.43	121.29	-	120.33
8	LITTH-710	141.49	133.61	133.05	67.09	118.81
9	NBH-167	93.65	-	-	-	93.65
10	NBH-166	86.23	-	-	-	86.23
LSD (0.05)		4.85	9.92	8.20	4.12	-

It is evident from the above table that differences among means for fruit yield due to varieties were significant at all locations. However on average basis, none of the

entries produced higher fruit yields than the high yielding check Salar F₁ (144.55 t/ha) which is also the top ranked entry. The lowest fruit yield of 86.23 t/ha was recorded in hybrid namely NBH-166.

2. PEAS (*Pisum sativum* L.)

2.1 COLLECTION, EVALUATION AND MAINTENANCE OF GERMPLASM

A total of seventy five varieties/lines comprising of local and exotic were sown on 22-11-16 in observational trial having a plot size of 4.0 × 1.25 m² for their maintenance. Range for different characters in available germplasm is presented in the Table.

Table-28 Range of Different Morphological Traits in Peas local/exotic lines planted at Vegetable Research Institute, Faisalabad.

S. No.	Traits	Minimum	Maximum
1.	Days to 50 % Flowering	29	86
2.	No. of Seeds/pod	5	8
3.	Pod Length (cm)	6	11
4.	Pod Width (cm)	1.4	2.0
5.	Plant Height (cm)	39	110
6.	Fresh 100 Seed Weight (g)	14	74

2.2 HYBRIDIZATION AND STUDY OF FILIAL GENERATIONS

2.2.1 Hybridization

To develop high yielding and early maturing varieties in peas, three cross combinations were made. The early maturing genotype i.e. 9374 were crossed with high yielding lines i.e. Safeer, 9200-1 and 9800-5. Hundred flowers of each genotype were emasculated and crossed with the pollen of desired parents. The seed of three cross combinations were harvested and threshed separately for further studies in F₁ generation. The success rate was about 45%.

2.2.2 Study of Filial Generations

Following filial generations were studied and high yielding, early bearing and disease tolerant/resistant plants were selected in different generations. The detail is given as below:

Table-29 Study/Selection of Progenies from Filial Generations (2016-17)

GENERATION	CROSS	# of crosses/progenies	
		STUDIED	SELECTED

F ₁	Meteor × 9374	3	Selected as bulk & selfed plants were rogued out
	Lina Pak × 9374		
	1300-8 × 9374		
F ₂	Meteor × 2001-40	200	33
F ₃	9800-10 × 2001-40	100	14
	2001-20 × 2001-40	175	26
	Lina pak × 2001-40	210	33
F ₄	9375 × 2001-40	145	9
	Pea-2009 × 2001-40	120	11
	9200-1 × 2001-40	75	6
	9375 × 9374	70	9
F ₅	9200-1 × 2001-60	85	10
F ₆	Pea-09 × 2001-60	200	22
	9800-10 × 2001-60	175	12
	Meteor Fsd × 2001-60	190	18
F ₇	a) 2001-20 × It-96	250	15
	b) 9200-1 × No. 267	300	25
	c) 2001-35 × No. 267	200	10
F ₈	a) GRW-45 × It-96	19	5
	b) 9800-5 × No. 267	14	3
	c) PF-400 × No. 267	5	2

2.2.2.1 F₁ generation

Three crosses i.e. Meteor × 9374, Lina Pak × 9374 and 1300-8 × 9374 were sown along with parents on both sides of one meter wide beds to raised F₁ generation. Selfed plants of crosses were rogued out at different plant growth stages. At maturity, ensured seed of cross combination was harvested in bulk separately.

2.2.2.2 F₂ generation

Two hundred seeds of Meteor × 2001-40 were sown on both sides of 6 meter long raised beds. Thirty three single plants were selected from cross and bulk on the basis of desirable traits like yield contributing traits (number of pods, pod bearing and pod size), disease resistance/tolerance and earliness for further studies in the subsequently F₃ generation. Seed of cross 9374 × 2001-40 was sown for generation advancement but germination of seed was observed very poor and no seed for further generation advancement was obtained.

2.2.2.3 F₃ generation

One hundred seeds of 9800-10 × 2001-40, One hundred and seventy five seeds of 2001-20 × 2001-40, Two hundred and ten seeds of Lina pak × 2001-40 were sown on both sides of 6 m long beds. Fourteen, twenty six and thirty three single plants were selected from each cross respectively and bulk separately on the basis of desirable traits like yield contributing traits (number of pods, pod bearing and pod size), disease resistance/tolerance and earliness for further studies in the subsequently F₄ generation.

2.2.2.4 F₄ generation

One hundred and forty five seeds of 9375 × 2001-40, one hundred and twenty seed of Pea-2009 × 2001-40, seventy five seeds of 9200-1 × 2001-40 and seventy seed of cross 9375 × 9374 were sown on both sides of 6 m long beds. Nine, eleven, six and nine single plants were selected from respective crosses and bulk separately on the basis of desirable traits like yield contributing traits (number of pods, pod bearing and pod size), disease resistance/tolerance and earliness for further studies in the subsequently F₅ generation.

2.2.2.5 F₅ generation

Eighty five seeds of 9200-1 × 2001-60 were sown on both sides of 6 m long beds. Ten single plants were selected and bulk the seed of selected plants on the basis of early/late maturity, yield contributing traits (number of pods, pod size and good pod bearing), earliness and disease resistance/tolerance for further studies in F₆ generation.

2.2.2.6 F₆ generation

Two hundred seeds of Pea-09 × 2001-60, One hundred and seventy five seeds of 9800-10 × 2001-60 and one ninty seeds of Meteor Fsd. × 2001-60 were planted and twenty two, twelve and eighteen single plants were selected respectively on the basis of good bearing and disease tolerance and earliness for growing plant to row progenies in next generation.

2.2.2.7 F₇ generation

Two hundred and fifty seeds of 2001-20 × It-96, Three hundred seeds of 9200-1 × No. 267 and two hundred seeds of 2001-35 × No. 267 were planted and fifteen, twenty five

and ten single plants were selected respectively on the basis of good bearing and disease tolerance and earliness for growing plant to row progenies in next generation.

2.2.2.8 F₈ generation

Nineteen plant to row progenies of cross GRW-45 × It-96, fourteen of 9800-5 × No. 267, five plant to row progenies of cross PF-400 × No. 267 were planted and five, three and two progenies of three crosses were selected respectively on the basis of good bearing and disease tolerance and earliness for checking their potential in preliminary yield trail.

2.3 EVALUATION OF PEA VARIETIES/ADVANCE LINES FOR EARLY PLANTING

Ten varieties/lines of peas were planted on 25-10-16 at Faisalabad to study the performance of early pea varieties/advance lines. The layout was conducted according to Randomized Complete Block Design with three replications in a plot size of 4.0 × 1.5 m. Plant to plant and row to row distances were kept as 5 cm and 75cm, respectively. The data on different traits were recorded and is presented in the Table.

Table-30 Performance of Pea Strains/Varieties in Early Peas Varietal Trial at Vegetable Research Institute, Faisalabad during 2016-17

S. No.	Variety/ Line	Days to 50 % flower	Plant Height (cm)	No. of pods/ plant	Seeds/ pod	100-Seed Weight (g) Fresh	Green Pod Yield (T/ha)
1	1300-8	44.00	52.0	5.7	7.4	49.00	6.98
2	Sarsabz (C)	44.00	61.1	8.8	7.0	70.13	6.29
3	Pea-2009 (C)	44.33	54.0	4.6	8.0	66.73	5.97
4	Meteor	41.00	41.3	4.1	5.5	41.05	5.31
5	Lina pak	42.00	30.3	3	6.7	39.47	4.87
6	2001-40	44.67	59.4	5.6	6.0	48.47	4.71
7	2001-20	38.00	35.6	3.1	5.7	38.33	4.57
8	9200-1	42.00	41.6	3	6.0	37.89	4.28
9	9800-5	42.33	43.6	4.0	6.3	48.20	4.09
10	Strike	37.00	37.5	2.9	5.6	41.13	4.08
LSD (0.05)		0.76	5.67	1.08	1.06	4.68	1.40

Differences of means due to genotypes were significant for all studied traits. Maximum green pod yield of (6.98T/ha) was recorded for the advance line 1300-8 which

is statistically significant with the check varieties Sarsabz and Pea 2009. The strain Strike took minimum days to 50% flower (37.00days) which is statistically significant with all other lines. Highest fresh 100-seed weight of 70.13g was recorded for check variety Sarsabz followed by approved variety Pea-2009 with fresh 100-seed weight 66.73g which are statistically at par with each other and statistically significant with all other high yielding lines. Maximum plant height was observed for variety Sarsabz (61.1 cm) followed by 59.4 recorded in line 2001-40. Maximum number of pods per plant was recorded in variety Sarsabz (8.8 pods/plant) as compared with all other lines.

2.4 EVALUATION OF PEA VARIETIES/LINES FOR NORMAL PLANTING

Twelve varieties/lines including two checks were sown on 22-11-2016 to test their performance in normal planting time for green pod yield. The experiment was designed according to Randomized Complete Block Design with three replications. The plot size of the experiment was kept $6.0 \times 1.0 \text{ m}^2$. Plant to plant and row to row distances were kept as 10 cm and 100cm, respectively. The data on different traits were recorded and are presented in Table.

Table-31 Performance of Pea Strains/Varieties in normal planting at Vegetable Research Institute, Faisalabad during 2016-17

S. No.	Variety	Days to 50 % flower	No. of pods/plant	Seeds/pod	100-Seed Weight (g) Fresh	Green Pod Yield (T/ha)
1	1300-8	50.0	12.0	7.5	45.93	10.88
2	Pea-2009	54.0	11.8	7.4	60.20	10.67
3	Lina pak	43.0	10.7	7.4	44.67	10.64
4	Super lina	43.0	6.8	6.4	48.53	9.13
5	2001-40	55.3	15.0	6.4	48.33	9.04
6	9375	68.0	11.6	7.0	45.07	7.58
7	Climax	57.3	11.8	6.4	47.13	6.46
8	1500-8	71.0	15.8	7.0	36.27	6.44
9	PTL-1	61.0	14.8	7.7	45.67	6.31
10	PTL-6	87.6	15.2	7.6	37.40	5.58
11	PTL-3	87.0	14.2	7.9	40.63	4.96
12	PTL-7	59.0	13.8	7.8	39.67	4.27
LSD (0.05)		0.68	5.08	0.82	5.3	1.37

Differences of means due to genotypes were significant for all traits. Maximum green pod yield (10.88 T/ha) was produced by the advance line 1300-8 followed by

approved variety Pea-2009 (10.67 T/ha) and line Lina Pak (10.64 T/ha) which are statistically at par with each other. Maximum 100 seed weight of (60.20 g) was recorded for the check variety Pea-2009 which are significantly higher from all other genotypes. The line Lina pak and super lina were earliest in producing 50% flowering in (43.00 days) while maximum days to 50% flowering was taken by PTL-6 (87.6 days).

2.5 ADAPTABILITY TRIAL OF EXOTIC PEA VARIETIES CONDUCTED AT VEGETABLE RESEARCH INSTITUTE, FAISALABAD DURING RABI 2016-17 (Set-1)

Seven pea varieties received from different seed companies were tested along with two locally cultivated check varieties at Vegetable Research Institute, Faisalabad. The trial was laid out according to RCB design with three replications on 25-10-2016. The planting geometry of the trial is as under:

Method of Sowing	Dibble sowing on both sides of the beds
Plot Size	4 × 1.5 m
Plant to plant spacing	5 cm
Bed width	75 cm

Standard cultural practices and plant protection measures were adopted. Data regarding days to 50% flowering, 100 seed weight (Fresh) and green pod yield were recorded and results are presented in the following table.

Table-32 Performance of exotic pea at Vegetable Research Institute, Faisalabad during 2016-17

Rank	Varieties / Line	Days to 50% flowering	100 seed weight Fresh (g)	green pod yield (T/ha)
1	Anmol	60.00	37.00	7.63
2	Pea-2009 (C)	46.00	69.37	7.04
3	Meteor (C)	44.00	38.33	6.94
4	Champion	45.33	53.57	6.61
5	Orion	45.67	56.05	6.06
6	Super polo	39.00	45.73	5.3
7	Mission	44.00	47.27	5.17

8	Polo pak	45.00	49.43	5.05
9	Summer Plus	60.00	36.60	4.36
LSD (0.05)		0.45	4.84	1.20

The data presented in the above table reveals that exotic variety Anmol Showed yield (7.63 T/ha) which is statistically at par with the check varieties. The exotic varieties Champion (6.61 T/ha) and Orion (6.06 T/ha) also showed non significant yields with the check varieties Pea-2009 and Meteor. Hence none of exotic variety / line surpassed the check variety Pea-2009 (7.04 t/ha) statistically. Variety Summer plus produced the lowest yield (4.36 t/ha). Data depicted that variety Anmol was found comparatively late as compared to check varieties.

Set-2

Two pea varieties received from a seed company were tested along with locally cultivated check varieties at Vegetable Research Institute, Faisalabad. The trial was laid out according to RCB design with three replications on 26-12-2016. The planting geometry of the trial is as under:

Method of Sowing	Dibble sowing on both sides of the beds
Plot Size	4 × 1.50 m
Plant to plant spacing	5 cm
Bed width	75 cm

Standard cultural practices and plant protection measures were adopted. Data regarding pods/plant, 100 seed weight (Fresh) and green pod yield were recorded and results are presented in the following table.

Table-33 Performance of exotic pea at Vegetable Research Institute, Faisalabad during 2016-17

Rank	Varieties/ Line	Days to 50% flowering	100 seed weight Fresh (g)	Green pod yield (T/ha)
1	1300-8	49.3	33.0	6.10
2	Sarsabz (Check)	51.0	59.6	5.58
3	Lina Pak	50.6	36.0	5.42
4	CKD-Tiger	62.0	38.0	4.58

0	Shine	51.0	42.6	3.82
6	Climax	65.0	26.6	3.75
LSD (0.05)		0.87	1.02	1.02

The data presented in the above table reveals that none of the exotic variety / line surpassed the check variety Sarsabz (5.58 t/ha). Imported variety CKD Tiger produces yield (4.58 t/ha) which is at par with the check variety Sarsabz. Variety Climax produced the lowest yield (1.02 t/ha). The data depicted that the exotic variety CKD-Tiger and local variety Climax are late varieties and got maximum days (62 days) and (65 days) respectively to 50% flowering as compared with all other varieties. The samples of exotic varieties received very late for adaptability trial hence these lines could be tested in next year to confirm their potentials.

3. BITTER GOURD (*Momordica charantia*)

3.1 GERmplasm COLLECTION AND MAINTENANCE

To maintain the germplasm a total of thirteen varieties/collections were sown on 11-03-17 in the observational plots with plot size measuring 4.0 × 2.5 m by keeping the plant to plant distance of 45 cm. All standard agronomic practices were adapted. The germplasm was maintained through sib-mating.

3.2 DEVELOPMENT OF INBRED LINES

The breeding material comprising of two S₀, three S₁, three S₂, seven in S₄, five in S₆, twenty five in S₇ and eleven in S₈ progenies were planted in varying plot sizes on 11-03-17 according to the availability of seeds for inbred line development programme. At flowering, germinated progenies were advanced through selfing. The detail of the successful selfed fruits obtained from the germinated lines is given in the table below.

Table-34 Number of Successful Selfed Fruits Obtained from Different Inbred lines

Generations	No. of Fruits
S₀	
Panther	2
S₁	
Black king × 888	5
HBG-37	4
S₂	
888 × Black king	3
1324 × Black king	4

S₃	
No.786	4
S₄	
HBG-34	3
S₅	
Raja	3
KHBG-37	4
S₇	
Fsd long	4
S₈	
Chaman	8
Collection-III	3
Collection-I	3
S₉	
Janpuri	7
Collection-II	3

3.3 DEVELOPMENT OF SYNTHETIC VARIETIES IN BITTER GOURD

Ten inbred lines received from S₉ generation of inbred lines development programme were sown on 11-03-2017 along with common tester variety Black king. The inbred lines were crossed with common tester to get the F₁ seed of each cross and harvested and bulked the matured seed of each cross separately. Furthermore these lines were also maintained by sib mating.

3.4 DEVELOPMENT OF BITTER GOURD (MEDIUM SIZED) OFF-SEASON CULTIVAR

Sowing of trail was accomplished on 04-08-2017. The data recording and cross combinations are under process.

3.5 EVALUTION OF BITTERGOURD VARIETIES/HYBRIDS IN ADAPTABILITY TRIAL FOR FEB-MARCH SOWING SEASON (Set-1)

An adaptability trial comprising of fourteen genotypes, thirteen received from different seed companies and one local check (Black King) was conducted on 10-03-2017 in three replications at the experimental area of Vegetable Research Institute, Faisalabad in Randomized Complete Block Design. The plot size of the trial was kept as 4.0 × 2.5 m and plant to plant distance was maintained at 45 cm. The data recorded for fruit yield (T/ha) is presented in the table below.

Table-35 Performance of different Bitter Gourd Varieties/Hybrids in Adaptability Trial at Vegetable Research Institute, Faisalabad during Kharif, 2017

Rank	Variety/Hybrid	Fruit Yield (T/ha)
1	Kashan	20.43
2	Carlos	17.63
3	Bg-4719	17.02
4	Black King (Check)	16.43
5	BGLP-255	13.49
6	Safa	13.43
7	Victory	12.66
8	7894	12.02
9	BG-402	11.30
10	BG-4722	10.23
11	BGP-234	10.15
12	Klash	9.82
13	MKS-545	7.00
14	Crescent	4.43
	LSD(0.05)	3.42

The data depicted that exotic variety Kashan (20.43 T/ha) performed better among all varieties and found statistically at par with variety Carlos (17.63 T/ha) while this line is found statistically significant with all other lines. However the exotic lines Bg-4719 (17.02 T/ha), BGLP-255 (13.49T/ha) and Safa (13.43 T/ha) produced yields at par with the check variety (Black king). So these lines could be tested for next year to confirm their adaptability.

