1. TOMATO (Solanum lycopersicum L.)

1.1 MAINTENANCE OF GENE POOL

292 genotypes of both determinate (144) and indeterminate (148) types of local & exotic origins were sown for the purpose of maintenance. The nursery of indeterminate genotypes was sown on 18.10.2017 and transplanted on 04.12.2017 whereas; the nursery of determinate genotypes was sown on 31.10.2017 and transplanted on 27.12.2017. The plot size was kept as 4.5×0.75 m and 7.5×1.25 m for indeterminate and determinate genotypes respectively. The detailed below entries were maintained during the year:

	DETERMINATE									
S.	Entry	S.	Entry	S.	Entry					
No.	•	No.		No.						
1	09065	49	17265	97	Nagina					
2	10114	50	17266	98	Nageeb					
3	10139	51	17267	99	NB-242					
4	10142	52	17268	100	NB-326					
5	10143	53	17269	101	NI-Cherry					
6	10160	54	17270	102	No. 109					
7	10173	55	17271	103	NTH-242					
8	10178	56	17272	104	Ox Heart					
9	13189	57	3001 (Akbar)	105	Pakit					
10	13198	58	Alaskan Fancy	106	Polar Baby					
11	13202	59	AUT-302	107	Prescott					
12	13205	60	AUT-305	108	QF-Red-Rio Fuego-2-1-5-4-7					
13	13209	61	AUT-309	109	Rio Grande					
14	13210	62	AUT-312	110	RK Raksha					
15	13213	63	AUT-315	111	Rocky (Akbar)					
16	13215	64	AUT-318	112	Roma					
17	13216	65	AUT-324	113	Saad-49					
18	13218	66	AUT-330	114	Savana					
19	13220	67	AVTOV-1002-LO-2752-0-3-7-11-5	115	Summer Sensation					
20	13229	68	AVTOV-1002-LO-2752-2-4-15-8-9	116	Stripped Stuffer					
21	13230	69	Beaverlodge Slicer-10184-11-25-5	117	Tiny Tim					
22	13232	70	Big Beef	118	T-04					
23	13234	71	Bonita	119	T-95					
24	13239	72	CLN-2123 C	120	T-96					
25	13240	73	CLN-2498 D	121	T-97					
26	16241	74	Feston Early	122	T-117					
27	16242	75	Flame	123	TAI-687/786-6-3-2-19-1-2					
28	16243	76	Glacier	124	TAI-687/786-6-3-15-6-0					
29	16244	77	Grushovka	125	TAI-687/786-6-3-15-5-9					
30	16245	78	Invictus Lot-335	126	TAI-687/786-6-3-5-1-6					
31	16246	79	IQS-7073 (China)	127	TAI-687/786-6-3-15-13					
32	16247	80	IQS-7080 (China)	128	TAI-687/786-6-3-15-6-3					

 Table-1 Maintenance of Tomato Germplasm Lines / Varieties (2017-18)

33	16248	81	IQS-7	096 (China)	129) T	AI-687/786-6-3-1-5-5-9		
34	16249	82	IQS-7	098 (China)	130) U	C-134		
35	16251	83	IQS-7	099 (China)	13	l Ui	rfa Frengi		
36	16252	84	IQS-7	100 (China)	132	2 W	ayahead		
37	17253 (QF-Red)	85	IQS-7	102 (China)	133	3 Ya	aqui-5-1		
38	17254	86	IQS-7	104 (China)	134	4 Za	arnitza		
39	17255	87	Jaguar	ſ	13	5 Zł	nezha		
40	17256	88	LA-32	231	130	5 Cł	nerry Tomato Round (Taiwan)		
41	17257	89	Legen	d	13	7 Bl	ack Cherry (Taiwan)		
42	17258	90	Lima		138	3 Ye	ellow Cherry (Taiwan)		
43	17259	91	LITTH	I-559-17-5-1-2 (Det)	139) Ch	nerry Tomato Oblong-1 (Taiwan)		
44	17260	92	LO-27	752	140) Ch	nerry Tomato Oblong-2 (Taiwan)		
45	17261	93	LO-27	752-Rio Fuego-33-1-5-6	14	l La	rge Cherry Round (Taiwan)		
46	17262	94	Magli	a Rooa	142	2 Ch	nocolate Cherry (Taiwan)		
47	17263	95	Meiyi	ng No. 2 Cherry	143	3 O1	ange Cherry (Taiwan)		
48	17264	96	Nadir		144	4 Ch	nerry Round (Taiwan-Visit)		
		1		INDETERMINATE	1	I	•		
S.	Entry		S.	Entry		S.	Entry		
No			No			No			
1	08502		51	H Gold-11-2-2-7		100	NSX-6658/59-Bulk		
2	08502 (PL)		52	H Gold-12-2-6-1-1		101	NSX-6658-SPS-2		
3	08503		53	Independence Day		102	Nyagous		
4	08504		54	Italian Heirloom		102	Nepal		
5	08505		55	Iaffa		103	Onalka		
6	08506		56	Kornesevsije		105	Peron		
7	08510		57	LA-2530		105	Porter's Improved		
8	08513		58	LA-2821		107	Puniab Gauray		
9	08514		59	LA-3027		108	Russian Big Roma		
10	08516		60	LA-3216		100	Sahel-2-3-2		
11	08517		61	LA-3238		110	Sahel-4-11-9-5-10-1		
12	08533		62	LA-3296		111	Sahel-4-11-9-5-6		
13	08543		63	LA-3310		112	Sahel-4-11-9-5-6-1		
14	08546		64	LA-3847		113	Salar-11-8-2-1-7 (Oblong)		
15	08553		65	LITTH-539-1-8-4-4-1-2		114	Salar-11-8-2-1-7 (Round)		
16	08566		66	LITTH-539-4-8-4-4-1-1		115	Salar-16-8-6-1-7		
17	08567		67	LITTH-539-4-8-5-1-9		116	Salar-16-8-9-4-7		
18	08581		68	LITTH-539-4-8-6-3-9		117	Salar-16-8-9-4-7-1		
19	08582		69	LITTH-539-4-8-7-6-9		118	Salar-16-8-9-4-7-2		
20	08585		70	LITTH-539-4-8-8-4-9		119	Salar-16-8-9-4-7-2-4		
21	08586		71	LITTH-566-3-3-2-10		120	Salar-16-8-9-6-1-7		
22	08587		72	LITTH-607-1-5-9-4-7		121	Salar-16-8-9-6-2-10		
23	08588		73	LITTH-651-4-9-6-1		122	Salar-16-8-9-6-1-4		
24	08589		74	LITTH-657-2-5-4-1		123	Salar-16-8-9-6-2-4		
25	08590		75	LITTH-657-2-5-9-1		124	Salar-6-8-4-1-5-9		
26	08591		76	LITTH-664-4-7-9-2		125	San Francisco Fog		
27	08594		77	LITTH-664-4-7-9-3		126	Soberano-6-4-1-8		
28	Advanta		78	LITTH-682-1-2-4-7		127	Soberano-6-4-2-4		
29	Amish Paste		79	LITTH-682-4-4-2-3		128	Soberano-6-4-7		
30	Amish Red		80	LITTH-682-4-5-1-9		129	Soberano-6-4-9		
31	Anna-7-6-3		81	LITTH-682-6-7-4-2		130	Stupice		
32	Anna Russian		82	LITTH-682-6-7-4-8		131	Sunset's Red Horizon		
	Deef Steels		83	LITTH-682-6-7-5-8		132	Super Sioux		

34	Believe it or Not	84	LITTH-682-7-3-8-4	133	TAI-687/786-6-3-15-6-3
35	Black Pear	85	LITTH-682-8-5-4-6	134	TAI-687/786-6-3-15-3-1
36	Black Prince	86	LITTH-682-9-1-7	135	TAI-687/786-6-3-15-3-9
37	Bloody Butcher	87	LITTH-682-9-1-7-3	136	TAI-687/786-6-3-15-6-13
38	Bonny Best	88	LITTH-682-9-1-8	137	TAI-687/786-6-3-5-3-7
39	Boxcar Willie	89	LITTH-682-9-1-10-0	138	TAI-687/786-6-3-5-3-3
40	Bradley	90	LITTH-682-11-9-8-2	139	T-Semi
41	Bulgarian Triumph	91	Marion	140	Tigrella
42	Bull's Heart	92	Marmande	141	Tomato Cherry
43	Caspian Pink	93	Moskvich	142	Tropics
44	Cherry-14	94	Mrs. Maxwell's Big Italian	143	T-49
45	Cherry Tomato-3	95	Matina	144	T-63
46	Creole	96	Money Maker	145	T-112
47	Debarao	97	New Cherry	146	T-156
48	Earliana	98	NI-Cherry	147	UAF-1
49	Ela's Yellow Latvian	99	NSX-6658 (S. Ob.)	148	Wisconsin-55
50	Fireworks				

1.2 HYBRIDIZATION

A. CROSSING WORK TO CREATE GENETIC VARIABILITY

Todevelop high yielding tomato varieties possessing tolerance against biotic and abiotic stresses, nursery of 20 parents each of indeterminate and determinate types was sown on 19.10.2017 and 31.10.2017 respectively. Indeterminate type was transplanted on 04.12.2017 whereas; determinate type was transplanted on 27.12.2017 in crossing blocks to create genetic variability for the selection of desired progenies as well as for heterosis studies. Crosses were attempted to produce F_0 hybrid seed suitable for open field and tunnel cultivation. The detail of successful cross combinations is presented in table below.

	I	NDE	TERMINAT	E		DETERMINATE					
S. No.	Hybrid	S. No.	Hybrid	S. No.	Hybrid	S. No.	Hybrid	S. No.	Hybrid	S. No.	Hybrid
1	Saandal F ₁	28	LITTH-906	55	LITTH-938	1	Ahmar Hybrid	18	LTH-499	34	LTH-515
2	Salar F ₁	29	LITTH-909	56	LITTH-939	2	LTH-381	19	LTH-500	35	LTH-516
3	Surkhail F ₁	30	LITTH-909	57	LITTH-940	3	LTH-440	20	LTH-501	36	LTH-517
4	LITTH-707	31	LITTH-910	58	LITTH-941	4	LTH-460	21	LTH-502	37	LTH-518
5	LITTH-710	32	LITTH-911	59	LITTH-942	5	LTH-461	22	LTH-503	38	LTH-519
6	LITTH-765	33	LITTH-912	60	LITTH-943	6	LTH-462	23	LTH-504	39	LTH-520
7	LITTH-779	34	LITTH-917	61	LITTH-944	7	LTH-464	24	LTH-505	40	LTH-521
8	LITTH-818	35	LITTH-918	62	LITTH-945	8	LTH-484	25	LTH-506	41	LTH-522
9	LITTH-832	36	LITTH-919	63	LITTH-946	9	LTH-486	26	LTH-507	42	LTH-523
10	LITTH-835	37	LITTH-920	64	LITTH-947	10	LTH-491	27	LTH-508	43	LTH-524
11	LITTH-836	38	LITTH-921	65	LITTH-948	11	LTH-492	28	LTH-509	44	LTH-525
12	LITTH-842	39	LITTH-922	66	LITTH-949	12	LTH-493	29	LTH-510	45	LTH-526
13	LITTH-844	40	LITTH-923	67	LITTH-950	13	LTH-494	30	LTH-511	46	LTH-527
14	LITTH-861	41	LITTH-924	68	LITTH-951	14	LTH-495	31	LTH-512	47	LTH-528
15	LITTH-867	42	LITTH-925	69	LITTH-952	15	LTH-496	32	LTH-513	48	LTH-529

Table-2 List of tomato crosses (F₀) made during 2017-18

16	LITTH-873	43	LITTH-926	70	LITTH-953	16	LTH-497	33	LTH-514	49	LTH-530
17	LITTH-875	44	LITTH-927	71	LITTH-954	17	LTH-498				
18	LITTH-878	45	LITTH-928	72	LITTH-955						
19	LITTH-879	46	LITTH-929	73	LITTH-956						
20	LITTH-882	47	LITTH-930	74	LITTH-957						
21	LITTH-884	48	LITTH-931	75	LITTH-958						
22	LITTH-885	49	LITTH-932	76	LITTH-959						
23	LITTH-887	50	LITTH-933	77	LITTH-960						
24	LITTH-888	51	LITTH-934	78	LITTH-961						
25	LITTH-891	52	LITTH-935	79	LITTH-962						
26	LITTH-904	53	LITTH-936	80	LITTH-963						
27	LITTH-905	54	LITTH-937	81	LITTH-964						

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

Two (2) indeterminate tomato parental lines were sown on 19.10.2017 and transplanted on 08.12.2017 on an area of one kanal. Only one cross combination was attempted to produce the seed of approved indeterminate tomato hybrid namely Saandal F_1 . A total of 0.5 kg of indeterminate tomato hybrid seed suitable for high tunnels cultivation was produced for general cultivation.

C. EFFECT OF REPEATED POLLINATION ON TOMATO HYBRID SEED YIELD UNDER FIELD CONDITIONS

To assess the effect of repeated pollination on tomato hybrid seed yield an experiment comprising of two parental lines of an approved indeterminate tomato hybrid **Saandal F**₁ was planted under high tunnel on 08.12.2017 at VRI, Faisalabad. At the time of flowering, crossings were made as per plan and following results were obtained;

Temperature $(17^{0}C - 28.6^{0}C)$							
Parameter	T ₁	T_2	T ₃	T_2-T_1	T ₃ - T ₁		
Mean of fruit setting %	54.6	71.0	75.2	-	-		
Mean number of seeds per fruit	26.1	39.2	41.4	-	-		
Combined number of seeds	1423.7	2783.9	3112.4	95.5 %	118.6 %		
Temperature $(30^{\circ}C - 33^{\circ}C)$							
Mean of fruit setting %	72.3	67.3	51.7	-	-		
Mean number of seeds per fruit	29.9	44.9	38.6	-	-		
Combined number of seeds	2158.7	3020.7	1997.4	39.9 %	-7.5 %		
Temperature $(17^{\circ}C - 33^{\circ}C)$							
Mean of fruit setting %	60.5	69.8	67.3	-	-		
Mean number of seeds per fruit	27.3	41.1	40.5	_	_		
Combined number of seeds	1653.9	2867.8	2725.9	73.4 %	64.8 %		

 Table-3 Percent increase / decrease in overall seed number on account of repeated pollination

The study has proved that there has been considerable increase in fruit setting and number of seeds/fruit by involving two times (T₂) and three times (T₃) pollinations. However, considering relationship of pollination frequencies and variable temperatures (day max.) it has been concluded that two times pollination (T₂) remained more effective as compared to one time (T₁), and three times (T₃) especially at a temperature range of $17^{0}C - 28.6^{0}C$. However, beyond this temperature ($30^{0}C - 33^{0}C$) repeated pollination appears to be ineffective in general as there is decrease in T₂ and drastic reduction of seed yield in T₃. Therefore, it is concluded that two times pollination (T₂) at a temperature range of $17^{0}C - 28.6^{0}C$ is more economical on account of 95.5 % more seed yield. Beyond this, there is a further increase in seed yield (118.6 %) by involving three times pollination (T₃) but the seed producer should also consider the engagement of extra labour as it may increase the seed cost.

1.3 NUTRITIONAL ANALYSIS OF TOMATO FRUIT(S)

Tomato is a rich source of nutritional components required to fulfill the human daily dietary needs. To estimate the important nutritional constituents present in tomato fruits with an aim to use the better ones in breeding program, the fruit samples of different genotypes (hybrids, varieties, advanced lines etc.) were supplied to three different Authorized Testing Labs. The results of these Labs are as under;

S.	Genotype	Lycopene	Total Sugar	Ascorbic Acid	Beta Carotene			
No.		(mg/100 g)	(%)	(mg/ 100 ml)	(µg/100 g)			
Determinate types								
1	Ahmar Hybrid	5.11	6.63	20.0	174.08			
2	Nadir	4.92	6.77	16.5	188.6			
3	Naqeeb	5.41	6.63	23.1	174.6			
4	Roma	6.11	5.53	19.8	186.9			
5	Pakit	6.70	6.33	19.8	196.7			
6	Nagina	6.72	6.74	22.3	184.8			
7	T-1359 F ₁	5.71	7.04	16.5	187.4			
8	AUT-305	5.89	6.18	18.3	207.8			
9	AUT-309	5.34	7.01	22.1	217.7			
10	UAF-1 Cherry	7.03	5.64	19.8	203.4			
11	10139	7.73	7.08	23.1	208.2			
12	10142	8.76	6.37	21.1	222.5			
13	10173	7.73	7.11	20.1	192.7			
14	13198	4.73	7.13	19.8	216.3			
15	13213	5.34	6.37	23.1	206.9			
16	13239	6.33	6.16	21.9	170.9			
17	17253	4.49	6.26	21.5	177.4			

Table-4 Nutritional Analysis of Tomato Fruit Conducted by Post Harvest Research Centre, Ayub Agricultural Research Institute, Faisalabad

18	17263	5.25	6.06	20.6	190.2
		Inde	terminate type	S	
19	Sahel F ₁	17.36 ± 0.43	6.48 ± 0.03	23.7 ± 0.51	206.82 ± 3.22
20	Surkhail F ₁	6.53 ± 0.36	6.40 ± 0.03	22.1 ± 0.40	165.38 ± 4.39
21	Saandal F ₁	5.37	6.93	17.54	168.06
22	Salar F ₁	5.09	7.98	20.17	170.48
23	Sundar Hybrid	5.23	6.73	22.81	189.60
24	LITTH-682	530	5.43	20.0	178.66
25	LITTH-710	6.63	6.09	22.5	172.46
26	LITTH-765	6.48	6.40	22.5	210.79
27	LITTH-779	5.25	6.13	20.0	171.81
28	LITTH-818	5.71	6.40	22.9	169.79
29	08502	4.87	6.19	21.92	175.85
30	08504	5.20	5.80	16.66	170.70
31	08505	6.01	6.28	19.29	178.27
32	08543	4.80	6.06	20.17	159.31
33	08594	5.28	5.43	22.80	157.39
34	17595	8.19	6.69	22.9	184.9
35	17596	5.10	6.47	19.3	196.2
36	17597	5.45	6.33	18.4	193.25
37	17598	6.90	6.34	21.3	205.6
38	17599	6.48	6.26	16.7	183.13

Table-5 Nutritional Analysis of Tomato Fruit Conducted by Pakistan Council of Science & Industrial Research (PCSIR), Ferozpur Road, Lahore

S. No.	Genotype	Lycopene (mg/100 g)	Total Sugar (%)	Vitamin C (mg/ 100 g)	Beta Carotene (mg/100 g)				
	Determinate types								
1	10139	2.68	4.50	4.37	0.06				
2	17253	0.29	4.75	3.09	0.03				
3	17269	0.45	4.75	2.91	0.09				
4	T-1359 F ₁	9.37	5.00	3.54	0.11				
5	Nadir	2.16	3.25	2.96	0.09				
6	Naqeeb	0.48	4.50	4.52	0.08				
		Inde	eterminate type	S					
7	Sahel F ₁	3.79	1.44	2.85	0.40				
8	Surkhail F ₁	8.46	0.79	4.66	0.64				
9	Saandal F ₁	4.96	2.06	5.06	0.54				
10	08567	1.31	5.25	4.66	0.11				

Table-6 Nutritional Analysis of Tomato Fruit Conducted by Institute of Soil Chemistry and Environmental Sciences, Ayub Agricultural Research Institute, Faisalabad

S. No.	Genotype	Calcium (%)	Phosphorus (%)	Potassium (%)	Iron (mg/kg)	Zinc (mg/kg)			
Determinate types									
1	Ahmar Hybrid	0.62	0.23	5.35	101.32	26.04			
	Indeterminate types								

2	Surkhail F ₁	0.61	0.23	3.62	12.89	19.07
3	Saandal F ₁	0.68	0.18	5.86	52.88	19.48
4	Salar F ₁	0.80	0.28	7.37	55.75	25.24
5	Sundar Hybrid	0.68	0.22	5.35	60.83	21.62
6	Sahel F ₁	0.66	0.29	3.88	47.72	23.05
7	08502	0.72	0.33	6.87	69.73	24.01
8	08504	0.68	0.24	6.36	59.98	22.74
9	08505	0.70	0.28	6.36	54.47	27.37
10	08543	0.72	0.32	5.35	75.66	31.46
11	08594	0.62	0.30	5.35	70.79	27.77
12	17596	0.56	0.17	4.34	46.09	13.26
13	17597	0.66	0.29	5.35	98.25	26.06
14	17598	0.64	0.27	4.85	53.31	18.13
15	17599	0.60	0.42	4.85	102.59	35.68
16	LITTH-682	0.66	0.22	5.35	38.57	20.29
17	LITTH-710	0.58	0.23	4.34	67.50	15.90
18	LITTH-765	0.68	0.20	4.85	26.18	23.44
19	LITTH-779	0.64	0.21	5.35	97.08	15.34
20	LITTH-818	0.52	0.21	4.34	17.38	18.41

1.4 STUDY OF FILIAL GENERATIONS

To advance the generations of indeterminate type, the nursery of different segregating generations was sown on 18.10.2017 and transplanted on 07.12.2017 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 27.10.2017 and transplanted on 13.12.2017 in open field. The desired progenies/ lines were selected and the detail of generations/ number of selected plant progenies is given in following table:

S. No.	Cross	Single Plant Progenies							
		Selected							
	a) INDETERMINATE TYPES								
F ₂ Gen	F ₂ Generations								
1	TAI-687/786-6-3-15-7 [Ind] (08587) × AUT-309	5							
2	Lyco [L. S] (08543) \times Polar Baby	1							
3	TWL-99-4-5-1 (08504) × Bonita	2							
4	$Jaffa \times Salar-16-8-9-4-7$	6							
5	TWL-10-3-7-1 (08506) × LITTH-566-3-3-2-10	1							
6	Soberano-6-4-9 × Salar-16-8-9-4-7	6							
7	Pantano \times Salar-16-8-9-4-7	3							
8	Salar-11-8-2-1-7 (Oblong) × Kornesevsije	5							
9	NSX-6658-SPS-1 × Lyco [L. S] (08543)	5							

Table-7 Study/ Selection of Progenies from Filial Generations (2017-18)

10	08504 (H. Oblong) × Lyco [L. S] (08543)	2
11	TWL-33-5-2-1 (08517) × LITTH-566-3-3-2-10	1
12	Qasba *	1
13	Cherry Tomato *	2
14	Saandal *	4
15	Sahel *	5
F ₃ Gen	erations	
1	08594×08504	3
2	08533×08582	2
3	$08543 \times \text{QF-Red}$	1
4	$08504 \times Polar Baby$	1
5	$08533 \times Polar Baby$	2
6	$08543 \times Polar Baby$	1
7	08504 (H. Ob.) × 08543	1
F4 Gen	erations	
1	Gigantesque \times 08504	4
2	Matina \times 08582	1
3	H. Gold-2-2-6-1 × 08503	4
4	$08543 \times QF-Red$	4
5	08585×08503	3
6	08506 × 08504	2
7	Sahel-2-3-2 × 08504	1
8	$08504 \times Legend$	1
9	Realeza *	2
F5 Gen	erations	
1	08594×08504	5
2	08502 × 08504	6
3	Traveller-76 \times 08504	1
4	Anna *	9
F ₆ Gen	erations	
1	Gigantesque \times 08504	10
2	Carmello \times 08504	1
3	Manapal \times 08504	1
4	$Merion \times 08504$	2
5	Anna *	3
6	Sahel *	1
F7 Gen	erations	
1	08553×08504	3
2	Soberano *	3
	b) DETERMINATE TYPES	
F ₂ Gen	erations	
1	Glacier \times AUT-324	5
2	Nadir \times AUT-324	12
3	10137 × AUT-309	7
4	10139 × AUT-324	6
5	10170 × AUT-305	8
6	CBS-292 *	5
7	SV-3466 *	4

8	14T-4770 *	7
9	Kanwal *	2
10	Qasba *	4
11	Rover *	3
12	TAI-14-6242 *	5
13	Avenue *	5
14	Prasun *	7
15	Solo-1 *	7
16	Turkey	10
17	Sencan	1
F ₃ Gen	erations	
1	AVTOV-1007 × Nadir	13
2	Grushovka \times NTH-242	12
3	Rio Grande × AUT-318	13
4	Rio Fuego × CLN-1621 F	1
5	Solo-1 *	8
6	Super Sindh *	3
7	Kanon *	1
8	Kortaja *	4
9	GAR-12 *	2
10	RS-1312 *	20
11	HT-1570 *	1
12	DRD-8564 *	6
13	Roshan *	16
14	Shamas *	12
15	MDS Red Diamond *	7
16	T-08	1
17	T-078	1
18	AA	3
F ₄ Gen	erations	
1	Naqeeb \times Grushovka	5
2	Nadir \times Grushovka	7
3	Yaqui-5-1 × Grushovka	4
4	Beaverlodge Slicer \times 10184	6
5	MDS Red Diamond *	14
6	Kanwal *	7
7	GHT-2 *	3
8	HN-2855 *	1
9	NBH-2 *	13
10	RS-1312 *	10
F ₅ Gen	erations	
1	Forme de Coeur \times 17-07	1
2	AS-2565 *	4
3	Baby Red *	3
4	Amazon *	2
5	TO-1057 *	4
F ₆ Gen	erations	
1	Pony Express *	9

2	Gemco Star *	1	
3	Advanta-1242/A *	6	
F7 Gen	erations		
1	AVTOV-1002 × LO-2752	30	
* Commercial Variety/ Hybrid			

1.5 PRELIMINARY EVALUATION OF DETERMINATE TOMATO LINES

To evaluate the yield performance of newly selected lines from segregating generations, a trial comprising of 20 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 25.10.2017 and transplanting was done on 12.12.2017 according to Randomized Complete Block Design (RCBD) with three replications in a plot size of 7.5×1.25 m with plant to plant distance of 50 cm. Data recorded for fruit length, fruit width, fruit shape index, fruit weight, fruit firmness and fruit yield is presented in the table below.

