ANNUAL TECHNICAL REPORT

2020-21

ARID ZONE RESEARCH INSTITUTE, BHAKKAR

CONTENTS

1. WHEAT:

1.1 VARIETY DEVELOPMENT:

A high yielding, disease and temperature stress tolerant spring bread wheat variety in the name of **BHAKKAR 2020** was got approved for general cultivation from Punjab Seed Council, Punjab.

1.2 COLLECTION AND MAINTENANCE OF WHEAT GERMPLASM 2020-21

Introduction, collection, evaluation, maintenance and improvement of plant genetic resources play crucial role in the evolution of crop varieties. Four hundred and fifty strains collected from various research organizations were laid out in observational plots to identify cultivars having high yield potential coupled with desirable attributes. Plot size was kept 1m x 0.6m maintaining row to row distance 0.3m. Sowing was carried out on 23-11-2020 with the help of dibbler to ensure uniform plant population. All the agronomic practices were carried out as and when required. One hundred and eighty lines were rejected due to disease incidence and poor performance. This experiment was harvested on 22-05-2021. Data regarding days to 50% heading, spikes per plant, plant height, diseases incidence, grain weight per spike and grain yield per plant were recorded accordingly. Maximum and minimum range values of characters; days to 50% heading, days to maturity, tillers per plant, plant height, grain weight per ear, 1000 grain weight and grain yield per plant were 95-120, 135-170, 3-35, 65-145, 1-5, 32-52g and 2-48g, respectively.

1.3 WHEAT HYBRIDIZATION PROGRAMME 2020-21

Two hundred and forty promising strains/varieties with special reference to desirable attributes were planted in paired rows plot having length 1.5m and maintaining row to row distance 0.30m among the parental lines. Sowing was done on 25-11-2020 and harvesting was carried out on 07-05-2021. One hundred and forty crosses were attempted among promising varieties/strains with basic objective to combine desirable attributes in single genotype. Seed of one hundred successful crosses was harvested to study F_1 progenies during the next crop season 2021-22.

1.4 EVALUATION OF SEGREGATING GENERATIONS

1.4.1 F_1 GENERATIONS

Ninety five F1 progenies by making use of F_0 seeds (Crosses) were planted alongwith their parents for evaluation. The plot size was kept 1.0m x 0.9m by maintaining plant to plant distance 0.15m and row to row distance 0.30m. Sowing was done on 23-11-2020 and harvesting was carried out on 17-05-2021. All the agronomic practices were carried out as and when required. The seed was obtained from eighty five desirable disease resistant F_1 populations alongwith parents to raise F_2 generations during the next crop year 2021-22.

1.4.2 F_2 SEGREGATING GENERATIONS

Quantum of genetic variability existing in F_2 generations is a basic tool of a plant breeder for his successful breeding programme. Sixty five F_2 segregating populations were studied alongwith parental lines during the year 2020-21. The plot size was kept 3.5m x 1.2m having row to row distance 0.30m. The sowing was done on 24-11-2020. Segregation was observed in all

populations. One thousand single plant selections from sixty segregating populations were made on the basis of visual performance and disease incidence in field conditions on 25-05-2021 to raise F_3 generations during crop season 2021-22.

1.4.3 F_3 SEGREGATING GENERATIONS

One hundred and forty four segregating populations being the descendants of F_2 progenies were planted to raise F_3 populations. Sowing was done on 24-11-2020 and gross plot size was maintained 3.5m x 0.9m. Selections of desirable plants were made from 13-05-2021 to 25-05-2021. Eleven hundred single plant selections from one hundred and fifteen segregating populations were made on the basis of visual performance and disease incidence in field conditions on 30-05-2021 to raise F_4 generations during crop season 2021-22.