Set-2

An adaptability trial comprising of thirteen genotypes, twelve exotic received from different seed companies and one local check (Black King) was conducted on 10-03-2017 in three replications at the experimental area of Vegetable Research Institute, Faisalabad in Randomized Complete Block Design. The plot size of the trial was kept as 4.0 × 2.5 m and plant to plant distance was maintained at 45 cm. The data recorded for fruit yield (T/ha) is presented in the table below.

Table-36 Performance of different Bitter Gourd Varieties/Hybrids in Adaptability Trial at Vegetable Research Institute, Faisalabad during Kharif, 2017

Rank	Variety/Hybrid	Fruit Yield (T/ha)
1	Kohsar	24.32
2	Panther	21.92
3	Tarzan	21.31
4	Black king (Check)	20.43
5	SHBG-48	18.69
6	HBG-882 a	18.64
7	HBG-892a	18.10
8	HBG-153b	17.92
9	No-94	17.80
10	Na-241	16.37
11	BGLP-265	16.16
12	Baby	14.47
13	BGP-244	12.07
14	Sigma-749	10.53
LSD(0.05)		3.16

The data depicted that exotic variety Kohsar (24.32 T/ha) performed better and statistically significant among all varieties. However the exotic lines Panther (21.92 T/ha) and Tarzan (21.31T/ha), SHBG-48 (18.69 T/ha), HBG-882a (18.64 T/ha), HBG-892a (18.10 T/ha), HBG-153b (17.92T/ha) and No-94 (17.80 T/ha) produced yields at par with the check variety. So these lines could be tested for next year to confirm their adaptability.

Set-3

An adaptability trial comprising of fourteen genotypes, twelve received from different seed companies and two local checks (Black King and FSD long) was conducted on 10-03-2017 in three replications at the experimental area of Vegetable Research Institute, Faisalabad in Randomized Complete Block Design. The plot size of

the trial was kept as 4.0 × 2.5 m and plant to plant distance was maintained at 45 cm. The data recorded for fruit yield (T/ha) is presented in the table below.

Table-37 Performance of different Bitter Gourd Varieties/Hybrids in Adaptability Trial at Vegetable Research Institute, Faisalabad during Kharif, 2017

Rank	Variety/Hybrid	Fruit Yield (T/ha)
1	PBA-01	19.05
2	Heera	18.83
3	BGH-743	18.47
4	Cross -888	17.93
5	Prime	16.90
6	Sultan	16.43
7	Black king (Check)	16.33
8	Bali	14.68
9	TBG-02	13.66
10	Riayan	13.42
11	Kundan	12.74
12	Rida	11.66
13	Sapna	11.34
14	FSD long (Check)	10.41
	LSD(0.05)	3.74

The data depicted that exotic variety PBA-01 (19.05 T/ha) performed better among all varieties. However the lines PBA-01 (19.05 T/ha), Heera (18.83 T/ha), BGH-743 (18.47 T/ha), Cross -888 (17.93 T/ha), Prime (16.90 T/ha), Sultan (16.43T/ha), Bali (14.68 T/ha) and TBG_02 (13.66T/ha), Riayan (13.42 T/ha) and Kundan (12.74 T/ha) produced yields at par with the better check variety (Black king). So these lines could be tested for next year to confirm their adaptability.

4. CHILIES (*Capsicum annuum* L.)

4.1 COLLECTION AND MAINTENANCE OF GERMPLASM

For the maintenance of germplasm, nursery of 120 genotypes was sown on 23.09.2016. Transplanting was carried out on 04.11.2016 under tunnel by keeping plant

to plant distance of 45 cm in observational rows of 3.0 m long. At onset of flowering, tunnels were covered with net cloth to prevent cross pollination through insects. One to three branches of true to type plants were selected and tagged. All the set fruit and open floral buds were removed from selected branches. Selfed fruits of tagged branches were harvested separately for further use in breeding program. Range of various traits in available germplasm is as under.

Table-38 Range of Chillies Germplasm

S. No.	Character	Range	
		Minimum	Maximum
1	Plant height (cm)	20	120
2	Fruit Length (cm)	2	15
3	Fruit diameter (cm)	0.5	3.0
4	Growth habit	Dwarf to tall	
5	Fruit position	Upward to downward	
6	Fruit color	Light green to dark purple	
7	Fruit bitterness	Less bitter to bitter	
8	Fruit behavior	Solitary to bunch	

4.2 FILIAL GENERATION STUDIES TO DEVELOP OPEN POLLINATED VARIETIES IN CHILIES

Objective of this trial is to evolve open pollinated varieties. Nursery of filial generations was sown on 18.11.2016 which includes 30 F₁ crosses, 25 F₂ populations, 16 F₃ populations, 18 F₄ populations, 13 F₅ populations and 7 F₆ populations. The transplanting was carried out on 21.02.2017 in open field. Single plant selections were made on the basis of plant structures, fruit shape, fruit size, earliness and disease incidence. All fruit and open floral buds were removed from selected plants. Then individual plants were covered with net cloth to ensure self-pollination. After fruit setting in net cloth, selfed fruit was harvested to advance the generations for further studies to develop open pollinated varieties.

4.3 NYUT TRIAL FOR HOT PEPPER

Ten varieties/ hybrids along with one standard received for NYUT from NARC were tested for their performance at Vegetable Research Institute, Faisalabad during

Kharif 2016-17. Trial was conducted in randomized complete block design with two replications in open field. Nursery was sown on 07.12.2016 and transplanted on 17.03.2017. Plot size was 4 × 0.75 m. The recommended agronomic and plant protection measures were adopted to maintain the crop. The data recorded for various traits and fresh green fruit yield is presented below.

Table-39 Mean Performance of varieties/Hybrids in NYUT trial on Chillies 2016-17

Rank	Genotype	Yield (T/ha)	Fruit Width (mm)	Fruit Length (cm)	Fruit Weight (g)	No. of Fruits / Plot	Fruit Color
1	CH 16001	7.32 ^{BCD}	11.1	11.2	5.3	558	Light green
2	CH 16007	5.25 ^{DE}	7.5	12.8	4.4	476	Light green
3	CH 16017	5.36 ^{DE}	13.3	8.9	5.9	361	Light green
4	CH 16019	8.11 ^{BC}	12.5	9.0	6.3	514	Yellowish green
5	CH 16023	10.66 ^A	13.1	9.9	4.6	924	Light green
6	CH 16027	9.26 ^{AB}	13.3	10.0	5.0	738	Light green
7	CH 16034	2.10 ^F	9.7	5.8	3.4	249	Light green
8	CH 16037	8.89 ^{ABC}	15.4	3.5	3.5	1019	Light green
9	CH 16041	4.40 ^{EF}	5.1	13.6	2.6	688	Green
10	CH 16047	6.79 ^{CDE}	5.1	10.9	2.4	1135	Green
11	P-6 (Standard)	6.85 ^{BCD}	9.6	5.0	3.1	896	Green
	LSD (0.05)	2.4					

4.4 ADAPTABILITY TRIAL FOR HOT PEPPER UNDER PLASTIC TUNNEL

Five varieties/hybrids received from different seed companies were tested for their performance in adaptability trial under tunnel at Vegetable Research Institute, Faisalabad during 2016-17. The trial was laid out in randomized complete block design with three replications. The recommended agronomic and plant protection measures were adopted to maintain the crop. The data recorded for fresh green fruit yield is presented below.

No. of varieties/Hybrids: 5 + 1 (Check)
 Date of nursery sowing: 27.10.2016
 Date of transplanting: 02.01.2017
 Plot size: 4 × 1.5 m
 Plant to plant distance: 0.45 cm

Table-40 Performance of Hot Pepper under Tunnel (Set-1)

Rank	Entry	Company	Yield (t/ha)	Fruit Length (cm)	Fruit Width (mm)
1	P-6	Standard	29.34	6.8	14.3
2	THP-033	Tara Crop Sciences (Pvt.) Ltd.	29.27	9.6	17.7
3	UTTAL	Monsanto Pakistan (Pvt.) Ltd.	27.01	10.7	15.7
4	THP-034	Tara Crop Sciences (Pvt.) Ltd.	23.35	10.2	18.9
5	Revival	Monsanto Pakistan (Pvt.) Ltd.	23.04	10.4	16.1
6	SV9736HM	Monsanto Pakistan (Pvt.) Ltd.	17.82	5.2	11.9
LSD (0.05)			2.42		

THP-033 and UTTAL performed statistically at par to check “P-6”. “THP-033” has downward fruiting habit with long, dark green, smooth fruit which turn dark bright red on maturity. It exhibited good and stable fruit setting during months of April to July. It also exhibited moderate tolerance against viruses. “UTTAL” bears long, smooth surface, green, downward fruit. It is early yielder as well as exhibit good fruiting at high temperature with moderate virus tolerance.

4.5 ADAPTABILITY TRIAL FOR HOT PEPPER IN OPEN FIELD

Forty One varieties/hybrids received from different seed companies were tested for their performance in adaptability trial in open field at Vegetable Research Institute, Faisalabad during 2016-17. The crop was sown in three sets depending upon the provision of seed samples by different seed companies and number of hybrids/varieties. The trials were laid out in randomized complete block design with three replications. The recommended agronomic and plant protection measures were adopted to maintain the crop. The data recorded for fresh green fruit yield is presented below.

Set-1

No. of varieties/hybrids: 17 + 1 (Check)
 Date of nursery sowing: 24.11.2016
 Date of transplanting: 22.02.2017
 Plot size: 5.5 × 0.75 m
 Plant to plant distance: 0.45 cm

Table-41 Performance of Hot Pepper in Open Field (Set-1)

Rank	Entry	Yield (t/ha)	Fruit Length (cm)	Fruit Width (mm)
1	Super Hot F ₁	19.34	8.8	14.30
2	GSL-119	18.58	8.2	16.76
3	PE 102 F ₁	18.40	10.2	15.16

4	Super King F ₁	18.21	8.9	11.39
5	HP 1130	16.95	8.5	10.95
6	Patyala F ₁	16.56	9.1	10.84
7	Green King F ₁	16.24	7.7	10.90
8	N-Xiangla-2	16.18	8.6	12.77
9	Simrun	15.65	10.5	14.13
10	Xiangla 712	14.98	8.1	10.37
11	Numex	14.85	7.2	9.17
12	Smarty	14.80	7.3	12.28
13	MDS-5748	14.64	8.6	11.15
14	P-6 (C)	14.61	7.3	12.32
15	Fire Volcano	14.54	8.3	6.98
16	CBS-214	14.46	10.1	17.19
17	Seirra	13.94	9.3	8.89
18	Fire Cracker	10.65	6.6	6.81
LSD (0.05)		2.17		

In Set-1, variety/hybrid “Super Hot” gave the highest fresh green fruit yield. It bears medium long, single downward fruit. Entries from rank # 1-5 gave statistically higher fresh green fruit yield than check “P-6”. Moreover, entries from rank # 6-17 performed statistically at par to check “P-6”.

Set-2

No. of varieties/Hybrids: 16 + 1 (Check)
Date of nursery sowing: 24.11.2016
Date of transplanting: 22.02.2017
Plot size: 5.5 × 0.75 m
Plant to plant distance: 0.45 cm

Table-42 Performance of Hot Pepper in Open Field (Set-2)

Rank	Entry	Yield (t/ha)	Fruit Length (cm)	Fruit Width (mm)
1	Sundari F ₁	17.793	8.3	8.13
2	007 F ₁	17.503	9.2	20.75
3	Sky Cross F ₁	17.190	6.9	9.19
4	Sky Way	16.653	8.1	9.48
5	Hot Pepper 01	16.637	6.9	8.78
6	Green Gold	16.253	7.2	8.78
7	P-6 (C)	15.173	7.5	12.74
8	Galaxy 2	15.067	9.5	10.79
9	Skyline 2	14.810	6.5	9.88
10	Sky Red	14.577	6.7	9.24
11	Indu F ₁	14.060	6.4	7.21

12	German	13.907	7.2	6.86
13	Rainbow	13.707	8.3	9.53
14	PE 101 F ₁	13.067	7.3	10.9
15	404 F ₁	13.057	9.2	15.63
16	Hot Pepper 02	12.953	6.9	13.31
17	Laser F ₁	12.893	7.5	6.22
	LSD (0.05)	1.75		

In Set-2, hybrid “Sundari F₁” gave the highest fresh green fruit yield. It bears medium long, single downward fruit. Entries 007 F₁ and Sky Cross F₁ also gave statistically higher fresh green fruit yield than check “P-6”. Moreover, entries from rank # 4-13 performed statistically at par to check “P-6”.

Set-3

No. of varieties/Hybrids: 8 + 1 (Check)
Date of nursery sowing: 07.12.2016
Date of transplanting: 17.03.2017
Plot size: 5.5 × 0.75 m
Plant to plant distance: 0.45 m

Table-43 Performance of Hot Pepper in Open Field (Set-3)

Rank	Entry	Company	Yield (t/ha)	Fruit Length (cm)	Fruit Width (mm)
1	HP 264 F ₁	Naveel Seed Corporation (Pvt.) Ltd. Gujranwala	11.37	12.38	14.41
2	High Sky F ₁	Sohni Dharti Seeds, Sahiwal	8.70	8.3	13.47
3	P-6	Check	6.35	6.44	11.14
4	No. 1031	Naveel Seed Corporation (Pvt.) Ltd. Gujranwala	4.43	6.6	12.04
5	HP 1449	Naveel Seed Corporation (Pvt.) Ltd. Gujranwala	4.12	12.59	7.2
6	Divya F ₁	NTL Seed Company, Gujranwala	2.87	5.2	21.16
7	Kent	NTL Seed Company, Gujranwala	1.77	6.5	6.19
8	SVHA 1182	Monsanto Pakistan (Pvt.) Ltd., Lahore	1.13	11.2	8.97
9	Disney	NTL Seed Company, Gujranwala	0.68	7.3	8.09
LSD (0.05)			1.21		

In Set-3, variety/hybrid “HP 264 F₁” and High Sky F₁ gave statistically higher fresh green fruit yield than check “P-6”.

Note: Varieties / Hybrids in Set III were received very late. Due to this reason, these varieties /hybrids gave very low yield as compared to earlier sets.

- Following Varieties / Hybrids did not germinate despite of two times sowing. So not included in results.
 - “1240 F₁” submitted by NTL Seed Company, Gujranwala
 - “Hot 409” submitted by Weal Ag Corporation, Lahore

5. SWEET PEPPER (*Capsicum annuum* L.)

5.1 ADAPTABILITY TRIAL ON SWEET PEPPER VARIETIES/ HYBRIDS

Six varieties/hybrids received from different seed companies were tested for their performance in adaptability trial in two sets, one under tunnel and one in open field at Vegetable Research Institute, Faisalabad during 2016-17. The trials were laid out in randomized complete block design. The recommended agronomic and plant protection measures were adopted to maintain the crop. The data recorded for fresh green fruit yield is presented below.

Adaptability trial under tunnel (Set-1)

No. of varieties/Hybrids: 1 + 1 (Check)
 Date of nursery sowing: 27.10.2016
 Date of transplanting: 02.01.2017
 Plot size: 7 × 1.5 m
 Plant to plant distance: 0.45 m

Table-44 Performance of Sweet Pepper in Open Field (Set-1)

Rank	Entry	Company	Yield (t/ha)
1	TSP-041	Tara Crop Sciences (Pvt.) Ltd.	26.57
2	Coral F ₁	Check	26.96

The above table shows that the variety/hybrid TSP-041 performed at par to standard Coral. TSP-041 is early fruiting with dark green fruit which turn yellow to orange on maturity.

Adaptability trial under in open field (Set-2)

No. of varieties/Hybrids: 5 + 1 (Check)
 Date of nursery sowing: 24.11.2016
 Date of transplanting: 22.02.2017
 Plot size: 6 × 0.75 m
 Plant to plant distance: 0.45 m

Table-45 Performance of Sweet Pepper in Open Field (Set-2)

Rank	Entry	Company	Yield (t/ha)
1	MDS-9026	Mehr Muhammad Din & Sons, Gujranwala	14.46

2	Freedom F ₁	NTL Seed Company, Gujranwala	10.22
3	Coral F ₁	Check	10.15
4	Savio F ₁	Ch. Ahmad Din & Sons, Gujranwala	9.54
5	Capisto F ₁	Rashid Seeds, Gujranwala	7.97
6	Orbit F ₁	Rashid Seeds, Gujranwala	7.77
LSD (= 5%)			2.90

The above table shows that the variety/hybrid “MDS-9026” exhibited the highest fresh green fruit yield (14.46 t/ha) followed by “Freedom F₁” with yield value of 10.22 t/ha. All other varieties / hybrids performed statistically at par to standard “Coral F₁”.

6. CARROT (*Daucus carota* L.)

6.1 MAINTENANCE OF GERMPLASM IN CARROT

8 genotypes viz; 5 Red Genotypes (DC-3, DC-4, DC-90, DC-W and T-29), Purple genotypes (DC-B), Yellow genotype (1), and Orange genotype (1) were sown on 26-10-2016 for their maintenance. All the recommended agronomic and plant protection measures were adapted. All the genotypes were selected and sibbed in isolation chamber. The genotype DC-4 was kept in field till the end of March to have frost tolerant non bolters genotype to meet market demand and acceptability for late season.

The “Black Carrot” (DC-B) was selected for purity and uniformity of purple pigments throughout xylem and phloem. Small quantity of seed of each genotype is available for future manipulation.