Rank	Entry	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit
		length	width	shape	firmness	weight	yield
		(mm)	(mm)	index	(kg/cm^2)	(g)	(T/ha)
				(L/W)			
1	17256	58.4	46.9	1.24	3.80	83.2	50.62
2	17265	62.4	45.6	1.37	3.56	89.6	49.71
3	17261	63.4	48.9	1.30	3.74	90.2	47.39
4	10139	60.5	50.7	1.19	3.84	90.6	46.05
5	17260	62.1	48.4	1.28	3.78	84.8	45.71
6	17257	62.2	50.4	1.23	3.64	96.4	45.39
7	Nadir (Check)	58.2	51.3	1.13	3.78	88.4	45.14
8	Naqeeb (Check)	58.1	49.7	1.17	3.80	87.8	44.54
9	17258	64.4	51.1	1.26	3.62	87.2	44.03
10	17264	65.8	51.4	1.28	3.72	109.6	43.68
11	17254	59.9	46.5	1.29	3.60	84.0	42.95
12	17263	57.7	49.7	1.16	3.76	89.2	42.24
13	17268	55.7	48.1	1.16	3.66	83.2	40.51
14	17255	64.4	49.6	1.30	3.58	97.2	40.40
15	17259	62.6	48.1	1.30	3.74	93.2	40.27
16	Rio Grande (Check)	58.0	48.4	1.20	3.88	84.2	39.57
17	17270	57.5	51.2	1.12	3.68	94.4	36.57
18	17272	56.6	50.4	1.12	3.70	82.4	33.86
19	17271	59.1	50.8	1.16	3.94	85.2	33.67
20	17269	60.8	50.9	1.20	3.84	99.2	33.07
21	17266	63.1	54.7	1.15	3.80	106.4	32.41
22	17262	67.4	47.3	1.42	3.80	92.8	31.03
23	17267	51.4	45.2	1.14	3.70	65.6	28.49

Table-8 Performance of Determinate Tomato Advanced Lines inPreliminary Yield Trial at VRI, Faisalabad during 2017-18

The perusal of table indicates that differences among means for fruit yield due to varieties were significant. The entries ranked at No. 1 & 2 namely 17256 (50.62 t/ha) and 17265 (49.71 t/ha) produced significantly higher fruit yields than the high yielding check Nadir (45.14 t/ha). However; the entries ranked at No. 4 - 6 & 9 - 12 remained statistically at par in terms of fruit yields against the highest yielding check Nadir. The lowest fruit yield of 28.49 t/ha was depicted by the entry 17267.

1.6 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 25.10.2017 and transplanted on 12.12.2017 in a Randomized Complete Block Design with three replications. The plot size was kept as 7.5×1.25 m with plant to plant distance of 50 cm. Data recorded for fruit length, fruit width, fruit shape index, fruit weight, fruit firmness and fruit yield is given in the table below.

Rank	Entry	Fruit length (mm)	Fruit width (mm)	Fruit shape index (L/W)	Fruit firmness (kg/cm ²)	Fruit weight (g)	Fruit yield (T/ha)
1	13234	57.7	50.0	1.15	3.70	82.6	51.11
2	13240	44.7	44.5	1.00	3.66	64.8	50.92
3	10139	61.4	48.5	1.27	3.82	87.4	50.47
4	Nadir (Check)	57.2	50.5	1.13	3.80	86.2	49.28
5	16249	51.7	49.0	1.06	4.12	75.2	48.15
6	Naqeeb (Check)	57.6	48.6	1.19	3.82	83.8	45.96
7	13239	61.4	51.9	1.18	3.68	90.4	45.44
8	16245	61.5	46.7	1.32	3.86	84.0	44.42
9	13229	55.9	47.4	1.18	3.74	75.8	44.15
10	Rio Grande (Check)	59.3	50.4	1.18	3.92	85.4	41.06
11	16252	53.7	51.8	1.04	4.04	94.4	39.22
	LSD (0.05)						3.71

Table-9 Performance of Determinate Tomato Advanced Lines inStation Yield Trial at VRI, Faisalabad during 2017-18

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 performed statistically at par in terms of fruit yields in comparison with the highest yielding check entry Nadir (49.28 t/ha). The highest yield was produced by the entry 13234 (51.11 t/ha) and lowest fruit yield was recorded in entry 16252 (39.22 t/ha).

1.7 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 five (5) entries along with three checks (Nadir, Naqeeb & Rio Grande) was conducted at four different locations viz; VRI Faisalabad, VRSS Sheikhupura, VRSS Multan and VRSS Bahawalpur. The nursery of these lines was sown on 23.10.2017. 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	12.12.2017	7.5 × 1.25 m
VRSS, Sheikhupura	20.12.2017	$7.0 \times 1.25 \text{ m}$
VRSS, Multan	22.12.2017	$7.0 \times 1.25 \text{ m}$
VRSS, Bahawalpur	22.12.2017	$7.0 \times 1.25 \text{ m}$

Table-10 Performance of Determinate	Tomato Advanced Lines in
Multi-locational / Zonal Trials at VRI,	Faisalabad during 2017-18

Rank	Entry	Fruit length (mm)	Fruit width (mm)	Fruit shape index (L/W)	Fruit firmness (kg/cm ²)	Fruit weight (g)	Fruit yield (T/ha)
1	10173	56.4	49.2	1.15	3.78	79.2	53.38
2	Nadir (Check)	59.0	51.7	1.14	3.82	89.2	50.15
3	10142	56.2	48.6	1.16	3.80	88.4	48.82
4	10139	56.7	46.5	1.22	3.86	80.4	46.40
5	13239	51.8	48.6	1.07	3.66	77.8	46.10
6	Naqeeb (Check)	60.9	49.4	1.23	3.78	87.2	44.11
7	Rio Grande (Check)	59.1	49.6	1.19	3.94	86.8	42.08
8	13198	60.0	50.0	1.20	3.92	91.2	28.33
	LSD (0.05)						3.03

It is evident from the above table that differences among means for fruit yield due to varieties were significant. The top ranked entry namely 10173 produced significantly higher fruit yield against the highest yielding check Nadir (50.15 t/ha). Similarly, the entry ranked at No. 3 namely 10142 (48.82 t/ha) performed statistically at par in terms of fruit yield in comparison with the higher yielding check Nadir. The lowest fruit yield of 28.33 t/ha was depicted by the entry 13198.

Donk	Entw		Fru	it yield (T/	eld (T/ha)				
Nalik	Entry	FSD	S. Pura	Multan	B. Pur	Average			
1	10173	53.38	37.87	30.27	17.18	34.68			
2	10142	48.82	36.65	29.01	15.98	32.62			
3	10139	46.40	34.59	29.43	18.42	32.21			
4	Nadir (Check)	50.15	33.73	26.61	14.63	31.28			
5	Naqeeb (Check)	44.11	30.76	27.22	15.03	29.28			
6	13239	46.10	28.10	24.97	13.30	28.12			
7	Rio Grande (Check)	42.08	29.43	24.23	12.34	27.02			
8	13198	28.33	23.83	22.38	10.80	21.34			
	LSD (0.05)	3.03	2.08	2.19	2.36	-			

 Table-11 Performance of Determinate Tomato Advanced Lines in

 Multi-locational / Zonal Trials at Different Locations during 2017-18

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 10173 produced higher fruit yield of 34.68 t/ha against the highest yielding check Nadir which gave an average fruit yield of 31.28 t/ha. The lowest average fruit yield of 21.34 t/ha was depicted by the entry 13198.

1.8 EVALUATION OF EXOTIC TOMATO VARIETIES/ HYBRIDS IN ADAPTABILITY TRIAL

A. DETERMINATE TYPES

Thirty eight (38) exotic determinate tomato hybrids/ varieties received from different Seed Companies were tested along with three checks namely T-1359 F_1 (exotic), Ahmar Hybrid (local) and Nadir (local) in three sets for their performance in adaptability trial at Vegetable Research Institute, Faisalabad during Rabi, 2017-18. 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 shape index, fruit firmness, fruit weight and fruit yield is presented below.

Table-12 Performance of Exotic Determinate Tomato Varieties/ Hybrids in
Adaptability Trial at VRI, Faisalabad during 2017-18

<u>Set-1</u>

Date of nursery sowing:	25.10.2017
Date of transplanting:	13.12.2017
Plot size:	7.5 imes 1.25 m
Plant to plant distance:	50 cm

Rank	Variety/ Hybrid	Fruit	Fruit	Fruit	Fruit	Ave.	Fruit
		length	width	shape	firmness	fruit	yield
		(mm)	(mm)	index	(kg/cm^2)	weight	(T/ha)
				(L/W)		(g)	
1	14T-1184 F ₁	50.1	49.0	1.02	3.58	72.4	52.35
2	Randah F ₁	53.4	49.0	1.09	3.64	80.8	52.18
3	TAI-14-6242	52.7	45.1	1.17	3.72	73.6	50.11
4	TO-2048	51.0	47.6	1.07	3.82	65.2	48.34
5	Kama F ₁	57.2	48.3	1.18	3.52	74.4	45.25
6	TAI-2120	47.9	44.0	1.09	3.48	60.6	44.13
7	T-1359 F ₁ (Check)	52.2	45.9	1.14	3.42	68.8	43.24
8	14T-4770 F ₁	68.4	52.6	1.30	3.50	104.4	41.80
9	Taseer AB F ₁	53.1	50.4	1.05	3.40	82.4	41.71
10	Red King	54.0	49.3	1.10	3.62	74.8	41.49
11	Ahmar Hybrid (Check)	51.6	48.5	1.06	3.46	76.0	41.15
12	V-369 F ₁	61.4	49.1	1.25	3.46	89.2	40.04
13	Nadir (Check)	60.0	52.0	1.15	3.60	91.2	38.88
14	Red AB F ₁	46.2	42.7	1.08	3.20	52.8	37.73
15	MKS-383 F ₁	51.3	44.1	1.16	3.78	61.2	37.19
16	MKS-380 F ₁	50.2	44.6	1.13	3.50	63.6	36.94
17	Anokhi F ₁	57.0	51.0	1.12	3.46	84.8	36.90
18	Jumbo Super AB F ₁	52.1	46.2	1.13	3.38	67.6	35.51
19	Super Special AB F ₁	51.1	44.7	1.14	3.48	90.3	34.91
20	Caporal F ₁	56.6	47.4	1.19	3.40	75.4	34.01
21	TTM-503	59.2	52.3	1.13	3.48	80.6	33.28
	LSD (0.05)						4.06

It is evident from the above table that the six entries ranked 1 - 4 produced significantly higher fruit yields than high yielding check T-1359 F₁ (43.24 t/ha). However, entries ranked from 5 - 6 and 8 - 12 remained statistically at par in comparison with high yielding check T-1359 F₁. The highest fruit yield of 52.35 t/ha was recorded in entry 14T-1184 F₁ while the lowest fruit yield was depicted by the entry TTM-503(33.28t/ha).

Regarding fruit firmness, the highest value of 3.82 kg/cm^2 was recorded in entry TO-2048 and lowest value of 3.20 kg/cm^2 was observed in entry Red AB F₁. Concerning fruit shape index, maximum value was given by the entry 14T-4770 F₁ (1.30) and minimum value was shown by the entry 14T-1184 F₁ (1.02). Similarly in case of average fruit weight, the entry 14T-4770 F₁ (104.4 g) remained at top whereas; the entry Red AB F₁ (52.8 g) remained at the bottom.

Table-13 Performance of Exotic Determinate Tomato Varieties/ Hybrids in Adaptability Trial at VRI, Faisalabad during 2017-18

<u>Set-2</u>

Date of nursery sowing: 31.10.2017

Date of transplanting:	13.12.2017
Plot size:	7.5×1.25 m
Plant to plant distance:	50 cm

Rank	Variety/ Hybrid	Fruit	Fruit	Fruit	Fruit	Ave.	Fruit
		(mm)	(mm)	index	(kg/cm^2)	n un weight	(T/ha)
		(1111)	(mm)	(L/W)	(ing/cill)	(g)	(1/114)
1	Avenue F ₁	55.4	47.4	1.17	3.50	68.8	46.61
2	Rover F ₁	55.1	46.9	1.17	3.60	74.2	44.56
3	T-1359 F ₁ (Check)	52.1	47.4	1.10	3.48	69.6	44.47
4	Qasba F ₁	60.7	55.7	1.09	3.60	110.0	43.45
5	Miracle F ₁	57.5	51.4	1.12	3.46	79.2	42.23
6	Ahmar Hybrid (Check)	56.5	50.2	1.13	3.52	78.6	41.11
7	Firmont F ₁	57.8	51.3	1.13	3.56	85.2	41.07
8	TTM-513	44.3	52.6	0.84	3.38	81.0	40.57
9	Amazon F ₁	57.1	49.7	1.15	3.54	86.0	38.15
10	Nadir (Check)	58.1	51.1	1.14	3.62	88.4	37.05
11	Nasdette F ₁	60.1	51.6	1.16	3.64	83.8	36.07
12	AS-6484 F ₁	57.6	50.8	1.13	3.36	85.4	35.92
13	Sparkle F ₁	65.5	55.1	1.19	3.66	112.6	34.88
14	Betsy	57.0	47.6	1.20	3.46	76.0	34.77
15	TTM-509	48.7	46.5	1.05	3.58	62.2	34.39
16	TTM-511	72.0	53.8	1.34	3.44	121.6	33.72
17	AS-333 F ₁	57.3	52.0	1.10	3.50	84.0	33.45
18	AS-222 F ₁	55.6	50.6	1.10	3.48	81.2	31.97
19	TTM-507	47.9	56.4	0.85	3.64	95.4	30.87
20	Rebecca F ₁	59.4	51.3	1.16	3.52	88.8	29.59
21	US-3383 F ₁	57.3	49.8	1.15	3.44	85.0	27.85
	LSD (0.05)						3.43

The above table reveals that entries ranked from 1 - 2 and 4 - 7 are statistically at par in terms of fruit yields in comparison with high yielding check T-1359 F₁ (44.47 t/ha). The highest and lowest fruit yields were recorded in entries namely Avenue F₁ (46.61 t/ha) and US-3383 F₁ (27.85 t/ha) respectively.

In case of fruit firmness, the highest value of 3.66 kg/cm^2 was recorded in entry Sparkle F₁ and lowest value of 3.36 kg/cm^2 was observed in entry AS-6484 F₁. Concerning fruit shape index, maximum value was given by the entry TTM-511 (1.34) and minimum value was shown by the entry TTM-513 (0.84). Regarding average fruit weight, the entry TTM-511 (121.6 g) remained at top whereas; the entry TTM-509 (62.2 g) remained at the bottom.

Table-14 Performance of Exotic Determinate Tomato Varieties/ Hybrids in Adaptability Trial at VRI, Faisalabad during 2017-18 Set-3

Date of transplanting:13.02.2018Plot size: 7.5×1.25 mPlant to plant distance:50 cm

Rank	Variety/ Hybrid	Fruit length (mm)	Fruit width (mm)	Fruit shape index (L/W)	Fruit firmness (kg/cm ²)	Ave. fruit weight (g)	Fruit yield (T/ha)
1	Ahmar Hybrid (Check)	55.1	48.0	1.15	3.56	74.6	19.85
2	Bull's Eye F ₁	67.0	51.5	1.30	3.62	100.2	18.07
3	SV-3543 TE	71.1	52.2	1.36	3.42	108.8	16.72
4	T-1359 F ₁ (Check)	55.1	46.6	1.18	3.38	69.0	16.04
	LSD (0.05)						3.15

The above table shows that entries ranked from 2 - 3 produced statistically at par fruit yields in comparison with high yielding check Ahmar Hybrid (19.85 t/ha). The highest fruit yield was depicted by the check entry Ahmar Hybrid (19.85 t/ha) whereas the lowest fruit yield was recorded in the 2^{nd} check entry T-1359 F₁ (16.04t/ha).

Regarding fruit firmness, the highest value of 3.62 kg/cm²was recorded in entry Bull's Eye F₁ and lowest value of 3.38 kg/cm²was observed in entry T-1359 F₁. Concerning fruit shape index, maximum value was given by the entry SV-3543 TE (1.36) and minimum value was shown by the entry Ahmar Hybrid (1.15). Similarly in case of average fruit weight, the entry SV-3543 TE (108.8 g) remained at top whereas; the entry T-1359 F₁ (69.0 g) remained at the bottom.

B. INDETERMINATE TYPES

One exotic indeterminate tomato hybrid received from CKD Seeds and Fertilizers, Gujranwala was tested along with two checks i.e. Sahel F_1 (exotic) and Salar F_1 (local) for their performance in adaptability trial under high tunnel at Vegetable Research Institute, Faisalabad during Rabi, 2017-18. 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 shape index, fruit firmness, fruit weight and fruit yield is given below.

Table-15 Performance of Exotic Indeterminate Tomato Varieties/ Hybrids in Adaptability Trial under High Tunnel at VRI, Faisalabad during 2017-18

Date of nursery sowing:	18.10.2017
Date of transplanting:	29.11.2017
Plot size:	$4.5 \times 1.5 \text{ m}$
Plant to plant distance:	40 cm

Rank	Variety/ Hybrid	Fruit length (mm)	Fruit width (mm)	Fruit shape index (L/W)	Fruit firmness (kg/cm ²)	Ave. fruit weight (g)	Fruit yield (T/ha)
1	Salar F ₁ (Check)	59.8	49.4	1.21	4.02	85.6	125.04
2	Sahel F ₁ (Check)	63.4	54.4	1.16	3.94	112.8	121.13
3	Cosmic F ₁ (Check)	57.5	51.5	1.12	3.98	92.4	101.52
	LSD (0.05)						5.48

The above table reveals that differences among means for fruit yield due to varieties were significant. The local check Salar F_1 produced the maximum fruit yield of 125.04 t/ha whereas the exotic check Sahel F_1 produced statistically at par fruit yield of 121.13 t/ha in comparison with the high yielding check i.e. Salar F_1 . The lowest fruit yield of 101.52 t/ha was depicted by the entry Cosmic F_1 .

Regarding fruit firmness, the highest value of 4.02 kg/cm²was recorded in entry Salar F₁ and lowest value of 3.94 kg/cm²was observed in entry Sahel F₁. Concerning fruit shape index, maximum value was given by the entry Salar F₁ (1.21) and minimum value was shown by the entry Cosmic F₁ (1.12). Similarly in case of average fruit weight, the entry Sahel F₁ (112.8 g) remained at top whereas; the entry Salar F₁ (85.6 g) remained at the bottom.

1.9 EVALUATION OF LOCALLY DEVELOPED DETERMINATE TOMATO ADVANCED LINES FOR AUTUMN PLANTING

To evaluate the performance of autumn sown determinate tomato advanced lines under different ecological zones of Punjab, an experiment comprising of nine (9) advanced lines along with one exotic check namely RS-1312 F_1 was conducted at two different locations viz; VRI Faisalabad and BARI Chakwal. The details of the experiment are as under:

Table-16 Performance of Determinate Tomato Advanced Lines in Multi-locational Trials in Open Fields at VRI, Faisalabad and BARI, Chakwal during 2017-18 (Autumn Planting)

Particulars	Faisalabad	Chakwal
Sowing date:	21.08.2017	17.07.2017
Transplanting date:	26.09.2017	20.08.2017

No. of Entries:	10	10
No. of Replications:	2	3
No. of Plants/ Entry:	12	11
Plant to plant distance:	50 cm	50 cm
Plot size:	7.0×1.25 m	$7.0 \times 1.25 \text{ m}$

Rank	Entry	Fruit yield (T/ha)					
		VRI,	BARI,	Avorago			
		Faisalabad	Chakwal	Average			
1	RS-1312 F ₁ (Check)	17.87	12.19	15.03			
2	AUT-315	14.96	10.55	12.76			
3	AUT-312	13.10	11.01	12.06			
4	AUT-318	13.93	10.10	12.02			
5	AUT-305	13.50	9.33	11.42			
6	AUT-309	11.91	7.12	9.52			
7	AUT-302	9.50	6.70	8.10			
8	AUT-324	9.15	6.63	7.89			
9	10139	8.60	6.44	7.52			
10	AUT-330	6.73	5.94	6.34			
	LSD (0.05)	2.27	1.28	-			

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 F_1 produced higher fruit yield of 15.03 t/ha than all the entries. The lowest average fruit yield was harvested from the entry AUT-330 (6.34 t/ha).

1.10 EVALUATION OF TOMATO ADVANCED LINES FOR SPRING PLANTING

To evaluate the yield potential and other valuable characteristics a trial comprising of 5 entries (2 advanced lines + 3 checks) was planted during the spring season. The nursery of these genotypes was sown on 15.01.2018 and transplanting was done on 11.03.2018 according to RCB design with 3 replications. The plot was kept as 7.0×1.25 with plant to plant distance of 50 cm. The data recorded for fruit length, fruit width, fruit shape index, fruit firmness, fruit weight and fruit yield is given as under;

Rank	Entry	Fruit length (mm)	Fruit width (mm)	Fruit shape index	Fruit firmness (kg/cm ²)	Fruit weight (g)	Fruit yield (T/ha)
1	13213	53.2	44.0	1.21	3.38	73.6	5.40
2	T-1359 F ₁ (Check)	55.9	47.2	1.18	3.38	69.8	5.01
3	10139	53.5	44.5	1.20	3.28	71.4	4.72

Table-17 Performance of Advanced Lines during Spring Season at VRI, Faisalabad during 2017-18

4	Naqeeb (Check)	53.2	46.3	1.15	3.40	77.2	4.14
5	Rio Grande (Check)	57.1	48.8	1.17	3.44	78.0	2.76
	LSD (0.05)						0.55

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 namely 13213 (5.40 t/ha) and 10139 (4.72 t/ha) produced statistically at par fruit yields against the highest yielding check T-1359 F_1 (5.01 t/ha). The lowest fruit yield of 2.76 t/ha was shown by the check entry Rio Grande.

1.11 EVALUATION OF CHERRY TOMATO GENOTYPES

To evaluate the yield performance of semi-determinate cherry type tomato genotypes under different ecological zones of Punjab, a trial comprising of four (4) entries (1 genotype + 3 checks) was conducted at four different locations viz; VRI Faisalabad, NIAB Faisalabad, ARF Sheikhupura and NARC Islamabad. The nursery of these genotypes was sown on 23.10.2017. The transplanting of the nursery was done according to RCBD in 3 replications and plant to plant distance was kept as 40 cm. The data recorded for fruit length, fruit width, fruit shape index, fruit firmness, fruit weight and fruit yield is given in tables below.

Location	Transplantation Date	Plot Size
VRI, Faisalabad	29.11.2017	$4.5 \times 1.5 \text{ m}$
NIAB, Faisalabad	21.12.2017	3.5×1.5 m
ARF, Sheikhupura	20.12.2017	$2.8 \times 1.5 \text{ m}$
NARC, Islamabad	20.12.2017	3.6 × 1.5 m

Table-18 Performance of Cherry Tomato Genotypes inMulti-locational / Zonal Trial at VRI, Faisalabad during 2017-18

Rank	Entry	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit
		(mm)	(mm)	snape index	(kg/cm^2)	(g)	(T/ha)
				(L/W)		8	
1	17253	31.2	22.0	1.42	2.62	12.4	34.73
2	New Cherry (Check)	31.3	35.6	0.88	2.76	21.6	32.52
3	UAF Cherry (Check)	24.6	26.8	0.92	2.40	15.8	26.15
4	NI-Cherry (Check)	20.2	21.4	0.94	2.50	11.0	23.82
	LSD (0.05)						3.36

It is evident from the above table that differences among means for fruit yield due to varieties were significant. The top ranked entry namely 17253 (34.73 t/ha) produced statistically at par fruit yield against the highest yielding check New Cherry (32.52 t/ha). The lowest fruit yield of 23.82 t/ha was depicted by the entry NI-Cherry.

		Fruit yield (T/ha)							
Rank	Entry	VRI, FSD	NIAB, FSD	ARF, S. Pura	NARC, ISD	Average			
1	17253	34.73	42.32	25.56	30.75	33.34			
2	New Cherry (Check)	32.52	41.23	25.24	28.13	31.78			
3	UAF Cherry (Check)	26.15	23.81	21.90	25.11	24.24			
4	NI-Cherry (Check)	23.82	25.97	17.78	22.80	22.59			
	LSD (0.05)	4.36	7.17	4.72	3.12	-			

Table-19 Performance of Cherry Tomato Genotypes inMulti-locational / Zonal Trials at Different Locations during 2017-18

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 17253 produced higher fruit yield of 33.34 t/ha against the highest yielding check New Cherry which gave an average fruit yield of 31.78 t/ha. The lowest average fruit yield of 22.59 t/ha was depicted by the entry NI-Cherry.

1.12 INTERCROPPING STUDIES IN DETERMINATE TOMATO

A trial comprising of six different crops involving twelve (12) different intercropping combinations was planted to determine the suitable intercropping combination for increasing the income on per unit area basis. Standard agronomic and plant protection measures were adopted to maintain the healthy crop. The detail of experiment along with the economics is as under;

Main crop:	Tomato (Saandal F ₁) & Tomato (Naqeeb)					
Intercrop(s):	Peas, Strawberry, Onion (Seedlings & Direct	Seeded), Turnip				
Intercropping	$T_1 =$ Sole crop (Saandal F_1)					
combination(s):	$T_2 =$ Saandal $F_1 +$ Peas					
	$T_3 =$ Saandal $F_1 +$ Strawberry					
	$T_4 = $ Saandal $F_1 + $ Onion					
	$T_5 =$ Saandal F_1 + Onion (D.S)					
	$T_6 = $ Saandal $F_1 + $ Turnip					
	$T_7 = $ Sole crop (Naqeeb)					
	$T_8 = Naqeeb + Peas$					
	$T_9 = Naqeeb + Strawberry$					
	$T_{10} = Naqeeb + Onion$					
	$T_{11} = Naqueb + Onion (D.S)$					
	$T_{12} = Naqeeb + Turnip$					
Planting date:	Tomato (Saandal F ₁ + Naqeeb)	18 11 2017				
	Peas	10.11.2017				
	 Onion (Seedlings + D. S) 					
	• Strawberry 20.11.2017					
	 Turnip 					
No. of replications:	2					
Plot size:	7.5× 0.75 m					

Rank	Combination	Gross Income / ha (Rs.)
1	Saandal F ₁ + Turnip	468924/-
2	Naqeeb + Turnip	347801/-
3	Saandal F ₁ + Peas	276654/-
4	Saandal F ₁ + Strawberry	262262/-
5	Naqeeb + Strawberry	219292/-
6	Saandal F ₁	207870/-
7	Saandal F_1 + Onion (D.S)	179356/-
8	Saandal F ₁ + Onion	175238/-
9	Naqeeb + Peas	152857/-
10	Naqeeb + Onion	82404/-
11	Naqeeb	62836/-
12	Naqeeb + Onion (D.S)	58244/-

Table-20 Evaluation of Different Intercropping Combinations to Determine the Most Profitable (Economically) at VRI, Faisalabad during 2017-18

The gross income data reveals that the intercropping combination Saandal F_1 + Turnip produced highest income (Rs. 468924/- per ha) followed by the combination Naqeeb + Turnips which gave an income of Rs. 347801/- per ha. The lowest gross income of Rs. 58244/- per ha was shown by the combination Naqeeb + Onion (D.S).