1.4.4 F_4 SEGREGATING GENERATIONS

Eighty four segregating populations connected through the ancestry line of F_3 populations of previous year were planted. The plot size of each progeny was 3.5 m x 0.6m. Space planting was done by maintaining plant to plant and row to row 0.15m and 0.30m distance respectively on 24-11-2020. The segregation was observed in most of the populations and eight hundred single plants were selected and six hundred were finally selected in the laboratory on the basis of plant height, spikes per plant, grain weight per spike and grain yield per plant to raise F_5 generations during crop season 2021-22.

1.4.5 F_5 SEGREGATING GENERATIONS

Forty nine segregating progenies being the descendants of F_4 generations were laid out. The plot size of each progeny was maintained 3.5m x 1.2m. Sowing was carried out on 24-11-2020 with the help of dibbler as per planting geometry of row to row distance and plant to plant distance 0.30m and 0.15m respectively. Two seeds per hole were sown and single baby plant was ensured after germination through thinning operation. Seven hundred single plants were selected on visual observation from field and six hundred and twenty were finally selected in the laboratory on the basis of plant height, spikes per plant, and average grain weight per spike and grain yield per plant to raise F_6 generations during next sowing season 2021-22.

1.4.6 F_6 SEGREGATING GENERATIONS

Forty two populations collected from ancestry line of F_5 generations of previous year were planted. Plot size for each progeny was kept 3.5m x 1.2m. The sowing was carried out on 25-11-2020 with the help of dibbler as per planting geometry of row to row distance and plant to plant distance 0.30m and 0.15m respectively. Two seeds per hole were sown and single baby plant was maintained after germination by thinning operation. Twenty eight uniform populations were selected on the basis of field observations and twenty two were finally selected in the laboratory on the basis of grain yield per plant alongwith allied attributes to incorporate in preliminary wheat yield trials during sowing season 2021-22.

1.5 REPLICATED WHEAT YIELD TRIALS 2020-21

1.5.1 PRELIMINARY WHEAT YIELD TRIAL (A_1) 2020-21

A preliminary wheat yield trial-A_1 comprising twenty entries viz; TW2020-01, TW2020-02, TW2020-03, TW2020-04, TW2020-05, TW2020-06, TW2020-07, TW2020-08, TW2020-09,

TW2020-10, TW2020-11, TW2020-12, TW2020-13, TW2020-14, TW2020-15, TW2020-16, TW2020-17, TW2020-18, Bhakkar Star and Akbar-19 was laid out in hot irrigated dry climate of arid zone. The trial was laid out according to Randomized Complete Block Design with three replications. The sowing was done on 03-11-2020 with gross plot size 5.0m × 1.2m. All the cultural practices were carried out as and when required. The trial was harvested on 07-05-2021. The grain yield data are given in Table-1.

Table-1: Grain yield of preliminary wheat yield trial (A_1) 2020-21

S. No	Variety /Strain	Grain Yield (kg /ha)	S. No	Variety /Strain	Grain Yield (kg /ha)
1	TW2020-11	5017	11	Akbar-19	3761
2	TW2020-10	4658	12	TW2020-04	3656
3	TW2020-18	4556	13	TW2020-14	3555
4	TW2020-09	4464	14	TW2020-03	3333
5	TW2020-02	4439	15	TW2020-05	3275
6	TW2020-13	4172	16	TW2020-08	3234
7	TW2020-15	4144	17	TW2020-12	3211
8	TW2020-17	4133	18	TW2020-01	3200
9	TW2020-06	3894	19	TW2020-07	3167
10	Bhakkar Star	3806	20	TW2020-16	3111
$LSD_{0.05}$ = 373 kg/ha. CV (%) = 8					

Statistical analysis of yield data revealed that the differences among the means of entries were significant (Table-1). The strain TW2020-11 was top yielder with followed by TW2020-10 having grain yield value 5017,4658 kg /ha respectively. Check varieties Bhakkar Star and Akber-2019 depicted grain yield 3806 and 3761 kg /ha, respectively. The strain TW2020-16 gave the lowest yield with mean yield value 3111 kg /ha. Seed of four top yielding and disease tolerant genotypes (TW2020-11, TW2020-10, TW2020-18 & TW2020-09) with high agronomic score was reserved for layout of regular yield trial during rabi crop season 2021-22.