6.2 DEVELOPMENT OF CARROT VARIETIES FOR EARLY SOWING

Three Populations viz; DC-3, DC-90, and DC-W were sown on 26-10-2016. The sowing was done on both sides of 75 cm wide ridges. Selection was done on the basis of root color and marketable roots. The transplanting of selected roots was done after 90 days for DC-90 and more than 100 days after sowing date for the remaining genotypes, ie, DC-3 and DC-W to develop the lines for short and normal crop span of the crop. The line DC-90 is early bulking with variable root and core color. DC-3(red core) and DC-W (white core) are slightly early genotypes. All three lines have slightly light skin color compared to Indian lines in the market but tastier. To improve the populations for darker red outer skin color, the selected material of the lines was crossed with purple line to have three new populations viz., Pop-1-17, Pop-2-17 and Pop-3-17 for second cycle. These new populations along with parent populations will be compared, evaluated and advanced for further genetic improvement. To improve DC-B, black carrot for red core,

further two new population viz., pop-4 and pop-5 were also developed in isolations. Being highly crossed pollinated crop a variation in root color and foliage was observed in the previous material which will be further screened to develop acceptable uniformity with darker red skin color by open crossing and mass selection of the populations.

DC-W is a soft and white core line suitable for juice. Bolting behavior shows that variety can easily prone to low bolting and high marketability for longer period through vigorous marketable root selection. All lines are susceptible to frost resulting dull root color.

6.3 DEVELOPMENT OF CARROT VARIETY SUITABLE FOR LATE PLANTING

Two Populations viz; DC-4(Red) and DC-orange are being developed for late planting and late bolting. DC-4 is a red line for late bolting and late supply till March without quality deterioration. The DC-orange which was derived from non bolters exotic orange hybrid populations through chilling to induce flowering in Pakistan is highly variable and is being used to develop a three line breeding system necessary to develop hybrid production for both red and orange lines. The sowing of the material was done on both sides of 75 cm wide ridges on 26.10.2016. Plant to plant distance was kept as 3 cm by thinning after three weeks of germination. Selection was based on resistance to frost, marketable root and non-bolting behavior till the end of March. To develop a frost tolerant and late bolting variety for longer supply, sever selection against bolting and susceptibility to frost remained in progress till March. Moreover plants resistant to frost with marketable roots were harvested which produce small amount of seed for further use in future. DC-orange is the only single line having orange flesh, frost tolerance and late bolters under our environment. It is a very good source of variability and requires further population improvement.

6.4 DEVELOPMENT OF CMS LINES

Seventy seven entries of crosses between BC-3, F₄ and 9 restorers were sown on 05-09-2016 and transplanted under isolation cages on 9 and 15 December, 2016 to take BC-4 and F₅ generations. Moreover, 9 genotypes selected during previous year were crossed with females but only three crosses viz., No.46, No.73, No.87 and No.98 were successfully harvested for further evaluation of restorability fertility. All the material including back Crosses, F₄ generations and fertile male single plants will be used for

further back crossing and selfing to develop three line breeding systems for hybrid development.

6.5 ADAPTABILITY / VARIETAL TRIAL OF CARROT AT VEGETABLE RESEARCH INSTITUTE FAISALABAD

Nine carrot varieties/ hybrids received from different seed companies were tested for their performance at Vegetable Research Institute, Faisalabad during Rabi 2016-17. The trial was conducted in randomized complete block design in four replications under recommended production technology. The plot size was kept as 8.0 × 0.75 m. The data recorded for root yield is presented below.

Table-46 Performance of Carrot Varieties/Hybrids

Date of Sowing :26-10-2016		Date of harvesting:16 -01-2017
Rank	Variety / Hybrid	Yield (T/Ha)
1	AS725	58.7
2	Nanyab	56.8
3	Sweety F ₁	56.5
4	T-29 (check)	53.5
5	Pukhraj	47.3
6	Hermoso F ₁	46.7
7	Kirti Rose	46.0
8	Lakshmi F ₁	42.9
9	Red Pearl	38.1
10	Best Choice F ₁	12.7
LSD(0.05)		3.4

AS-725 exhibited significantly higher root yield (58.7 T/ha) than the standard T-29. Moreover Nayab and Sweety F₁ are also statistically at par to the standard variety T-29 with root yield of 56.8 T/ha and 56.5 T/ha respectively.

7. RADISH (*Raphanus sativus*)

7.1 ADAPTABILITY TRIAL OF EXOTIC RADISH VARIETY

Radish variety No.025, Red Prince received from Rashid Seeds, Jilani building, Sheikhpura more, Gujranwala were tested at Vegetable Research Institute, Faisalabad along with the check variety Mino Selection. The trial was sown on 20-10-016 in

triplicate RCB design keeping plot size of 8.0 × 0.75m. The sowing was done on both sides of ridges made 75 cm apart. The harvesting was done 09-01-2017. Yield data collected is given in table

Table-47 Performance of Late Radish Varieties in Adaptability Trial at VRI, Faisalabad 2016-17 (Set-1)

Rank	Variety	Root +Leave yield(T/ha)
1	Mino Early White Long	56.46 a
2	Desi White	45.71 ab
3	Mino Local	37.19 bc
4	Lal Pari	28.27 c
5	No.025	23.45 cd
6	Red Prince	14.99 d
LSD (0.05)		10.65

The table reveals that varieties were statically significant for yield. The maximum yield was given by Mino Early White Long (56.46T/ha) followed by Desi White (45.71).The imported variety Mino Early Long White gave statistically at par yield with variety Desi White (45.71 T/ha). However, variety Mino Early Long White gave higher yield than Mino Local (56.46 T/ha) and found low bolting. Whereas No.025 gave 23.45 T/ha and Red Prince (14.99T/ha)

Set-2

The trial consisting of seven varieties was planned to evaluate the radish varieties for yield and yield components. The trial was sown on 26-9-16 in triplicate RCB design keeping plot size of 8.0 m × 1.5m. The sowing was done on both sides of ridges made 75 cm apart. The harvesting was done 13-12-2016. Yield data collected is given in table

Table-48 Performance of Late Radish Varieties in Adaptability Trial at VRI, Faisalabad 2016-17

Rank	Variety	Root +Leave yield(T/ha)
1	Purple Neck	69.75
2	Mino Local	66.02
3	Green Neck	65.61
4	Desi White	65.41
5	Mino Selection	57.84
6	Gang Seong	57.03
7	Lal Pari	48.00
LSD (0.05)		5.25

The table reveals that varieties were statically significant for yield. The maximum yield was given by Purple Neck (69.75 T/ha) followed by Mino Local (66.02). The lowest yield was given by Lal Pari 48.00. This variety is for salad purposes.

7.2 PRE-BASIC SEED PRODUCTION IN RADISH

To maintain the purity, seed of six radish varieties viz., 40 Days, Desi White, Mino selection and Lal Pari was sown during the month of September, 2016. The off-type plants keeping in view the leave and root characteristics (shape and root colour) from different varieties were removed. The true to type roots of specific variety were selected at harvest. Steckling of selected root were made and planted during the month of December, 2016 for the production of pre-basic seed in isolation (1000m). Early bolters and late bolters were rouged out from the seed production plots to maintain the variety. Detail of the seed produced is given in table no.

Table-49 Pre-basic seed produced during 2016-17

Rank	Varieties	Quantity (g)
1	Mino Local	100
2	40 Days	4000
3	Desi White	150
4	Lal Pari	2000
5	Mino Selection	2000

8. TURNIP (*Brassica comprestis* var. *rapa*)

8.1 ADAPTABILITY OF TURNIP VARIETIES FOR YIELD

Turnip variety Stylo, Golden World F₁, Kansar received from Rashid Seeds, Jilani building, Sheikhpura more, Gujranwala was tested at Vegetable Research Institute, Faisalabad along with the check variety Purple Top. The sowing of these varieties was done on 20-10-16. The lay out was according to RCBD with three replications. The sowing was done on ridges made 75 cm apart in a plot size of 8 × 0.75m. All agronomic and plant protection measures were adopted to maintain the crop. The harvesting of the crop was done on 9-1-17. The data recorded for root and leave yield (Marketable) is presented in the table below.

Table-50 Performance of Turnip Variety in Adaptability Trial at VRI, Faisalabad 2016-17

Rank	Variety	Root +leave Yield (T/ha)
1	Desi Red	61.68a
2	Green Top	60.49a
3	Kansar	56.25ab
4	Purple Top	52.70ab
5	Golden	50.32b
6	Stylo	49.60b
7	Golden World F ₁	37.27c
LSD (0.05)		13.53

The maximum yield (61.68 T/ha) gave by variety Desi White followed by Green Top with yield of 60.49 t/ha. Data was found significant statistically. All pair wise comparison was used to compare the yield. The imported variety Kansar gave yield (56.25T/ha) with check variety Purple Top (52.70 T/ha). Other varieties Stylo (49.60T/ha) and Golden World F₁ showed spastically lower yield than purple Top and Golden.

8.2 EVALUATION OF TURNIP VARIETIES FOR YIELD

The trial was conducted to evaluate the performance of seven varieties *viz*; Green top, purple top, White, Purple Golden, Golden, Desi Red and Purple. The sowing of these varieties was done on 29-9-16. The lay out was according to RCBD with three replications. The sowing was done on ridges made 75 cm apart in a plot size of 8 × 1.5m. All agronomic and plant protection measures were adopted to maintain the crop .The harvesting of the crop was done on 8-12-16. The data recorded for root and leave yield is presented in the table below.

**Table-51 Performance of Turnip Variety in Adaptability Trial
at VRI, Faisalabad 2016-17**

Rank	Variety	Root +leave Yield (T /ha)
1	Green Top	54.02
2	Purple Top	50.74
3	White	49.92
4	Golden	48.27
5	Purple	47.96
6	Desi Red	40.82
7	Purple Golden	40.58
LSD (0.05)		9.39

The maximum yield (54.02 T/ha) gave by variety Green Top, followed by Purple Top with yield of 50.74T/ha. Data was found significant statistically. All pair wise comparison was used to compare the yield.

8.3 PRE-BASIC SEED PRODUCTION IN TURNIP VARIETIES

Single plant progenies of Purple Top Punjab and Golden varieties were sown on 19-9-2017 and 25-9-2017 on both sides of ridges made 75 cm apart. Thinning was done at early stage to get vigorous roots of good shape. All off type plants from both varieties were rouged out to maintain the purity of the varieties. The stecklings of desirable and true to type roots in the varieties of Purple Top and Golden were planted on 2.12.17 and 6-12-2017, respectively, in isolation. Early bolters, late bolters and diseased plants were rouged out from the plots of both varieties. At crop maturity 100 single plants of Purple Top and 51 single plants of Golden Ball Faisalabad were harvested and seed was collected for the production of next year pre-basic seed. Pre-basic seed of 350 g of variety Purple Top and 500 g seed of golden was produced.

8.4 DEVELOPMENT OF HEAT TOLERANT VARIETY

Random mated population (8rd selection cycle) was sown on 4-8-16 for selection of heat tolerance. Plants were selected on the basis of root shape and size. At maturity for marketable root, selected roots were planted on 1-11-16 for seed production under random mating for 9rd selection cycle. At maturity of seed crop 8 plants was collected on 2-4-17. It is now evaluated with other varieties.

9. MUSKMELON (*Cucumis melo* L.)

9.1 ADAPTABILITY TRAIL OF EXOTIC MUSKMELON VARIETY IN FIELD, 2017

Set-1

Muskmelon varieties; Badsha F₁, HSM-053b , MKS-661 F₁, AS-22 F₁, Zamra F₁, MDS-2223, MD-584, 1301 F₁, HSM-051a , Sweet Peridot , Venus F₁, HSM-062a , Honey-7 , Honey Plus and Ravi as check received from companies were tested at Vegetable Research Institute, Faisalabad along with Ravi . The sowing of these varieties was done on 22-2-2017 in open field. The lay out was according to RCBD with three replications. The sowing was done on bed made 300 cm apart with plot size 7 × 3m. All agronomic and plant protection measures were adopted to maintain the crop .The

harvesting of the fruit was done on 2-5-2017. The data recorded for fruit yield and TSS is presented in the table below.

Table-52 Performance of Muskmelon Varieties in Field at VRI, Faisalabad 2017

Rank	Variety/Hybrid	Yield (T/ha)	TSS (%)
1	Ravi	5.10	11
2	Badsha F ₁	4.05	10
3	HSM- 053B	3.44	9
4	MKS-661 F ₁	3.24	11
5	AS-22 F ₁	2.98	8
6	Zamra F ₁	2.51	10
7	MDS- 2023	2.46	9
8	MDS-584	2.38	10
9	1301 F ₁	2.37	9
10	HSM -051A	2.21	10
11	Sweat Peridot	2.03	11
12	Venus F ₁	1.94	10
13	HSM -062A	1.60	9
14	Honey-7 F ₁	1.41	11
15	Honey Plus F ₁	1.25	10
LSD (0.05)		1.37	

Overall yield of all varieties were observed due to high temperature. The maximum fruit yield (5.10 T/ha) with TSS value of 11 % gave by variety Ravi, followed by Badsha F₁ with fruit yield of 4.05 t/ha with TSS value of 10%. Varieties were found significant statistically. Due to heat current this year, over all yield potential of all varieties was low. However, the imported varieties suffered the most.

Set-2

Muskmelon varieties; Qaiser F₁, Mankara-212, NMMH-19 , Kesar , CADS-6812, NSC-6, Ravian, NSC-1, TSM-01, Rachna, Ajwa, G-HSM-1, Star-1, TSM02, NSC-2, Sweat-010 and T-96 as a check were tested at Vegetable Research Institute, Faisalabad along with T-96. The sowing of these varieties was done on 22-2-2017 in open field. The lay out was according to RCBD with three replications. The sowing was done on bed made 300 cm apart with plot size 7 × 3m. All agronomic and plant protection measures were adopted to maintain the crop .The harvesting of the fruit was done on 23-5-2017. The data recorded for fruit yield and TSS is presented in the table below.

Table-53 Performance of Muskmelon Varieties in field at VRI, Faisalabad 2017

Rank	Variety/Hybrid	Yield (T/ha)	TSS (%)
1	T-96	5.15	11
2	Qaiser F ₁	5.10	12
3	Mankara-212	4.11	10
4	NMMH- 19	4.10	11
5	Kesar	3.83	9
6	CADS-6812	3.57	10
7	NSC-6	3.08	11
8	Ravian	2.27	11
9	NSC-1	2.10	12
10	TSM-01	2.02	8
11	Rachna	2.02	11
12	Ajwa F ₁	1.63	8
13	G-HSM-1	1.98	11
14	Star-1	1.86	9
15	TSM-02	1.86	10
16	NSC-2	1.44	12
17	Sweat-010 F ₁	1.40	9
LSD (0.05)		1.22	

The maximum fruit yield (5.15 T/ha) with TSS value of 11 % gave by variety T-96, followed by Qaiser F₁ with fruit yield of 5.10 t/ha with TSS value of 12%. Varieties were found significant statistically. The imported varieties showed statistically significant results than check variety T-96.

Set-3

Muskmelon varieties/hybrids super one received from Abdul Waheed & Sons (Pvt.) .H/no. C.9,St. 1 Near New Hotel ,G.T. Road Peshawar and White Hero ACS Arisco crop Sciences Shop# 12 old Sabzi Mandi Jelous Bazar Larkana. were tested under low plastic tunnel at Vegetable Research Institute, Faisalabad along with T-96 as a check. The sowing of these varieties was done on 4-11-2016 under low plastic tunnel. The lay out was according to RCBD with three replications. The sowing was done on bed made 300 cm apart with plot size 3 × 6 m. All agronomic and plant protection measures were adopted to maintain the crop .The harvesting of the fruit was started on 28-4-2017. The data recorded for fruit yield and TSS is presented in the table below.

Table-54 Performance of muskmelon Varieties in Adaptability Trial at VRI, Faisalabad 2016

Rank	Variety/Hybrid	Yield (T/ha)	TSS (%)
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1	White Hero ACS	8.24a	10
2	T-96	7.52ab	12
3	VRIM9 × VRIM10	7.38ab	12
4	Super One	7.12b	13
5	VRIM10 × VRIM9	6.54b	14
LSD (0.05)		1.61	

The maximum fruit yield (8.24t/ha) with TSS value of 10 % gave by variety white Hero ACS followed by T-96, with fruit yield of 7.52 t/ha with TSS value of 12%. All varieties were found significant statistically. The imported varieties were found heat susceptible than check variety. However, all other varieties/ hybrids showed earliness in fruit bearing than the check variety.

9.2 DEVELOPMENT OF HYBRIDS/INBREAD IN MUSKMELON

Selected inbred lines (VRIM-9 × VRIM-10; VRIM-10 × VRIM-9) were sown during 2nd fortnight of 4.11. 2016, keeping plant to plant and row to row distance of 60 cm and 300 cm, respectively, under plastic tunnel to enhance temperature. During first week of March, 2017the tunnel was covered with nylon net to make isolation chamber to avoid pollinators. Female flowers were crossed with respective male parent manually. Furthermore all genotypes was selfed / sibbed to get at least one mature fruit in each genotype to maintain the inbreed lines.

10. WATERMELON (*Citrullus lanatus* L.)

10.1 EVALUATION OF EXOTIC WATERMELON VARIETIES /HYBRIDS IN ADAPTABILITY TRIAL UNDER LOW PLASTIC TUNNEL

Five hybrids/varieties along with check hybrids / varieties Sugar baby and Black beauty were sown on 11-12-2015 to check their adaptability under low plastic tunnel. Sowing was done 45-50 cm apart in hills, according to Randomized Complete Block Design with three replications keeping plot size of 7.0 × 3.0 m. Germination of all the hybrids/varieties was satisfactory. Agronomic practices and plant protection measures were adopted regularly. Data regarding fruit yield were recorded and presented in the following table.