1.13 STUDY ON OPTIMAL USE OF SUNLIGHT INTENSITY IN TOMATO CROP

A trial comprising of one determinate tomato variety "Naqeeb" involving six different treatments was conducted to study the effect of different planting directions in connection with sunlight / radiation harvesting on the productivity of tomato crop. Standard agronomic and plant protection measures were adopted to maintain the optimum crop health. The detail of parameters used along with the fruit yield data is as under;

Variety	Naqeeb						
Treatments:	T_1 = North-East to South-West sunlight facing (Control)						
	T_2 = North-West to South-East sunlight facing						
	T_3 = East to West sunlight facing						
	$T_4 = T_1 + $ Inversion of water channel						
	$T_5 = T_2 + $ Inversion of water channel						
	$T_6 = T_3 + $ Inversion of water channel						
Nursery date:	31.10.2017						
Transplanting date:	29.12.2017						
No. of replications:	3						
Plot size:	7.5 × 1.25 m						
Methodology:	Three different directional layouts were used $(T_1, T_2 \& T_3)$.						
	Planting was done only on one side of the beds expected to						

face more sunlight for maximum radiation harvesting. In
mid-February when temperature raised and began to
become favorable for tomato crop the water channels
alongside the beds were inverted i.e. the empty side of the
beds were converted in to water channels and their soil was
used to close / fill the existing water channels (T_4 , T_5 & T_6).
The purpose behind was to reduce the effect of sunlight
intensity and increase in water availability duration for
plants during the hotter months i.e. March – May.

Table-21 Evaluation of Sunlight Effect on the Productivity of Tomato Crop b	y
using Different Directional Layouts at VRI, Faisalabad during 2017-18	

Variety = Naqeeb					
Rank	Rank Treatment				
		(T/ha)			
1	T_3 = East to West sunlight facing	29.18			
2	$T_4 = T_1 + $ Inversion of water channel	27.86			
3	$T_6 = T_3 +$ Inversion of water channel	23.75			
4	$T_5 = T_2 + $ Inversion of water channel	22.02			
5	T_2 = North-West to South-East sunlight facing	20.46			
6	T ₁ = North-East to South-West sunlight facing (Control)	18.43			
	LSD (0.05)	2.28			

The above table reveals that differences among means for fruit yield due to treatments were significant. Treatments ranked from No. 1 – 4 produced significantly higher fruit yields ranging from 22.02 - 29.18 t/ha than the control treatment T₁ (18.43 t/ha). The highest fruit yield of 29.18 t/ha was produced by the treatment T₃ and lowest fruit yield of 18.43 t/ha was depicted by the treatment T₁ (Control). The results showed the positive effect of sunlight (T₃ = East to West sunlight facing) as planting on this direction receives maximum sunlight.

1.14 STUDIES ON MULCH AND PLANTING DIRECTION EFFECT IN TOMATO CROP

A trial comprising of one determinate tomato variety "Nadir" involving four different treatments was conducted to study the effect of mulching along with two different planting directions on the productivity of tomato crop. Standard agronomic and plant protection measures were adopted to maintain the optimum crop health. The detail of parameters used along with the fruit yield data is as under;

Variety	Nadir				
Treatments:	T_1 = Planting on Eastern Side + Black Polythene Sheet Mulch				
	T_2 = Planting on Eastern Side (Control-1)				
	T_3 = Planting on Western Side + Black Polythene Sheet Mulch				
	T_4 = Planting on Western Side (Control-2)				
Nursery date:	31.10.2017				
Transplanting date:	29.12.2017				

No. of replications:	5
Plot size:	$7.5 \times 1.25 \text{ m}$

Table-22 Evaluation of Mulching Effect on the Productivity of Tomato Crop at VRI, Faisalabad during 2017-18

Variety = Nadir						
Rank	Treatment	Fruit yield				
		(T/ha)				
1	T_1 = Planting on Eastern Side + Black Polythene Sheet Mulch	31.49				
2	T_3 = Planting on Western Side + Black Polythene Sheet Mulch	31.12				
3	T ₂ = Planting on Eastern Side (Control-1)	25.74				
4	T ₄ = Planting on Western Side (Control-2)	22.52				
	LSD (0.05)					

The above table indicates that differences among means for fruit yield due to treatments were significant. Two top ranked treatments viz; T_1 (31.49 t/ha) and T_3 (31.12 t/ha) produced significantly higher fruit yields in comparison with Control-1 (25.74 t/ha) and Control-2 (22.52 t/ha). The results revealed the positive effect of mulching on the productivity of tomato crop. Similarly in case of planting direction, there is a significant difference between T_2 and T_4 .

1.15 PRE-BASIC SEED PRODUCTION OF APPROVED DETERMINATE TOMATO VARIETY(S)

Two approved determinate tomato varieties namely "Nadir" and "Naqeeb" were sown on 25.10.2017 and transplanted on 15.12.2017 on an area of two kanals. A combined total of 6 kg pre-basic seed of both varieties was produced for further multiplication / cultivation.

1.16 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 three checks (T-1359 F₁, TO-1057 F₁& Ahmar Hybrid) in two sets (20 hybrids and three checks in each set) was conducted at VRI, Faisalabad during Rabi, 2017-18. The nursery was sown on 23.10.2017 and transplanted on 12.12.2017 in RCBD with two replications. Plot size was kept as 7.5×1.25 m and plant to plant distance was maintained at 50 cm. Data recorded for fruit length, fruit width, fruit shape index, fruit firmness, fruit weight and fruit yield are presented in table below.

Rank	Entry	Fruit length	Fruit width	Fruit shape	Fruit firmness	Fruit weight	Fruit yield
		(mm)	(mm)	index (L/W)	(kg/cm²)	(g)	(T/ha)
1	LTH-459	54.8	47.5	1.16	3.92	78.0	50.35
2	TO-1057 F ₁ (Check)	53.4	48.7	1.10	4.04	75.4	49.78
3	LTH-457	51.9	47.6	1.09	3.66	76.0	46.93
4	LTH-465	43.3	46.6	0.93	3.50	80.4	45.91
5	T-1359 F ₁ (Check)	53.3	47.0	1.13	3.84	71.0	45.72
6	LTH-458	52.3	49.0	1.07	3.72	78.8	45.18
7	LTH-469	53.3	50.0	1.07	3.60	88.4	44.77
8	LTH-466	55.2	51.8	1.07	3.98	100.8	43.60
9	Ahmar Hybrid (Check)	51.3	45.9	1.12	3.90	73.2	43.56
10	LTH-464	50.5	48.0	1.05	3.54	85.6	42.91
11	LTH-455	53.2	52.4	1.02	3.90	90.8	42.90
12	LTH-461	54.0	46.0	1.17	3.68	66.0	41.35
13	LTH-468	56.5	53.8	1.05	3.74	114.4	38.82
14	LTH-452	49.8	46.1	1.08	3.60	67.6	37.13
15	LTH-451	52.7	47.5	1.11	3.88	74.4	37.09
16	LTH-463	49.6	45.8	1.08	3.88	62.8	36.99
17	LTH-456	56.9	48.9	1.16	4.10	92.0	36.20
18	LTH-467	50.7	45.6	1.11	3.72	63.6	35.82
19	LTH-462	51.7	49.5	1.04	3.96	80.4	35.25
20	LTH-453	50.3	53.0	0.95	3.74	102.0	35.24
21	LTH-470	51.9	54.1	0.96	3.86	105.6	34.97
22	LTH-454	59.3	49.0	1.21	3.68	93.6	33.14
23	LTH-460	47.6	47.3	1.01	3.46	63.2	32.38
	LSD (0.05)						4.83

Table-23 Performance of Locally Developed Determinate Tomato Hybrids in
Preliminary Yield Trial at VRI, Faisalabad during 2017-18 (Set-1)

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 & 6 produced statistically at par fruit yields in comparison with the better check TO-1057 F_1 which gave the fruit yield of 49.78 t/ha. The highest fruit yield was produced by the entry LTH-459 (50.35 t/ha) whereas; the lowest fruit yield was depicted by the entry LTH-460 (32.38 t/ha).

Table-24 Performance of Locally Developed Determinate Tomato Hybrids in
Preliminary Yield Trial at VRI, Faisalabad during 2017-18 (Set-2)

Rank	Entry	Fruit length (mm)	Fruit width (mm)	Fruit shape index (L/W)	Fruit firmness (kg/cm ²)	Fruit weight (g)	Fruit yield (T/ha)
1	LTH-482	48.8	49.0	1.00	3.80	73.0	50.13
2	LTH-478	49.0	50.8	0.96	3.70	72.2	47.28

3	TO-1057 F ₁ (Check)	55.8	47.8	1.17	3.94	79.2	46.81
4	T-1359 F ₁ (Check)	53.8	47.5	1.13	3.82	72.4	44.35
5	LTH-471	53.2	48.5	1.10	3.52	62.6	44.25
6	Ahmar Hybrid (Check)	52.5	46.9	1.12	3.88	74.0	43.23
7	LTH-476	45.9	46.5	0.99	3.56	57.8	41.85
8	LTH-475	55.5	47.4	1.17	4.12	73.0	41.04
9	LTH-483	53.4	52.7	1.01	3.54	76.8	40.95
10	LTH-477	44.3	45.5	0.97	3.48	49.6	39.48
11	LTH-474	43.4	45.5	0.95	3.64	59.4	38.14
12	LTH-473	50.4	47.7	1.06	3.62	73.6	37.18
13	LTH-472	51.8	47.6	1.09	3.74	68.2	36.98
14	LTH-481	47.7	45.9	1.04	3.64	51.8	36.64
15	LTH-479	48.3	42.9	1.13	3.52	53.0	36.25
16	LTH-484	50.8	47.4	1.07	3.88	70.4	35.97
17	LTH-486	54.4	49.1	1.11	4.06	83.2	35.02
18	LTH-485	59.3	51.4	1.15	4.02	80.2	34.48
19	LTH-487	55.4	52.1	1.06	3.48	75.0	32.21
20	LTH-490	51.2	48.1	1.06	3.42	63.4	31.82
21	LTH-488	55.0	46.8	1.18	3.86	71.6	28.86
22	LTH-480	58.3	52.1	1.12	3.66	84.0	27.32
23	LTH-489	49.9	46.8	1.07	3.46	66.8	27.17
	LSD (0.05)						4.60

The above table reveals that differences among means for fruit yield due to genotypes were significant. The entries ranked from No. 1, 2 & 5 performed statistically at par in terms of fruit yields as compared with the higher check TO-1057 F_1 (46.81 t/ha). The highest and lowest fruit yields were depicted by the entries LTH-482 (50.13 t/ha) and LTH-489 (27.17 t/ha) respectively.

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

An experiment comprising of seven (7) determinate tomato hybrids along with three checks namely T-1359 F₁, TO-1057 F₁ and Ahmar Hybrid was conducted at VRI, Faisalabad to evaluate the yield potential and other valuable characteristics. The nursery was sown on 23.10.2017 and transplanted on 12.12.2017 in RCBD with three replications. Plot size was kept as 7.5×1.25 m and plant to plant distance was maintained at 50 cm. Data recorded for fruit length, fruit width, fruit shape index, fruit firmness, fruit weight and fruit yield are presented in table below.

Rank	Entry	Fruit length (mm)	Fruit width (mm)	Fruit shape index (L/W)	Fruit firmness (kg/cm ²)	Fruit weight (g)	Fruit yield (T/ha)
1	LTH-421	54.4	47.0	1.16	3.80	70.4	47.52
2	TO-1057 F ₁ (Check)	53.3	45.6	1.17	3.78	72.6	46.57
3	LTH-436	54.7	47.7	1.15	3.60	72.6	45.47
4	LTH-405	48.5	47.4	1.02	3.64	69.4	44.15
5	LTH-440	51.1	49.1	1.04	3.76	74.0	44.10
6	T-1359 F ₁ (Check)	52.9	45.9	1.15	3.74	69.2	43.74
7	Ahmar Hybrid (Check)	53.8	46.1	1.17	3.82	69.6	43.32
8	LTH-420	53.2	46.3	1.15	3.68	74.8	43.20
9	LTH-422	56.0	47.4	1.18	3.80	78.4	35.52
10	LTH-444	52.6	45.2	1.16	3.66	71.6	33.88
	LSD (0.05)						3.04

Table-25 Performance of Locally Developed Determinate Tomato Hybrids in
Secondary/ Station Yield Trial at VRI, Faisalabad during 2017-18

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 & 5 produced statistically at par fruit yields against the higher check TO-1057 F_1 (46.57 t/ha). The highest fruit yield was produced by the entry LTH-421 (47.52 t/ha) and lowest fruit yield was depicted by the entry LTH-444 (33.88 t/ha).

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

A trial comprising of seven (7) locally developed determinate tomato hybrids along with three checks i.e. Ahmar F_1 (local), T-1359 F_1 and T-1057 F_1 (exotic) was planted to evaluate the performance at four different locations viz; VRI Faisalabad, VRSS Sheikhupura, VRSS Multan and VRSS Bahawalpur. The nursery of these hybrids was sown on 23.10.2017 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	12.12.2017	$7.0 \times 1.25 \text{ m}$
VRSS, Sheikhupura	20.12.2017	7.0×1.25 m
VRSS, Multan	22.12.2017	7.0×1.25 m
VRSS, Bahawalpur	22.12.2017	$7.0 \times 1.25 \text{ m}$

Rank	Entry	Fruit length (mm)	Fruit width (mm)	Fruit shape index (L/W)	Fruit firmness (kg/cm ²)	Fruit weight (g)	Fruit yield (T/ha)
1	LTH-324	46.5	48.3	0.96	3.76	76.0	48.30
2	T-1359 F ₁ (Check)	50.2	43.8	1.15	3.70	66.4	48.04
3	NBH-5	60.1	42.2	1.42	3.76	66.2	45.34
4	Ahmar Hybrid (Check)	52.7	47.7	1.11	3.78	73.2	44.21
5	TO-1057 F ₁ (Check)	53.5	49.8	1.07	3.90	74.6	42.16
6	NBH-149	57.9	48.9	1.18	3.74	83.4	38.29
7	LTH-366	60.3	45.6	1.32	3.88	76.0	38.18
8	LTH-379	46.5	43.3	1.07	3.82	66.8	37.63
9	LTH-350	49.9	50.7	0.98	3.74	75.0	37.06
10	LTH-405	55.3	47.5	1.17	3.62	79.0	35.73
	LSD (0.05)						3.72

Table-26 Performance of Determinate Tomato Hybrids in Multi-locational / Zonal Trial at VRI, Faisalabad during 2017-18

The above table reveals that differences among means for fruit yield due to genotypes were significant. The hybrid entries ranked at 1 & 3 produced statistically at par fruit yields as compared with the highest yielding check T-1359 F_1 (48.04 t/ha). The highest fruit yield of 48.30 t/ha was depicted by the entry LTH-324 whereas; the lowest fruit yield of 35.73 t/ha was given by the entry LTH-405.

Table-27 Performance of Determinate Tomato Hybrids in Multi-locational / Zonal Trials at Different Locations during 2017-18

Donk	Entry	Fruit yield (T/ha)							
Kalik	Entry	FSD	S. Pura	Multan	B. Pur	Average			
1	LTH-324	48.30	39.75	35.20	22.08	36.33			
2	NBH-5	45.34	40.67	33.94	21.75	35.43			
3	T-1359 F ₁ (Check)	48.04	37.96	32.15	19.14	34.32			
4	Ahmar Hybrid (Check)	44.21	35.79	30.34	17.89	32.06			
5	NBH-149	38.29	36.29	30.72	19.39	31.17			
6	TO-1057 F ₁ (Check)	42.16	34.65	27.01	16.08	29.98			
7	LTH-350	37.06	32.61	24.97	16.90	27.89			
8	LTH-366	38.18	30.70	26.11	15.81	27.70			
9	LTH-405	35.73	30.40	25.54	12.38	26.01			
10	LTH-379	37.63	28.19	23.85	13.50	25.79			
	LSD (0.05)	3.72	2.41	2.15	2.03	-			

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 entry namely LTH-324 (36.33 t/ha) produced higher fruit yield than the highest yielding check T-1359 F₁ which gave average fruit yield of 34.32 t/ha. The lowest average fruit yield of 25.79 t/ha was recorded in entry LTH-379.

1.19 PRELIMINARY EVALUATION OF LOCALLY DEVELOPED INDETERMINATE TOMATO HYBRIDS

A varietal trial comprising of 42 hybrids along with two checks i.e. Sahel F_1 (exotic) and Saandal F_1 (local) was planted in three sets (14 hybrids and two checks in each set) to evaluate the performance of locally developed indeterminate tomato hybrids. Nursery was sown on 18.10.2017 and transplanted on 29.11.2017 in Randomized Complete Block Design with two replications under high tunnel with drip fertigation. The plot size was kept as 4.5×0.75 m while, plant to plant spacing was maintained at 40 cm. Fruit picking was started on 22.03.2018 and continued till 06.06.2018 with total number of twelve pickings. The data recorded for fruit length, fruit width, fruit shape index, fruit firmness, fruit weight and fruit yield is presented in table below.

 Table-28 Performance of Locally Developed Indeterminate Tomato Hybrids under

 High Tunnel in Preliminary Yield Trial at VRI, Faisalabad during 2017-18 (Set-1)

Rank	Entry	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit
		length	width	shape	firmness	weight	yield
		(mm)	(mm)	index	(kg/cm^2)	(g)	(T/ha)
				(L/W)			
1	LITTH-879	55.2	52.4	1.05	4.02	95.2	129.81
2	LITTH-872	57.6	43.4	1.33	3.68	65.2	120.72
3	LITTH-877	65.0	50.2	1.29	3.72	106.0	118.86
4	LITTH-874	67.8	44.9	1.51	3.80	84.0	118.26
5	Saandal F ₁ (Check)	60.0	54.2	1.11	3.84	108.4	118.25
6	Sahel F ₁ (Check)	64.2	54.9	1.17	3.80	110.0	116.18
7	LITTH-873	68.9	49.2	1.40	3.86	100.2	110.66
8	LITTH-875	61.6	58.1	1.06	3.76	131.6	108.31
9	LITTH-876	44.8	50.0	0.90	3.74	75.6	102.02
10	LITTH-878	51.4	47.3	1.09	3.80	67.4	89.65
11	LITTH-880	52.3	41.1	1.27	3.60	57.6	81.10
12	LITTH-884	52.7	51.3	1.03	3.84	86.0	79.83
13	LITTH-886	56.6	54.3	1.04	3.82	97.2	74.17
14	LITTH-881	54.2	46.4	1.17	3.76	74.8	73.04
15	LITTH-882	60.9	43.4	1.40	3.78	62.8	71.53
16	LITTH-885	38.6	42.4	0.91	3.70	51.6	62.93
	LSD (0.05)						6.04

The perusal of the table indicates that differences among means for fruit yield due to genotypes were significant. The top ranked entry namely LITTH-879 (129.81 t/ha) produced significantly higher fruit yield as compared with the highest yielding check Saandal F_1 (118.25 t/ha). However, entries ranked from 2 – 4 performed statistically at par in terms of fruit yields in comparison with the highest yielding check Saandal F_1 . The lowest fruit yield of 62.93 t/ha was recorded in hybrid entry LITTH-885.

Rank	Entry	Fruit length	Fruit width	Fruit shape	Fruit firmness	Fruit weight	Fruit yield
		(mm)	(mm)	index (L/W)	(kg/cm ⁻)	(g)	(1/na)
1	LITTH-901	62.9	45.0	1.40	3.66	88.4	128.24
2	LITTH-900	71.6	45.5	1.57	3.76	82.0	124.08
3	LITTH-895	44.5	49.9	0.89	3.54	72.8	122.88
4	LITTH-899	79.7	45.2	1.76	3.60	95.2	121.50
5	LITTH-898	76.6	43.7	1.75	3.52	86.4	116.50
6	Sahel F ₁ (Check)	63.1	53.0	1.19	3.70	105.6	115.75
7	Saandal F ₁ (Check)	60.9	54.3	1.12	3.72	109.2	114.91
8	LITTH-897	53.2	41.7	1.28	3.62	61.6	97.26
9	LITTH-891	73.8	45.9	1.61	3.68	96.0	93.63
10	LITTH-894	53.2	46.5	1.14	3.60	73.2	92.61
11	LITTH-888	57.3	53.4	1.07	3.70	104.4	90.65
12	LITTH-887	59.5	47.0	1.27	3.76	76.4	89.67
13	LITTH-892	54.9	44.0	1.25	3.62	59.6	82.68
14	LITTH-896	43.2	45.3	0.95	3.56	56.8	81.02
15	LITTH-893	46.8	51.8	0.90	3.58	82.0	75.62
16	LITTH-890	41.8	45.6	0.92	3.66	58.6	70.58
	LSD (0.05)						5.88

 Table-29 Performance of Locally Developed Indeterminate Tomato Hybrids under

 High Tunnel in Preliminary Yield Trial at VRI, Faisalabad during 2017-18 (Set-2)

The perusal of table indicates that differences among means for fruit yield due to genotypes were significant. The entries ranked from 1 - 3 produced significantly higher fruit yields against the highest yielding check Sahel F₁ (115.75 t/ha) whereas; the entries ranked at No. 4 & 5 depicted the statistically at par fruit yields against the higher check Sahel F₁. The highest and lowest fruit yields were recorded in hybrid entries LITTH-901 (128.24 t/ha) and LITTH-890 (70.58 t/ha).

Rank	Entry	Fruit length (mm)	Fruit width (mm)	Fruit shape index	Fruit firmness (kg/cm ²)	Fruit weight (g)	Fruit yield (T/ha)
1	LITTH-908	67.5	53.5	1.26	3.70	112.4	136.60
2	LITTH-907	67.3	53.5	1.26	3.78	116.0	128.18
3	LITTH-903	66.3	52.2	1.27	3.68	113.2	124.46
4	LITTH-914	56.5	49.7	1.14	3.56	89.6	123.09
5	LITTH-904	63.5	48.4	1.31	3.74	91.2	121.25
6	LITTH-912	55.2	46.4	1.19	3.60	73.2	120.32
7	Sahel F ₁ (Check)	64.1	54.3	1.18	3.70	111.6	119.01
8	Saandal F ₁ (Check)	60.9	55.2	1.10	3.76	115.4	117.47
9	LITTH-913	51.0	52.2	0.98	3.72	86.8	116.28

 Table-30 Performance of Locally Developed Indeterminate Tomato Hybrids under

 High Tunnel in Preliminary Yield Trial at VRI, Faisalabad during 2017-18 (Set-3)

10	LITTH-902	64.9	51.5	1.26	3.78	106.4	115.50
11	LITTH-909	71.0	45.6	1.56	3.56	92.4	115.04
12	LITTH-910	73.8	43.8	1.68	3.80	83.2	111.05
13	LITTH-915	60.8	42.2	1.44	3.54	62.8	108.34
14	LITTH-916	46.8	45.6	1.03	3.86	60.2	95.18
15	LITTH-911	74.6	45.3	1.65	3.52	90.8	94.21
16	LITTH-905	64.4	49.3	1.31	3.58	98.4	90.27
	LSD (0.05)						5.75

The perusal of table indicates that differences among means for fruit yield due to genotypes were significant. Two top ranked entries performed significantly better in terms of fruit yields in comparison with the highest yielding check Sahel F₁ (119.01 t/ha). However, entries ranked from 3 - 6 and 9 - 11 showed statistically at par fruit yields against the highest yielding check Sahel F₁. The highest fruit yield of 136.60 t/ha was produced by the hybrid entry LITTH-908 whereas; the lowest fruit yield of 90.27 t/ha was depicted by the hybrid entry LITTH-905.

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

To evaluate the performance of promising locally developed indeterminate F_1 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 with drip fertigation. The nursery was sown on 18.10.2017 and transplanted on 29.11.2017 in a Randomized Complete Block Design with three replications. The plot size was kept as 4.5×1.50 m while, plant to plant spacing was maintained as 40 cm. Fruit picking was started on 22.03.2018 and continued till 06.06.2018 with total number of twelve pickings. The data recorded for fruit length, fruit width, fruit shape index, fruit firmness, fruit weight and fruit yield are presented in table below.

Rank	Entry	Fruit length	Fruit width	Fruit shape	Fruit firmness	Fruit weight	Fruit yield
		(mm)	(mm)	index	(kg/cm^2)	(g)	(T/ha)
				(L/W)			
1	LITTH-835	62.7	53.1	1.18	3.58	103.8	120.24
2	LITTH-861	65.3	51.1	1.28	3.72	106.0	118.11
3	Sahel F ₁ (Check)	66.7	56.4	1.18	3.84	118.6	117.42
4	LITTH-869	57.3	49.5	1.16	3.84	94.4	115.88
5	Saandal F ₁ (Check)	61.2	55.3	1.11	3.80	116.2	115.56
6	LITTH-844	68.3	50.6	1.35	3.68	109.2	113.61
7	LITTH-842	68.1	51.5	1.32	3.54	108.2	108.31

Table-31 Performance of Indeterminate Tomato Hybrids under High Tunnel in
Secondary / Station Yield Trial at VRI, Faisalabad during 2017-18

8	LITTH-832	63.5	48.3	1.31	4.04	87.4	101.83
9	LITTH-852	61.6	48.1	1.28	3.82	88.8	101.00
	LSD (0.05)						4.73

The above table reveals that differences among means for fruit yield due to varieties were significant. The entries ranked at No. 1, 2, 4 & 6 produced statistically at par fruit yields against the high yielding check Sahel F_1 (117.42 t/ha). The highest and lowest fruit yields of 120.24 t/ha and 101.00 t/ha were depicted by the hybrid entries LITTH-835 and LITTH-852 respectively.

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

A trial comprising of five (5) locally developed indeterminate F_1 tomato hybrids along with three checks namely Sahel F_1 (exotic), Saandal F_1 (local) and Salar F_1 (local) was planted to evaluate the performance at four different locations viz; VRI Faisalabad, VRSS Sheikhupura, VRSS Multan and BARI Chakwal. The nursery of these hybrids was sown on raised beds whereas; transplanting 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 shape index, 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	Sowing Date	Transplantation Date	Plot Size
VRI, Faisalabad		29.11.2017	$4.50 \times 1.50 \text{ m}$
VRSS, Sheikhupura	18.10.2017	20.12.2017	$2.80 \times 0.85 \text{ m}$
VRSS, Multan		22.12.2017	$2.80 \times 0.85 \text{ m}$
BARI, Chakwal	26.09.2017	28.10.2017	$10.0 \times 0.75 \text{ m}$

Table-32 Performance of Indeterminate Tomato Hybrids	s under High Tunnel in
Multi-locational / Zonal Trial at VRI, Faisalabad	during 2017-18

Rank	Entry	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit
		length	width	shape	firmness	weight	yield
		(mm)	(mm)	index	(kg/cm^2)	(g)	(T/ha)
				(L/W)			
1	LITTH-682	52.9	49.3	1.07	3.62	83.2	116.46
2	Salar F ₁ (Check)	56.1	46.1	1.22	3.94	78.2	115.15
3	Sahel F ₁ (Check)	63.2	53.7	1.18	3.88	108.0	113.79
4	LITTH-710	53.1	48.1	1.10	3.90	80.8	112.48
5	Saandal F ₁ (Check)	61.0	55.6	1.10	3.82	111.6	111.57
6	LITTH-765	63.4	52.7	1.20	3.88	100.4	104.29
7	LITTH-779	52.0	48.2	1.08	3.66	85.4	103.10
8	LITTH-818	50.9	51.1	1.00	3.74	88.6	101.39

LSD (0.05)	4.12
The above table reveals that differences among means for fruit yield	d due to
varieties were significant. The entries ranked at No. 1 & 4 showed statistically a	t par fruit
yields in comparison with the highest yielding check Salar F_1 (115.15 t/ha). The	ne highest
fruit yield of 116.46 was recorded in entry LITTH-682 whereas; the lowest fruit	it yield of
101.39 t/ha was depicted by the entry LITTH-818.	