Table-55 Yield Performance of various Varieties/Hybrids of Watermelon during 2016

Rank	Variety / Hybrid	Yield (T/ha)
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1	GSL-13	26.49
2	Orion-F ₁	24.98
3	CBS-11	24.49
4	Cheeta-F ₁	22.94
5	Black Beauty (Check)	21.49
6	Sugar Baby (Check)	20.54
7	Gorilla-F ₁	19.34
LSD (0.05)		2.2

It is evident from the above table that the hybrid GSL-13 exhibited the highest fruit yield of 26.49 T /ha followed by hybrid Orion-F₁ 24.98 T /ha whereas, the hybrid/variety Gorilla-F₁ showed the lowest fruit yield 19.34 T /ha.

10.2 EVALUATION OF EXOTIC WATERMELON VARIETIES /HYBRIDS IN ADAPTABILITY TRIAL

Sixteen entries in set-1, sixteen in set-2, fifteen in set-3 and seventeen in set-4 along with check variety Sugar baby were sown on 26-02-2016 to check their adaptability. Sowing was done 45-50 cm apart in hills, according to Randomized Complete Block Design with three replications keeping plot size of 7.0 × 3.0 m. Germination of all the hybrids/varieties was satisfactory. Agronomic practices and plant protection measures were adopted regularly. Data regarding fruit yield were recorded and presented in the following tables.

Table-56 Yield performance of various Varieties/Hybrids of Watermelon during 2016 (Set-1)

Rank	Variety / Hybrid	Yield (T/ha)
1	Shoulder	23.83
2	1250-F ₁	21.72
3	Bpvw-14-1	20.99
4	Capsule-F ₁	20.95
5	WM-1648	20.75
6	My Honey	20.47

7	Ayesh	20.43
8	Noor- F ₁	20.16
9	Big Top ACS	19.76
10	Sugar Baby	19.42
11	Cobra	19.34
12	WM-483	18.87
13	Veer-F ₁	18.78
14	WM-482	18.54
15	Super Star ACS	18.23
16	Laal Badshah	17.74
LSD(0.05)		2.4

The data presented in table-1 reveals that all the hybrids / varieties showed highly significant differences for fruit yield. The hybrid/variety Shoulder exhibited the highest fruit yield of 23.83 T/ha followed by hybrid 1250-F₁ 21.72 T/ha whereas, the hybrid/variety Laal Badshah showed the lowest fruit yield 17.74 T/ha in set-I.

Table-57 Yield performance of various Varieties/Hybrids of Watermelon during 2016 (Set-2)

Rank	Variety/Hybrid	Yield (T/ha)
1	Advanta-1401	27.06
2	Advanta-F ₁ -1431	24.20
3	KHWM-063	23.90
4	Advanta-F ₁ -1445	23.59
5	Aswm-72-55	23.24
6	G-HWM-1	22.24
7	Advanta- F ₁ -1436	22.19
8	Black Happy- F ₁	21.71
9	552- F ₁	21.55
10	HWM-271 A	21.26
11	Rocket- F ₁	21.15

12	Turi- F ₁	20.54
13	Sweet King	19.68
14	HWM-251 A	19.63
15	Sugar Baby	19.23
LSD (0.05)		2.8

The data presented in table-2 reveals that difference among means due to hybrids/varieties were significant at 5 % level of significance for fruit yield. The hybrid/variety Advanta-1401 gave the highest fruit yield of 27.06 T/ha followed by hybrid/variety Advanta- F₁-1431 (24.20 T/ha) whereas, the variety Sugar Baby (check) showed the lowest fruit yield 19.23 T/ha in set-2.

Table-58 Yield performance of various Varieties/Hybrids of Watermelon set-3 during 2016

Rank	Variety / Hybrid	Yield (T/ha)
1	Red Star	25.71
2	Lusia	25.00
3	Nun-8674	24.44
4	Round-8	24.34
5	Black Tiger	24.05
6	Hitto- F ₁	23.33
7	Vezel- F ₁	22.86
8	Zinco- F ₁	22.62
9	Ayesha	21.95
10	Mego-10	21.93
11	Puma- F ₁	21.78
12	Carlos- F ₁	21.44
13	Charlos- F ₁	21.42
14	Jerry- F ₁	19.64
15	Sugar Baby	18.57
LSD (0.05)		2.5

Data presented in the above table-3 reveals that hybrid/variety Red Star exhibited the highest fruit yield of 25.71 T/ha followed by hybrid/variety Lusia 25.00 T/ha whereas, the variety Sugar Baby (check) showed the lowest fruit yield 18.57 T/ha in set-3.

Table-59 Yield performance of various varieties/hybrids of watermelon set-4 during 2016

Rank	Variety / Hybrid	Yield (T/ha)
1	Vera- F ₁	26.18
2	Haider- F ₁	24.95
3	Red Tiger-59	24.44
4	Jamjuri-55	24.06
5	Doblin- F ₁	23.79
6	Dulice- F ₁	23.71
7	Capton	23.24
8	Star-434- F ₁	22.89
9	3550- F ₁	22.52
10	WT-1604	22.18
11	WT-4001	21.91
12	WT-1606	21.86
13	WT-4002	21.79
14	Don- F ₁	21.41
15	Doblin	21.23
16	Sugar Baby	20.72
LSD(0.05)		4.7

Data presented in the above table-4 reveals that hybrid /variety Vera- F₁ exhibited the highest fruit yield of 26.18 T/ha followed by hybrid /variety Haider- F₁ 24.95 T/ha whereas, the variety Sugar Baby (check) showed the lowest fruit yield 20.72 T/ha in set-4.

10.3 DEVELOPMENT OF INBRED LINES IN WATERMELON

The seed of 4 S₅ progenies/lines was sown in fruit to row fashion on 18-03-2016 on both sides of 3 meter wide beds keeping plant to plant distance of 60 cm. 2-3 flowers

on 3-4 selected plants in each bed were selfed to get at least one mature fruit for generation advancement. At maturity selfed seed of 4 S₅ lines was collected.

10.4 DEVELOPMENT OF OPEN POLLINATED VARIETIES IN WATER

MELON

From broad based population, two types of fruits were selected (Green oblong and green round) and maintained by sowing in isolation. These were sown on 04-03-2016 in isolation on both sides of 3 meter wide bed, keeping plant to plant distance of 60 cm. Plants having desirable fruits on the basis of rind color, shape and TSS %age were selected.

11. CAULIFLOWER (*Brassica oleracea* Var. botrytis)

11.1 EVALUATION OF EXOTIC CAULIFLOWER VARIETIES/HYBRIDS SUITABLE FOR 2ND EARLY SEASON IN ADAPTABILITY TRIAL

Eleven hybrids/varieties including standard variety FD-II were sown for raising the nursery on 21.07.2016 to check their adaptability. Germination of all the varieties was satisfactory. The trial was laid out according to RCB design with three replications keeping plot size of 7 × 1.5m. Seedlings of all varieties/hybrid were transplanted in the field at a distance of 30 cm on one side of 75 cm made ridges on 05.09.16. Standard cultural practices and plant protection measures were carried out regularly. Data regarding curd yield, biomass, average curd weight and plant weight of hybrids/varieties were recorded.

Table-60 Yield Performance of Cauliflower Hybrids/Varieties (2nd early) during 2016-17

Rank	Varieties/hybrid	Average Curd Weight (kg)	Average Plant Weight (kg)	Biomass (T/ha)	Curd Yield (T/ha)
1	CFH-1522	0.94	1.88	62.07	31.14
2	HCF-12	0.93	1.79	59.71	30.86
3	CKD-1924	0.81	1.60	53.40	27.14
4	CKD-2014	0.82	1.68	56.91	26.86
5	HCF-13	0.78	1.67	55.91	25.91
6	C-6099	0.84	1.69	50.97	25.43
7	CKD-1425	0.75	1.53	51.16	24.95
8	White Glow	0.84	1.16	35.20	24.38

9	C-6015	0.71	1.61	53.81	23.71
10	FD-II	0.70	1.47	49.13	23.24
11	HCF-11	0.77	1.75	52.35	23.05
LSD (0.0 5)				2.70	3.67

The data presented in the above table showed that the differences among means due to varieties were significant for curd yield and biomass. The hybrid /variety CFH-1522 gave the highest curd yield 31.14 T/ha closely followed by HCF-12 30.86 T/ha. The lowest curd yield was given by HCF-11 23.05 T/ha. The variety CFH-1522 showed highest biomass 62.07 T/ha followed by HCF-12 30.86 T/ha and the lowest biomass were given by White Glow 35.20 T/ha. Moreover, variety CFH-1522 gave the highest average curd weight of 0.94 kg followed by HCF-12 0.93 kg whereas, CFH-1522 showed the highest average plant weight 1.88 kg followed by HCF-12 with average plant weight of 1.79 kg.

11.2 EVALUATION OF EXOTIC CAULIFLOWER VARIETIES/HYBRIDS SUITABLE FOR MID SEASON IN ADAPTABILITY TRIAL

Set-1

Twelve hybrids / varieties including standard variety FD-III were sown for raising the nursery on 16.08.2016 to check their adaptability. Germination of all the varieties was satisfactory. The trial was laid out according to RCB design with three replications keeping plot size of 7 × 1.5m. Seedlings of all varieties/hybrid were transplanted in the field at a distance of 45 cm on one side of 75 cm made ridges on 21.09.16. Standard cultural practices and plant protection measures were carried out regularly. Data regarding curd yield, biomass, average curd weight and plant weight of hybrids/varieties were recorded.

Table-61 Yield Performance of Cauliflower Hybrid/Varieties (Mid-season Set-I) during 2016-17

Rank	Varieties/hybrid	Average Curd Weight (kg)	Average Plant Weight (kg)	Biomass (T/ha)	Curd Yield (T/ha)
1	Greta-F ₁	2.03	3.11	89.09	58.21
2	HCF-23	1.24	2.22	73.87	41.32
3	Hansa	1.34	2.52	76.87	40.71
4	Whistler	1.28	2.76	84.05	39.12
5	White Mountain	1.35	2.72	77.60	38.45

6	RS-5340	0.87	1.94	64.81	29.03
7	Remi-F ₁	0.86	1.60	48.84	26.24
8	HCF-22	0.79	1.58	52.77	26.18
9	White-270	0.75	1.77	59.19	24.81
10	FD-III	0.79	2.60	79.26	23.92
11	HCF-21	0.87	1.70	51.81	23.89
12	SV4051AC	0.45	0.92	30.81	15.00
LSD (0.05)				8.31	4.58

The data presented in table-1 reveals that variety/hybrid Greta-F₁ exhibited highest curd yield of 58.21 T/ha followed by HCF-23 which showed curd yield of 41.32 T/ha. The lowest curd yield was given by SV4051AC 15.00 T/ha. The hybrid Greta-F₁ exhibited higher biomass of 89.09 T/ha followed by Whistler 84.05 T/ha. The lowest biomass was given by SV4051AC 30.81 T/ha. The variety/hybrids Greta-F₁ gave the highest average curd weight of 2.03 kg followed by White Mountain with average curd weight 1.35 kg. The variety/hybrids Greta-F₁ showed the highest average plant weight 3.11 kg followed by Whistler 2.76 kg.

Note: In this set variety / hybrid SV4051AC start developing marketable heads earlier as compared to other varieties; this resulted in lower yield of this variety. This variety may be suitable for sowing in early season

Set-2

Six hybrids/varieties including standard variety FD-III were sown for raising the nursery on 08.09.2016 to check their adaptability. Germination of all the varieties was satisfactory. The trial was laid out according to RCB design with three replications keeping plot size of 7 × 1.5m. Seedlings of all varieties/hybrid were transplanted in the field at a distance of 45 cm on one side of 75 cm made ridges on 17.11.16 in set-II. Standard cultural practices and plant protection measures were carried out regularly. Data regarding curd yield, biomass, average curd weight and plant weight of hybrids / varieties were recorded.

Table-62 Yield performance of Cauliflower Hybrid/Varieties (Mid-season) Set-II during 2016-17

Rank	Varieties/hybrid	Average Curd weight (kg)	Average Plant Weight (kg)	Biomass (t/ha)	Curd Yield (t/ha)
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1	CF-38-42	1.88	3.69	98.48	50.24
2	Meigetsu 55-F ₁	0.95	1.13	37.83	31.79
3	G-CF-1	0.95	1.88	62.72	31.75
4	Snow Mountain	0.82	1.78	59.62	27.54
5	FD-III	0.86	2.28	69.71	26.48
6	Snow Muffin	0.65	1.52	50.76	21.94
LSD (0.05)				7.03	4.8

The data presented in table-2 reveals that variety/hybrid CF-38-42 exhibited highest curd yield of 50.24 t/ha followed by Meigetsu 55-F₁ which showed curd yield of 31.79 t/ha. The lowest curd yield was given by Snow Muffin 21.94 T/ha. The hybrid CF-38-42 exhibited higher biomass of 98.48 T/ha followed by FD-III 69.71 T/ha. The lowest biomass was given by Meigetsu 55-F₁ 37.83 t/ha. The variety / hybrids CF-38-42 gave the highest average curd weight of 1.88 kg followed by Meigetsu 55-F₁ and G-CF-1 with average curd weight 0.95 kg. The variety/hybrids CF-38-42 showed the highest average plant weight 3.69 kg followed by FD-III 2.28 kg.

11.3 EVALUATION OF EXOTIC CAULIFLOWER VARIETIES/HYBRIDS SUITABLE FOR LATE-SEASON IN ADAPTABILITY TRIALS

Set-1

Six hybrids/varieties including standard variety FD-IV were sown for raising the nursery on 06.10.2016 to check their adaptability. Germination of all the varieties was satisfactory. The trial was laid out according to RCB design with three replications keeping plot size of 7 × 1.5m. Seedlings of all varieties/hybrid were transplanted in the field at a distance of 30 cm on one side of 75 cm made ridges on 17.11.2016. Standard cultural practices and plant protection measures were carried out regularly. Data regarding curd yield, biomass, average curd weight & plant weight of hybrids/varieties were recorded.

Table-63 Yield performance of cauliflower hybrid/varieties (Late season) Set-I during 2016-17

Rank	Varieties/hybrid	Average Curd Weight (kg)	Average Plant Weight (kg)	Biomass (t/ha)	Curd Yield (t/ha)
1	Giewont	1.18	1.74	62.1	39.2
2	Whistler	1.03	1.52	54.7	36.9
3	White Queen	1.05	1.61	51.7	33.5
4	SARA-F ₁	1.10	1.78	54.3	33.4
5	Hansa	0.79	1.38	50.6	27.2

6	FD-IV	0.67	1.52	54.3	22.5
LSD 5%				5.80	4.2

The data presented in table-1 reveals that variety / hybrid Giewont exhibited highest curd yield of 39.2 T/ha followed by Whistler which showed curd yield of 36.9 T/ha. The lowest curd yield was given by FD-IV 22.5 T/ha. The hybrid Giewont exhibited higher biomass of 62.1 T/ha followed by Whistler 54.7 T/ha. The lowest biomass was given by Hansa 50.6 T/ha. The variety/hybrids Giewont gave the highest average curd weight of 1.18 kg followed by SARA-F₁ with average curd weight 1.10 kg. The variety/hybrids SARA-F₁ showed the highest average plant weight 1.78 kg followed by Giewont 1.74 kg.

Set-2

Six hybrids/varieties including standard variety FD-IV were sown for raising the nursery on 20.10.2016 to check their adaptability. Germination of all the varieties was satisfactory. The trial was laid out according to RCB design with three replications keeping plot size of 7 × 1.5m. Seedlings of all varieties/hybrid were transplanted in the field at a distance of 30 cm on one side of 75 cm made ridges on 01.12.2016. Standard cultural practices and plant protection measures were carried out regularly. Data regarding curd yield, biomass, average curd weight and plant weight of hybrids/varieties were recorded.

Table-64 Yield performance of cauliflower hybrid/varieties (Late season) Set-II during 2016-17

Rank	Varieties/hybrid	Average Curd Weight (kg)	Average Plant Weight (kg)	Biomass (t/ha)	Curd Yield (t/ha)
1	Carona-F ₁	0.76	1.33	38.0	21.8
2	Vanesa-F ₁	0.75	1.29	37.0	21.5
3	Capton-F ₁	0.67	1.29	36.9	19.1
4	FD-IV	0.46	1.27	36.3	13.2
LSD (0.05)				N.S	3.19

The data presented in table-2 reveals that variety/hybrid Carona-F₁ exhibited highest curd yield of 21.8 T/ha followed by Vanesa-F₁ which showed curd yield of 21.5 T/ha. The lowest curd yield was given by FD-IV 13.2 T/ha. The hybrid Carona-F₁ exhibited higher biomass of 38.0 T/ha followed by Vanesa-F₁ 37.0 T/ha. The lowest biomass was given by FD-IV 36.3 T/ha. The variety/hybrids Carona-F₁ gave the highest average curd weight of 0.76 kg followed by Vanesa-F₁ with average curd weight 0.75 kg. The variety/hybrids

Carona-F₁ showed the highest average plant weight 1.33 kg followed by Vanesa-F₁ and Capton-F₁ 1.29 kg.

Note: In this set two varieties Kohinoor and Altis turned in to buttoning and no marketable heads were developed. Therefore data was not recorded of these varieties.

Set-3

Eight hybrids/varieties including standard variety FD-IV were sown for raising the nursery on 20.10.2016 to check their adaptability. Germination of all the varieties was satisfactory. The trial was laid out according to RCB design with three replications keeping plot size of 7 × 1.5m. Seedlings of all varieties / hybrid were transplanted in the field at a distance of 30 cm on one side of 75 cm made ridges on 01.12.2016. Standard cultural practices and plant protection measures were carried out regularly. Data regarding curd yield, biomass, average curd weight and plant weight of hybrids / varieties were recorded.

Table-65 Yield performance of cauliflower hybrid/varieties (Late season) Set-3 during 2016-17

Rank	Varieties/hybrid	Average Curd Weight (kg)	Average Plant Weight (kg)	Biomass (t/ha)	Curd Yield (t/ha)
1	TCF-601	0.59	1.47	42.0	16.9
2	Star Cauliflower-02	0.58	1.43	40.7	16.5
3	Classic-F ₁	0.57	1.24	35.6	16.4
4	Bushra ACS	0.57	1.36	39.1	16.2
5	Kipper ACS	0.54	1.31	37.4	15.4
6	FD-IV	0.49	1.18	33.7	14.0
7	Leo-F ₁	0.48	1.03	29.5	13.8
8	Star Cauliflower-01	0.46	1.07	30.7	13.1
(LSD 0.05)				3.80	1.61

The data presented in table-3 reveals that variety / hybrid TCF-601 exhibited highest curd yield of 16.9 T/ha followed by Star Cauliflower-02 which showed curd yield of 16.5 T/ha. The lowest curd yield was given by Star Cauliflower-01 13.1 T/ha. The hybrid TCF-601 exhibited higher biomass of 42.0 T/ha followed by Star Cauliflower No-2 40.7 T/ha. The lowest biomass was given by Leo-F₁ 29.5 t/ha. The variety/hybrids TCF-601 gave the highest average curd weight of 0.59 kg followed by Star Cauliflower-02 with average curd weight

0.58 kg. The variety/hybrids TCF-601 showed the highest average plant weight 1.47 kg followed by Star Cauliflower-02 1.43 kg.

11.4 DEVELOPMENT OF SELF-INCOMPATIBLE INBRED LINES IN FD-II AND FD-III GROUPS OF CAULIFLOWER

The nursery of the varieties was planted according to standard practice and area availability. 30 desirable plants were selected in FD-II and FD-III season cauliflower. 4-5 branches of all the selected plants were selfed normally and through bud pollination. The seed developed in both conditions i.e. normally pollinated as well as bud pollinated flowers. There was not any plant found self-incompatible in FD-II and FD-III cauliflower.

11.5 DEVELOPMENT OF OPEN POLLINATED VARIETIES

The seed obtained from random mated population was sown in the field on 21-09-2016 keeping plant to plant and row to row distance of 45 and 75 cm, respectively. Morphologically similar and healthy plants with desirable heads on the basis of color, shape and compactness were selected to get high yielding genotypes to start first selection cycle. At maturity seed was harvested and bulked for further studies.

12. CABBAGE(*Brassica oleracea* Var. *capitata*)

12.1 EVALUATION OF EXOTIC CABBAGE VARIETIES / HYBRIDS (Set-I)

Five hybrids/varieties viz; Cabbage No-1, Green Stone-F₁, G-CB-1, Vaneza-F₁ and Ever Green- F₁ were sown in nursery on 08.09.2016. Germination of all the varieties was satisfactory and were transplanted in the field on 17.10. 2016 in RCB Design with three replications in a plot size of 7 × 1.5m. Transplanting was done by keeping plant to plant and row to row distances of 30 cm and 75 cm, respectively. Standard cultural practices and plant protection measures were adopted. Data regarding head yield, biomass, average head weight and average plant weight were recorded.

Table-66 Yield performance of cabbage hybrids/varieties during 2016-17 (Set-1)

Rank	Varieties/hybrid	Biomass (t/ha)	Average Plant Weight (kg)	Average Head Weight (kg)	Head Yield (t/ha)
1	Vaneza-F ₁	60.3	1.81	1.35	45.1
2	Green Stone-F ₁	65.4	1.96	1.35	45.0
3	G-CB-1	62.7	1.78	1.27	44.9
4	Ever Green-F ₁	61.8	1.85	1.24	41.3
5	Cabbage No-1-F ₁	55.1	1.65	1.09	36.3
	LSD (0.05)	5.71			3.84

The data presented in Table-1 depicted that the hybrid/variety Vaneza-F₁ gave the highest head yield 45.1 T/ha closely followed by Green Stone-F₁ 45.0 T/ha whereas, the lowest head yield was given by Cabbage No-1-F₁ 36.3 T/ha. In case of biomass variety/hybrids Green Stone-F₁ showed the highest biomass of 65.4 T/ha followed by G-CB-1 62.7 T/ha, whereas, the lowest biomass was produced by variety Cabbage No-1-F₁ 55.1 T/ha. The hybrid/variety Vaneza-F₁ and Green Stone-F₁ gave highest average head weight of 1.35 kg followed by G-CB-1 (1.27 kg). In case of average plant weight Green Stone-F₁ showed the highest average plant weight 1.96 kg followed by Ever Green-F₁ with average plant weight of 1.85kg.

Set-2

Four hybrids/varieties viz; Tropicana, Saint, Summer Highland and Red Flama were sown in nursery on 06.10.2016. Germination of all the varieties was satisfactory and were transplanted in the field on 17.11.2016 in RCB Design with three replications in a plot size of 7m × 1.5m. Transplanting was done by keeping plant to plant and row to row distances of 30 cm and 75 cm, respectively. Standard cultural practices and plant protection measures were adopted. Data regarding head yield, biomass, average head weight and average plant weight were recorded.

Table-67 Yield performance of cabbage hybrids/varieties during 2016-17 (Set-2)

Rank	Varieties/hybrid	Biomass (t/ha)	Average Plant Weight (kg)	Average Head weight (kg)	Head Yield (t/ha)
1	Summer Highland	69.89	2.29	1.50	45.8
2	Tropicana	66.20	1.97	1.23	41.1
3	Saint	57.30	1.71	1.11	36.9
4	Red Flama	53.00	1.85	1.18	33.7
LSD (0.05)		7.9			3.39

The data presented in Table-2 depicted that the hybrid/variety Summer Highland gave the highest head yield 45.8 T/ha followed by Tropicana 41.1 T/ha whereas, the lowest head yield was given by hybrid / variety Red Flama 33.7 T/ha. In case of biomass variety/hybrids Summer Highland showed the highest biomass of 69.89 T/ha followed by Tropicana 66.20 T/ha, whereas, the lowest biomass was produced by hybrid / variety Red Flama 53.00 T/ha. The hybrid/variety Summer Highland gave highest average head weight of 1.50 kg followed

by Tropicana 1.23 kg. In case of average plant weight Summer Highland showed the highest average plant weight 2.29kg followed by Tropicana with average plant weight of 1.97kg.

Set-3

Four hybrids / varieties viz; Roca-F₁, Austin-F₁, Marco-F₁ and Red Ball-F₁ were sown in nursery on 20.10.2016. Germination of all the varieties was satisfactory and were transplanted in the field on 01.12.2016 in RCB Design with four replications in a plot size of 7m × 1.5m. Transplanting was done by keeping plant to plant and row to row distances of 30 cm and 75 cm, respectively. Standard cultural practices and plant protection measures were adopted. Data regarding head yield, biomass, average head weight and average plant weight were recorded.

Table-68 Yield performance of Cabbage Hybrids/Varieties during 2016-17 (Set-3)

Rank	Varieties/hybrid	Biomass (t/ha)	Average Plant Weight (kg)	Average Head Weight (kg)	Head Yield (t/ha)
1	Marco-F ₁	52.1	1.71	1.13	34.4
2	Roca-F ₁	49.0	1.61	1.12	34.1
3	Austin-F ₁	43.9	1.44	0.99	30.4
4	Red Ball-F ₁	58.2	1.92	0.91	27.8
LSD (0.05)		6.67			3.4

The data presented in Table-3 depicted that the hybrid/variety Marco-F₁ gave the highest head yield 34.4 T/ha followed by Roca-F₁ 34.1 T/ha whereas, the lowest head yield was given by hybrid / variety Red Ball-F₁ 27.8 T/ha. In case of biomass variety/hybrids Marco-F₁ showed the highest biomass of 52.1 T/ha followed by Roca-F₁ 49.0 T/ha, whereas, the lowest biomass was produced by hybrid/variety Austin-F₁ 43.9 T/ha. The hybrid/variety Marco-F₁ gave highest average head weight of 1.13 kg followed by Roca-F₁ 1.12 kg. In case of average plant weight Red Ball-F₁ showed the highest average plant weight 1.92 kg followed by Marco-F₁ with average plant weight of 1.71kg.

13. Broccoli (*Brassica oleracea* var. *italica*)

13.1 EVALUATION OF EXOTIC BROCCOLI VARIETIES / HYBRIDS

Three hybrids/varieties Green Pia, Baro Star and Paraiso were sown in nursery on 06.10.2016. Germination of all the varieties was satisfactory and was transplanted in the field on 17.11.2016 in RCB Design with three replications in a plot size of 7 × 1.5m. Transplanting was done by keeping plant to plant and row to row distances of 30 cm and

75 cm, respectively. Standard cultural practices and plant protection measures were adopted. Data regarding head yield was recorded.

Table-69 Yield performance of Broccoli Hybrid/Varieties during 2016-17

Rank	Varieties/hybrid	Head Yield (T/ha)
1	Paraiso	18.6
2	Green Pia	15.6
3	Baro Star	13.9
LSD (0.05)		2.97

The data presented in the above table-69 depicted that the hybrid/variety Paraiso gave the highest head yield 18.6 T/ha followed by Green Pia 15.6 T/ha whereas, the lowest head yield was given by variety Baro Star 13.9 T/ha.

14. ONION (*Allium cepa* L.)

14.1 DEVELOPMENT OF ONION INBRED LINES

Four new strains were selected for inbreeding namely, Yellow Granex, White Pearl, Pink Panther and Golden ORB. Seed were sown during October 2016 for nursery set production. Sets were harvested and stored in May 2017.

The sets of four varieties i.e. Robina, Desi Red, TI-172 and NO-2 were planted during August 2016 and were re-planted during December 2016 keeping row to row and plant to plant distance of 75 and 30 cm, respectively. Twenty five umbels from each variety were covered with bags prior to flower opening. The covered umbels were shaken daily till the opening of the flowers. S₁ seed of these varieties were collected on maturity for further studies in the next generation.

S₁ Seed of three varieties i.e. Desi Red, red moon and Ceylon produced during the previous year was sown during October 2016 for nursery sets production for next generation and sets were harvested and stored during May 2017.

The S₁ sets of two varieties i.e. Red Imposta and VRIO-4 were planted during August 2016 and were re-planted during December 2016 keeping row to row and plant to plant distance of 75 and 30 cm, respectively for selfing. Twenty five umbels from each variety were covered with bags prior to flower opening. The covered umbels were shaken

daily till the opening of the flowers. So S₂ seed of these varieties was collected on maturity for further studies in the next generation.

S₂ Seed of five varieties i.e., Red Imposta, Selection-1, Faisal Red, Mirpur khas and Selection-1V produced during the previous year was sown during October 2016 for nursery sets production for next generation and sets were harvested during May 2017 and stored.

S₂ Sets of five varieties i.e., Robina, VRIO-6, VRIO-3, Early red and Faisal Red was planted in August 2016 and then replanted during December 2016 keeping row to row and plant to plant distance of 75 and 30 cm, respectively for selfing. Twenty five umbels were covered with bags prior to flower opening. The covered umbels were shaken daily till the opening of the flowers. Seed of S₃ generation was collected for further studies.

S₃ seed of three varieties i.e., Nasar puri, HON-1069 and Desi red were sown for nursery sets production in October 2016 and sets were harvested and stored during May 2017 for further studies. S₃ sets of six varieties viz; VRIO-9-79, VRIO-9-75, Early Red, PK10321 and Faisal Red were planted during August 2016 and replanted in December 2016 for inbreeding. Twenty-five umbels were covered with bags prior to flower opening. The covered umbels were shaken daily till the opening of the flowers. Seed of S₄ generation was collected and stored for further studies.

S₄ seed of one variety harvested during previous year were sown for nursery set production during Oct-2016. Sets were harvested and stored in May-2017. S₄ sets of two varieties viz; Mirpurkhas and Faisal Red were planted in August 2016 and then replanted during December 2016 keeping row to row and plant to plant distance of 75 and 30 cm, respectively for selfing. Twenty five umbels were covered with bags prior to flower opening. The covered umbels were shaken daily till the opening of the flowers. Seed of S₅ generation was collected for further studies.

14.2 EXOTIC VARIETIES/HYBRID IN ADAPTABILITY TRIAL CONDUCTED AT VEGETABLE RESEARCH INSTITUTE, FAISALABAD DURING RABI SEASON 2016-17

Set-1

Fifteen varieties/hybrid received from different seed companies were tested along with check (Phulkara) for their performance in adaptability trial at vegetable research

institute, Faisalabad during rabi season 2016-17. The nursery was sown on 1.11.2016 and transplanted on 4.01.2017 in the field according to Randomized Complete Block Design with three replications. The plot size was kept as 7 × 1.5 m. Fifteen onion cultivars i.e. Onion red crystal, Pink panther, CBS-130, F1 Mustang, Diana, Marvi, Golden ORB, SV1695NP, GSL-132, HIKE, White Pearl, Red ORB, 1133 F₁ Hybrid, Ruby F₁ and Phulkara Check were transplanted on both sides of 75 cm apart ridges with 10 cm plant to plant distance within row. All agronomic and plant protection measures were adopted to maintain the crop. Crop harvesting was done on 4.05.2017 and data regarding onion bulb yield were recorded and presented in the following Table.

Table-70 Yield Performance of Exotic Onion Varieties/Hybrids in Adaptability Trial conducted at VRI, Faisalabad

Rank	Entries	NOL	PH	BD	ND	NOR	BW	Yield
1	Pink Panther	13	57.97	7.89	0.93	8.15	236.59	35.08
2	1133 F ₁ Hybrid	12	58.40	8.46	1.10	8.33	269.67	34.09
3	SV1695NP	13	66.87	8.75	0.99	10.19	268.61	32.91
4	Hybrid Ruby F ₁	11	61.03	8.36	1.00	9.03	262.83	32.71
5	GSL132	12	61.43	7.60	0.92	9.43	208.50	32.37
6	White Pearl	10	49.33	7.79	0.92	7.88	233.91	31.60
7	Golden ORB	11	56.33	7.91	0.94	8.63	241.33	31.11
8	HIKE	12	60.87	7.43	0.98	9.03	216.17	30.67
9	CBS-130	12	54.80	7.57	0.91	9.80	206.17	28.25
10	Onion Red Crystal	12	57.07	7.63	0.93	7.50	200.33	28.15
11	F ₁ Mustang	12	67.00	6.85	1.08	9.07	177.50	22.24
12	Red ORB	13	71.57	7.06	1.22	9.07	167.00	20.89
13	Marvi	12	57.97	7.02	1.07	8.70	150.33	20.27
14	Phulkara (C)	22	63.43	7.14	1.49	9.10	137.33	19.70
15	Diana	15	69.07	6.70	1.85	9.80	125.67	14.19
LSD (0.05)		16	4.82	0.64	0.30	0.89	43.69	6.09

BW=bulb weight, PH=plant height, NOR=number of rings per bulb, BD=bulb diameter, ND=neck diameter, Y=yield

The data presented in the above table reveals that differences among means due to varieties were significant for yield. Top four ranked entries namely Red King (8.10 t/ha), Red Moon (7.51 t/ha), Monica (7.24 t/ha) and Robin F₁ (6.94 t/ha) produced significantly higher yield than check Phulkara (4.88 t/ha). The lowest fruit yield was recorded in the entry Premium F₁ (2.87 t/ha)

Set-2

Eighteen varieties/hybrids received from different seed companies were tested along with check (Phulkara) for their performance in adaptability trial at vegetable research institute, Faisalabad during rabi season 2016-7. The nursery was sown on 1.11.2016 and transplanted on 4.01.2017 in the field according to Randomized Complete Block Design with three replications. The plot size was kept as 7 × 1.5 m. Nineteen onion cultivars i.e. Barkeel, F₁ Amaloan, Anoki, Onion Sultan, Sv0748 NP, 1122 F₁ Hybrid, Rania, 84, Texas Early Grano, F₁ Zeous, Super Sarhad F₁, 88. 92. Hybrid Yellow Granex, Prema, Robin Hybrid, Red Flame, Red King F₁ and Phulkara Check were transplanted on both sides of 75 cm apart ridges with 10 cm plant to plant distance within row. All agronomic and plant protection measures were adopted to maintain the crop. Crop harvesting was done on 4.05.2017 and data regarding onion bulb yield were recorded and presented in the following Table.

Table-71 Yield performance of exotic onion varieties/hybrids in adaptability trial conducted at VRI, Faisalabad

Rank	Entries	NOL	PH	BD	ND	NOR	BW	Yield
1	Hybrid Yellow Granex	13	63.10	8.30	0.93	9.40	234.67	40.00
2	Red King F ₁	13	61.37	8.29	1.09	9.33	234.83	36.03
3	Texas Early Grano	13	60.73	8.05	1.02	8.05	230.35	34.44
4	SV 0748 NP	12	59.07	7.89	0.92	7.96	231.69	32.83
5	92.00	12	61.70	8.40	0.94	9.27	250.67	30.95
6	Onion Sultan	12	56.27	7.93	1.02	8.77	215.73	30.79
7	1122 F ₁ Hybrid	12	62.47	8.18	0.92	8.33	243.33	30.16
8	Barkeel	11	62.60	7.95	1.08	8.83	224.67	25.91
9	F ₁ Zeous	13	54.60	7.19	1.05	9.00	150.67	23.43

10	Anoki	12	64.23	7.86	1.16	9.09	182.04	22.75
11	Red Flame	13	62.07	7.68	1.00	8.73	173.50	22.63
12	F ₁ Amaloan	45	56.70	7.79	0.93	8.67	198.67	22.06
13	Rania	13	60.37	7.52	0.99	9.37	158.78	21.26
14	Phulkara (C)	22	63.43	7.14	1.49	9.10	137.33	19.70
15	88.00	14	57.73	6.52	1.16	8.87	117.17	19.05
16	Robin Hybrid	12	70.67	7.13	1.21	8.90	133.17	16.90
17	84.00	17	53.53	7.34	1.70	9.14	141.80	16.48
18	Prema	16	58.97	6.89	1.38	8.67	130.83	16.10
19	Super Sarhad F ₁	16	72.70	6.31	1.82	9.37	115.83	14.37
LSD (0.05)		16	4.82	0.64	0.30	0.89	43.69	6.09

BW=bulb weight, PH=plant height, NOR=number of rings per bulb, BD=bulb diameter, ND=neck diameter, Y=yield

The data presented in the Table 2. reveals that difference among means due to varieties were significant for yield. Top eight varieties produced significantly high yield than Phulkara check (19.7 t/ha). Hybrid Yellow Granex produced highest yield (40 t/ha) while Red King F₁ (36.03 t/ha) came on the second and Texas Early Grano (34.44 t/ha) came on third position. Super Sarhad F₁ produces lowest yield.