Donk	Entry	Fruit yield (T/ha)					
Nalik		FSD	S. Pura	Multan	Chakwal	Average	
1	Salar F ₁ (Check)	115.15	110.22	104.55	-	109.97	
2	LITTH-682	116.46	109.38	101.54	83.47	102.71	
3	Sahel F ₁ (Check)	113.79	107.49	101.05	84.62	101.74	
4	Saandal F ₁ (Check)	111.57	108.75	100.14	86.22	101.67	
5	LITTH-710	112.48	105.88	95.94	80.84	98.79	
6	LITTH-765	104.29	98.39	98.39	81.51	95.65	
7	LITTH-779	103.10	101.82	93.77	78.62	94.33	
8	LITTH-818	101.39	93.49	90.62	74.09	89.90	
	LSD (0.05)	4.12	6.18	5.65	4.35	-	

Table-33 Performance of Indeterminate Tomato Hybrids under Tunnels at Different Locations in Multi-locational / Zonal Trial during 2017-18

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 F_1 (109.97 t/ha) which is also the top ranked entry. The lowest fruit yield of 89.90 t/ha was recorded in hybrid entry LITTH-818.

1.22 EVALUATION OF LOCALLY DEVELOPED HYBRID (SURKHAIL F_1) AGAINST INTERNATIONAL HYBRID (SAHEL F_1)

A trial comprising of two entries was conducted to evaluate the yield performance of locally developed hybrid Surkhail F_1 against the international hybrid Sahel F_1 under different ecological zones of Punjab. The nursery of these genotypes was sown on 18.10.2017. The transplanting of the nursery was done according to RCB design with plant to plant distance of 40 cm. The data recorded for fruit length, fruit width, fruit shape index, fruit firmness, fruit weight and fruit yield is given in tables below.

Location	Transplantation Date	No. of Reps.	Plot Size
VRI, Faisalabad	20.12.2017	6	4.5×1.5 m
NIAB, Faisalabad	21.12.2017	6	2.8×1.5 m
ARF, Sheikhupura	20.12.2017	5	2.8×1.5 m
NARC, Islamabad	20.12.2017	6	3.6 × 1.5 m

Rank	Entry	Fruit length (mm)	Fruit width (mm)	Fruit shape index (L/W)	Fruit firmness (kg/cm ²)	Fruit weight (g)	Fruit yield (T/ha)
1	Surkhail F ₁	70.5	46.5	1.52	3.90	95.6	101.24
2	Sahel F ₁	60.4	51.9	1.16	3.94	103.8	100.37
	LSD (0.05)						3.30

Table-34 Performance of Surkhail F₁ against Sahel F₁ in Multi-locational / Zonal Trial at VRI, Faisalabad during 2017-18

It is evident from the above table that differences among means for fruit yield due to varieties were significant. The local hybrid Surkhail F_1 produced higher fruit yield of 101.24 t/ha against the international hybrid Sahel F_1 which depicted the fruit production of 100.37 t/ha.

Fruit yield (T/ha) Rank Entry VRI. NIAB. ARF. NARC, Average FSD **FSD** S. Pura ISD Surkhail F₁ 101.24 90.95 80.56 86.86 1 74.7 2 Sahel F₁ 100.37 76.6 88.10 78.48 85.89 LSD (0.05) 4.30 8.90 8.01 6.02

Table-35 Performance of Surkhail F1 against Sahel F1 inMulti-locational / Zonal Trial at Different Locations during 2017-18

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, local hybrid entry Surkhail F_1 (86.86 t/ha) performed better in terms of fruit yield than the international hybrid Sahel F_1 (85.89 t/ha).

1.23 EARLY PRODUCTION OF TOMATO HYBRID(S)

A trial comprising of three hybrids viz; two locally developed (Saandal F_1 & Salar F_1) and one exotic (Sahel F_1) was planted to study the earlier fruit production pattern coupled with economics. The nursery was sown on 15.08.2017 and transplanted on 14.09.2017 in a Randomized Complete Block Design with three replications. The plot size was kept as 4.5×0.75 m while, plant to plant spacing was maintained as 40 cm. Fruit pickings started from 21.12.2017 and lasted up to 06.06.2018 with total number of 19 pickings. The data recorded for fruit yield along with the economics is presented in table below.

	Doto/	Saano	dal F ₁	Sah	el F ₁	Sala	ar F ₁
Date of Picking	kg (Rs.)	Fruit yield (t/ha)	Value (Rs.)	Fruit yield (t/ha)	Value (Rs.)	Fruit yield (t/ha)	Value (Rs.)
21.12.17	40	1.75	70000	0.24	9600	1.02	40800
05.01.18	25	2.80	70000	1.28	32000	1.68	42000
19.01.17	18	3.76	67680	2.08	37440	2.41	43380
01.02.18	22	6.60	145200	3.49	76780	3.73	82060
13.02.18	20	6.93	138600	4.68	93600	4.92	98400
26.02.18	14	7.64	106960	5.18	72520	5.82	81480
07.03.18	14	8.85	123900	10.85	151900	12.12	169680
19.03.18	12	11.07	132840	12.26	147120	13.65	163800
26.03.18	17	11.08	188360	14.16	240720	14.87	252790
03.04.18	20	12.99	259800	14.45	289000	14.33	286600
10.04.18	18	13.42	241560	15.12	272160	14.81	266580
16.04.18	18	14.44	259920	16.92	304560	17.18	309240
23.04.18	12	11.21	134520	12.00	144000	12.16	145920
30.04.18	14	9.10	127400	9.16	128240	8.87	124180
07.05.18	9	6.62	59580	5.68	51120	5.74	51660
14.05.18	12	5.24	62880	5.42	65040	4.24	50880
22.05.18	9	3.98	35820	3.46	31140	3.44	30960
29.05.18	11	2.33	25630	2.43	26730	2.71	29810
06.06.18	13	0.96	12480	1.39	18070	1.13	14690
	Total	140.77	2263130	140.25	2191740	144.83	2284910
Differen	ce from	Sahel F ₁	+71390	-	-	-	+93170

Table-36 Economics of Early Planted Indeterminate Tomato Hybrids under High Tunnel at VRI, Faisalabad during 2017-18

It is evident from the above table that pickings were started from 21.12.2017 and lasted up to 06.06.2018 with total number of 19 pickings. In first six (6) pickings, the hybrid entry Saandal F_1 gave higher fruit yield than the other two entries while in terms of overall production, the entry Salar F_1 remained at top with fruit yield of 144.83 t/ha followed by Saandal F_1 (140.77 t/ha) and Sahel F_1 (140.25 t/ha). Similarly, in case of overall gross income the entries Salar F_1 (Rs. +93170/-) and Saandal F_1 (Rs. +71390/-) proved economically more profitable than the international hybrid Sahel F_1 .

2. **PEAS** (*Pisum sativum* L.)

2.1 COLLECTION AND MAINTENANCE OF GERMPLASM

A total of seventy five varieties/lines comprising of local and exotic were sown on 28-11-17 in observational trial having a plot size of $4.0 \times 1.25 \text{ m}^2$ for their maintenance.Range for different characters in available germplasm is presented in the Table.

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

Table-37 Range of Different Morphological Traits in Peas germplasm

2.2 HYBRIDIZATION AND STUDY OF FILIAL GENERATIONS

2.2.1 HYBRIDIZATION

To develop high yielding, early maturing and disease tolerant varieties in peas, two cross combinations were made. The early maturing genotype *i.e*; 9374 were crossed with high yielding and disease resistant lines respectively *i.e*; Pea-2009 and PTLNo-1. Eighty flowers of each genotype were emasculated and pollinated with the pollen of desired parents. The seed of two cross combinations were harvested and threshed separately for further studies in F_1 generation. The success rate was about 50%.

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:

CENEDATION	CDOSS	# of crosses/progenies		
GENERATION	CRU55	STUDIED	SELECTED	
	Safeer × 9374		Selected as	
F_1	9800-5 × 9374	3	bulk and selfed plants	
	9200-1 × 9374		were rogued	
			out	
	Meteor \times 9374	75	5	
F_2	Lina Pak × 9374	85	10	
	$1300-8 \times 9374$	80	11	
F.	Meteor \times 2001-40	210	19	
1'3	$9374 \times 2001-40$	185	12	
	$9800-10 \times 2001-40$	100	5	
F_4	$2001-20 \times 2001-40$	185	20	
	Lina pak \times 2001-40	220	18	
F	9375 × 2001-40	145	12	
Г5	Pea-2009 × 2001-40	150	9	

Table-38 Study/Selection	of Progenies from	Filial Generations	(2017-18)
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	9200-1 × 2001-40	155	9
	9375 × 9374	200	13
F_6	9200-1 × 2001-60	170	11

2.2.2.1 F_1 GENERATION

Three crosses i.e. Safeer \times 9374, 9800-5 \times 9374 and 9200-1 \times 9374 were sown along with parents on both sides of one meter wide beds to raise F₁ generation. Selfed plants of crosses were rouged out at different plant growth stages. At maturity, ensured seed of cross combination was harvested in bulk separately.

$2.2.2.2 F_2$ GENERATION

Seventy five seeds of cross Meteor \times 9374, eighty five seeds of cross Lina Pak \times 9374 and eighty seeds of cross 1300-8 \times 9374 were sown on both sides of 6 meter long raised beds. Five, ten and eleven single plants were selected from each cross respectively 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.

2.2.2.3 F₃ GENERATION

Two hundred ten seeds of Meteor \times 2001-40 and One hundred and eighty five five seeds of 9374 \times 2001-40 were sown on both sides of 6 m long beds. Nineteen and twelve 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 seeds of 9800-10 \times 2001-40, one hundred and eighty five seed of 2001-20 \times 2001-40 and two twenty seeds of Lina pak \times 2001-40 were sown on both sides of 6 m long beds. Five, twenty and eighteen 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

One hundred and forty five seeds of $9375 \times 2001-40$, one hundred and fifty seed of Pea-2009 \times 2001-40, one hundred and fifty five seeds of $9200-1 \times 2001-40$ and two hundred
seeds of 9375×9374 were sown on both sides of 6 m long beds. Twelve, nine, nine and thirteen 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 F_6 generation.

2.2.2.6 F₆ GENERATION

One hundred and seventy seeds of 9200-1 \times 2001-60 were planted and eleven 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.

2.3 EVALUATION OF PEA VARIETIES/ADVANCE LINES FOR EARLY PLANTING

Ten varieties/lines of peas were planted on 24-10-17 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 5.0×1.5 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.

S.	Variety/	Days	Plant	No.	Seeds/	100-	Green
No.	Line	to	Height	of	pod	Seed	Pod
		50 %	(cm)	pods/		Weight	Yield
		flowering		plant		(g)	(T/ha)
						Fresh	
1	1300-8	32.67	51.66	8.0	7.2	37.33	8.90
2	Pea-2009	33.00	68.77	7.6	7.0	61.67	8.46
3	Sarsabz (C)	39.00	75.44	7.6	6.6	62.33	8.26
4	Lina pak	32.67	44.11	4.2	5.8	36.67	8.11
5	Meteor	30.67	55.11	6.2	5.2	43.33	8.07
6	2001-20	32.00	46.44	4.4	5.8	38.67	7.56
7	9200-1	33.33	69.77	7.6	6.6	49.33	6.79
8	9800-5	35.00	62.80	7.6	5.7	53.33	6.68
9	9374	32.00	44.40	4.0	5.8	42.67	6.20
10	2001-40	43.33	87.88	6.9	7.0	33.33	4.81
LSD	(0.05)	0.92	5.07	1.71	0.89	4.61	1.31

Table-39 Performance of Pea Strains/Varieties in Early Peas Varietal Trial atVegetable Research Institute, Faisalabad during 2017-18

Differences of means due to genotypes were significant for all studied traits. Maximum green pod yield of (8.90T/ha) was recorded for the advance line 1300-8 which is statistically significant with the check varieties Sarsabz (8.26T/ha) and Pea 2009 (8.46T/ha). The strain Meteor took minimum days to 50% flowering (30.67days) which is statistically significant with all other lines. Highest fresh 100-seed weight of 62.33g was recorded for check variety Sarsabz followed by approved variety Pea-2009 with fresh 100-seed weight 61.67g which are statistically at par with each other and statistically significant with all other high yielding lines. Maximum plant height was observed for line 2001-40 (87.88 cm) followed by Sarsabz (75.44cm). Maximum number of seeds per pod was recorded in line1300-8 (7.2seeds/pod) as compared with all other lines.

S. No.	Variety/ Line	Yield at First pick (78days)	Yield at Second pick (87days)	Yield at Third pick 99days)	Yield at Fourth pick (107days)	Total yield
1	1300-8	0.900	4.860	8.278	5.988	20.026
2	Pea-2009 (C)	-	3.371	9.6	6.06	19.031
3	Sarsabz (C)	-	-	-	18.578	18.578
4	Lina pak	2.708	7.906	5.604	2.029	18.247
5	Meteor	1.856	7.95	4.89	3.461	18.157
9	9374	2.41	6.284	4.012	1.25	13.956

Table-40 Days To Picking of Pea Strains/Varieties in Early Peas Varietal Trial recorded At Vegetable Research Institute, Faisalabad During 2017-18

The data depicted that the line 1300-8 showed better potential among all lines and produced early yield as compared with approved varieties Pea-2009 and Sarsabz. The line has the potential to produce early pick in comparison with commercial line Lina pak and meteor in early segment and have higher yield than both of the commercial varieties.

2.4 EVALUATION OF PEA VARIETIES/LINES FOR NORMAL PLANTING

Twelve varieties/lines including two checks were sown on 20-11-2017 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 $5.0 \times 1.25 \text{ m}^2$. Plant to plant and row to row distances were kept as 10 cm and 125cm, respectively. The data on different traits were recorded and are presented in Table.

S. No.	Variety	Days to 50 % flower	No. of pods/ plant	Seeds/ pod	100- Seed Weight (g) Fresh	Green Pod Yield (T/ha)
1	Pea-2009(C)	58.67	10.7	7.7	62.17	10.35
2	9375	75.00	10.4	7.2	44.87	9.16
3	Climax	66.67	10.6	7.6	43.83	6.73
4	PTL-1	79.00	10.6	7.8	41.73	5.98
5	PTL-6	78.67	10.5	7.5	37.17	5.86
6	PTL-3	78.00	8.6	6.6	34.83	5.65
I	LSD (0.05)	0.74	1.07	0.60	1.26	1.05

Table-41 Performance of Pea Strains/Varieties in Normal Planting at VegetableResearch Institute, Faisalabad during 2017-18

Differences of means due to genotypes were significant for all traits. Maximum green pod yield (10.35 T/ha) was produced by approved variety Pea-2009 followed by line 9375 (9.16 T/ha) which is statistically significant with check variety Pea-2009. Maximum 100 seed weight of (62.17 g) was recorded for the check variety Pea-2009 which is significantly higher than all other genotypes. The check variety Pea-2009 was earliest in producing 50% flowering in (58.00 days) while maximum days to 50% flowering was taken by PTL-1 (79.0 days). The data depicted that none of the tested lines showed at par or better yield as compared with check variety further these lines also took maximum days to flowering as compared with check.

2.5 EVALUATION OF PEA VARIETIES/ LINES IN PRELIMINARY YIELD TRIAL FOR EARLY PLANTING

Three lines of peas were planted on 25-10-17 along with check varieties at Faisalabad to study the performance of new lines in Preliminary Yield Trial for early planting time. The layout was conducted according to Randomized Complete Block Design with three replications in a plot size of $4 \times 1.5 \text{ m}^2$. 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-42 Performance of Pea Strains/Varieties in Preliminary Yield Trial atVegetable Research Institute, Faisalabad during 2017-18

S. No.	Variety/ Line	100- Seed Weight(g) Fresh	Green Pod Yield(T/ha)
1	Meteor (C)	43.67	8.80

2	Sarsabz (C)	57.33	7.93
3	1700-1	45.67	6.86
4	1700-2	41.33	6.48
5	1700-3	43.67	6.22
6	9374	42.67	5.40
	LSD (0.05)	3.28	1.06

Differences of means due to genotypes were significant for all studied traits. Maximum green pod yield of (8.80T/ha) was recorded for the check variety Meteor followed by check variety Sarsabz (7.93 T/ha). None of the lines tested in preliminary yield trial gave yield at par with check varieties. Lowest yield (5.40 T/ha) was recorded for the line 9374. Highest fresh 100-seed weight of 57.33 was recorded for approved variety Sarsabz while minimum 100 seed weight (41.33) was recorded for line 1700-2.

2.6 EVALUATION OF PEA VARIETIES/ LINES IN PRELIMINARY YIELD TRIAL FOR NORMAL PLANTING

Seven lines of peas were planted on 28-11-17 along with two check varieties at Faisalabad to study the performance of new lines in preliminary yield trial for normal planting time. The layout was conducted according to Randomized Complete Block Design with three replications in a plot size of 3×1 m². Plant to plant and row to row distances were kept as 10 cm and 100cm, respectively. The data on different traits were recorded and is presented in the Table.

S. No.	Variety/ Line	100-Seed Weight(g) Fresh	Green Pod Yield (T/ha)
1	Pea-2009 (C)	58.33	9.89
2	1700-9	33.67	8.00
3	Climax (C)	40.67	7.69
4	1700-4	41.40	7.17
5	1700-10	31.33	6.94
6	1700-5	43.67	6.78
7	1700-7	40.67	5.90
8	1700-6	41.17	5.35
9	1700-8	43.67	4.61
]	LSD (0.05)	2.18	0.84

Table-43 Performance of Pea Strains/Varieties in Preliminary Yield Trial atVegetable Research Institute, Faisalabad during 2017-18

Differences of means due to genotypes were significant for all studied traits. Maximum green pod yield of (9.89T/ha) was recorded for the check variety Pea-2009 followed by line 1700-9 (8.00 T/ha). The lines 1700-9,700-4 and 1700-10 tested in preliminary yield trial gave yield at par with check varieties. So these lines will be tested in advance lines trial in next year to confirm their yield potential and other characteristics. Lowest yield (4.61 T/ha) was recorded for the line 1700-8. Highest fresh 100-seed weight (58.33g) was recorded for approved variety Pea-2009 while minimum 100 seed weight (31.33) was recorded for line 1700-10.

2.7 EVALUATION OF PEA VARIETIES IN MULTILOCATIONAL TRAIL

Faisalabad, Sheikhupura, Layyah and Multan to check their performance at different places.

Six lines/Varieties including two checks were tested at four different locations i.e.

2.7.1 EVALUATION OF PEA LINES/VARIETIES AT VEGETABLE RESEARCH INSTITUTE FAISALABAD

The trial was laid out in Randomized Complete Block Design with three replications on 28-11-2017. The plot size was kept as $2 \times 5 = 10 \text{ m}^2$. Plant to plant and row to row distance was maintained as 5 cm and 75cm respectively. The data recorded for green pod yield are presented in table.

Table-44 Performance of Pea Lines/Varieties in Multi-Locational Trail at Vegetable Research Institute, Faisalabad, during 2017-18

Rank	Variety/	Green Pod
No.	Line	Yield(T/ha)
1	Lina Pak	8.11
2	Meteor (C)	8.02
3	1300-8	7.90
4	Sarsabz (C)	6.50
5	9800-5	5.80
6	9374	5.41
	LSD (0.05)	2.28

Differences of means due to genotypes were significant for green pod yield. Maximum green pod yield of 8.11 T/ha was recorded in line Lina Pak followed by check variety Meteor (8.02 T/ha) which is statistically non-significant with the candidate line 1300-8 (7.90 T/ha). Minimum green pod yield (5.41 T/ha) was recorded for the line 9374.

2.7.2 EVALUATION OF PEA LINES/VARIETIES AT VEGETABLE RESEARCH SUB-STATION SHEIKHUPURA

The trial was laid out in Randomized Complete Block Design with three replications on 11-11-2017. The plot size was kept as $4 \times 0.75 = 3 \text{ m}^2$. Plant to plant and row to row

distance was maintained as 5 cm and 75cm respectively. The data recorded for green pod yield are presented in Table.

		0
Rank	Variety/	Green Pod
No.	Line	Yield(T/ha)
1	1300-8	8.27
2	Sarsabz (C)	7.38
3	9800-5	6.16
4	Lina Pak	5.61
5	Meteor (C)	5.61
6	9374	4.94
Ι	LSD (0.05)	2.14

Table-45 Performance of Pea Lines/Varieties in Multi-Locational Trail at VRSS Sheikhupura During 2017-18

Differences of means due to genotypes were significant for green pod yield. Maximum green pod yield of 8.27 T/ha was recorded in the advance line 1300-8 followed by the check variety Sarsabz (7.38 T/ha). The advance line 1300-8 showed significantly higher yield in comparison with check variety Meteor. Minimum green pod yield (3.1 T/ha) was recorded for the line 9374.

2.7.3 EVALUATION OF PEA LINES/VARIETIES AT BZU SUB CAMPUS LAYYAH

The trial was laid out in Randomized Complete Block Design with three replications on 15-11-2017. The plot size was kept as $4 \times 0.75 = 3 \text{ m}^2$. Plant to plant and row to row distance was maintained as 5 cm and 75cm respectively. The data recorded for green pod yield is presented in table.

Rank	Variety/ Line	Green Pod Yield(T/ha)
1	1300-8	7.20
2	Meteor (C)	6.67
3	Sarsabz (C)	6.67
4	lina pak	6.18
5	9800-5	4.57
6	9374	4.22
L	SD (0.05)	2.45

Table-46 Performance of Pea Lines/Varieties in Multi-Locational Trail AtBZU Sub Campus, Lavyah During 2017-18.

Differences of means due to genotypes were significant for green pod yield. Maximum green pod yield of 7.20 T/ha was recorded in the advance line 1300-8 followed by the check variety Meteor (6.67 T/ha). The advance lines 1300-8 showed yield at par with the check variety Meteor. Minimum green pod yield (4.22 T/ha) was recorded for the check variety 9374.

2.7.4 EVALUATION OF PEA LINES/VARIETIES AT VRSS MULTAN

The trial was laid out in Randomized Complete Block Design with three replications on 15-11-2017. The plot size was kept as $4 \times 1.5 = 6 \text{ m}^2$. Plant to plant and row to row distance was maintained as 5 cm and 75cm respectively. The data recorded for green pod yield are presented in table.

Rank	Variety/	Green
	Line	Pod
		Yield
		(T/ha)
1	1300-8	9.77
2	9800-5	9.68
3	Lina Pak	9.40
4	Sarsabz (C)	8.88
5	Meteor (C)	8.48
6	9374	7.95
	LSD (0.05)	1.00

Table-47 Performance of Pea Lines/Varieties in Multi-LocationalTrail at VRSS Multan during 2017-18

Differences of means due to genotypes were significant for green pod yield. Maximum green pod yield of 9.77 T/ha was recorded in the advance line 1300-8 followed by the advance line 9800-5 (9.68 T/ha). The advance lines 1300-8 showed yield significantly higher than the check variety Sarsabz (8.88 T/ha). Minimum green pod yield (7.95 T/ha) was recorded for the check variety 9374.

2.8 ADAPTABILITY TRIAL OF EXOTIC PEA VARIETIES CONDUCTED AT VEGETABLE RESEARCH INSTITUTE, FAISALABAD DURING RABI 2017-18

Eight 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 24-10-2017. The planting geometry of the trial is as under:

Method of Sowing	Dibble sowing on both sides of the beds
Plot Size	$5 \times 1.5 \text{ m}$
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.

Rank	Varieties/	Days to 50%	100 Seed	GreenPod
	Line	flowering	Weight Fresh (g)	Yield(T/ha)
1	Pea-2009 (C)	36.00	70.67	9.54
2	Meteor (C)	32.00	47.33	9.37
3	Super Polo	32.00	45.33	7.76
4	Prince	59.00	44.67	7.62
5	Karishma	59.00	43.00	7.42
6	Diplomat	58.67	46.67	7.09
7	Green Gold	35.00	50.00	6.91
8	Super Aleena	35.00	40.33	6.56
9	Mission	37.00	50.67	6.31
10	Peas Summer Plus	58.67	43.33	5.73
	LSD (0.05)	0.41	4.81	2.47

Table-48 Performance of Exotic Pea at Vegetable Research Institute, Faisalabad during 2017-18

The data presented in the above table reveals that check varieties Pea-2009 (9.54 T/ha) and Meteor (9.37 T/ha) produced better yield among all exotic varieties. The statistical analysis predicts that the exotic lines Super polo (7.76 T/ha), Prince (7.62 T/ha), Karishma (7.42 T/ha), Diplomat (7.09 T/ha) and Green gold (6.91 T/ha) produced yield which is at par with the check varieties. So these lines could be tested for next year to confirm their adaptability. Variety Peas Summer Plus produced the lowest yield (5.73 T/ha) among all lines. Data depicted that check variety Meteor and exotic line Super Polo is comparatively early among all tested lines.

3. CHILIES (Capsicum annuum L.)

3.1 COLLECTION AND MAINTENANCE OF GERMPLASM

For the maintenance of germplasm, nursery of 54 genotypes was sown on 18.10.2017. Transplanting was carried out on 27.12.2017 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 and sun dried. After drying, seed was extracted manually for further use in breeding program. Range of various traits in available germplasm is as under.

S.	Character	Range		
No.		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 bu	inch	

Table-49 Range of Chillies Germplasm

3.2 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 23.11.2017 which includes 10 F_1 crosses, 03 F_2 populations, 06 F_3 populations, 06 F_4 populations, 11 F_5 populations, 6 F_6 populations and 4 F_7 populations. There was heavy spell of smog right after nursery sowing. Germination was delayed comparatively. The transplanting was carried out on 03.01.2018 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 and sun dried. After drying, seed was extracted manually to advance the generations for further studies to develop open pollinated varieties.

3.3 DEVELOPMENT OF MALE STERILE LINES IN CHILLIES

The objective of this trial is to develop three line ABR system for commercial production of hybrids in chillies. Two male sterile chillies plants were identified from segregating filial generations and were crossed with male fertile plants of same progeny during 2016-17. The nursery of harvested seed was sown on 18.10.2017. Transplantation was done on 21.12.2017. At flowering, individual plants were screened for male sterility and total four male sterile plants were identified and tagged from two progenies. These male sterile plants were crossed with male fertile plants of respective progenies to advance the generation. Crossed fruits were harvested at maturity and sun dried. After drying, seed was extracted manually to advance the generations for further studies.

3.4 ADAPTABILITY TRIAL FOR HOT PEPPER UNDER PLASTIC TUNNEL

Three varieties/hybrids received from different seed companies along with three checks were tested for their performance in adaptability trial under tunnel at Vegetable Research Institute, Faisalabad during 2017-18. 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:	3 + 3 Checks
Date of nursery sowing:	31.10.2017
Date of transplanting:	17.01.2018
Plot size:	$7 \text{ m} \times 1.5 \text{ m}$
Plant to plant distance:	60 cm

Table-50 Performance of Exotic Chili at Vegetable Research Institute, Faisalabad during 2017-18

Rank	Entry	Company	Yield (T/ha)	Fruit Length (cm)	Fruit Width (mm)
1	Green Fire	Syngenta, Pakistan Ltd.	54.4	8.82	15.6
2	Golden Hot	Check (Downward fruiting)	52.9	6.18	22.3
3	THP-034	Tara Crop Sciences (Pvt.) Ltd.	48.2	18.56	24.1
4	SV7864HM	Check (Upward fruiting)	37.8	4.84	7.8
5	P-6	Check (Downward fruiting)	35.3	6.8	12.5
6	THP-036	Tara Crop Sciences (Pvt.) Ltd.	34.0	4.52	6.8
LS	SD (0.05)		5.8		

Green Fire gave the highest yield for fresh green fruit. It bears single downward medium long fruits which turn dark red on maturity. It exhibited moderate resistance for collar rot. It also exhibited good fruit setting at high temperature in months of May and June. THP-034 has very long downward fruits of green colour with high fruit weight. THP-036 bears bullet type upward fruits in clusters with beautiful green colour which turn red on maturity.

3.5 ADAPTABILITY TRIAL FOR HOT PEPPER IN OPEN FIELD

Twenty two varieties/hybrids received from different seed companies along with three checks were tested for their performance in adaptability trial in open field at Vegetable Research Institute, Faisalabad during 2017-18. The crop was sown in two 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:	11 + 3 (Checks)
Date of nursery sowing:	23.11.2017
Date of transplanting:	22.02.2018
Plot size:	$7 \text{ m} \times 0.75 \text{ m}$
Plant to plant distance:	60 cm

Table-51 Performance of Exo	tic Hot Pepper at Vegetable Research Institute,
	Faisalahad during 2017-18

raisalabau uuring 2017-10						
Rank	Entry	Yield (T/ha)	Fruit Length (cm)	Fruit Width (mm)		
1	Golden Hot (C)	36.7	7.04	19.6		
2	BSS-410	35.1	7.16	17.5		
3	SV7864HM	30.1	5.18	8.2		
4	P-6 (C)	29.9	7.4	12.5		
5	PH-274 F ₁	27.0	10.7	14.4		
6	Advanta 512	26.8	4.8	8.5		
7	Veerji	24.8	7.4	9.1		
8	Advanta 5017	22.2	5.9	10.1		
9	Green Gold	21.4	7.1	9.4		
10	Divya	18.4	6.2	23.1		
11	HP-1410	17.8	7.2	8.2		
12	Green Star	17.3	6.7	21.8		
13	Disney F ₁	12.6	6.48	7.1		
14	Kent	10.7	6.78	6.4		
	LSD (0.05)	5.9				

In set-1, Golden Hot (Check) gave the highest fresh green fruit yield followed by "BSS-410". "BSS-410" bears single downward medium long fruits of green color which turn bright red on maturity. It exhibited good fruit setting in months of June and July. "BSS-410" is the only variety/hybrid which performed statistically at par to "Golden Hot" (Check). Moreover, entries from rank no. 5-7 performed statistically at par to "P-6" (Check). "Advanta 512" and "Advanta 5017" bear upward fruits in clusters. "Advanta 512" performed statistically at par to upward fruit bearing check "SV7864HM".

Set-2:

No. of varieties/Hybrids:	12 + 3 (Checks)
Date of nursery sowing:	23.11.2017
Date of transplanting:	22.02.2018
Plot size:	$7 \text{ m} \times 0.75 \text{ m}$
Plant to plant distance:	60 cm

Faisalabau uuring 2017-10					
Rank	Entry	Yield (T/ha)	Fruit Length	Fruit Width	
			(cm)	(mm)	
1	Kalae 542 F ₁	48.7	10.8	14.5	
2	HP 264 F ₁	40.1	7.9	13.8	
3	HP 1449 F ₁	39.9	8.34	9.1	
4	Golden Hot (C)	37.4	6.1	21.0	
5	555 F ₁	36.3	6.8	10.8	
6	No. 1031	36.0	8.1	10.7	
7	MDS-5748	34.6	8.4	9.5	
8	Royal Hot	33.4	11.1	6.4	
9	Marvi 558	33.1	4.4	8.2	
10	Big Red AB	31.6	8.8	12.3	
11	Super Sky AB	29.1	4.6	8.4	
12	SV7864HM	28.7	4.8	8.1	
13	P-6 (C)	27.4	7.2	11.8	
14	Veerji F ₁	22.9	7.3	9.0	
15	Divya F ₁	18.1	6.4	24.4	
-	LSD (0.05)	6.3			

Table-52 Performance of Exotic Hot Pepper at Vegetable Research Institute,Faisalabad during 2017-18

In set-2, variety/hybrid "Kalae 542 F_1 " gave the highest fresh green fruit yield. It bears single downward green fruit which turn red on maturity. It exhibited good fruit setting throughout the crop period. "HP-264 F_1 " is ranked 2nd, it bears single downward green fruit with good fruit setting throughout crop period. Varieties/Hybrids from rank # 1-10 performed statistically at par to "Golden Hot" (Check), whereas all varieties/hybrids gave higher yield than "P-6" (Check) except "Veerji F_1 " which is statistically at par to P-6 (check). "Marvi 558" and "Super Sky AB" bear upward fruits in clusters and both gave higher yield than upward fruit bearing check "SV7864HM".

4. SWEET PEPPER (Capsicum annuum L)

4.1 ADAPTABILITY TRIAL ON SWEET PEPPER VARIETIES/ HYBRIDS

One variety/hybrid received from Seed Company was tested for its performance in adaptability trial in open field at Vegetable Research Institute, Faisalabad during 2017-18. The trials were laid out in Randomized Complete Block Design with eight 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:	1 + 1 (Check)
Date of nursery sowing:	23.11.2017
Date of transplanting:	22.02.2018

Plot size:

 $7 \text{ m} \times 0.75 \text{ m}$ Table-53 Performance of Exotic Sweet Pepper at Vegetable Research Institute, Faisalabad during 2017-18

i albalabad daring 2017				
Rank	Entry	Yield (T/ha)		
1	MDS-9026	9.9		
2	Coral F ₁ (Check)	9.2		

The above table shows that the variety/hybrid "MDS-9026" performed better to standard "Coral F₁". MDS-9026 is early fruiting with beautiful fruit shape and good fruit setting at high temperature.

5. CARROT (Daucus carota L.)

5.1 MAINTENANCE OF GERMPLASM IN CARROT

Seven genotypes viz; 5 Red Genotypes (DC-3, DC-4, DC-90, DC-W and T-29), Purple genotype (DC-B), and Orange genotype(Orange-2007) were sown on 07-09-2017 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 get 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 the xylem and phloem. Small quantity of seed of each genotype is available for future manipulation.

5.2 **DEVELOPMENT OF CARROT VARIETIES FOR EARLY SOWING**

Two genotypes viz; DC-3 and DC-90 and two populations viz; Pop.1-17 and Pop.2-17 were sown on 07-09-2017. 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 Pop.1-17 whereas more than 100 days after sowing for the remaining genotypes, i.e., DC-3 and Pop.2-17 to develop the lines for short and normal crop span of the crop. The line DC-90 is early line with slightly variable root skin and core color. DC-3(red core) and Pop.2-17 (light red core) are slightly early genotypes. All four lines have slightly light skin color as compared to Indian lines in the market but are tastier. Being highly crossed pollinated crop a variation in phloem and xylem color was observed in the material which will be further screened to develop acceptable uniformity with darker red skin color by open crossing and mass selection of the genotypes. DC-3 require further one selection cycle for betterment.

5.3 DEVELOPMENT OF CARROT VARIETY SUITABLE FOR LATE PLANTING

Two genotypes viz; DC-4(Red) and DC-orange(Orange-2007) were 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 was derived from non-bolters exotic orange hybrid populations through chilling. The sowing of the material was done on both sides of 75 cm wide ridges on 07.11.2017. 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.

5.4 DEVELOPMENT OF CMS LINES

Eighty entries of crosses between BC-4 and F_5 were sown on 07-09-2017.Sixty one successful entries were harvested and transplanted under isolation cages on 18^{th} to 25^{th} January, 2018 to get BC-5 and F_6 generations.One hundred and sixty six new crosses were made among previous 61 entries by identifying male and female flowers.But only 130 crosses were harvested successfully.Moreover,two almost pure entries were also identified for further evaluation of restorability and fertility. All the material will be used for further back crossing and selfing to develop three line breeding systems for hybrid development.

5.5 ADAPTABILITY TRIAL OF CARROT EXOTIC VARIETIES

Four carrot varieties/ hybrids received from different seed companies were tested for their performance in adaptability trial in two sets at Vegetable Research Institute, Faisalabad during Rabi 2017-18.

Trial was conducted in randomized complete block design with three replications. The plot size was kept as 8.0 m \times 1.5 m. Trial was sown on 21.09.2017. The recommended agronomic and plant protection measures were adopted to maintain the crop. Harvesting was done on 30.01.2018. The data recorded is tabulated below.

I disalabad during 2017-10 (Bet-1)					
Rank	Entry	Root Length (cm)	Root Width (mm)	Root Flesh Color	Yield (T/ha)
1	AS-725	25.8	39.4	Red	52.9
2	DC-90	24.8	39.8	Red	48.9
3	T-29 (Check)	26.4	43	Red	43.6
4	DC-W	22.4	34.3	Red	41.6
5	DC-4	24.6	36.6	Red	38.6
6	Maverick	27.6	32.9	Orange	34.6
Ι	LSD(0.05)				2.33

Table-54 Performance of Exotic Carrot at Vegetable Research Institute, Faisalabad during 2017-18 (Set-1)

AS-725 exhibited significantly higher root yield (52.9 T/ha) than standard T-29(43.6T/ha).

Trial was conducted in Randomized Complete Block Design with three replications. The plot size was kept as $7.0 \text{ m} \times 1.5 \text{ m}$. Trial was sown on 07.11.2017. The recommended agronomic and plant protection measures were adopted to maintain the crop. Harvesting was done on 30.03.2018. The data recorded is tabulated below.

Table-55 Performance of Exotic Carrot at Vegetable Research Institute, Faisalabad during 2017-18 (Set-2)

Rank	Entry	Root Length (cm)	Root Width (mm)	Root Flesh Color	Yield (T/ha)
1	DC-4	23.4	40.43	Red	32.1
2	Appache	21.5	28.53	Orange	28.6
3	Maverick	21.3	22.83	Orange	27.3
4	DC-3	22.7	39.95	Red	23.8
5	T-29	25.5	34.83	Red	19.0
6	DC-W	24.6	32.68	Red	13.6
Ι	LSD (0.05)				3.2

DC-4 ranked first (32.1T/ha) followed by Appache (28.6 T/ha) and Maverick (27.3 T/ha).

6. **BITTER GOURD** (*Momordica charantia*)

6.1 GERMPLASM COLLECTION AND MAINTENANCE

To maintain the germplasm a total of thirteen varieties/collections were sown on 9-03-18 in the observational plots with plot size measuring $4.0 \times 2.5 \text{ m}^2$ by keeping the plant to plant distance of 45 cm. All standard agronomic practices were adapted. The germplasm was maintained through sib-mating.

6.2 DEVELOPMENT OF INBRED LINES

The breeding material comprising of two S_0 , nine S_1 , seven S_2 , four S_3 , three S_4 , seven S_5 , four in S_7 and fourteen in S_8 progenies were planted in varying plot sizes on 9-03-18 according to the availability of seeds for inbred line development programme. At flowering, progenies were advanced through selfing. The detail of the successful selfed fruits obtained from the lines is given in the table below.

Generations	No. of Fruits
S ₀	
Kohsar	2
Tarzan	2
S ₁	
Panther	6
S_2	
Black king × 888	7
HBG-37	10
S ₃	
888 × Black king	7
1324 × Black king	6
S ₄	
No.786	6
S ₅	
HBG-34	3
S ₆	
Raja	2
KHBG-37	4
S ₇	
Fsd long	4
S ₈	
Fsd long	3
S ₉	
Chaman	8
Collection-III	3
Collection-I	1

 Table-56 Number of Successful Selfed Fruits Obtained from Different Inbred lines

 Cenerations

 No. of Fruits

6.3 DEVELOPMENT OF SYNTHETIC VARIETIES IN BITTER GOURD

Seven inbred lines received from S_9 generation of inbred lines development programme with parents Janpuri and collection-2 were sown on 09-03-2018 along with common tester variety Black king. The inbred lines were crossed with common tester to get the F_1 seed of each cross and harvested and bulked the matured seed of each cross separately. Furthermore these lines were also maintained by sib mating.

6.4 DEVELOPMENT OF BITTER GOURD (MEDIUM SIZED) OFF SEASON CULTIVARS

Eight genotypes obtained from different sources were sown on 04-08-2017 to check the adaptability of varieties/ hybrids in Autumn season. All required agronomic practices were carried out in trial. Due to severe smog and viral/fungal diseases all the lines were failed to produce sibbed seed for generation advancement and did not show encouraging results in Autumn season. However the line obtained from the cross of Safeena smooth \times Long special showed better results and was maintained by sib mating for further evaluation in next season.

6.5 EVALUTION OF BITTERGOURD VARIETIES/HYBRIDS IN ADAPTABILITY TRAIL FOR FEB-MARCH SOWING SEASON

An adaptability trial comprising of thirteen genotypes, twelve received from different seed companies and one local check (Aswad) was conducted on 9-03-2018 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 3.0×2.5 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.

5.110.	v uniceg/my onic	
1	Kohsar F ₁	17.14
2	Panther F ₁	15.10
3	Tarzan F ₁	14.27
4	Aswad (Check)	12.64
5	Nelum F ₁	11.59
6	Zarar	10.44
7	HBG-892 A	9.90
8	BGH-741	9.70
9	882 A	9.42
10	Safa	8.40
11	SHBG-48	7.82
12	MKS-545 F ₁	7.53
13	Carlos	5.77
	LSD(0.05)	2.38

Table-57 Performance of Bitter Gourd Varieties/Hybrids in AdaptabilityTrial at Vegetable Research Institute, Faisalabad during Kharif, 2018 (Set-1)S. No.Variety/HybridFruit Yield (T/ha)

The data depicted that variety Kohsar F_1 performed better (17.14 T/ha) among all varieties and found statistically at par with variety Panther F_1 (15.10 T/ha) while these two lineswere found statistically significant in comparison with check. However the lines Tarzan F_1 (14.27 T/ha), Nelum F_1 (11.59 T/ha) and Zarar (10.44 T/ha) produced yields at par with the check varietyAswad (12.64 T/ha). The variety Carlos (5.77 T/ha) produced lowest yield among all genotypes. The better performer lines could be tested for the second year adaptability to confirm their potential.

An adaptability trial comprising of ten genotypes, nine received from different seed companies and one local check (Aswad) was conducted on 9-03-2018 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 3.0×2.5 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.

5. NO.	variety/Hybrid	Fruit Yield (1/na)
1	7499 F ₁	12.02
2	Daizy	10.23
3	Aswad (Check)	8.03
4	Target Bg-555	7.89
5	TBG-101	7.40
6	Sakuna-208 F ₁	7.10
7	MSC-125	6.68
8	PS-777	6.51
9	NA-241	6.14
10	4722	3.94
	LSD(0.05)	2.34

 Table-58 Performance of different Bitter Gourd Varieties/Hybrids in Adaptability

 Trial at Vegetable Research Institute, Faisalabad during Kharif, 2018 (Set-2)

The data depicted that variety 7499 F_1 performed better (12.02 T/ha) and statistically significant with the check variety Aswad (8.03 T/ha). However the lines Daizy (10.23 T/ha), Target bg-555 (7.98 T/ha), TBG-101 (7.40 T/ha), Sakuna-208F1 (7.10 T/ha), Msc-125 (6.68 T/ha), PS-777 (6.51 T/ha) and Na-241 (6.14 T/ha) produced yields at par with the check variety. So these lines could be tested for next year to confirm their adaptability.

6.6 EVALUTION OF BITTERGOURD VARIETIES/HYBRIDS IN NUYT FOR FEB-MARCH SOWING SEASON

A NUYT trial comprising of six genotypes including check received from Pakistan Agricultural Research Council (Plant Science Division), Islamabad was conducted on 9-03-2018 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 3.0×2.5 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.

S. No.	Variety/Hybrid	Fruit Yield
		(T/ha)
1	BG-18008	20.54
2	Kohsar F ₁	19.50
3	BG-18018	19.40
4	BG-18028	16.99
5	BG-18022	16.25
6	BG-18015	8.20
	LSD(0.05)	3.29

Table-59 Performance of Different Bitter Gourd Entries in NUYT Trial atVegetable Research Institute, Faisalabad during Kharif, 2018

The data depicted that entry BG-18008 (20.54T/ha) performed better among all entries. However the entries BG-18018 (19.40 T/ha), BG-18028 (16.99 T/ha) and BG-18022 (16.25 T/ha) produced yields at par with the check variety(Kohsar F_1). The line/entry BG-18015 (8.20 T/ha) produced lowest yield among all lines.

7. RADISH (Raphanus sativus)

7.1 ADAPTABILITY TRAIL OF EXOTIC RADISH VARIETY

Two radish varieties namely; No.025 and Red Prince received from Rashid Seeds, Jilani building, Sheikhupura more, Gujranwala were tested at Vegetable Research Institute, Faisalabad along with the check variety Mino Selection. The trial was sown on 14-9-2017 in triplicate RCB design keeping plot size of $8.0 \text{ m} \times 0.75 \text{ m}$. The sowing was done on both sides of ridges made 75 cm apart. The harvesting was done 6-12-2017. Yield data collected is given in table

S. No.	Variety	Root +Leave vield(T/ha)
1	Mino Selection	75.83
2	Purple Neck	67.77
3	Small Leave	67.22
4	Desi White	65.67
5	Gang Seong	62.22
6	Green Neck	57.22
7	Lal pari	48.33
8	Mino Local	47.77
9	No.025	32.22
10	Red Prince	28.33
	LSD (0.05)	6.29

Table-60 Performance of Late Radish Varieties in Adaptability Trial at VRI, Faisalabad 2017-18

The table reveals that varieties were statically significant for yield. The maximum yield was given by Mino Selection (75.83T/ha) followed by Purple Neck (67.77 T/ha).

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, 2017. 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, 2017 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-61 Pre-BasicSeed produced during 2017-18

S. No.	Varieties	Quantity (g)
1	Mino Local	100
2	40 Days	4000
3	Desi White	150
4	Lal Pari	2500
5	Mino Selection	3000

8. TURNIP (Brassica comprestris var. rapa)

8.1 ADAPTABILITY TRAIL OF EXOTIC TURNIP 2017-18

Turnip varieties; Purple Top (M-17-6358) and Purple Top (M-17-6299) received from Rashid Seeds, Jilani building, Sheikhupura more, Gujranwala was tested at Vegetable Research Institute, Faisalabad along with the check variety Purple Top. The sowing of these varieties was done on 2-11-017. 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 8×0.75 m. All agronomic and plant protection measures were adopted to maintain the crop. The harvesting of the crop was done on 08-01-2018. The data recorded for root and leave yield (marketable) is presented in the table below.

S.	Variety	Root +leave
INO.		rield (1/na)
1	Golden	58.33
2	Purple Top (Lot. No.M-17-6358)	52.22
3	Desi Red	52.77
4	Purple Top (Lot. No.M-17-6299358)	52.22
5	Purple	50.55
6	Purple Top (check)	50.55
7	Purple Golden	45.00
8	Green Top	44.44
9	Kunsar	31.11
10	White Local	27.77
	LSD (0.05)	8.17

Table-62 Performance of Turnip Variety in Adaptability Trial at VRI, Faisalabad 2017-18

The maximum yield (58.33 t/ha) gave by variety Golden followed by Purple Top (LOT. NO.M-17-6358) with yield potential of 52.22 t/ha. Data was found significant statistically.

8.2 PRE-BASIC SEED PRODUCTION IN TURNIP VARIETIES

Single plant progenies of Purple Top Punjab and Golden varieties were sown on 14-09-2017 and 16-12-2017 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 in Dec. 2017, 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 450 g of variety Purple Top and 600 g seed of Golden was produced.

8.3 EVALUATION OF HEAT TOLERANT LINE OF TURNIP

The trial was sown on 27.7.2017 and harvesting was done on 10.10.2017 for comparison of heat tolerance among different genotypes. Five traits: number of leaves per

plant, length of leaf per plant, width of root per plant, length of root per plant and length to rootratio was calculated by diving length by width. The data was calculated by averaging the five plants in each trait. According to table the lowest ratio got by Purple Top Agita (1.11), which means near to round shape whereas maximum ratio was got by Purple Top (Exotic) 1.90, which means oblong shape and it is due to heat effect.

S. No.	Types of Turnip	Number of	Length of	Width of	Length	Length
		Leaves	Leaves	Root	of Root	/ Width
1.	Purple Top (S)	10.1	35.2	3.9	6.5	1.66
2.	Purple Top (Agitta)	12.4	34.4	5.8	6.6	1.11
3.	Purple Top (N)	8.2	30.4	4.7	6.1	1.30
4.	Purple Top (Exotic)	9.3	32.4	3.7	7.2	1.90

Table-63 Types of Turnip showing Different Traits of Different Top

9. MUSKMELON

9.1 ADAPTABILITY TRAIL OF EXOTIC MUSKMELON VARIETY IN FIELD, 2018

Muskmelon varieties; Isabel, MSC.HIM.006, MKS661, MSC HIM. 009, CAD 6812, HSM 051A, Sweaty, Qaiser, MSCN1003 and HSM 062A received from different companies were tested at Vegetable Research Institute, Faisalabad along with Ravi as a check. The sowing of these varieties was done on 02-03-2018 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 $7.60 \times 3m$. All agronomic and plant protection measures were adopted to maintain the crop .The harvesting of the fruit was done on 07-05-2018. The data recorded for fruit yield and TSS is presented in the table below.

S. No.	Varieties	Yield T/ha	TSS
1	Ravi (check)	7.42	13
2	HSMO62A	7.27	11
3	Isabel F ₁	5.68	9
4	MSCHIM006	4.67	11
5	MKS661	4.60	8
6	MSCHIM 009	4.60	10
7	CAD 6812	4.60	9
8	HSM051A	4.79	10
9	Sweaty F ₁	4.29	9
10	Qaiser	4.27	10
11	MSC.HIM.003	3.77	11
	LSD (0.05)	2.41	10

Table-64 Performance of Muskmelon Varieties in field at VRI, Faisalabad 2018

Overall yield of all varieties were observed low due to high temperature in April. The maximum fruit yield (7.42 T/ha) with TSS value of 13 % gave by variety Ravi, followed by HSMO62A with fruit yield of 7.27t/ha with TSS value of 11%. All Varieties were found significant statistically.

9.2 ADAPTABILITY TRIAL OF EXOTIC MUSKMELON VARIETY IN FIELD, 2018

Thirteen muskmelon varieties; NSC-1, Zumra, Venus, AS22, Cofio, Zeta, Alwa, Mankera 212, Spalsh 465, NSC-5, NSC-2, Ravian ANS ASH-1and T-96as a checkwere tested at Vegetable Research Institute, Faisalabad. The sowing of these varieties was done on 02-02-2018 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 $7 \times 3m$. All agronomic and plant protection measures were adopted to maintain the crop .The harvesting of the fruit was done on 7-5-2018. The data recorded for fruit yield and TSS is presented in the table below.

S. No.	Varieties	Yield T/ha	TSS (%)
1	T-96	7.94	13
2	NSC-1	6.25	13
3	Zumra F ₁	6.22	12
4	Venus	6.19	11
5	AS22	5.41	10
6	Cofio	5.16	12
7	Zeta F ₁	4.66	11
8	Ajwa	4.66	10
9	Mankera 212	4.66	11
10	Spalsh 4.65	4.65	10
11	NSC.5	4.61	12
12	NSC.2	4.53	11
13	Ravian	4.04	9
14	ASH-1	3.38	12
	LSD (0.05)	2.45	

Table-65 Performance of Muskmelon Varieties in field at VRI, Faisalabad 2018

The maximum fruit yield (7.54T/ha) with TSS value of 13 % gave by variety T-96, followed by NSC-1 F_1 with fruit yield of 6.25 T/ha with TSS value of 13%. Varieties were found significant statistically.

9.3 ADAPTABILITY TRAIL OF EXOTIC MUSKMELN VARIETY IN FIELD, 2018

Muskmelon varieties; Shower, TMM1102, MDS1963, TM1101, Sweat Peridot and T-96 as a checkwere tested at Vegetable Research Institute, Faisalabad along with T-96. The sowing of these varieties was done on 2-3-2017 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 of $7 \times 3m$. All agronomic and plant protection measures were adopted to maintain the crop .The harvesting of the fruit was done on 7-5-2018. The data recorded for fruit yield and TSS is presented in the table below.

S. No.	Varieties	Yield T/ha	TSS(%)		
1	T-96	6.99	12		
2	Shower	4.45	11		
3	TMM1102	4.07	10		
4	MDS1963	3.76	9		
5	TM1101	3.49	12		
6	Sweat Peridot	3.21	11		
	LSD (0.05)	3.18			

Table-66 Performance of Muskmelon Varieties in Field at VRI, Faisalabad 2018 (Set-1)

The maximum fruit yield (6.99 T/ha) with TSS value of 12 % was revealed by variety T-96, followed by Shower with fruit yield of 4.45 T/ha with TSS value of 11%. Varieties were found significant statistically.

Muskmelon varieties; M-74 F₁, M-48 F₁, M-85 F₁, M-103 F₁, M -42 F₁, M-9 F₁, M81- F₁, M-64F₁, M-37 F₁and T-96as a checkwere tested at Vegetable Research Institute, Faisalabad along with T-96. The Seedling of these varieties was transplanted on 7-3-2018 in open field. The seedling was overgrown. The lay out was according to RCBD with three replications. The sowing was done on bed made 2.5 m apart with plot size 5×2.5 m. All agronomic and plant protection measures were adopted to maintain the crop .The harvesting of the fruit was done on 8-5-2018. The data recorded for fruit yield and TSS is presented in the table below.