14.3 EVALUATION OF ONION VARIETIES FOR SPRING SEASON

The nursery of 23 varieties including check variety Phulkara were sown on 1.11.2016 and transplanting was done on 5.1.2017 in Randomized Complete Block Design with three replications. Transplanting was done on both sides of the ridges made 75 cm apart keeping plant to plant distance of 10 cm. The data regarding yield and other characters was recorded at maturity on 04-5-2017 and is presented in the following Table.

Table-72 Performance of onion genotypes during spring season 2016-17

Rank	Entries	PH	NOL	BW	BD	ND	NOR	Yield
1	Dark Red	60.47	17.87	119.33	6.85	1.50	9	21.82
2	Phulkara(C)	59.20	19.93	111.33	6.96	1.30	10	21.01
3	VRIO-1	57.47	15.13	116.67	6.69	1.17	9	20.33
4	Mirpur Khas	64.20	15.80	123.33	6.90	1.34	9	20.23
5	Husri	60.40	14.33	123.33	6.61	1.42	10	20.09
6	VRIO-2	57.07	15.13	111.00	6.61	1.28	9	19.71

7	S-C-16	66.67	14.20	121.33	6.86	1.25	9	19.67
8	Early Red	60.47	14.93	125.00	7.17	1.42	9	19.18
9	VRIO-6	56.20	18.27	123.92	6.66	1.21	8	18.43
10	Red Nasic	64.00	16.13	133.00	6.49	1.34	8	18.23
11	VRIO-7	57.40	15.27	128.00	6.85	1.19	9	18.00
12	Desi Red	65.07	16.53	137.67	6.79	1.30	10	17.97
13	PK 10321	61.20	17.60	139.33	7.23	1.61	8	17.90
14	Desi Large	63.73	13.73	121.67	6.59	1.35	9	17.74
15	VRIO-3	61.60	14.33	130.00	6.40	1.12	8	17.21
16	VRIO-4	62.87	16.33	119.00	6.71	1.35	10	16.52
17	Faisal Red	63.67	15.33	129.48	6.87	1.35	9	16.38
18	Red Imposta	57.93	17.80	109.00	6.33	1.41	8	16.36
19	VRIO-5	58.60	13.47	131.33	6.81	1.22	9	16.08
20	Robina	55.40	14.87	118.67	7.05	1.17	9	15.88
21	VRIO-9	61.93	15.07	109.67	6.43	1.20	9	15.75
22	Pusa Red	56.73	16.27	120.33	6.53	1.15	9	15.75
23	VRIO-8	57.67	15.53	115.33	6.38	1.29	9	15.44
	LSD (0.05)	4.00	3.90	40.00	0.89	0.20	1.30	1.57

BW=bulb weight, PH=plant height, NOL=number of leaves per plant, NOR=number of rings per bulb, BD=bulb diameter, ND=neck diameter, Y=yield

The differences among varieties/strains in yield are statistically significant. The variety Dark Red secured first position by producing bulb yield 21.82 t/ha which was followed by the varieties Phulkara (21.01 t/ha) and VRIO-1 (20.33 t/ha). Lowest yield was observed in varieties VRIO-9 (15.75 t/ha), Pusa red (15.75 t/ha) and VRIO-8 (15.44 t/ha).

Maximum plant height was shown by the variety S-C-16 (66.67 cm) followed by Mirpurkhas (64.20 cm) and Red Nasic (64 cm) while the variety Robina showed minimum plant height (55.40 cm) presented in Table 3. PK10321 produced heaviest bulbs of weight 139.33 g while VRIO-2 produced least heavy bulbs of weight 111.33 g.

14.4 TRIAL FOR OPTIMIZATION OF SOWING METHODS

The trial was designed to find the best combination of sowing method. Sowing was done on all the experimental units including nursery was done on 24-10-2016 in factorial randomized complete block design. A and B were two factors. Factor A comprised of two levels i.e., flat and ridge while factor B was comprised of three levels i.e., broadcasting, line sowing and transplanting of the nursery. Plant to plant distance

was kept 10 cm and row to row was kept 30 cm while transplanting of nursery. All other agronomic practices were performed according to standards.

Data of plant height, no.of leaves per plant and bolting %age were recorded at maturity and data of yield and other characters were recorded after harvesting on 8-5-2017 which is presented in the following table.

Table-73 Yield and other Agronomic Traits of all the Treatment Combinations

A	B	Yield (t/ha)	Bulb Weight (g)	Plant Height (cm)	No.of Leaves/plant	Bolting %	Bulb Diameter (cm)	No.of bulbs/kg
Flat	Broadcast	22.14	94.50	65.77	16.60	28.33	5.67	16.11
	Lines	15.26	70.50	64.67	18.67	11.67	5.03	13.56
	Transplanting	16.85	93.00	59.57	11.53	0.37	5.83	12.67
Ridge	Broadcast	13.18	100.00	63.50	21.00	17.67	6.03	12.33
	Lines	26.83	58.70	63.33	12.83	38.33	4.69	22.22
	Transplanting	23.84	107.00	67.10	12.33	2.13	6.21	9.44
LSD	A	3.09	11.33	3.96	1.60	2.17	0.57	3.26
	B	3.70	13.00	4.85	2.04	2.66	0.69	4.00
	A*B	5.35	19.61	6.80	2.89	3.76	0.98	5.65

Maximum yield was observed in line sowing on ridges (26.83 t/ha) while minimum yield was obtained in broadcast on ridges (13.18 t/ha). But the transplanting on ridges produced maximum bulb weight (107 g) and maximum bulb size (6.21 cm). Smallest bulbs were produced in line sowing on flat and ridge presented in Table 4.

Bolting %age was high in line sowing on ridges followed by broadcast on flat area but very less bolting was observed in transplanting's both on flat and ridge experimental units(Table-4.)

15. OKRA (*Abelmoschus esculentus* L.)

15.1. COLLECTION AND MAINTENANCE OF GERMPLASM

Germplasm comprising of 43 lines/varieties of okra viz; Amrapali, Amoli, OK-1312, Sabz pari, OK-1301, OK-1302, OK-1303, OK-1304, OK-1305, OK-1307, OK-1308, OK-1309, OK-1310, OK-1315, OK-1316, Pusa swani, Green wonder, Pen beauty, Parbhani karanti, Ikra, Arka anamika, Sanum, Punjab selection, Anarkali, Kiran, China red, OK-152, OK-2015, OK-1505, OK-1509, OK-1507, OK-1506, OK-1510, OK-1503, OK-1508, OK-1504, OK-1502, OK-1501, OK-1602, OK-1601, OK-1313, OK-1314 and OK-1401 were sown on 23-02-2017 to maintain the genetic purity and to utilize in future breeding program. Sowing was done on one

side of 75 cm wide ridges by keeping plant to plant distance of 30 cm. Selfed and matured fruits of true to type plants in each genotype were harvested separately, for further use in future breeding programme. Range of different traits in available germplasm is given in the Table.

Table-74 Range of different Morphological Traits in Okra Lines/Varieties

S. No.	Traits	Minimum	Maximum
1.	Days to 1 st Flower initiation	35	45
2.	Inter-nodal length (cm)	2.5	5.0
3.	Pod Length (cm)	13	18
4.	Pod Width (cm)	1.6	2.2
5.	Beak length (cm)	2.5	3.5

HYBRIDIZATION

To develop high yielding and disease tolerant okra varieties, five female parent and four parent were sown on 23-02-17 in crossing block to create genetic variability for further studies. Crosses were attempted to produce F₁ hybrids. The detail of successful cross combinations is shown in table below.

Table-75 List of okra crosses (F₀) made during February, 2016

S. No.	Name of Cross
1.	OK-1505 × OK-1313
2.	OK-1505 × OK-1314
3.	OK-1505 × OK-1401
4.	OK-1505 × China Red
5.	OK-1509 × OK-1313
6.	OK-1509 × OK-1314
7.	OK-1509 × OK-1401
8.	OK-1509 × China Red
9.	OK-1507 × OK-1313
10.	OK-1507 × OK-1314
11.	OK-1507 × OK-1401
12.	OK-1507 × China Red
13.	OK-1506 × OK-1313
14.	OK-1506 × OK-1314
15.	OK-1506 × OK-1401
16.	OK-1506 × China Red
17.	OK-1510 × OK-1313
18.	OK-1510 × OK-1314
19.	OK-1510 × OK-1401
20.	OK-1510 × China Red

15.2. STUDY OF FILIALS

Generations were sown on one side of 75cm wide ridge by keeping plant to plant distance of 30 cm 23-02-2016. Standard agronomic and plant protection measures were adopted to raise the crop. All crosses germinated normally. From each population healthy plants were selected on the basis of disease tolerance, number of fruits and fruit shape. At maturity, ripened fruits from segregating generations were harvested and seeds were collected for next year sowing to advance the generation. The desired progenies/ lines were selected and the detail of generation is given below:

Table-76 Study/ Selection of Progenies from Filials

S. No.	Cross
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F₁ Generations	
1.	Sabz Pari × OK-1313
2.	Sabz Pari × OK-1314
3.	OK-1312 × OK-1313
4.	OK-1312 × OK-1314
5.	OK-1313 × OK-1312
6.	OK-1314 × OK-1312
F₂ Generations	
1.	OK-1313 × Kashish
2.	Sanum × OK-1313
3.	Sanum × OK-1314
4.	Sanum × Kashish
5.	OK-1312 × Kashish
6.	OK-1312 × China Red
7.	OK-1314 × Kashish
8.	OK-1314 × OK-1313
F₃ Generations	
1.	Parbhani Karanti × OK-1313
2.	Parbhani Karanti × OK-1314
3.	Ikra × Sabz Pari
4.	OK-1313 × OK-152
5.	OK-1313 × Ikra
F₄ Generations	
1.	OK-1314 × OK-1312

2.	OK-1313 × OK-1312
3.	OK-1312 × OK-1313
4.	Sabz Pari × OK-1313
5.	Sabz Pari × OK-1314
F₅ Generations	
1.	Pusa swani × Anarkali
2.	Pusa swani × Arka anamika
3.	Pusa swani × Parbhani karanti
4.	Punjab selection × Anarkali
5.	Punjab selection × Arka anamika
6.	Punjab selection × Parbhani karanti
7.	Sanum × Anarkali
8.	Sanum × Arka anamika
9.	Sanum × Parbhani karanti
10.	Ikra × Anarkali
11.	Ikra × Arka anamika
12.	Ikra × Parbhani karanti

16.4. EVALUATION OF OKRA HYBRIDS / VARIETIES IN ADAPTABILITY TRIAL

Two exotic varieties/hybrids imported by seed companies were tested to check their adaptability against the check variety “Sabz Pari”. The trial was sown in the field according to Randomized Complete Block Design with five replications keeping plot size of 7 × 1.5 m on 21-07-2016. Sowing was done on both side 75 cm apart ridges through dibbler keeping plant to plant distance of 15 cm. All varieties germinated normally and all agronomic practices and plant protection measures were adopted when needed. Fresh

marketable fruit picking was started on 09-09-16 and continued till 10-11-16. Data regarding fresh fruit yield were recorded and showed in the following table.

Table-77 Yield performance of exotic okra hybrids/varieties in adaptability trial conducted at VRI Faisalabad during kharif season, 2016

Rank	Variety	Fresh Fruit Yield (T/ha)
1.	Samrat	14.95
2.	Shakti-F ₁	12.94
3.	Sabz pari	12.24
	LSD(0.05)	1.58

The data presented in the above table showed that difference among means due to varieties were significant for fresh fruit yield. Samrat with fruit yield value of 14.95 t/ha gave significant higher fresh fruit yield than standard variety Sabz Pari (12.24 t/ha). While exotic variety Shakti F₁ showed yield (12.94 T/ha) which is statistically at par with standard variety Sabz Pari.

Eleven exotic varieties/hybrids in set-I and twelve in set-II imported by seed companies were tested to check their adaptability against the check variety “Sabz Pari”. The trial was sown in the field according to Randomized Complete Block Design with three replications keeping plot size of 7 × 1.5 m on 21-02-2017. Sowing was done on both sides of ridge keeping plant to plant distance of 10 cm and row to row distance of 75 cm. All varieties germinated normally and all agronomic practices and plant protection measures were adopted when needed. Fresh marketable fruit picking was started on 19-04-2017 and continued till 03-07-2017. Data regarding fresh fruit yield was recorded and presented in the following tables.

Table-78 Yield performance of exotic okra hybrids/varieties in adaptability trial conducted at VRI Faisalabad during kharif, 2017 (set-I)

Rank	Variety	Fresh fruit yield (t/ha)	Seed Company

1	Resham F ₁	18.74	Rashid Seeds, Jilani Building, Sheikhpura More, Gujranwala.
2	Green Star F ₁	18.60	Star Seed Co. Seed Market, Sheikhpura Road, Gujranwala.
3	Mornee F ₁	18.46	Rashid Seeds, Jilani Building, Sheikhpura More, Gujranwala.
4	HO-042-B	17.73	Kanzo Quality Seeds, 103-A, Aitchison Society, Raiwind Road, Lahore.
5	K-HO-1	17.68	Kanzo Quality Seeds, 103-A, Aitchison Society, Raiwind Road, Lahore.
6	Anmol	17.56	NTL Seed Co. Madni Plaza, Main Sheikhpura Road, Gujranwala.
7	Rohi F ₁	17.34	NTL Seed Co. Madni Plaza, Main Sheikhpura Road, Gujranwala.
8	Resham	17.00	Haji Sons, 65/13, Cavalry Ground, Lahoe cantt, Lahore.
9	Hunza	16.89	NTL Seed Co. Madni Plaza, Main Sheikhpura Road, Gujranwala.
10	Noori-786	16.70	NTL Seed Co. Madni Plaza, Main Sheikhpura Road, Gujranwala.
11	Sabz Pari	16.07	(Check) Vegetable Research Institute, Faisalabad
12	Lakshmi F ₁	15.76	Rashid Seeds, Jilani Building, Sheikhpura More, Gujranwala.
LSD (0.05)		2.05	

The data presented in the above table shows that difference among means due to varieties were significant for fresh fruit yield. Three varieties/hybrids Resham F₁, Green Star and Mornee F₁ with fruit yield range of 18.74 to 18.46 t/ha gave significant higher fresh fruit yield than standard variety Sabz Pari (16.07 t/ha) while the lowest yield was recorded in Lakshmi F₁ (15.76 t/ha).

Table-79 Yield performance of exotic okra hybrids/varieties in adaptability trial conducted at VRI Faisalabad during kharif, 2017 (set-II)

Rank	Variety	Fresh fruit yield (t/ha)	Seed Company
1	OH-940	20.61	Syngenta Pakistan Ltd., 90-Industrial Estate, Kot Lakhpat, Lahore.
2	HS-15	20.02	Haji Sons, 65/13 Cavalry Ground, Lahore Cantt, Lahore.
3	No. 64	19.72	NTL Seed Co. Madni Plaza, Main Sheikhpura Road, Gujranwala.

4	ASOK-49-82	19.64	Ch. Ahmad Din & Sons, Seed Market, Sheikhpura Road, Gujranwala.
5	THO-02	19.45	Tri Star Seed Corporation, 1Km Taj Garh Road, Rahim Yar Khan.
6	Suraksha F ₁	19.08	Naveel Seed Corporation (Pvt) Ltd. Fazal Centre, Sheikhpura More, Gujranawala.
7	THO-01	19.04	Tri Star Seed Corporation, 1Km Taj Garh Road, Rahim Yar Khan.
8	Raksha F ₁	18.99	Naveel Seed Corporation (Pvt) Ltd. Fazal Centre, Sheikhpura More, Gujranawala.
9	Super Green	18.74	NTL Seed Co. Madni Plaza, Main Sheikhpura Road, Gujranwala.
10	Malka F ₁	18.72	Rachna Agri. Business, Rachna Complex, Sheikhpura Road, Gujranwala.
11	Sabz Pari	17.55	(Check) Vegetable Research Institute, Faisalabad
12	Sureeli F ₁	17.23	Rachna Agri. Business, Rachna Complex, Sheikhpura Road, Gujranwala.
13	Shabnam F ₁	16.49	Rachna Agri. Business, Rachna Complex, Sheikhpura Road, Gujranwala.
LSD (0.05)		2.68	

The data presented in the above table shows that difference among means due to varieties were significant for fresh fruit yield. Variety/hybrid OH-940 with fruit yield 20.61 t/ha gave significant higher fresh fruit yield than standard variety Sabz Pari (17.55 t/ha) while the lowest yield was recorded in Shabnam F₁(16.49 t/ha).

16. SPONGE GOURD (*Lufa cylindrica* L.)

16.1 MAINTENANCE OF SPONGE GOURD GERMPLASM

To maintain germplasm for further utilization in breeding program, 13 sponge gourd genotypes were sown on 13-03-2017 in a plot size of 3 × 5 m keeping plant to plant distance of 50 cm. Germination of all the entries was good. Each genotype was maintained through sib mating and seed was collected separately. Days to first female flowering, fruit color, disease resistance, fruit weight, no of female flowers per plant and fruit length were recorded.