S. No.	Varieties	Yield (T/ha)	TSS(%)
1	M74F1	24.92	12
2	M-48 F ₁	23.11	13
3	M85 F ₁	22.35	12
4	M103 F ₁	21.28	12
5	M 42 F ₁	20.72	13
6	M 9 F ₁	20.69	12
7	M 81 F ₁	20.39	11
8	M 64 F ₁	19.40	13
9	M37 F ₁	18.76	12
10	T-96 (check)	17.30	14
Ι	LSD (0.05)	4.43	

Table-67 Performance of Muskmelon Varieties in field at VRI, Faisalabad 2018 (Set-2)

The maximum fruit yield (24.92 T/ha) with TSS value of 12 % was revealed by variety M74 F_1 , followed by M 48 F_1 with fruit yield of 23.11 T/ha with TSS value of 11%. Varieties were found significant statistically.

9.4 ADAPTABILITY TRAIL OF EXOTIC MUSKMELON VARIETY RECEIVED DURING 2018

Muskmelon varieties/hybrids Melon 1301, VRIM-10,Green Flesh, Ravi, White Hero ACS, RangioPio RZ were tested under low plastic tunnel at Vegetable Research Institute, Faisalabad along with T-96 as a check. The transplanting of the seedlings was done on 10-1-2018 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 of 3×7 m. All agronomic and plant protection measures were adopted to maintain the crop .The harvesting of the fruit was started on 9-4-2018. The data recorded for fruit yield and TSS is presented in the table below.

S.No.	Varieties	Yield (T/ha)	TSS (%)
1	Melon 1301	16.75	13
2	VRIM-10	15.69	13
3	T-96 (check)	15.63	12
4	Green Flesh	14.34	15
5	Ravi	12.70	14
6	White Hero ACS	11.96	11
7	Rangi Pio RZ	11.18	10
	LSD (0.05)	4.78	

Table-68 Performance of muskmelon Varieties in Adaptability Trial at VRI,Faisalabad 2017-18

The maximum fruit yield (16.75T/ha) with TSS value of 13 % gave by variety Sweat Melon followed by VRIM-10, with fruit yield of 15.69 T/ha with TSS value of 13%. All varieties were found significant statistically

10. WATERMELON (Citrullus lanatus L.)

10.1 EVALUATION OF EXOTIC WATERMELON VARIETIES /HYBRIDS IN ADAPTABILITY TRIAL, 2018

Thirteen entries in set-1, thirteen in set-2 and thirteen in set-3 along with check variety Sugar baby were sown on 14.03.2018 to check their adaptability. Sowing was done 50 cm apart in hills, according to Randomized Complete Block Design with three replications keeping plot size of 6.3×3.0 m. Germination of all the hybrids/varieties was satisfactory. Agronomic practices and plant protection measures were adopted regularly.

Data regarding fruit yield, TSS and fruit splitting were recorded and presented in the following tables.

Rank	Variety/Hybrid	TSS (%)	Yield (T/ha)
1	Commandor F ₁	9.17	10.97
2	WMH-4715	8.66	10.95
3	SVWC-6988	7	8.13
4	NSC WM2 F ₁	10	7.78
5	WMT 4807	8.33	7.06
6	SVWC 4183	7.66	6.6
7	Launcher	6.66	5.70
8	Sugar Baby (Check)	9	4.84
9	Advanta1401	7.16	4.83
10	MDS-770	7	4.4
11	NSC WM1 F ₁	7.33	4.13
12	Nautilus	8	2.11
13	Turi-F ₁	7	2.13
14	MDS 101	7	1.83
	LSD (0.05)	1.18	2.17

Table-69 Yield performance of various Varieties/Hybrids of Watermelon during 2018(Set-1)

The data presented in table-69 revealed that all the hybrids / varieties showed highly significant differences for fruit yield and TSS% age. Thehybrid Commandor F_1 exhibited the highest fruit yield of 10.97 T/ha followed byhybrid/variety WMH-4715 (10.95T/ha) whereas, the hybrid/variety MDS 101 showed the lowest fruit yield (1.83 T/ha) in set-I. Thehybrid NSC WM2 F_1 exhibited the highest value of TSS (10%) followed byhybrid/variety Commandor $F_1(9.17\%)$ and Sugar Baby (9%) whereas, the hybrid/variety Launcher showed the lowest TSS value (6.66 %) in set-I.

Table-70 Yield performance of various Varieties/Hybrids of Watermelon during2018 (Set-2)

Rank	Variety/Hybrid	TSS%	Yield (T/ha)
1	525 F ₁	7.3	10.53
2	WM 4163	7	8.14
3	Prince	8	6.52
4	MDS 452	7.7	6.37
5	NSC WM3	7.3	5.84
6	WS93	7.7	5.32
7	WMT 4809	6.7	5.21
8	TWM 1610	8	4.75
9	Global	7	4.08
10	Vigo	7.3	3.95
11	Jackie	7	3.52
12	SVI 770WC	7	3.50
13	Sugar Baby (Check)	8.8	2.85

14	MDS 2159	8	1.94
	LSD (0.05)		

The data presented in table-70 reveals that all the hybrids / varieties showed highly significant differences for fruit yield and non-significant differences for TSS% age. The hybrid/variety 525 exhibited the highest fruit yield of 10.53 T/ha followed byhybrid/variety WM4163 (8.14T/ha) whereas, the hybrid/variety MDS 2159 showed the lowest fruit yield (1.94 T/ha) in set-2.

Rank	Variety / Hybrid	TSS (%)	Yield (T/ha)
1	MKS 301	7.33	10.53
2	Sultan Hope	8.67	8.14
3	QF WSR 28	7.33	6.52
4	Rocket F ₁	6	6.37
5	Swera F ₁	7	5.84
6	Rambo F ₁	7	5.32
7	Ptanegra	7.33	5.21
8	Summer-7	7.33	4.75
9	Zinco	7.33	4.08
10	TWM-1608	7	3.95
11	World King	8	3.52
12	Rexy F ₁	11.33	3.50
13	Sugar Baby	9	2.85
14	Fiesta F ₁	7	1.94
	LSD (0.05)	0.85	2.8

Table-71 Yield performance of various Varieties/Hybrids of Watermelon during 2018 (Set-3)

The data presented in table-71 revealed that all the hybrids / varieties showed highly significant differences for fruit yield and TSS%. Thehybrid/variety MKS 301exhibited the highest fruit yield of 7.26T/ha followed byhybrid/variety Sultan Hope (6.06T/ha) whereas, the hybrid Fiesta F_1 showed the lowest fruit yield (2.35 T/ha) in set-3. Thehybrid Rexy F_1 exhibited the highest value of TSS (11.33%) followed byCheck variety Sugar Baby(9%) whereas, the hybrid Rocket F_1 showed the lowest TSS value (6%) in set-3.

Note: This year yield is low because of high temperature and spread of viral diseases and fungal diseases.

10.2 DEVELOPMENT OF INBRED LINES IN WATERMELON

The seed of four S_7 progenies/lines and five S_2 progenies/lines was sown in fruit to row fashion on 14.03.2018 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 four S_7 lines and five S_2 progenies/lines was collected.

10.3 DEVELOPMENT OF HYBRIDS

Four lines in S₇ generation were crossed to have six hybrids combination.

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 16.03.2018 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

Eight hybrids/varieties including standard variety FD-II were sown for raising the nursery on 20.07.2017 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 7×1.5 m. 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 31.08.17. Standard cultural practices and plant protection measures were carried out regularly. Data regarding plant weight, curd weight and curd yield of hybrids / varieties were recorded.

Rank	Variety	Average Plant	AverageCurd	CurdYield
		Weight (kg)	Weight(kg)	(T/ha)
1	Snow Muffin	1.28	0.67	14.23
2	Snow Waltry	1.23	0.59	12.67
3	CFH-1522	0.89	0.44	11.24
4	FD-II (check)	0.79	0.45	10.39
5	Dawn 175	0.70	0.37	9.37
6	SV 4051AC	0.70	0.41	9.03
7	Esk.002 F ₁	0.72	0.37	8.83
8	MEIGETSU-55	0.88	0.32	6.71
	LSD (0.05)			1.53

Table-72 Yield performance of Cauliflower Hybrid/Varieties (2ndEarly-season) during2017-18

It is evident from the above table that the differences among means due to varieties were significant for curd yield. Entries Snow Muffin and Snow Waltry produced significantly higher curd yields than check variety FD-II (10.39 T/ha).

However, varieties CFH-1522, Dawn 175 and SV 4051AC remained at par in comparison with check FD-II. The highest curd yield of 14.23 T/ha was recorded in entry Snow Muffin while the lowest curd yield (6.71T/ha) was depicted by the entry MEIGESTU-55. Moreover, variety Snow muffin gave the highest average curd weight of 0.67 kg followed by Snow Waltry 0.59 kg whereas, Snow Muffin showed the highest average plant weight 1.28 kg followed by Snow Waltry with average plant weight 1.23 kg.

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

Nine hybrids/varieties including standard variety FD-III were sown for raising the nursery on 17-09-2017 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 7×1.5 m. 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 13-10-17. Standard cultural practices and plant protection measures were carried out regularly. Data regarding plant weight, curd weight and curd yield of hybrids / varieties were recorded.

Table-73 Yield performance of Cauliflower Hybrid/Varieties (Mid-Season) during 2017-18

	2017-10				
Rank	Variety	Average Plant Weight (kg)	Average Curd Weight (kg)	Curd Yield (T/ha)	
1	CF-4180	2.97	1.82	46.70	
2	HCF-12	2.88	1.80	46.17	
3	HCF-23	2.61	1.58	40.70	
4	CF-4175	2.24	1.38	35.43	
5	HCF-22	2.76	1.33	34.25	
6	HCF-13	2.24	1.28	32.85	
7	FD-III (check)	2.81	1.18	30.35	
8	Snow Wizard	1.82	0.93	23.86	
9	Snow Mountain	1.56	0.86	22.01	
	LSD (0.05)	0.42	0.14	2.16	

It is evident from the above table that the entries CF-4180, HCF-12, HCF-23, CF-4175 and HCF-22 produced significantly higher curd yields than high yielding check FD-III (30.35 T/ha). However, the entry HCF-13 remained at par in comparison with high yielding check FD-III. The highest curd yield of 46.70 T/ha was recorded in entry

CF-4180 closely followed by HCF-12 while the lowest curd yield was depicted by the entry Snow Mountain (22.01T/ha). Moreover, variety CF-4180 gave the highest average curd weight of 1.82 kg followed by HCF-12 1.80 kg whereas, CF-4180 showed the highest average plant weight 2.97 kg followed by HCF-12 with average plant weight 2.88 kg.

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

Seven hybrids/varieties including standard variety FD-IV were sown for raising the nursery on 11-10-2017 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 7×1.5 m. 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 16-11-17 in Set-I. Standard cultural practices and plant protection measures were carried out regularly. Data regarding plant weight, curd weight and curd yield of remaining hybrids / varieties were recorded and is presented below.

Rank	Variety	Average Plant Weight (kg)	Average Curd Weight (kg)	Curd Yield (T/ha)
1	Sara F ₁	2.85	1.55	44.40
2	Madubani	2.38	1.32	37.84
3	FD-IV (check)	2.25	1.17	33.52
4	Moon Light F ₁	2.03	1.06	30.34
LSD (0.05)			1.33

Table-74 Yield performance of Cauliflower Hybrid/Varieties (Late-Season Set-I) during2017-18

It is evident from the above table that the entries Sara F_1 and Madubani produced significantly higher curd yields than check FD-IV (33.52 T/ha). However, the entry Moon Light F_1 produced significantly lower curd yields comparison with check FD-IV. The highest curd yield of 44.40 T/ha was recorded in variety Sara F_1 while the lowest curd yield was depicted by the entry Moon Light (30.34T/ha). Moreover, variety Sara F_1 gave the highest average curd weight of 1.55 kg followed by Madubani 1.32 kg whereas Sara F_1 showed the highest average plant weight 2.85 kg followed by Madubani with average plant weight 2.38 kg. The hybrid/varieties CKD-1425, CKD-1924 and CKD-2014 turned in to buttoning at very early stage and no marketable heads were developed hence no data for these varieties could be recorded. These varieties were also tested in 2ndEarly season in 2016-17. In 2nd early season they did not turned into buttoning, therefore it is recommended to test them in 2^{nd} early season not for late season.

Five hybrids/varieties including standard variety FD-IV were sown for raising the nursery on 2-11-2017 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 7×1.5 m. 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 15-12-17 in set-2. Standard cultural practices and plant protection measures were carried out regularly. Data regarding plant weight, curd weight and curd yield of remaining hybrids / varieties were recorded and is presented below.

		during2017-18		
Rank	Variety	Average Plant	Average Curd	Curd Yield
		Weight (Kg)	Weight(Kg)	(17ha)
1	Sara F ₁	3.31	1.18	33.57
2	TCF-601	2.23	1.06	30.31
3	FD-IV (check)	2.68	1.01	28.99
LSD (0.05)			1.62	

Table-75 Yield performance of Cauliflower Hybrid/Varieties (Late-Season Set-2) during2017-18

It is evident from the above table that the entry Sara F_1 produced significantly higher curd yields than check FD-IV (28.99 T/ha). However, the variety TCF-601 remained at par in comparison with check FD-IV. The highest curd yield of 33.57 T/ha was recorded in entry Sara F_1 . Moreover, variety Sara F_1 gave the highest average curd weight of 1.18 kg followed by TCF-601 1.06 kg whereas Sara F_1 showed the highest average plant weight 3.31 kg followed by TCF-601 with average plant weight 2.23 kg. The hybrid/varieties CKD-1425 and TCF-603 turned in to buttoning at very early stage and no marketable heads were developed hence no data for these varieties could be recorded therefore they are not recommended for late season.

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. Thirty 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 matted population was sown in the field on 17-09-2017 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. capitate*)

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

Four hybrids/varieties were sown for raising the nursery on 20-09-2017 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 7×1.5 m. 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 26-10-17 in set-I. Standard cultural practices and plant protection measures were carried out regularly. Data regarding plant weight, head weight and yield of hybrids / varieties were recorded.

Rank	Variety	Average Plant Weight (kg)	Average Head Weight (kg)	Head Yield (T/ha)
1	Red Flama	2.09	1.14	32.45
2	HCB-141B	1.80	1.09	31.14
3	Blue Moon	1.56	0.84	23.95
4	T1-138	1.08	0.82	23.47
	LSD (0.05)			2.571

Table-76 Yield performance of Cabbage Hybrid/Varietiesduring

It is evident from the above table that the entries Red Flama and HCB.141.B produced significantly higher head yields than Blue moon and T1.138. The highest head yield of 32.45 T/ha was recorded in entry Red Flama followed by HCB-141B while the lowest head yield (23.47 T/ha) was depicted by the entry T1-138. The hybrid/variety Red Flama gave highest average head weight of 1.14 kg followed by HCB-141 B (1.09 kg). In case of average plant weight Red Flama showed the highest average plant weight 2.09 kg followed by HCB-141 B with average plant weight of 1.80 kg.

Three hybrids/varieties were sown for raising the nursery on 2-11-2017 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 7×1.5 m. 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 15-12-17 in set-2. Standard cultural practices and plant

protection measures were carried out regularly. Data regarding plant weight, head weight and head yield of hybrids / varieties were recorded.

	2017-18(Set-2)				
Rank	Variety	Average Plant Weight (kg)	Average Head Weight (kg)	Yield (T/ha)	
1	HCB-142A	1.92	1.24	35.38	
2	HCB-143C	1.48	0.94	26.79	
3	T1-138	1.23	0.86	24.50	
	LSD (0.05)			2.31	

Table-77 Yield performance of Cabbage Hybrid/Varieties during 2017-18(Set-2)

It is evident from the table-76 that the entry HCB-142A produced significantly higher head yields than rest of the varieties or hybrids. The entry HCB-142A gave the highest head yield of 35.38 T/ha followed by HCB-143C (26.79 T/ha) while the lowest head yield (24.50 T/ha) was depicted by the entry T1-138. The hybrid/variety HCB-142A gave highest average head weight of 1.24 kg followed by HCB-143 C 0.94 kg. In case of average plant weight HCB-142A showed the highest average plant weight 1.92 kg followed by HCB-143 C with average plant weight of 1.23 kg.

13. ONION (Allium cepa L.)

13.1 MAINTENANCE OF GERMPLASM

Thirty two genotypes of onion of local and exotic origin were sown for the purpose of maintenance in the previous season and their bulbs were stored. Bulbs were transplanted in isolation chambers for seed production through open pollination on 10.11.2017 keeping plot size of 30×5 m. Seed was harvested at maturity and saved. The detailed below entries were maintained during the year:

S. No.	Entry	S. No.	Entry
1	VRIO-1	17	Red Nasik
2	VRIO-2	18	Pusa Red
3	VRIO-3	19	Desi Large
4	VRIO-4	20	Mirpurkhas
5	VRIO-5	21	Dark Red
6	VRIO-6	22	Early Red
7	VRIO-7	23	Phulkara
8	VRIO-8	24	PK10321

Table-78 Maintenance of Onion Germplasm

9	VRIO-9	25	Local
10	VRIO-10	26	Pink Panther
11	VRIO-11	27	Prema
12	Robina	28	Zeus
13	Desi Red	29	Texas Early Grano
14	Red Imposta	30	Golden ORB
15	Husri	31	White Pearl
16	Faisal Red	32	Yellow Granex

13.2 DEVELOPMENT OF ONION INBRED LINES 13.2.1 S₁ Generation

Four new strains were selected for inbreeding namely, Yellow Granex, White Pearl, Pink Panther and Golden ORB. Their bulbs were saved in the previous season were transplanted on 10.11.2017 for selfing keeping row to row and plant to plant distance of 75 and 30 cm, respectively. At flowering unopened umbels were covered with butter paper bag. The covered umbels were shaken daily till the opening of the flowers. S_1 seed of these varieties were collected at maturity for further studies in the next generation.

 S_1 Seed of six varieties i.e. red King, Kareem, Prema, T1-172, Desi Red and Robina produced during the previous year was sown during October 2017 for nursery sets production for next generationand sets were harvested and stored during May 2018.

Complete detail of inbred lines is given in Table 2.

13.2.2 S₂Generation

The S_1 sets of three varieties *i.e.* Desi Red, Ceylon and Red moon were planted during August 2017 and were re-planted during November 2017 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. S_2 seed of these varieties were collected on maturity for further studies in the next generation.

 S_2 seed of two varieties *i.e.* VRIO-4 and Red Imposta produced during the previous year was sown during October 2017 for nursery sets production for next generationand sets were harvested and stored during May 2018.

13.2.3 S₃ Generation

The S_2 sets of six varieties *i.e.* Mirpurkhas, Selection IV, Selection I, Selection I yellow, Faisal Red and Red Imposta were planted during August 2017 and were re-

planted during November 2017 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. S_3 seed of these varieties were collected on maturity for further studies in the next generation.

 S_3 seed of five varieties i.e. VRIO-3, Red Imposta, Robina, Early red and VRIO-6 produced during the previous year was sown during October 2017 for nursery sets production for next generationand sets were harvested and stored during May 2018.

13.2.4 S₄ Generation

The S_3 sets of three varieties i.e. Nasarpuri, Desi Red and HON-1069 were planted during August 2017 and were re-planted during November 2017 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. S_4 seed of these varieties were collected on maturity for further studies in the next generation.

 S_4 seed of six varieties i.e. Desi Large, PK-10321, Faisal Red, Early Red, VRIO-9-79z and VRIO-9-75 produced during the previous year was sown during October 2017 for nursery sets production for next generationand sets were harvested and stored during May 2018.

13.2.5 S₅ Generation

The S_4 sets of one variety were planted during August 2017 and were re-planted during November 2017 keeping row to row and plant to plant distance of 75 and 30 cm, respectively. Twenty five umbels from the variety were covered with bags prior to flower opening. The covered umbels were shaken daily till the opening of the flowers. S_5 seed of this variety were collected on maturity for further studies in the next generation.

 S_5 seed of two varieties i.e. Faisal Red and Mirpurkhas produced during the previous year was sown during October 2017 for nursery sets production for next generationand sets were harvested and stored during May 2018.

	S. No.	S ₁	S ₂	S ₃	S ₄	S ₅
Sets	1	Red King	VRIO-4	VRIO-3	Desi Large	Faisal red
	2	Robina	Red Imposta	VRIO-6	VRIO-9-75	Mirpurkhas
	3	Desi Red		Red Imposta	Early Red	

Table-79 Detail of Inbred lines

	4	T1-172		Early red	Faisal Red	
	5	Prema		Robina	PK-10321	
	6	Kareem			VRIO-9-79	
Seed	1	Yellow Granex	Desi Red	Mirpurkhas,	Nasarpuri	4466
	2	Golden ORB	Red Moon	Red Imposta	Desi Red	
	3	Pink Panther	Ceylon	Faisal Red	HON-1069	
	4	White Pearl		Selection I yellow		
	5			Selection I		
	6			Selection IV		

13.3 EXOTIC VARIETIES / HYBRID IN ADAPTABILITY TRIAL CONDUCTED AT VEGETABLE RESEARCH INSTITUTE, FAISALABAD DURING RABI SEASON 2017-18

Eighteen 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 2017-18. The nursery was sown on 30.10.2017 and transplanted on 29.12.2017 in the field according to Randomized Complete Block Design with three replications. The plot size was kept as 7×1.5 m. Eighteen onion cultivars i.e.Marvi, Rania, Pink Panther, F₁ Mustang, F₁ Zeus, Premium F₁, Anoki F₁, Red Flame, Hybrid Yellow Granex, Hike, Diana, Kareem F₁, White Pearl, Super Sarhad, Red ORB F₁, F₁ Amaloan, Golden ORB 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 9.05.2018 and data regarding onion bulb weight, bulb diameter, neck diameter, no. of rings/bulb, no. of centre and bulb yield were recorded and presented in the following Table.

Table-80 Yield performance of Exotic Onion Varieties/Hybrids in AdaptabilityTrial conducted at VRI, Faisalabad

Entries	Bulb Weight (g)	Bulb Diameter (cm)	Neck Diameter (cm)	No. of Rings	No.of Centres	Yield (T/ha)
Pink Panther	235.67	7.25	0.88	9.47	2.13	35.36
Kareem F ₁	103.54	6.10	0.60	8.00	1.73	32.50
Hybrid Yellow Granex	147.53	6.49	0.82	9.07	2.33	25.72
Red Flame	125.80	6.05	0.69	8.73	2.13	22.67
F ₁ Mustang	151.07	5.93	1.01	9.20	2.07	21.72
Texas Early Grano	151.33	6.45	0.77	8.40	2.40	21.54
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Golden ORB	136.73	5.89	0.71	8.33	1.73	20.63
Premium F ₁	147.13	5.85	0.71	7.20	2.20	20.50
Hike	163.44	6.01	0.73	8.53	1.60	20.07
Super Sarhad	115.67	5.79	0.82	9.53	2.27	20.04
Phulkara (check)	104.73	5.93	0.83	9.20	3.60	18.30
F1 Zeus	123.20	5.58	0.85	9.00	2.27	17.89
Red ORB F ₁	111.80	5.61	0.87	8.07	1.60	17.00
F ₁ Amaloan	124.93	5.79	0.69	9.13	1.87	16.37
Anoki F ₁	111.73	5.63	0.72	9.20	2.40	16.04
Rania	98.67	5.71	0.75	8.73	3.33	15.75
Diana	89.33	5.27	0.93	8.93	4.60	14.82
White Pearl	114.67	5.66	0.63	7.53	1.73	13.86
Marvi	96.67	5.48	0.78	8.93	3.53	13.06
LSD (0.05)	55.47	0.65	0.18	1.28	0.76	4.606

The data presented in the above table reveals that differences among means due to varieties were significant for yield and all other studied traits. Pink panther (35.36 T/ha), Kareem $F_1(32.50)$ and Hybrid yellow granex (25.72 T/ha produced significantly highest yield than check Phulkara (18.30 T/ha). Pink panther produced higher yield and top among all with yield 35.36 T/ha. The lowest bulb yield was recorded in the entry Marvi(13.06 T/ha).

Pink panther produced heavier bulbs than all other genotypes with the weight (235.67 g). Hike came on second while F_1 Mustang and Texas Early Grano got third position regarding bulb weight (Table-79)

13.4 EVALUATION OF ONION VARIETIES FOR SPRING SEASON

The nursery of eleven varieties including check variety Phulkara were sown on 30.10.2017 and transplanting was done on 30.12.2017 in Randomized Complete Block Design with three replications keeping the plot size of 7×1.5 m. 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 04.05.2018 and is presented in the following table.

Entries	BW (g)	BD (cm)	NOR	NOC	PH (cm)	NOL	Yield (T/ha)
Dark red	113.13	6.29	8.13	2.53	60.47	17.87	16.18
VRIO-1	86.33	6.05	7.53	3.40	57.47	15.13	16.09
Local	102.67	6.07	8.53	4.33	64.47	12.40	14.99

Table-81 Performance of Onion Genotypes during Spring Season 2017-18

Early red	106.67	6.21	9.33	4.20	61.00	18.53	14.77
Phulkara (check)	93.80	5.93	9.07	4.00	59.20	19.93	14.64
VRIO-2	111.67	6.21	8.47	4.27	57.07	15.13	14.42
Robina	104.67	6.25	9.00	5.13	55.40	14.87	14.19
Mirpurkhas	112.67	6.64	8.40	4.47	64.20	15.80	13.95
Red Nasik	110.67	6.02	7.93	4.93	64.00	16.13	13.79
Husri	113.33	6.19	8.40	4.13	60.40	14.33	13.44
VRIO-6	98.67	5.85	8.27	4.33	56.20	18.27	12.78
LSD(0.05)	24.78	0.68	1.21	1.09	5.66	3.73	1.92

BW=bulb weight, BD=bulb diameter, NOR=number of rings, NOC=number of centres, PH=plant height, NOL=number of leaves,

All the genotypes showed statistically significant differences in the means of the studied traits. The variety Dark Red secured first position by producing bulb yield (16.17 T/ha) which was followed by the varieties VRIO-1 (16.09 T/ha) and Local (14.99T/ha). First two varieties showed significantly high yield as compared to check. Lowest yield was produced by the genotype VRIO-6 (12.78 T/ha) presented in Table-80.

Bulbs of Husri showed highest weight (113.33 g) followed by Dark red (113.13 g) and Mirpurkhas (112.67). Largest bulbs of mean diameter more than 6.25 cm were found in Mirpurkhas and Dark Red while the genotype VRIO-6 produced smaller bulbs of diameter5.85 cm.

13.5 TRIAL FOR OPTIMIZATION OF SOWING METHODS

The trial was designed to find the best combination of sowing method. Sowing of all the experimental units including nursery was done on 31-10-2017 in factorial randomized complete block design. 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 as 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 16-5-2018 which is presented in the following table.