16.2 DEVELOPMENT OF INBRED LINES IN SPONG GOURD

To develop inbred lines for the development of hybrids/composite varieties, the seed of S₀, S₂ and S₃ were sown during 1st week of March, 2017 on both sides of 3 meter wide beds keeping plant to plant distance of 50 cm. 10 flowers on 3-4 selected plants in

each bed were selfed to get at least one mature fruit for generation advancement. At maturity, selfed seed was collected, separately for further studies.

16.3 DEVELOPMENT OF HIGH YIELDING AND DISEASE RESISTANT OPVs

To develop high yielding and disease resistant open pollinated sponge gourd varieties 13 entries were sown on 13-03-2017 in a plot size of 3 × 5 m keeping plant to plant distance of 50 cm. 10 seeds from each variety were planted and at flowering pollen from each variety was collected and bulked. Ten female flowers from each line were pollinated from the bulked pollen. At maturity, ripened fruits were picked and seed was extracted and bulked for further studies.

16.4 REPORT ON EXOTIC VARIETIES/HYBRIDS OF SPONGE GOURD IN ADAPTABILITY TRIAL CONDUCTED AT VEGETABLE RESEARCH INSTITUTE, FAISALABAD DURING KHARIF SEASON 2017

Eight exotic varieties/hybrids in set-1 and twelve in set-2 along with local check of sponge gourd were sown in adaptability trial at Vegetable Research Institute, Faisalabad on 2-03-2017 to evaluate their yield performance. The layout was RCBD having three replications with a plot size of 5 × 3 m and plant to plant distance of 50 cm. Germination of all the entries was satisfactory. All agronomic and plant protection measures were taken to maintain growth of the crop. Fresh fruit pickings were started on 26-04-2017 and continued till 7-8-2017. Data regarding fruit yield were recorded from 41 pickings that are presented in Table 1 and Table 2. Days to first female flowering, virus attack intensity and fruit color were also recorded.

Table-80 Yield performance of Sponge Gourd Varieties/Hybrids in Adaptability Trial conducted at VRI during Kharif, 2017 (Set-1)

Rank	Variety/ Hybrid	Fruit yield (t/ha)	DFP	Virus attack	Fruit color
1	ASSP 65-90	15.57	49.33	MR	Dark green
2	Kohinoor F ₁	14.00	52.67	MS	Dark green
3	White Seeded F ₁	12.25	51.67	MR	Pale green
4	Star-555 F ₁	12.06	55.00	MR	Dark green
5	Dolly F ₁	11.86	49.67	HS	Green
6	Sham F ₁	11.63	53.33	S	Dark green

7	Barbie F ₁	10.62	51.66	HS	Dark green
8	Local (Check)	8.46	49.33	MS	Pale green
9	Green Pari AB	7.69	56.33	HS	Dark green
LSD (0.05)		1.83	1.09		

DDF=Days to first female flower MR=Moderately resistant MS=Moderately susceptible S= Susceptible
HS= Highly susceptible

The data presented in Table 1 depicted that the differences among means due to varieties/hybrids were significant for fresh fruit yield. Six varieties/hybrids gave significantly higher fresh fruit yield than standard variety Local check (8.46 t/ha) with the highest fruit yield of 15.57 t/ha was shown by ASSP-65-90 F₁ followed by Kohinoor F₁ (14 t/ha) and White Seeded F₁ (12.25 t/ha). Hybrid, Green Pari AB (7.69) gave lower fruit yield against the standard variety. No entry was early flower bearing than the check variety, Local (49.33 DFF). Data of viral diseases depicted that ASSP 65-90 F₁, White Seeded F₁ and Star-555 F₁ were moderately resistant while all other were moderately susceptible to highly susceptible in set-1.

Table-81 Yield performance of Sponge Gourd Varieties/Hybrids in Adaptability Trial conducted at VRI during Kharif, 2017 (Set-2)

Rank	Variety/ Hybrid	Fruit yield (t/ha)	DDF	Virus attack	Fruit color
1	TSG-02	15.25	51.00	MR	Bright green, shinning surface
2	Monika F ₁	14.30	54.00	MS	Light green
3	Anmol F ₁	14.25	43.67	S	Dark green
4	USTAV F ₁	13.69	47.67	HS	Dark green lining
5	Advanta 1101 F ₁	12.19	48.66	MR	Light green
6	HSPG 852 A	12.11	51.00	MS	Dark green
7	Ujala F ₁ Nath	11.58	50.33	MS	Light green
8	TSG-01	11.21	50.33	HS	Dark green
9	Komal (NSGH-7000 F ₁)	10.32	50.00	HS	Light green
10	Kajal (NSGH-7001 F ₁)	9.79	53.00	HS	Blackish green

11	White Pari AB	9.44	55.67	S	Very light green
12	Local (Check)	8.47	48.33	MS	Pale green
13	HSPG 842 A	7.8	54.00	MS	Light green
LSD (0.05)		2.12	1.97		

DDFF=Days to first female flower MR=Moderately resistant MS=Moderately susceptible S= Susceptible
HS= Highly susceptible

The data presented in Table 2 depicted that the differences among means due to varieties were significant for fresh fruit yield. Eight varieties/hybrids gave significantly higher fresh fruit yield than standard variety Local check (8.47 t/ha) with the highest fruit yield of 15.25 t/ha showed by TSG-02 followed by Monika (14.30 t/ha) and Anmol F₁ (14.25 t/ha). Variety/hybrid HSPG 842 (7.80 t/ha) gave lower fruit yield against the standard variety. Anmole F₁ was the early flower bearing variety having lower no of days to first female flower (43.67 days) than the check variety, Local (48.33 DFF). Data of viral diseases depicted that TSG-02 and Advanta 1101 F₁ were moderately resistant while all other were moderately susceptible to highly susceptible in set-2.

17. RIDGE GOURD ()

17.1 REPORT ON EXOTIC VARIETIES/HYBRIDS OF RIDGE GOURD IN ADAPTABILITY TRIAL CONDUCTED AT VEGETABLE RESEARCH INSTITUTE, FAISALABAD DURING KHARIF SEASON 2017

Nine exotic varieties/hybrids of ridge gourd along with “Local” check of sponge gourd were sown in adaptability trial at Vegetable Research Institute, Faisalabad on 02-03-2017 to evaluate their yield performance. The layout was RCBD having three replications with a plot size of 5 × 3 m and plant to plant distance of 50 cm. Germination of all the entries was satisfactory. All agronomic and plant protection measures were taken to maintain growth of the crop. Fresh fruit pickings were started on 24-04-2017 and continued till 7-07-2017. Data regarding fruit yield were recorded from 29 pickings that are presented in tables below.

Table-82 Yield performance of Ridge Gourd Varieties/Hybrids in Adaptability Trial conducted at VRI during Kharif, 2017

Rank	Variety/ Hybrid	Fruit Yield (t/ha)	Company Name
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1	Anmol F ₁	7.17	Rachna Agri Bussiness, Rachna Complex, Sheikhpura road, Gujranwala.
2	Mala F ₁	7.05	Rashid seeds, Jilani Building, Sheikhpura Road, Gujranwala.
3	Gagan F ₁	6.96	Rachna Agri Bussiness, Rachna Complex, Sheikhpura road, Gujranwala.
4	Mayuri	6.21	Rashid seeds, Jilani Building, Sheikhpura Road, Gujranwala.
5	Local (Check)	5.10	Vegetable Research Institute, Faisalabad.
6	Advanta 1601F ₁	4.68	ICI Pakistan Ltd, ICI House, 63 Mozang Road, Lahore.
7	Queen F ₁	2.62	Rachna Agri Bussiness, Rachna Complex, Sheikhpura road, Gujranwala.
8	Shruthi (NRGH-111)	2.20	DGA (R), AARI, FSD (Origin from India)
9	HRG 832 A	1.32	Kanzo Quality Seeds, 103 A- Aitchison Society, Raiwind road, Lahore.
10	Star-225 F ₁	1.01	Star Seed Co. Seed Market, Sheikhpura road, Gujranwala.
	LSD(0.05)	1.18	

The data presented in the above table revealed that the differences among means due to varieties were significant for fresh fruit yield. Three varieties/hybrids *viz*; Anmol F₁, Mala F₁ and Gagan F₁ with fruit yield of 7.17 , 7.05 and 6.96 t/ha respectively gave significantly higher fresh fruit yield than standard variety “Local” check (5.10 t/ha). Whereas remaining six varieties/hybrids gave lower fruit yield against the standard variety.

18. CUCUMBER (*Cucumis sativus* L.)

18.1 ADAPTABILITY TRIAL ON CUCUMBER UNDER HIGH TUNNEL IN DRIP IRRIGATION AT VRI FAISALABAD DURING (2016-17)

Twenty four Parthenocarpic hybrids named as Chelsea, 14CU5276-F₁, 15CU5277-F₁, Rayyan-F₁, TCB-701, TCB-702, TCB-703, TCB-704, Starcucumber-01, Starcucumber-02, PS-64, SV8047CB, SV5455CQ, SV0684CB, Termessos, Hoyrat-F₁, Poyraz-F₁, Sahin-F₁, A One-786, Bilqis, Happy Dance, Java-F₁, SXQ-3776-F₁ and

Khyber-F₁ of cucumber were tested at Vegetable Research Institute, Faisalabad under high tunnel in drip irrigation system during the year 2016-17. Sowing date of trial was 24-11-2016. Some seeds were not germinated from different varieties. To assure better germination re-sowing was done of those varieties whose germination was not up to mark in first sowing. The trial was laid out according to randomized complete block design (RCBD) with three replications. Plot size was maintained as 9.1 × 0.76 m and plant to plant distance was 30 cm. Fruit picking was started on February 14, 2017 and lasted up to May 05, 2017. Total sixteen pickings were taken from the trial. Yield data was recorded and analyzed statistically which is presented in the following table.

Table-83 Performance of Cucumber hybrids in an adaptability trial at Vegetable Research Institute, Faisalabad during 2016-17

Rank	Hybrids	Yield T/ha
1	Hoyrat-F ₁	98.18
2	Termessos (Check)	97.91
3	SV0684CB	93.31
4	SXQ-3776-F ₁	91.79
5	Bilqis	90.90
6	TCB-701	89.20
7	TCB-702	81.33
8	Star Cucumber-2	81.06
9	Sahin F ₁	80.27
10	Star Cucumber-1	79.33
11	SV8047CB	77.93
12	TCB-703	75.27
13	Khyber-F ₁	66.40
14	PS-64	64.35
15	Poyraz-F ₁	59.30
16	Rayyan-F ₁	58.26
17	15CU-5277-F ₁	56.33
18	Java-F ₁	55.88
19	14CU-5276-F ₁	53.11
20	SV5455CQ	51.80

21	TCB-704	50.19
22	Chelsea	49.06
23	A-One 786	46.04
24	Happy Dance	42.84
LSD(0.05)		30.40

The data in the above table revealed that only hybrid Hoyrat-F₁ is above the check hybrid that Termessos in yield. All others hybrids are below check hybrid. The hybrids SV0684CB, SXQ3776-F₁, Bilqis and TCB-701 are close to check. The hybrid 14CU-5276-F₁ started early flowering but these were male flowers it showed 60:40 male to female flower ratio and fruit is spiny. Star cucumber-1, Star cucumber-2, Bilqis, Ps-64, Khyber and Java-F₁ also produce male flowers before female flower. Bilqis has also spiny fruit. All other hybrids have long green and smooth fruit shape. Low germination was also observed in few entries especially Chelsea its germination was below 50% although it is good hybrid in terms of fruit shape and yield if germination percentage is increase this hybrid can compete.

18.2 ADAPTABILITY TRIAL ON CUCUMBER IN OPEN FIELD (KHARIF-2017)

Thirty seven varieties/hybrids including check Kheera Local of cucumber were tested at Vegetable Research Institute, Faisalabad in open field during Kharif 2017. Due to huge number of entries it is difficult to manage whole the material in one trial so these entries were tested in two sets. Eighteen cucumber varieties/hybrids namely Porto F₁, Zoro F₁, Spider F₁, Tiger-990 F₁, Vareene-F₁, Vella-F₁, Dania-730-F₁, Safaa, Alpha prime, Thamin-II, TCU-03, TCU-04, HCU-171C, HCU-172B, HCU-173A, CU45-62-F₁, Saram- F₁, and Kheera Local (Check) were sown in Set-I. Other nineteen cucumber varieties/hybrids namely, Dinar F₁, Advanta F₁ 701, Advanta F₁ 728, CU-6530-F₁, Hoosier, NCH-2, Messi-F₁, Evergreen, Crown, FARAH-F₁, Velly-F₁, GHC-2, Chaman F₁, Falcon F₁, Indus F₁, HC-999-F₁, Impress-F₁, KL-086, Kheera Local (check) were sown in Set-II in open field on March 10, 2017. Some seeds were not germinated from different varieties. To assure better germination re-sowing was done of those varieties whose germination was not up to mark in first sowing. The trials were laid out according to randomized complete block design (RCBD) with three replications. Plot size was maintained as 5 x 2 m and plant to plant distance was 30 cm. Fruits picking was started on April 25, 2017 and lasted up to May 25, 2017. Total six pickings were taken from the trial. During 3rd week of April severe attack of downy mildew was recorded and special remedial measures were adopted to overcome the

disease but the results were not appreciable. High temperature and disease badly damaged the vines of cucumber resulted in yield reduction and early completion. Data regarding fruit yield (t/ha) were recorded and analyzed statistically which is presented in the following tables.

Table-84 Performance of Cucumber hybrids/varieties in an adaptability trial at Vegetable Research Institute, Faisalabad during Kharif 2017 (Set-1)

Rank	Varieties/Hybrids	Fruit Yield T/ha
1	TCU-04	12.51
2	Tiger-990-F ₁	11.76
3	Vella-F ₁	11.13
4	Dania-730-F ₁	10.36
5	CU-4562-F ₁	10.33
6	Saram-F ₁	10.21
7	Spider- F ₁	10.06
8	HCU-171C	10.03
9	Kheera Local (C)	10.00
10	Vareene-F ₁	9.59
11	TCU-03	9.47
12	Proto-F ₁	9.43
13	HCU-173A	9.06
14	Zoro-F ₁	8.09
15	Alpha Prime	7.94

16	HCU-172P	7.09
17	Thamin-II	6.23
18	Saffa	5.49
LSD (0.05)		3.81

The data in the above table reveals that the overall fresh fruit yield of all varieties/ hybrids is low due to disease attack. But when we talk about the comparison of yield with check variety that is Kheera Local and with each other then the six genotypes (TCU-04, Tiger-990, Vella, Dania, CU-4562-F₁ and Saram-F₁) are higher in yield than check but results are insignificant. The genotype Spider-F₁ and HCU-171C are equal to check. All other are below check. Those varieties that start fruits early are more acceptable in farming community. Early fruits fetch higher prices in the market in early days of fruit

Table-85 Performance of Cucumber hybrids/varieties in an adaptability trial at Vegetable Research Institute, Faisalabad during Kharif 2017 (Set-2)

Rank	Varieties	Fruit yield (T/ha)
1	Advanta-728	12.52
2	Advanta-703	12.05
3	Falcon-F ₁	11.77
4	Denar-F ₁	11.53
5	Chaman-F ₁	11.26
6	Valley-F ₁	10.93
7	Indus-F ₁	10.26
8	GHC-2	9.53
9	Messi-F ₁	9.50

10	Kheera Local (C)	9.48
11	KL-086	9.45
12	Evergreen	8.48
13	Hoosier	8.39
14	Impress-F ₁	8.38
15	Farah-F ₁	8.34
16	NCH-2	8.19
17	CU-6530-F ₁	8.00
18	Crown	7.66
19	HC-999-F ₁	5.12
LSD (0.05)		3.37

In this set data reveals that seven genotypes (Advanta-728, Advanta-703, Falcon, Denar, Chamn, Valley and Indus) showing results higher in yield than check variety Kheera Local. Three genotypes GHC-2, Messi and KL.086 are equal to check and all others are below check in yield. Those varieties that start fruits early fetch higher prices in the market in early days of fruit season. Local variety has ability to tolerate more heat as compared to others.

19. BRINJAL (*Solanum nigrum* L.)

19.1 EVALUATION OF EXOTIC BRINJAL VARIETIES/HYBRIDS IN ADAPTABILITY TRIAL DURING 2016-17

The seed of seventeen brinjal entries including checks were sown on 29-12-2016 for raising the nursery and seedlings were transplanted in the field on 17-03-2017. The trial was laid out according to Randomized Complete Block Design with three replications in a plot size of 5.5 × 1.5m. The seedlings were transplanted with plant to

plant distance of 45 cm. Standard cultural practices and plant protection measures were adopted. The fruit yield data is given in the table below.

Table-86 Performance of Brinjal Entries during Kharif 2016-17

Rank	Genotypes	Yield (T/ha)
1	Jhansi-F ₁	23.1
2	Btbr-02	19.9
3	Var kokila	19.6
4	Cluster king-F ₁	19.6
5	Advanta-303-F ₁	19.4
6	Epc-900-F ₁	19.0
7	VRIB-2013	15.2
8	Choto	15.2
9	Dilnasheen (Check)	14.8
10	WEL	14.3
11	Nirala	13.2
12	Bemisal	13.1
13	Atbr-01	12.6
14	WER	11.6
15	GHB-01	10.4
16	Mardan	9.7
17	Banglore	9.0
LSD (0.05)		1.9

The data shown in the above table reveals that six hybrids i.e. Jhansi-F₁, Btbr-02, Var kokila, Cluster king-F₁, Advanta-303-F₁, Epc-900-F₁ are above round. They are significantly different from check while all others are below than check variety in fruit yield. None of the variety is tolerant against fruit and shoot borer. Only white eggplant is less attractive to fruit and shoot borer.