Α	В	Bulb Weight (g)	Bulb diameter (cm)	Plant height (cm)	No. of leaves/plant	Bolting %	No. of bulbs/kg	Yield (T/ha)
Flat	Broadcast	84.80	5.68	65.10	16.83	27.33	15.84	11.71
	Lines	77.27	5.64	64.33	18.33	12.00	14.59	7.93
	Transplanting	50.67	4.76	59.47	12.10	0.44	13.50	12.47
Ridge	Broadcast	96.20	6.13	63.17	20.97	16.00	13.17	6.54
	Lines	81.73	5.88	64.80	13.27	40.33	21.76	10.43
	Transplanting	80.27	5.77	66.83	12.60	2.45	10.94	9.41
LSD(0.05)	Α	16.59	0.48	3.86	1.66	2.08	3.03	3.24
	В	20.31	0.59	4.72	2.03	2.55	3.72	3.97
	A*B	28.73	0.84	6.68	2.87	3.61	5.26	5.62

Table-82 Yield and other Agronomic Traits of all the Treatment Combinations

Maximum yield was observed in transplanting on flat (12.47 T/ha) while minimum yield was obtained in broadcast on ridges (6.54 T/ha). But the same produced maximum bulb weight (96.20 g) and maximum bulb size (6.13 cm). Smallest bulbs were produced in transplanting on flat (Table-82).

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 experimentalunits(Table-82).

13.6 MULTILOCATION YIELD TRIAL AT RARI BAHAWALPUR

The nursery of six varieties including check variety Phulkara were sown on 30.10.2017 and transplanting was done on 3.01.2018 in Randomized Complete Block Design with three replications keeping the plot size of 7×1.5 m. 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 10-5-2018 and is presented in the following table.

	Bulb Weight	Bulb Diameter	Neck Diameter	Yield
Entries	(g)	(cm)	(cm)	(T/ha)
Dark Red	125.67	6.29	1.28	24.73
VRIO-1	115.00	6.07	1.44	23.33
Phulkara	104.33	6.29	1.31	22.13
Mirpurkhas	94.33	5.59	1.81	22.58
Early Red	87.00	5.44	1.85	21.60

Table-83 Performance of Onion Genotypes in a Multi-Locational Yield Trial at Bahawalpur during Spring Season 2017-18

Desi Red	87.67	5.57	1.56	20.98
LSD (0.05)	2.90	0.50	0.45	1.01

Results presented in above table showed that all the genotypes are significantly different from each other with respect to yield. Dark red (24.73 T/ha) and VRIO-1 (23.33 T/ha) produced high yield compared to check Phulkara (22.13 T/ha). Lowest yield was observed in Desi red (20.98 T/ha).

13.7 TRIAL TO OPTIMIZE PLANT SPACING

A trial was designed to find plant spacing at which maximum yield and good quality bulb produced. Sowing on all the experimental units including nursery was done on 31-10-2017 in factorial randomized complete block design. A and B were two factors. Factor A comprised of two varieties i.e., Phulkara and Dark red while factor B was comprised of three ridge sizes i.e., 1.75 foot, 2 foot and 2.5 foot. Plant to plant distance was kept 10 cm and transplanting of nursery was done on 18-01-2018. All other agronomic practices were performed according to standards. Bulbs were harvested on 21-05-2018.Data of bulb weight, bulb diameter and bulb yield were recorded at maturity which is presented in the following table.

		Bulb Weight	Bulb	Yield
Α	В	(g)	diameter cm)	(T/ha)
Phulkara	1(1.75 ft)	46.00	4.90	7.42
Phulkara	2(2 ft)	35.33	4.13	6.95
Phulkara	3 (2.5 ft)	44.00	4.48	5.42
Dark red	1 (1.75 ft)	41.00	4.28	8.59
Dark red	2 (2 ft)	42.33	3.95	6.34
Dark red	3 (2.5 ft)	32.67	3.82	4.27
LSD (0.05)	Α	12	0.51	1.69
	B	14.21	0.62	2.07
	$\mathbf{A} \times \mathbf{B}$	18.76	0.88	2.93

Table-84 Yield and other Agronomic Traits of all the Treatments

Data presented in the table showed that maximum yield was obtained at ridge size of 1.75 foot of both varieties. Maximum size and weight of bulbs is also achieved at the same size of ridges (1.75 ft). So it the best size of ridge for onion plantation to get high yield.

14. OKRA (Abelmoschus esculentus L.)

14.1. COLLECTION AND MAINTENANCE OF GERMPLASM

Germplasm comprising of 44 lines/varieties of okra viz; Amrapali, Amoli, Marmara, C-17, 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-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 22-02-2018 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;

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

Table-85 Range of different Morphological Traits in Okra Lines/Varieties

14.2 HYBRIDIZATION

To develop high yielding and disease tolerant okra varieties, four female parents and two maleparents were sown on 22-02-2018 in crossing block to create genetic variability for further studies. Crosses were attempted to produce F_1 hybrids. The detail of successful cross combinations is shown in table below.

S. No.	Name of Cross
1	Amarpali × OK-1313
2	Amarpali × OK-1401
3	Marmara × OK-1313
4	Marmara × OK-1314
5	Amoli × OK-1313
6	Amoli × OK-1314
7	Amoli × OK-1401
8	C-17 × OK-1313
9	C-17 × OK-1314
10	C-17 × OK-1401

Table 86 List of Okra Crosses (F₀) made during February, 2018

14.3 STUDY OF FILIALS

Different filial generations were sown on one side of 75cm wide ridge by keeping plant to plant distance of 30 cm on 22-02-2018. Standard agronomic and plant protection measures were adopted to raise the crop. All crosses germinated. 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:

S. No.	Cross				
F1 Gene	F ₁ Generations				
1.	OK-1505 × OK-1313				
2.	OK-1505 × OK-1314				
3.	OK-1505 × OK-1401				
4.	OK-1505 × OK-1601				
5.	OK-1505 × OK-1602				
6.	OK-1509 × OK-1313				
7.	OK-1509 × OK-1602				
8.	OK-1509 × OK-1401				
9.	OK-1506 × OK-1313				
10.	OK-1506 × OK-1314				
11.	OK-1506 × OK-1401				
12.	OK-1506 × OK-1602				
F2 Gene	erations				
1.	Sabz Pari × OK-1313				
2.	Sabz Pari × OK-1314				
3.	OK-1312 × OK-1313				

 Table-87 Study/ Selection of Progenies from Filials

P						
4.	OK-1312 × OK-1314					
5.	OK-1313 × OK-1312					
6.	OK-1314 × OK-1312					
F ₃ Gen	F ₃ 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					
F ₄ Gen	erations					
1.	Parbhani Karanti × OK-1313					
2.	Parbhani Karanti × OK-1314					
3.	Ikra \times Sabz Pari					
4.	OK-1313 × OK-152					
5.	OK-1313 × Ikra					
F ₅ Gen	erations					
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					
F ₆ Gen	erations					
1.	Pusa swani × Anarkali					
2.	Pusa swani $ imes$ Arka anamika					
3.	Pusa swani × Parbhani karanti					
4.	Punjab selection × Anarkali					
5.	Punjab selection \times Arka anamika					
6.	Punjab selection × Parbhani karanti					
7.	Sanum × Anarkali					
8.	Sanum \times Arka anamika					
9.	Sanum \times Parbhani karanti					
10.	Ikra × Anarkali					
11.	Ikra \times Arka anamika					
12.	Ikra \times Parbhani karanti					

14.4EVALUATION OF OKRA HYBRIDS / VARIETIES IN ADAPTABILITY TRIAL

Sixteen 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 three replications keeping plot size of 6.5×1.5 m on 22-02-2018. 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 16-04-2018 and continued till 05-07-2018. Data regarding fresh fruit yield was recorded and presented in the following table.

S. No.	Variety	Fresh Fruit Yield (T/ha)
1	Excel F ₁	18.82
2	HO-042B	18.53
3	OH-940	18.17
4	MSC-5050	18.15
5	BS-782	18.10
6	No. 64	17.68
7	Resham	17.52
8	Sabz Pari (Check)	17.33
9	HO-041B	17.22
10	HS-15	17.20
11	MSC-2020	17.07
12	Noori-786	17.05
13	Silky-460	16.86
14	Malka	16.58
15	MSC-3030	16.55
16	Sydney F ₁	16.30
17	MSC-2525	16.28
	LSD (0.05)	1.27

Table-88 Yield Performance of Exotic Okra Hybrids/Varieties in Adaptability Trial conducted at VRI Faisalabad during Kharif, 2018

The data presented in the above table shows that difference among means due to varieties were significant for fresh fruit yield. Only one variety/hybrid Excel F_1 with fruit yield of 18.82 T/ha gave significant higher fresh fruit yield than standard variety Sabz Pari (17.33 T/ha) while the lowest yield was recorded in MSC-2525(16.28 t/ha).

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

15.1 MAINTENANCE OF SPONGE GOURD GERMPLASM

To maintain germplasm for further utilization in breeding program, fifteen sponge gourd genotypes were sown on 12.03.2018 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 and no. of female flowers per plant were recorded.

15.2 DEVELOPMENT OF INBRED LINES IN SPONG GOURD

To develop inbred lines for the development of hybrids/composite varieties, the seed of S_0 , S_1 , S_2 , S_3 and S_4 were sown during 1st week of March, 2018 on both sides of 3 meter wide beds keeping plant to plant distance of 50 cm. Ten 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.

15.3 DEVELOPMENT OF HIGH YIELDING AND DISEASE RESISTANT OPVs

Sowing of open pollinated seed that were harvested from last year developed source populationwas sown on 12.03.2018. Selection of desirable plants and roughing of undesirable plants was done. At maturity, ripened fruits were picked and seed was extracted and bulked for further studies.

15.4 REPORT ON EXOTIC VARIETIES/HYBRIDS OF SPONGE GOURD IN ADAPTABILITY TRIAL CONDUCTED AT VEGETABLE RESEARCH INSTITUTE, FAISALABAD DURING KHARIF SEASON 2018

Eleven exotic varieties/hybrids along with local check of sponge gourd were sown in adaptability trial at Vegetable Research Institute, Faisalabad on 12.03.2018 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 26.04.2018 and continued till 9.7.2018. Data regarding fruit yield were recorded from 32 pickings that are presented in Table 1. Virus attack intensity and fruit color were also recorded.

Rank	Variety/ Hybrid	Virus Attack	Fruit Color	Fruit Yield
1	Reshmi	MR	Light green	17.18
2	No. 3942 F ₁	MR	Dark green	16.44
3	Kiran F ₁	MS	Light green	15.72
4	ASSP-65-90 F ₁	MS	Dark green	15.59
5	Monika F ₁	MR	Light green	15.46
6	SBS-14 F ₁	MS	Light green	14.92
7	White Seeded F ₁	S	Dark green	13.26
8	Kareena F ₁	S	Light green	12.28
9	NSCSG-1-F ₁	HS	Dark green	11.68
10	Local (Check)	S	Pale Green	10.81
11	USTAV F ₁	HS	Dark green	10.024
12	Sareena F ₁	S	Dark green	9.51
	LSD (0.05)			1.35

 Table-89 Yield performance of Sponge Gourd Varieties/Hybrids in Adaptability

 Trial conducted at VRI during Kharif, 2018

MR=Moderately resistant MS=Moderately susceptible S= Susceptible HS= Highly susceptible The data presented in Table-89 depicted that the differences among means due to varieties/hybrids were significant for fresh fruit yield. Seven varieties/hybrids gave significantly higher fresh fruit yield than standard variety Local check (10.81T/ha) with the highest fruit yield of 17.18 T/ha was shown by Reshmi F₁ followed by No. 3942 F₁ (16.44 T/ha) and Kiran F₁ (15.72 T/ha). Hybrid, Sareena F₁ (9.51 T/ha) gave lowest fruit yield. Data of viral diseases depicted that Reshmi F₁, No. 3942 F₁ and Monikawere moderately resistant while all other were moderately susceptible to highly susceptible.

16. RIDGE GOURD (Luffa acutangula L.)

16.1 REPORT ON EXOTIC VARIETIES/HYBRIDS OF RIDGE GOURD IN ADAPTABILITY TRIAL CONDUCTED AT VEGETABLE RESEARCH INSTITUTE, FAISALABAD DURING KHARIF SEASON 2018

Four exotic varieties/hybrids of ridge gourd along with "Local" check of sponge gourd were sown in adaptability trial at Vegetable Research Institute, Faisalabad on 12.03.2018 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 22.04.2017 and continued till 9.07.2017. Data regarding fruit yield were recorded from 28 pickings that are presented in table below. Virus attack intensity and fruit color were also recorded.

Rank	Variety/	Fruit color	Virus attack	Fruit Yield
	Hybria			(1/na)
1	NSCRG-2 F ₁	Light green	MS	8.92
2	Local (Check)	Pale green	MR	7.20
3	RG-4161	Light green	HS	6.81
4	MSC-8155	Light green	MS	6.58
5	NSCRG-1 F ₁	Dark green	HS	4.66
	LSD (0.05)			1.11

 Table-90 Yield performance of Ridge Gourd Varieties/Hybrids in

 AdaptabilityTrial conducted at VRI during Kharif, 2018

MR=Moderately resistant MS=Moderately susceptible S= Susceptible HS= Highly susceptible

The data presented in the above table revealed that the differences among means due to varieties/hybrids were significant for fresh fruit yield. Hybrid, NSCRG-2 F_1 (8.92 T/ha) showed higher fresh fruit yield than check (7.20 T/ha). Remaining three varieties/hybrids gave lower fruit yield against the standard variety. Data of viral diseases depicted that Local variety (check) was moderately resistant while all other were moderately susceptible to highly susceptible.

17. CUCUMBER (*Cucumis sativus* L.) **17.1 COLLECTION AND MAINTENANCE OF GERMPLASM**

One variety Kheera local was sown in open field on 21.02.2018 by keeping the plant to plant distance of 30 cm. All standard agronomic practices were adapted. It was maintained through sib-mating.

17.2 DEVELOPMENT OF INBRED LINES IN PARTHENOCARPIC CUCUMBER UNDER HIGH TUNNEL

The breeding material comprising of fifty S_0 , ten S_1 and thirteen S_2 progenies were planted in varying plot sizes on 20.11.17 according to the availability of seeds for inbred line development programme. After induction of male flowers in gynoecious lines, progenies were advanced through selfing.

17.3DEVELOPMENT OF SOURCE POPULATION

In total 70 varieties/strains were sown on both sides of raised beds made at 2.5 m apart in open field on 07.03.2018 for the development of source population. Agronomic and plant protection measures were kept constant for all the varieties. At flowering stage, pollen of Kheera local was collected and some specific crosses were made with other varieties. On the other side all varieties were allowed to randomly open pollinate. At maturity, ripened fruits were picked and seed was extracted for further studies. Mostly planted lines were hybrids and these produce only female flowers and the crosses made by using these female flowers were not become successful. Anyhow few fruits of Kheera local variety mated by different pollens were collected and seed of those randomly crossed fruits were extracted for further studies.

17.4 ADAPTABILITY TRIAL ON CUCUMBER UNDER HIGH TUNNEL IN DRIP IRRIGATION AT VRI FAISALABAD DURING (2017-18)

Fourteen Parthenocarpic hybrids named Java, Rayyan F₁, Poyraz F₁, TCB-701, SXQ-3776, 15CU5277, TCB-702, 14CU5276 F₁, TCB-703, Chelsea, TCB-705, Yielder, Kingstar and Multistar of cucumber were tested for their adaptability at Vegetable Research Institute, Faisalabad under high tunnel in drip irrigation system during the year 2017-18. Sowing date of trial was 20.11.2017. Germination rate of some varieties was poor. To assure their plant population re-sowing was done. The trial was laid out according to randomized complete block design (RCBD) with three replications. Plot size was maintained as 6×1 m and plant to plant distance was 30 cm. Fruit picking was started on 19.02.2018 and continued up to 04.05.2018 and seventeen pickings were taken from the trial. Data regarding yield and no. of fruits per plant was recorded and analyzed statistically which is presented in the following table.

Research institute, raisalabau uuring 2017-10				
Rank	Hybrid / Variety	Yield	No. of	
		(T/ha)	Fruits/Plant	
1	SXQ-3776 (Check)	108.43	14	
2	Poyraz	99.13	13	
3	Java	85.54	12	
4	Rayyan	72.06	10	
5	TCB-701	65.60	10	
6	15CU5277	58.89	10	
7	TCB-702	58.43	10	
8	Kingstar	56.91	10	
9	Chelsea	55.66	8	
10	Yielder	53.00	9	
11	TCB-705	47.45	8	
12	TCB-703	47.39	7	
13	Multistar	44.00	8	
14	15CU-5276	43.51	7	
LSD (0.05)	9.71		

Table-91 Performance of Cucumber Hybrids in an Adaptability Trial at Vegetable Research Institute, Faisalabad during 2017-18

The data in the above table revealed that the check (SXQ-3776) produced the highest yield (108.3 T/ha). All others hybrids showed low yield than check. The hybrid Poyraz yield is on second number after check. All hybrids had long green and smooth fruit shape. SXQ-3776 and Poyraz had more No. of fruits (14 and 13) than other varieties, respectively. Low germination was observed in some entries especially TCB-701 and TCB-703.

17.5 ADAPTABILITY TRIAL ON CUCUMBER IN OPEN FIELD (KHARIF-2018)

Eighteen varieties/hybrids of cucumber including check named SV6352CD, SV6346CD, Alpha Prime, Thamin II, NSC-CM₃ F_1 , Safaa, NSC-CM₁ F_1 , Messi F_1 , NSC-CM₄ F_1 , Akad, Debra, NSC-CM₂ F_1 , Early King, Target Kareena, HCU-171C, Kalaam F_1 , KL-086, and Kheera Local (check) were tested at Vegetable Research Institute, Faisalabad in open field during Kharif, 2018. All varieties/hybrids were sown in open field on 26.02.2018 to check their adaptability. Seed germination of some varieties was not good. To assure their plant population re-sowing was done. The trial was laid out according to randomized complete block design (RCBD) with three replications. Plot size was maintained as 5×3 m and plant to plant distance was 30 cm. Fruit picking was started on 16.04.2018 and continued up to 21.05.2018. In total nine pickings were taken from the trial. During April severe attack of Downy Mildew was recorded and special remedial measures were adopted to overcome the disease. High temperature and diseases badly damaged the vines of cucumber. Data regarding no. of fruits per plant and yield was recorded and analyzed statistically which is presented in the following table.

Rank	Varieties/Hybrids	No. of	Fruit Yield
		Fruits/Plant	(T/ha)
1	HCU-171C	5	30.75
2	Target Kareena	4	21.55
3	Messi-F ₁	4	21.23
4	NSC-CM ₄ F ₁	3	19.31
5	Akad	3	17.79
6	KL-086	3	17.52
7	NSC-CM ₃ F ₁	3	17.46
8	Thamin II	3	16.86
9	SV6346CD	3	15.55
10	Kalaam F ₁	3	14.60
11	NSC-CM $_1$ F $_1$	3	14.57
12	Debra	2	14.49
13	Safaa	3	14.25
14	Alpha Prime	2	13.20
15	SV6352CD	2	11.65
16	Kheera Local (Check)	2	7.86
17	Early King	2	7.25
18	NSC-CM ₂ F ₁	1	4.86
	LSD (0.05)		3.48

Table-92 Performance of Cucumber hybrids/varieties in an Adaptability Trial at Vegetable Research Institute, Faisalabad during Kharif 2018

The data in the above table reveals that fourteen varieties/hybrids (HCU-171C, Target kareena, Messi F₁, NSC-CM₄ F₁, Akad, KL-086, NSC-CM₃ F₁, Thamin II, SV6346CD, Kalaam F₁, NSC-CM₁ F₁, Debra, Safaa and Alpha Prime are significantly higher in yield than check. SV6352CD yield (11.65 T/ha) remained at par in comparison with check (7.86 T/ha). HCU-171C is significantly higher in yield (30.75 T/ha) and no. of fruits per plant (5) as compared to all varieties including check. Kheera local and kalaam were observed as more heat tolerant than other varieties.

18. BRINJAL (Solanum melongena L.)

18.1 COLLECTION AND MAINTENANCE OF BRINJAL GERMPLASM

For the maintenance of germplasm, nursery of 7 genotypes viz Dilnasheen, Bimissal, Nirala, White Egg Long, White Egg Round, VRIB-2013 and VRIB-2016 was sown on 10.07.2018. Transplanting was carried out on 17.08.2018 by keeping plant to plant distance of 50 cm in observational rows of 4.0 m long. At onset of flowering, flowers were covered with butter paper bags to prevent cross pollination through insects. After onset of fertilization selfed fruits were tagged. At the time of maturity selfed fruits were harvested separately and seed was extracted manually for further use in breeding program. Range of various traits in available germplasm is as under;

	0	
S.	Character	Range
No.		
1	Plant height (cm)	50-110
2	No. of Fruits/plant	7-18
3	Fruit weight (g)	50-150
4	Growth habit	Erect, Semi erect and Spreading
5	Leaf Shape	Long, Narrow and Broad
6	Fruit Color	White, Purple and Black
7	Fruit Shape	Round, Long and Oblong
	1	1

Table-93 Range of Brinjal Germplasm

18.2 STUDY OF FILLIAL GENERATIONS IN BRINJAL

Nursery of filial generations was sown on 10.07.2018 which includes 16 F_1 crosses, 3 F_2 populations and 40 F_3 populations. The transplanting was carried out on 17.08.2018 in the field. Single plant selections were made on the basis of plant structures, fruit shape, fruit size, earliness and disease incidence. Flowers were covered with butter paper bags to prevent cross pollination through insects. After onset of fertilization selfed fruits were tagged. At the time of maturity selfed fruits were harvested separately and seed was extracted manually to advance the generations for further studies to develop open pollinated varieties.

18.3 SYNTHESIS OF BRINJAL HYBRIDS

Nursery of 6 parents was sown on 02-02-2018 and seedlings were transplanted in the field on 26-03-2018. Crosses were attempted to produce F_0 seed. The detail of successful cross combinations is presented in table below.

S.	Hybrid
No.	
1	Dilnasheen × VRIB-2016
2	Dilnasheen × VRIB-2013
3	VRIB-2013 × Dilnasheen
4	Dilnasheen × WER
5	WEL × WER
6	WER × VRIB-2013
7	WEL × Dilnasheen
8	WEL × VRIB-2016
9	VRIB-2013 × VRIB-2016
10	VRIB-2016 × VRIB-2013
11	Bimissal × VRIB-2016

Table-94 List of Crosses

18.4 ADAPTABILITY TRIAL OF BRINJAL GENOTYPES

The seed of nine brinjal entries including checks were sown on 02-02-2018 for raising the nursery and seedlings were transplanted in the field on 26-03-2018. The trial was laid out according to Randomized Complete Block Design with three replications in a plot size of 4.5×1.5 m. 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.

S.	Genotypes	Yield
No.		(T/ha)
1	WEL	21.3
2	VRIB-2013	10.6
3	Kokila-F ₁	9.8
4	KHBR-202B	9.6
5	Dilnasheen (Check)	9.5
6	VRIB-2016	7.0
7	EP-900	6.2
8	KHBR-205E	4.5
9	Pala-49	0.0
LSD	0 (0.05)	6.9

Table-95 Performance of Brinjal Entries during Kharif 2018

The data shown in the above table reveals that entry WEL (White Egg Long) gave the highest fruit yield (21.3 T/ha) while entries VRIB-2013, Kokila-F₁, KHBR-202B, Dilnasheen (Check) VRIB-2016, EP-900 and KHBR-205E are statistically at par.

Exotic line Pala-49 did not produce any fruit as it was not adapted in local climatic conditions during this season, hence resulted in no yield. None of the variety is tolerant against Fruit and Shoot Borer of Brinjal.

19. VEGETABLE MARROW (*Cucurbita pepo*)

19.1 MAINTENANCE OF VEGETABLE MARROW LINES

To maintain two biotypes of vegetable marrow Round Shape and Pear Shape were sown on 16.11.2017 in isolation chambers having area of 15 marla 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 2018. Fruits were stored under shade and later on seed was extracted and stored after sun drying.

Pear Shape was sown in open field on 03.03.2018 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 2018. Fruits were stored under shade and later on seed was extracted and stored after sun drying.

9.2 DEVELOPMENT OF INBRED LINES

Inbred line development programme have been initiated in vegetable marrow with an aim to develop hybrids. Before describing the complete selfing/crossing procedure, it is pertinent to know that, in vegetable marrow, there is an issue of shriveled seed setting at high temperature during April-May. With such shriveled seeds the germination of desirable selected single fruits is also affected in next cropping cycle. In order to solve this problem, this year it has been planned to sow the crop material during October-November under tunnels to ensure lower temperature during vegetative stage, proper time span for pollination and seed development stage. So the sowing of crop material was done on 16.11.2017 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.

S. No.	Variety/Hybrid	No. of Fruits
1	Mishal F ₁	1
2	Cavili F ₁	1
3	Avila F ₁	1
4	Anita F ₁	1
5	PS-719 F ₁	1
6	Avila F ₁	1
7	Money Pani F ₁	1
8	Tiger Ball F ₁	1
9	Oval Star F ₁	1
10	SV-3923 F ₁	1
11	Sultan F ₁	1
12	Oval Shape F ₁	1
13	Dollar F ₁	1
14	Clarita F ₁	1
15	Malika F ₁	1
16	Euro F ₁	1
17	Olper F ₁	1

Table-96 S₀ GENERATION

19.3 DEVELOPMENT OF DOUBLE CROSS HYBRID COMBINATIONS IN VEGETABLE MARROW

Nine F_1 hybrids received from different seed companies were used to develop double cross hybrid combination to generate genetic variability in vegetable marrow at Vegetable Research Institute, Faisalabad during Rabi 2017. Sowing of cross combinations was done on 16.11.2017 under tunnel by keeping plant to plant spacing of 40 cm and row to row spacing of 125 cm. The same procedure of selfing-crossing as expressed above was adopted to develop double cross combinations. The detail of double cross hybrid combinations is as under;

S. No.	Name of Cross Hybrid	Fruit Type
1	Anita \times PS-719	
2	Anita \times SV-2987	
3	PS-719 × Anita	
4	PS-719 × SV-2987	Lang
5	SV-2987 × PS-719	Long
6	SV-2987× Anita	
7	Caivili × Avila	
8	Avila × Caivili	
9	Mishal \times SQ. Green Boy	Dound
10	Mishal \times SQ-3552	Kouna

Table-97 Development of Double Hybrid Combinations in Vegetable Marrow

At maturity only seven cross combinations could be possible the detail of such combinations is presented in table below;

S. No.	Name of Hybrid	No. of Fruits
1	Avila ×Cavili	4
2	SV-2987 × Anita	3
3	Mishal × SQ-3552	1
4	Cavili × Avila	1
5	PS-719 × Anita	1
6	Anita × SV-2987	1
7	Anita × PS-719	1

Table-98 Development of Hybrid Combinations in Vegetable Marrow

19.4 EVALUATION OF EXOTIC VARIETIES/ HYBRIDS IN ADAPTABILITY TRIAL

Twenty nine varieties/hybrids received from different seed companies were tested along with two local checks for their performance in adaptability trial in open field at Vegetable Research Institute, Faisalabad during Kharif 2018. Sowing of seeds was done on 22.02.2017 according to Randomized Complete Block Design with three replications. The plot size was kept as 7.0×1.25 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 type average no. of fruits and fruit yield is presented below.

S. No.	Genotypes	Fruit type	Avg. No. of Fruits	Yield (T/ha)
1	Squash Long (1702) F_1	Long	136.0	25.17
2	Cavili	Long	145.8	24.08
3	Falak	Long	121.1	22.33
4	Squash Malika F ₁	Round	162.7	22.08
5	Squash Green Star F ₁	Round	149.7	21.59
6	Frozen F ₁	Long	122.7	21.32
7	VRI-Check II	Round	133.0	20.60
8	Squash Oval Star	Round/Ablong	139.4	19.93
9	Kamla	Long	112.8	19.51
10	Oskar	Round	109.0	19.28
11	Mishal F ₁	Round	90.00	17.4
12	VRI-Check I	Pear	97.9	16.44
13	Zennat F ₁	Round	90.9	15.79
14	YOUMNA	Round	62	11.05
15	Beauty 222	Round	65.12	10.99
16	Asian Ball	Round	52.00	10.20
17	Green boy ACS	Round	63.6	10.11
LSD (0.05)		8.8	1.48	

Table-99 Performance of Exotic Vegetable Marrow at Vegetable Research Institute,
Faisalabad during 2017-18 (Set-I)

The results from the above table showed that three varieties/hybrids exhibited significantly higher fruit yields than Local check I entry i.e., Round Shape (20.60 T/ha). While two entries produced significantly lower fruit yield than both local checks. The highest fruit yield was recorded in entry Squash Long (1702) F_1 with yield value of 25.17 T/ha. The variety namely Squash Malika F_1 produced higher average number of fruits (162.7) but bear less fruit yield as compare to the variety namely squash long (1702) with yield value of 25.17 T/ha.

S. No.	Genotypes	Fruit type	Ave. No. of Fruits	Yield (T/ha)
1	HSQ-2	Long	159.24	29.87
2	TSQ-229	Long	139.81	23.89
3	TSQ-227	Round	134.86	22.35
4	Clarita	Long	120.38	21.95
5	Polka F ₁	Long	96.00	21.27
6	Anita	Long	117.71	20.92
7	Scarla	Long	113.52	20.87
8	TSQ-225	Round	129.14	20.69
9	VRI-Check II	Round	64.76	20.29
10	Tiger Ball	Round	144.76	20.29
11	VRI-Check I	Pear	97.90	16.20
12	Sama	Long	84.57	16.17
13	SV-2987YL	Long	85.33	15.58
14	Eskanderany	Long	86.86	14.52
15	King ball F ₁	Round	53.71	10.13
16	SV-3923YL	Long	52.95	9.89
LSD	(0.05)		6.85	1.94

Table-100 Performance of Exotic Vegetable Marrow at Vegetable ResearchInstitute, Faisalabad during 2017-18 (Set-II)

The above table reveals that three varieties/hybrids produced significantly higher fruit yields than local check II entry Round Shape (20.29 T/ha). While remaining five entries were remained at par than local check II. The entry namely HSQ-2 exhibited the highest fruit yield of 29.87 T/ha and average number of fruits (159.24) among all tested genotypes. One entry namely Tiger Ball produced significantly higher fruit yield (20.29 T/ha) than local check I, Pear Shape (16.20 T/ha) and also showed earliness in female flower inductions in comparison with all tested genotypes suffering severe temperature fluctuations around the whole cropping season. Among the remaining five entries last two entries produced significantly lower fruit yield and also including other three entries showed lower average number of fruits than the both local checks.

20. TINDA GOURD (Citrullus vulgaris var. fistulosus)

20.1 MAINTENANCE OF TINDA GOURD VARIETY

The tinda gourd variety namely "Dilpasand" was maintained in isolation. For this purpose, the crop was sown on 08.03.2018 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 2018. Fruits were stored under shade and later on seed was extracted and stored after sun drying.

20.2 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 09.03.2018 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 last week of June 2018 and seed was extracted. The detail of selfed material is given below.

20.3 S₅ GENERATION

Twenty six entries in S_7 generation were sown for the purpose of selfing. Sowing of crop material was done on 09.03.2018. Therefore, selfing was accomplished and seed was extracted individually. The detail of twenty six genotypes selfed is given below;

S.	Name of	No. of	S. No.	Name of	No. of
No.	Genotype	Fruits		Genotype	Fruits
1	P-351-1-9-7-2	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-34-1-1-5-7	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

Table-101 Detail of Selfed Fruits Harvested in S₅ Generation

20.5 EVALUATION OF EXOTIC VARIETIES/ HYBRIDS IN ADAPTABILITY TRIAL

Three 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 2018. Sowing was done on 09.03.2018 according to Randomized Complete Block Design with 4 replications. The plot size was kept as 5.0×3 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 average no. of fruits and fruit yield is presented below.

Rank	Entry	Avg. No. of Fruits	Fruit Yield (T/ha)
1	Chaman	163	9.03
2	Dilpasand 4040	172	8.11
3	Local Check	76	3.45
LSD (0.05)		3.2	0.8

Table-102 Evaluation of Exotic Varieties/Hybrid

The results from the above table revealed that entry ranked at No. 1 namely Chaman (9.03 t/ha) produced non-significant fruit yield in comparison with other entry but produced significantly higher fruit yield than local check (3.45 t/ha). Furthermore, entry Dilpasand 4040 produced significantly higher average number of fruits 172 than local check of 76.

21. TURMERIC (*Curcuma longa*)

The crop was planted on 28.03.2017 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 01.02.2018 and completed at 06.02.2018. The crop yield was obtained from Agronomy area as under;

S. No.	Tuber types	Yield (Kg)
1	Main Tubers	4473
2	Mother Tubers	2899
Drying losses		285
TOTA	L	7088

Table-103 Production of Turmeric during 2017-18

21.1 MULCHING AND INTERCROPPING TRIAL IN TURMERIC

A mulching and intercropping trial has been conducted in Randomized Complete Block Designwith three replication during 2016-17 and 2017-18 to check the mulching effects and intercropping studies in turmeric. The turmeric crop was planted during last week of March while mulch was applied after first irrigation. The intercrops i.e. cowpeas and okra were planted in 1st week of April for both years. The plant to plant and row to row spacing were kept as 20 and 60 cm respectively. All other agronomic practices were adopted during the whole crop season and at maturity the yield data was collected that is presented in below tables.

S.No.	Treatments	Yield (t/ha)	
		2016-17	2017-18
1	Cane trash (Mulch)	30.76	32.83
2	Cowpeas intercropped	22.11	20.77
3	Okra intercropped	16.15	17.96
4 No mulch/Intercrop (Control)		13.14	12.89
	LSD (0.05)	3.79	4.23

Table-104 Mulching and Intercropping Trial of Turmericat VRI, Faisalabad

The results from above table reveals that mulching of cane trash has significant effects on rhizome yield of turmeric as compare to intercropping of Cowpeas and Okra crop during both years.

22. FENUGREEK (Trigonellafoenum-graecum)

The trial of seven diverge lines of the said crop were planted on October 11, 2017 on ridges on an area of 10 marla by keeping $R \times R$ 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 on 13.12.2017 and 08.01.2018. 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;

	Fresh Leaf	Seed yield
Line No.	Yield (T/ha)	(T/ha)
1	28.03	0.38
2	23.52	0.40
3	26.47	0.42
4	25.07	0.41
5	24.76	0.39
6	26.98	0.42

Table-105 Fresh and Seed Yield of Fenugreek Lines during 2017-18

0.00

23. LETTUCE (*Lactuca sativa*)

One variety/hybrid received from a seed company was tested along with two local checks for their performance in adaptability trial at Vegetable Research Institute, Faisalabad during Rabi 2017-18. The nursery of these genotypes was grown on 18.10.2017 and their subsequent transplanting was done on 01.12.2017 according to Randomized Complete Block Design with 3 replications. The plot size was kept as 8.5×0.75 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.

Rank Variety/Hybrid		Leaf yield (T/ha)	
1	Local Salad I (Green)	10.91	
2	Local Salad I (Red)	10.67	
3	Blazia	8.92	
	LSD (0.05)	1.13	

Table-106 Evaluation of Exotic Varieties/Hybrid

The table reveals that none of the variety/hybrid tested exceeded from both checks significantly. The highest curd yield of 10.91 t/ha was observed by the local salad I (Green) whereas, the variety Blazia showed lower yield (8.92 t/ha) as compared with both checks.

24. BOTTLE GOURD (Lagenaria siceraria)

24.1 MAINTENANCE OF BOTTLE GOURD GERMPLASM

To maintain germplasm for further utilization in breeding program, six bottle gourd genotypes namely CG-8, No. 4545 Lattu, No. 5, Amroudi , Faisalabad Round and VRIBG-02 were sown on 23-02-2018 in a plot size of 7×4 m keeping plant to plant distance of 50 cm. Germination of all the entries was normal and satisfactory. Each genotype was maintained through sib mating and seed was collected separately.

24.2 DEVELOPMENT OF SOURCE POPULATION

The seed of six varieties namely Marjan F_1 , 4545 Lattu F_1 , Amroudi, No. 5, CG-8 (varieties from adaptability trial) and Faisalabad Round were sown on February 23, 2018 and the crop was used for development of source population. Agronomic and plant protection measures were kept constant for all the varieties. At flowering stage, pollen of all the varieties was collected and mixed and then pollinated the female flowers of all the

above mentioned varieties to obtain source population. At maturity, ripened fruits were picked and seed was extracted for further studies. Mostly the lines which were planted were hybrids and that produce only female flowers and the crosses made by using these female flowers were not become successful. Anyhow few fruits mated by different pollens were collected and seed of those crossed fruits were extracted for sowing it in 2^{nd} cycle of selection.

24.3 ADAPTABILITY TRIAL OF BOTTLE GOURD IN OPEN FIELD DURING KHARIF 2018 (Set-1)

Seven bottle gourd varieties namely Asian Pride, Badshah F_1 , HBO-241B, Waleed F_1 , Round F_1 , BOT-403, BOT-5703 along with Faisalabad Round Local (Check) were sown in open field on February 23, 2018. 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 7×4 m with three replications and plant to plant distance was 50 cm. Fruits picking was started on April 20, 2018 and lasted up to July 12, 2018. In total twenty eight pickings were taken from the trial. Standard cultural practices and plant protection measures were carried out to the trial. Data regarding emergence %age, no. of fruits /plant, fruit yield (T/ha) were recorded and analyzed statistically which are presented in the following table.

	Adaptability I rialat Vegetable Research Institute, Faisalabad				
Rank	Varieties	Emergence	No. of fruits	Fruit yield	
		(%)	/ plant	(T/ha)	
1	BOT-404	89.4	15.7	41.0	
2	Asian Pride	81.3	15.4	37.1	
3	BOT-403	86.7	18.4	32.3	
4	Fsd. Round (Check)	92.4	9.2	31.3	
5	HBO-241B	80.3	14.4	31.3	
6	Badshah F ₁	83.3	13.8	29.9	
7	BOT-5703	90.9	11.5	29.0	
8	Round F ₁	80.3	9.8	23.8	
9	Waleed F ₁	89.4	8.9	23.1	
LSD(0.05)		5.4	3.9	9.2	

Table-107 Performance of Cucumber Hybrids/Varieties in an AdaptabilityTrialat Vegetable Research Institute, Faisalabad

97

The data in the above table revealed that germination %age of the seed ranges from 80.3% (Round F_1 and HBO-241B) to 92.4% (Fsd. Round). Number of fruit per plant is an important component of yield and has significant impact on production. Number of fruits per plant recorded on an average basis. Maximum numbers of fruits recorded on an average basis were 18.4 (BOT-403) followed by 15.7 (BOT-404) and 15.4 (Asian Pride) whereas minimum numbers of fruits per plant (8.9) was recorded of variety Waleed F_1 . The variety BOT-404 produced higher yield (41.0 T/ha) followed by Asian Pride (37.1 T/ha) whereas variety Waleed F_1 produced the lowest fruit yield of 23.1 T/ha. 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 season and so that's why there can be the maximum profit by growing early fruiting varieties. BOT-404, Asian Pride and BOT-403 started fruiting from 3rd week of April. Regarding shape of the fruits, varieties BOT-403 have pear shape fruits whereas all others have round shape fruits.

Set-2

Four bottle gourd varieties namely Spacer F_1 , HBO-382A along with VRIBG-02 (Check) were sown in open field on February 23, 2018. 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 7 x 4 m with three replications and plant to plant distance was 50 cm. Fruits picking was started on April 20, 2018 and lasted up to July 12, 2018. In total twenty eight pickings were taken from the trial. Standard cultural practices and plant protection measures were carried out to the trial. Data regarding emergence %age, no. of fruits/plant, fruit yield (T/ha) were recorded and analyzed statistically which are presented in the following table.

Table-108 Performance of Cucumber Hybrids/Varieties in an AdaptabilityTrialat Vegetable Research Institute, Faisalabad

Rank	Varieties	Emergence	No. of fruits	Fruit yield
		%	/ plant	(T/ha)
1	Spacer F ₁	89.2	9.9	29.9
2	HBO-382 A	86.5	7.8	26.6
3	VRIBG-02 (check)	86.0	6.2	21.2

LSD (0.05) 3.1 2.9 7	.5
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The data in the above table revealed that germination % age of the seed ranges from 86.0% (VRIBG-02) to 89.2% (Spacer F_1) Number of fruit per plant is an important component of yield and has significant impact on production. Number of fruits per plant recorded on an average basis. Maximum numbers of fruits recorded on an average basis were 9.9 (Spacer F_1) followed by 7.8 (HBO-382A) whereas minimum numbers of fruits per plant being recorded were 6.2 which is of check variety VRIBG-02. The exotic variety Spacer F_1 produced highest yield (29.9 T/ha) followed by HBO-382 A (26.6 T/ha) whereas variety VRIBG-02 produced the lowest fruit yield of 21.2 T/ha. 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 season and so that's why there can be the maximum profit by growing early fruiting varieties. Spacer F_1 and HBO-382A started fruiting from 3rd week of April. Regarding shape of the fruits all varieties have long fruits (Loki).

25. CORIANDER (*Corriandrum sativum*)

25.1 MAINTENANCE OF CORANDER VARIETIES DURING RABI 2017-18

Two coriander varieties named as Dilpazeer and Qandhari were sown on 09-10-2017 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 5.0×0.75 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.

26. SPINACH (Spinacia oleracea)

26.1 ADAPTABILITY TRAIL OF SPINACH

The Trial was conducted to evaluate the performance of three varieties of spinach viz; Lahori Palak, Desi Palak and Green Star using Desi Palak as check. The layout of the trial was made according RCB design in five replications. The sowing of the varieties was done on 02.11.2017 at ridges made 75cm apart in a plot size of 5×2.25 m. All agronomic and plant protection measures were adopted to maintain the crop. Two cuttings were taken first on 15.01.18 and second on 06.02.18. The data recorded for leaf yield and other characteristics is presented in the table below.

S.	Varieties	No. of Leaf	Leaf Length	Leaf width	Leaf Yield
No.		/Plant	(without petiole)		(T/ha)
1	Desi Palak	10-15	20-25 cm	10-15 cm	73.3
2	Green Star	7-10	15-20 cm	8-10 cm	61.8
3	Lahori Palak	5-10	10-15 cm	8-10 cm	50.1
	(LSD 0.05)				1.9

Table-109 Performance of Spinach Varieties at VRI Faisalabad during 2017-18

The above table reveals that check variety (Desi Palak) gave the highest leaf yield (73.3 T/ha) followed by green star with yield value of 61.8 T/ha and Lahori Palak with yield of 50.1(T/ha). The difference among the varieties is highly significant.

27. GARLIC (Allium sativum)

22.1 COLLECTION AND MAINTENANCE OF GARLIC GERMPLASM

Four clones of Garlic comprising of local and exotic source were soon in the observational trials on 10.10.2018 by keeping plant to plant and row to row distance of 10cm and 20cm respectively in a plot size $5 \times 2m$ for their all maintenance.All agronomic and plant protection measures were adopted accordingly.The crop was observed closely to record the morphological trails of the clones which are given in table one.

S.	Clones	Mean Blub	Mean Clove	No. of Cloves /	Yield
No.		Weight(g)	Weight (g)	Bulb	(t/ac)
1	G-1701	20-25	1.0-1.5	20-25	1.5-2.0
2	G-1702	30-35	1.5-2.0	30-35	2.0-3.0
3	G-1703	40-45	5.0-6.0-	5-9	4.0-6.0
4	G-1704	55-60	10.0-12.0	5-6	8.0-10.0

Table-110 Performance of Garlic Clones after curing at VRI Faisalabad 2017-18

28. SEED PRODUCTION

Different varieties of winter and summer vegetables were planted at VRI, Faisalabad and its sub-stations on optimum sowing dates in isolation places. The off-type and diseased plants were rouged out in all the varieties during crop growth stages. The following quantity of Basic seed of different vegetables was produced during the year 2017-18 for distribution among the public and private seed companies and progressive vegetable growers.

S. No.	Vegetable	Pre-Basic (kg)	Basic Seed (kg)
1	Cauliflower FD-I	-	9.5
2	Cauliflower FD-II	-	40.5
3	Cauliflower FD-III	-	31.5
4	Coriander	-	1322
5	Spinach	300	4417
6	Radish (40days)	-	536
7	Radish (Mino)	50	1191
8	Radish (Lal pari)	-	151
9	Turnip (Golden)	20	843
10	Turnip (Purple Top)	20	1469
11	Carrot	180	2209
12	Peas (2009)	405	824
13	Peas (Sarsabz)	585	98
14	Peas (Meteor)	180	74
15	Mithi	-	1298
16	Onion	20	96
17	Muskmelon	-	18.5
18	Watermelon	-	12.1
19	Tinda Gourd	-	237
20	Long Melon	-	12
21	Vegetable Marrow	-	322
22	Tomato (OPV)	-	6
23	Cucumber	-	70
24	Okra	-	418
25	Bottle Gourd	-	48
26	Bitter Gourd	-	150
27	Sponge Gourd	-	89.5
28	Sarsoon	-	298
Total	·	1760	16,290.6

Table-111Seed Production during 2017-18

29. SEED KITS

2,70,000 seed kits of winter (1,70,000) and summer (60,000) vegetables were prepared and distributed among the Kitchen Gardeners to promote kitchen gardening.

30. RESEARCH PROJECTS

- i. An ADP project "Improvement of production technology in ginger and garlic" under Govt. of Punjab ADP program.
- ii. A PARB funded project on tomato entitled as "Development and commercialization of tomato hybrids and varieties suitable for sowing in Tunnels and Open fields of Punjab".

31. PUBLICATIONS

Scientific	05
Radio Talks	59
TV Talks	0
Urdu Articles	15

List of Scientific Publication (2017-18)

- Amin, E., M. M. Raza, M. Iqbal and M. Najeebullah. 2018. Kheera local: a new high yielding, well adaptable and heat tolerant cucumber (*cucumis sativus* L.) variety. J. Agric. Res., 2018, Vol. 56(1):13-16.
- Haq, M. E. U., M. Kamran, S. Ali, M. Idrees, M. Iqbal, H. Abbas, A. Rashid, S. Yaseen and M. Iqbal. 2017. Management of collor of pea through resistant germplasm and chemical application. Int. J. Biosci. Vol. 11(6):9-15.
- Mansoor, M., W. Abbas, J. D.V. Elsas, M.R. Bashir and M. Atiq. 2017. Genetic diversity of bacterial wilt caused by Ralstonia Solanacearum as accessed by PCR. Pak. J. Phytopathol. Vol. 29(1): 69-78.
- Bashir, M. R., M. Atiq, M. Sajid, M. Mohsan, W. Abbas, M. W. Alam and M. Bashair. 2017. Antifungal exploitation of fungicides against Fusarium oxysporum f. sp. Capsici causing Fusarium wilt of chilli pepper in Pakistan. J. Environ. Sci., Vol. 10: 1032-1036.
- Atiq. M., S. Arooj, N. A. Rajput, M. R. Bahir, N. Javed, E. Haq, W. Abbas and B. Khan. 2017. Induction of systemic resistance in cotton against Bacterial Blight and its effect on yield. Int. J. Biol. Biotech., Vol. 14(4): 591-595.

32. INCOME (in million Rs.) = 3.8

EXAMPLA BRIDGE REPORT 2017-18





Mr. Muhammad Najeebullah (Director)

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TABLE OF CONTENTS

OVE	RVIEW	3
	VEGETABLE RESEARCH INSTITUTE, FAISALABAD	3
Α.	ТОМАТО	4
i.	Cherry type tomato variety	
	17253	.4
В.	PEAS	5
	1300-8	5
C.	BITTER GOURD	5
_	Aswad	6
D.	ONION	6
	Open pollinated variety (Dark Red)	6
	Line for salad (VRIO-1)	.6
Ε.	TURNIP	6
	Agita purple Top	7
	Short duration and late bolting turnip	7
F .	RADISH	7
	Long rooted Lal Pari	.7
G.	CUCUMBER	7
	Parthenocarpic	7
Н.	RESEARCH PROJECTS	7
ī. –	SEED PRODUCTION	8
J.	INCOME	8
<u>к</u> .	SCIENTISTS	8





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OVERVIEW

The institute is located at a distance of four kilometers from the Faisalabad city on Jhang Road, Faisalabad. It stands in the flat plains of Northeast of Punjab, between longitude 73°74 East, latitude 30°31.5 North, with an elevation of 184m (604 ft.) above sea level.

Research on vegetable crops in this part of the sub-continent was started with the creation of a Vegetable Section in 1938, headed by an Assistant Botanist, at the Punjab Agri. College and Research Institute, Lyallpur (now called Faisalabad). In 1945, this Section was merged with the Fruit Section headed by a Fruit Specialist. In 1950, it was detached from the Fruit Section and a Vegetable Botanist was appointed to supervise the task of vegetable research. This Vegetable Section was upgraded to the status of Vegetable Research Institute (VRI) in 1975. Since then this institute has developed 57 high yielding better varieties/hybrids possessing biotic and abiotic stresses. This institute has also developed technology for growing off-season vegetables under plastic tunnels. This institute has got the status of pioneer institution for the supply of vegetable breeding material / germplasm to other organizations of the country for research. This institute has also prepared 2,70,000 seed kits (Winter & Summer) during the year 2017-18. The Vegetable Research Institute has been providing the advisory services to the vegetable growers and vegetable seed producers through Electronic and Print masses for enhancement of vegetable production in the country.

Research Work

A. TOMATO

Development of 1st ever Cherry type tomato variety "17253"

The spot examination of a semideterminate cherry type tomato advanced line namely 17253 (Fig.1) was successfully conducted on 02.05.2018. The salient characteristics of the said line are as under:

- 1. Highly suitable for fresh consumption (whole fruit) due to its pleasant taste.
- 2. Fruit size is small with higher yield.
- Attractive for kitchen gardeners as it can be grown even in pots.
- 4. It has tolerance against tomato diseases.

This newly developed cherry type variety could be grown both under tunnels as well as in open fields.



Fig.1. Cherry type tomato advanced line "17253" suitable for tunnels and open fields

B. PEAS

Development of high yielding pea advanced line "1300-8"

A newly developed advance line "1300-8" has shown encouraging results at vegetable research institute, Faisalabad and different stations located at Sheikhupura, Multan andLayyah against the check variety Meteor in respect of earliness and yield. This line is suitable for early planting and has good yield potential as compared with check variety. This line has been registered with FSC&RD to confirm its specific traits.



Fig.2. A field view of Peas Line "1300-8"

C. BITTER GOURD

Germplasm consisting of 15 entries was maintained through sibbing. Breeding programme for the development of new high yielding and well adapted varieties with desirable traits is on the way.



Fig.3 A view of selfing fruits in bitter gourd breeding programme

D. TURNIP

i. Purple Top Agita selection

A heat tolerant genotype named "Agita Purple Top" has been developed. It is being maintained as per standard procedure. This selection posseses heat tolerance and it is suitable for early production of turnips. It could be planted in end of July.



Fig.4 Agita Purple Top ii. Development of short duration and late bolting turnip named as "Rubi"

A line having characteristic of short duration and late bolting has been developed. This selection named as "Rubi" is a short duration and it requires only 35-40 days for maturity. It is cold tolerant and quite suitable for late planting. It could be planted during the months of Dec, Jan and Feb. It is late bolting.



Fig.5 Short duration and late bolting turnip "Rubi"

E. RADISH

i. Purple Top 40 Days

Germplasm comprising of 8 genotypes were maintained in isolations. An open pollinated line "Purple Top 40 days" (Fig-6)has been developed from this source population. This line might be suitable in early season with fascinating colour, when sown in August. The neck of this line is red color and has attractive root shape and size.



Fig.6 Purple Top 40 Days

ii. Long Rooted Lal Pari

A long rooted line was selected to develop new strain possessing long root. This selection

posseses characteristics of already approved salad variety named as "Lal Pari" but ne selection would be more attractive on account of long root.



Fig.7 Long Rooted Lal Pari

iii. Mino Selection

"Mino selection" is a long duration radish. It is suitable for mid and late season production. It possesses less foliage. DUS of this selection has been conducted.



Fig.8 Mino Selection

iv. Purple Neck

A new strain of radish purple neck has been developed. Its color is quite fascinating. It is long duration (50-60 days). It is suitable for mid and late season. It also possesses cold tolerance.



Fig.9 Purple Neck

F. MUSK MELON

i. Local Honey Dew

This is a newly developed muskmelon F_1 hybrid named as "Local Honey Dew". It is quite sweet having a 16 % TSS. It is suitable for early cultivation and production under low tunnel.



Fig.10 Local Honey Dew

ii. Green Flesh

This is also honey dew type. It has been named as "Green Flesh". It is heat tolerant. It possesses tolerance against root diseases. It has TSS 16%. It is also suitable for tunnel cultivation.


Fig.11 Green Flesh

G. CUCUMBER

Breeding in has been started Parthenocarpic cucumber. F₄ seed of Parthenocarpic cucumber has been extracted. Parthenocarpic breeding programme is successfully going on at vegetable research institute, Faisalabad.



Fig.12. Parthenocarpic cucumber self and cross fruits

H. RESEARCH PROJECTS

- An ADP project "Improvement of production technology in ginger and garlic" under Govt. of Punjab is under execution.
- ii) A PARB funded project on tomato entitled as "Development andcommercializationof tomato hybrids and varieties suitable for sowing in Tunnels and Open fields of Punjab" is under execution.
- I. <u>SEED PRODUCTION (BNS, PRE-</u> BASIC & BASIC)

Produced (Tones) = 16802.51 Seed Kits prepared & distributed = 1,90,000

J. INCOME (In million Rs.) = 3.8

K. SCIENTISTS

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