20. CORIANDER (*Corriandrum sativum*)

20.1 MAINTENANCE OF CORANDER VARIETIES DURING RABI 2016-17

Two coriander varieties named as Dilpazeer and Qandhari were sown on 25-10-2016 in Isolations in order to maintain the purity. Isolation was created by keeping the distance of one kilometer between the entries. The plot size was kept as 5 m × 0.75 m. The recommended agronomic and plant protection measures were adopted to maintain

the crop. True to type plants were selected and maintained. The crop was harvested at maturity and the seed was collected for further studies.

20.2 EVALUATION OF CORRIANDER VARIETIES IN ADAPTABILITY TRIAL DURING 2016-17

Two coriander varieties including check named as Omega and Dilpazeer were sown on 25-10-2016. The trial was laid out according to paired plot technique with 10 replications in a plot size of 5.5m x 0.75m. Standard cultural practices and plant protection measures were adopted. Fresh leaves yield data was recorded and are given in the table below

Table-87 Performance of Coriander varieties during 2016- 17

Rank	Entries	Yield (T/ha)
1	Dilpazeer (Check)	12.7
2	Omega	9.45
T calculated		11.74

The t test results are given in the above table showing that the two varieties are significantly different in yield from each other.

21. SPINACH (*Spinacia oleracea*)

21.1 MAINTENANCE OF SPINACH VARIETIES DURING RABI 2016-17

Two spinach varieties named as Desi Palak and Lahori Palak were sown on 25-10-2016 in Isolations in order to maintain the purity. Isolation was created by keeping the distance of one kilometer between the entries. The plot size was kept as 5 m × 0.75 m. The recommended agronomic and plant protection measures were adopted to maintain the crop. True to type plants were selected and maintained. The crop was harvested at maturity and the seed was collected for further studies.

22. GARLIC (*Allium sativum*)

22.1 MAINTENANCE OF GARLIC GERMPLASM

Two clones of garlic Gulabi and white were sown in the field on 25-10-2016 by keeping plant to plant and row to row distance of 10 cm and 20 cm, respectively in a plot size of 7 m × 3 m. The crop was observed closely and diseased plants were rouged out to produce pure seed.

22.2 NUYT of Garlic Genotypes sown at vegetable Research Institute Faisalabad During 2016-17

Eight Genotypes included check (3 clones from NARC Islamabad and 5 included by VRI, FSD) were tested for their performance in a trial at vegetable research institute, Faisalabad. Sowing was done on 9-11-2016 in randomized complete block design with three replications. The plot size was kept as 4 × 0.6m with plant to plant distance of 10cm. The recommended cultural and plant production measures were adopted to maintain the crop. The Clones W1-16, G3-16 and check (lehssan gulabi) were harvested on 14-4-2017, and the remaining five clones were harvested on 17-5-2017. The Clones (G-16014, G-16020, G2-16, G-16005 and W2-16) took 33days more to mature. Yield data and clove formation percentage is given in the following table.

Table-88 Performance of Garlic Genotypes in NUYT 2016-17

Rank	Genotypes	Clove formation	Yield
1	G-16014	100%	24.99
2	Wi-16	100%	15.4
3	G3-16	100%	13.7
4	Lehssan Gulabi (C)	100%	11.7
5	G2-16	50%	7.91
6	G-16005	40%	6.67
7	W2-16	40%	5.83
8	G-16020	30%	5.41
LSD (0.05)			1.04

Above data shows that three clones surpassed the check Lehssan Gulabi in yield comparison but the clones G-16014, G-16005, G-16020, G2-16 and W2-16 took 33 days more to mature. These aforesaid clones also respond differently as regards to clove formation. The genotype G-16014 only showed bolting behavior.

23. VEGETABLE MARROW (*Cucurbitapepo*)

23.1 MAINTENANCE OF VEGETABLE MARROW LINES

To maintain two biotypes of vegetable marrow Round Shape was sown on 10.11.2016 in isolation chamber having area of 15 merla by keeping plant to plant distance of 40 cm and row to row distance of 125 cm in research area of VRI, A.A.R.I., Faisalabad. Picking of matured true to type fruits was done during March 2017. Fruits were stored under shade and later on seed was extracted and stored after sun drying.

Pear Shape was sown on 03.03.2017 by keeping plant to plant distance of 40 cm and row to row distance of 125 cm in Agronomy area A.A.R.I., Faisalabad. Picking of true to type matured fruits was done during 3rd week of June 2017. Fruits were stored under shade and later on seed was extracted and stored after sun drying.

23.2 DEVELOPMENT OF INBRED LINES

Inbred line development programme have been initiated in vegetable marrow with an aim to develop hybrids. Sowing of crop material was done on 24.02.2017 by keeping plant to plant spacing of 40 cm and row to row spacing of 125 cm. For the purpose of selfing, male and female flowers were closed with jute string “Seba” one day before flower opening. Next day, just after the sunrise, jute string “Seba” was removed and male flowers were detached from the plant. After removing sepal and petals of the male flower, its androecium was gently touched on stigma of female flower of the same plant. Female flowers were again closed with jute string to avoid stray pollen contamination due to honeybee’s visit, and female flowers were tagged for the purpose of identification. At maturity, fruits were picked individually and seed was extracted.

Table- 89 S₀ GENERATION

S. No.	Variety/Hybrid	No. of Fruits
1	Mishal F ₁	1
2	Cavili F ₁	1
3	Malika F ₁	1

S₁ GENERATION

S. No.	Name of Genotype	No. of Fruits
1	Squash Green	1
2	Tiger Ball	1
3	Sultan	1
4	Mani Pani	1
5	Sitara	1
6	Oval Shape	1
7	Oval Star	1
8	Dallar	1

9	Dalas	1
10	SQ-35-52	1
11	Euro	1

S₂ GENERATION

S. No.	Name of Genotype	No. of Fruits
1	Cash Ball	1
2	Round Ball	1

23.3 EVALUATION OF HYBRID COMBINATIONS IN VEGETABLE MARROW

Seventeen cross combinations along with one local check for their performance in a yield trial at Vegetable Research Institute, Faisalabad during Kharif 2017. Sowing of cross combinations was done on 24.02.2017 in Randomized Complete Block Design with three replications. The plot size was kept as 5.0 × 1.25 m with plant to plant distance of 40 cm. The recommended agronomic and plant protection measures were adopted. The data recorded for fruit yield is presented below.

Table-90 Evaluation of Hybrid Cross combinations in Vegetable Marrow (Set-1)

Rank	Crosses	Yield (T/ ha)
1	Pear Shape (Check)	7.25
2	1503×1521	0.97
3	1503×1528	0.58
4	1506×1502	5.78
5	1506×1511	2.18
6	1506×1519	5.03
7	1506×1527	0.45
8	1509×1528	3.67
9	1510×1527	2.23
10	1510×1528	5.83
11	1511×1528	5.09
12	1516×1522	4.11
13	1519×1509	3.90
14	1521×1503	1.00
15	1521×1528	2.51

16	1527×1503	2.43
17	1527×1506	1.26
18	1528×1510	0.53
LSD (0.05)		1.00

The above table reveals that none of the cross combination could compete with the local check (Pear Shape) regarding yield. So there is no need of use of such combinations in further breeding programmes.

23.4 EVALUATION OF EXOTIC VARIETIES/ HYBRIDS IN ADAPTABILITY TRIAL

Thirty eight exotic varieties/hybrids received from different seed companies were tested along with one local check for their performance in adaptability trial at Vegetable Research Institute, Faisalabad during Kharif 2017. Five entries among thirty eight varieties/hybrids were tested under tunnel while remaining thirty three entries were tested in open filed. Sowing of tunnel crop was done on 10.11.2016 while of open filed crop was done on 24.02.2017 according to Randomized Complete Block Design with three replications. The plot size was kept as 5.0 × 1.25 m with plant to plant distance of 40 cm. The recommended agronomic and plant protection measures were adopted to maintain the crop. The data recorded for fruit yield is presented below.

Table-91 Performance of Exotic Vegetable Marrow at Vegetable Research Institute, Faisalabad during 2016-17 (Set-1)

Rank	Genotypes	Fruit Yield (T/Ha)
1	Mishal F ₁	26.40
2	Cavili F ₁	25.07
3	Malika F ₁	24.16
4	Oval Star	22.83
5	Cash Ball	22.72
6	Green Star	20.96
7	Long 1702 F ₁	20.91
8	Nimra F ₁	19.15
9	Frozen F ₁	17.97
10	Tiger Ball	17.81
11	Asma F ₁	16.53
12	Falak F ₁	15.15

13	Sama F ₁	14.55
14	TSQ-221	13.31
15	Beauty 222	11.95
16	Amber AB	11.52
17	Pear shape (Check)	7.25
18	TSQ-223	7.20
LSD (0.05%)		1.44

The results from the above table showed that all exotic varieties/hybrids except TSQ-223 produced significantly higher fruit yields than local check entry Pear shape (7.25 t/ha). The highest fruit yield was recorded in exotic entry Mishal (26.40 t/ha).

Table-92 Performance of Exotic Vegetable Marrow at Vegetable Research Institute, Faisalabad during 2016-17 (Set-2)

Rank	Genotypes	Fruit Yield (T/ha)
1	Avila F ₁	21.0
2	Money Pani	20.9
3	Olper F ₁	20.8
4	Emerald F ₁	18.3
5	TSQ-01	17.0
6	TSQ-02	16.8
7	SQ-35-53-F ₁	16.4
8	RSQ-6700 F ₁	16.2
9	Euro F ₁	14.0
10	Dallas F ₁	13.9
11	Oskar F ₁	13.9
12	Squash Zeenat F ₁	13.6
13	Kamala F ₁	12.2
14	SQ-35-52-F ₁	11.4
15	Marina F ₁	10.3
16	Green Boy ACS	7.0
17	Pear shape (Check)	7.25
LSD (0.05)		1.00

The above table reveals that all exotic varieties/hybrids except Green Boy produced significantly higher fruit yields than local check entry Pear shape (7.25 t/ha). The entry namely Avila exhibited the highest fruit yield of 21.0 t/ha among all tested genotypes.

Table-93 Performance of Exotic Vegetable Marrow at Vegetable Research Institute, Faisalabad during 2016-17 (Set-3 under Tunnel)

Rank	Genotypes	Fruit Yield (T/ha)
1	Anita	49.75
2	SV2987 YL	49.39
3	PS-719	48.00
4	SV 3923 YL	42.17
5	Clarita	40.44
6	Pear shape (Check)	28.23
	LSD (0.05)	2.14

The table reveals that all entries depicted significantly higher fruit yields than local check entry Pear shape (28.23 t/ha). However, the highest fruit yield was recorded in exotic entry namely Anita of 49.75 t/ha.

24. TINDA GOURD (*Citrullus vulgaris* var. *fistulosus*)

24.1 MAINTENANCE OF TINDA GOURD VARIETY

The tinda gourd variety namely “Dilpasand” was maintained in isolation. For this purpose, the crop was sown on 28.03.2017 by keeping plant to plant distance of 40 cm and row to row distance of 250 cm on an area of 1 acre. Picking of matured true to type fruits was done during 3rd week of June 2017. Fruits were stored under shade and later on seed was extracted and stored after sun drying.

24.2 EVALUATION OF TINDA GOURD ACCESSION FOR FURTHER HYBRIDIZATION PROGRAMME

In order to develop source population in tinda gourd twenty new accessions had been sown on 17.03.2017 by keeping plant to plant spacing of 40 cm and bed width of 2.50 m (planted on both sides). These accessions had been open pollinated for accumulation of superior genes and on maturity the ten superior plants had been selected for further hybridization programmes.

24.3 DEVELOPMENT OF INBRED LINES

Inbred line development programme is in progress in tinda gourd with an aim to develop hybrids. Sowing of crop material was done on 17.03.2017 by keeping plant to plant spacing of 40 cm and bed width of 2.50 m (planted on both sides). For the purpose of selfing, male and female flowers were covered with butter paper bags one day before flower opening. Next day, just after the sunrise butter paper bags were removed and male flowers were detached from the plant and its androecium was gently touched on the

stigma of female flower of the same plant. Selfed female flowers were again covered with butter paper bags to avoid stray pollen contamination through insects and female flowers were tagged for identification. At maturity fruits were picked individually during 29.06.2016 and seed was extracted. The detail of selfed material is given below.

24.4 S₇ GENERATION

Twenty six entries in S₇ generation were sown for the purpose of selfing. Sowing of crop material was done on 17.03.2017. Therefore, selfing was accomplished and seed was extracted individually. The detail of twenty six genotypes selfed is given below;

Table-94 Detail of Selfed Fruits Harvested in S₇ Generation

S. No.	Name of Genotype	No. of Fruits	S. No.	Name of Genotype	No. of Fruits
1	P-35--1-1-9-7-2	1	14	P-24-1-1-7-6-4	1
2	P-35-1-2-8-7	1	15	P-24-1-1-2-5	1
3	P-24-1-1-1-4	1	16	P-24-1-1-2-3	1
4	P-35-1-3-11-8-6	1	17	P-35-1-3-1-2-5-7	1
5	P-34-1-1-1-5-7	1	18	P-24-1-1-7-6-7	1
6	P-35-1-1-9-7-1	1	19	P-35-1-3-1-2-5-2	1
7	P-35-1-3-1-2	1	20	P-24-1-1-4-5	1
8	P-24-1-1-2-2	1	21	P-35-1-3-1-8-10	1
9	P-35-1-2-6-9	1	22	P-24-1-1-2-6	1
10	P-35-1-1-9-7-2	1	23	P-35-1-1-9-8	1
11	P-24-1-1-7-6-5-2	1	24	P-24-1-2-3-8	1
12	DP-4-2-2-7	1	25	P-35-1-3-1-2-6-2	1
13	P-35-1-3-1-2-5-1	1	26	P-35-1-1-9-8	1

24.5 EVALUATION OF EXOTIC VARIETIES/ HYBRIDS IN ADAPTABILITY TRIAL

Five exotic varieties/hybrids received from different seed companies were tested along with one local check for their performance in adaptability trial at Vegetable Research Institute, Faisalabad during Kharif 2017. Sowing was done on 17.03.2017 according to Randomized Complete Block Design with 4 replications. The plot size was kept as 5.0 × 2.50 m with plant to plant distance of 40 cm. The recommended agronomic and plant protection measures were adopted to maintain the crop. The data recorded for fruit yield is presented below.

Table-95 Evaluation of Exotic Varieties/Hybrid

Rank	Entry	Fruit Yield
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		(T/Ha)
1	TYNDA	6.40
2	CHAMAN	4.90
3	TTG-01	4.40
4	TTG-02	4.22
5	Dilpasand	4.01
6	HAG-802 A	2.85
LSD (0.05)		0.27

The results from the above table revealed that entry ranked at No. 1 namely TYNDA (6.40 t/ha) produced significantly higher fruit yield than local check Dilpasand (4.01 t/ha). The lowest yield of 2.85 t/ha was depicted by the entry HAG-802A.

25. TURMERIC (*Curcuma longa*)

The crop was planted on 03.04.2016 in agronomy filed on an area of 4 kanal with plant to plant spacing of 20 cm and 60 cm of row to row spacing. All agronomic practices were adopted during the crop season at both locations and digging was started at maturity on 14.02.2017 and completed at 17.02.2017. The crop yield was obtained from Agronomy area as under;

Table-96 Production of Turmeric during 2016-17

S. No.	Tuber types	Yield (Kg)
1	Main Tubers	3244
2	Mother Tubers	1372
Total		4616

26. FENUGREEK (*Trigonella foenum-graecum*)

The trial of seven diverge lines of the said crop were planted on October 19, 2016 on ridges on an area of 10 Anal by keeping R × R distance of 2.50 feet. The trial was planted in randomized complete block design with 2 replications. The yield data of fresh leaf was obtained during December 2016 and February 2017. After getting vegetative cuttings crop was left for seed production and at maturity the seed of seven fenugreek pure lines was obtained on 12.04.2017. The fresh leaf yield and seed data is given in table presented as under;

Table-97 Fresh and seed yield of fenugreek lines during 2016-17

Line	Fresh Leaf	Seed yield (T/ha)
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No.	Yield (T/ha)	
1	1.26	0.023
2	1.30	0.024
3	1.35	0.018
4	1.23	0.025
5	1.28	0.025
6	1.33	0.035
7	1.33	0.023

27. LETTUCE (*Lactuca sativa*)

Five exotic varieties/hybrids received from different seed companies were tested along with one check for their performance in adaptability trial at Vegetable Research Institute, Faisalabad during Rabi 2016-17. The nursery of these genotypes was grown on 24.10.2016 and their subsequent transplanting was done on 01.12.2016 according to Randomized Complete Block Design with 4 replications. The plot size was kept as 7.5 × 0.75 m with plant to plant distance of 40 cm. The recommended agronomic and plant protection measures were adopted to maintain the crop. The data recorded for leaf yield is presented below.

Table-98 Evaluation of Exotic Varieties/Hybrid

Rank	Variety/Hybrid	Leaf yield (T/ha)
1	Kaiser	7.05
2	New Red Fire	6.99
3	Local Salad (Check)	6.76
4	Blazia	5.69
5	Grand King	5.87
6	Adora	5.21
LSD (0.05)		1.45

The table reveals that differences for means due to varieties are significant. None of the exotic variety/hybrid exceeded the local salad (check) significantly. However, two exotic varieties namely; Kaiser (7.05 T/ ha) and New Red Fire (6.99 T/ha) showed higher leaf yield than local Salad (6.76 T/ha). The exotic entry namely Adora (5.21 T/ha) produced significantly lower leaf yield as compared with the check.