1.5.2 PRELIMINARY WHEAT YIELD TRIAL (A_2) 2020-21

A preliminary wheat yield trial-A_2 comprising twenty entries viz; TWS2020-21, TWS2020-22, TWS2020-23, TWS2020-24, TWS2020-25, TWS2020-26, TWS2020-27, TWS2020-28, TWS2020-29, TWS2020-30, TWS2020-31, TWS2020-32, TWS2020-33, TWS2020-34, TWS2020-35, TWS2020-36, TWS2020-37, TWS2020-38, Bhakkar Star and Akbar-19 was conducted in hot irrigated dry climate of arid zone. The trial was laid out according to Randomized Complete Block Design with three replications having plot size 5.0m x 1.2m. The sowing was done on 03-11-2020. All the cultural practices were carried out as and when required. The trial was harvested on 07-05-2021. The grain yield data are given in Table-2.

Table-2: Grain Yield of preliminary wheat yield trial (A_2) 2020-21

Sr. No	Variety /Strain	Grain Yield (kg /ha)	Sr. No	Variety /Strain	Grain Yield (kg /ha)
1	TWS2020-23	4900	11	Akbar-19	3933
2	TWS2020-25	4772	12	TWS2020-32	3911
3	TWS2020-38	4628	13	TWS2020-36	3772
4	TWS2020-30	4522	14	TWS2020-27	3722
5	TWS2020-21	4511	15	TWS2020-29	3694
6	TWS2020-31	4494	16	TWS2020-37	3639
7	TWS2020-28	4483	17	TWS2020-33	3278
8	TWS2020-22	4422	18	TWS2020-35	3267
9	TWS2020-34	4311	19	TWS2020-26	3167
10	Bhakkar Star	4100	20	TWS2020-24	3089
$LSD_{0.05}$ = 260 kg / ha CV (%) = 7.0					

It was revealed from the analysis of variance (Table-2) that the differences among the means of entries were significant. The strain TWS2020-23 gave maximum grain yield 4900 kg /ha followed by TWS2020-25 and TWS2020-38 having grain yield values of 4772, and 4628 kg /ha, respectively. Check varieties Bhakkar Star and Akbar-2019 gave the yield 4100 and 3933 kg /ha, respectively. The strain TWS2020-24 gave the lowest yield with mean yield value of 3089 kg /ha. Seed of five top yielding and disease tolerant genotypes having high agronomic score(TWS2020-23, TWS2020-25, TWS2020-38, TWS2020-30 & TWS2020-21) was reserved for layout of regular yield trial in crop season 2021-22.

1.5.3 REGULAR WHEAT YIELD TRIAL (B_1) 2020-21

A regular wheat yield trial-B_1 comprising twenty entries viz; TW1902, TW1903, TW1906, TW1911, TWS1912, TWS1917, TWS1926, TWS1923, TWS1937, TWS1938, TWS1922, TWS1925, TWS1949, TWS1954, TWS1962, TWS1947, TWS1953, TWS1966, F. Bhakkar and Anaj-2017 was conducted in irrigated condition. Trial was laid out according to Randomized Complete Block Design with three replications having plot size 5.0m x 1.2m. The sowing was done on 04-11-2020. All the cultural practices were carried out as and when required. The trial was harvested on 09-05-2021. The grain yield data are shown in Table-3.

Table-3: Grain Yield of regular wheat yield trial (B_1) 2020-21

Sr. No	Variety /Strain	Grain Yield (kg /ha)	Sr. No	Variety /Strain	Grain Yield (kg /ha)
1	TWS1923	5133	11	Fakhar-e-Bhakkar	4389
2	TWS1966	5033	12	TWS1954	4344
3	TWS1926	4739	13	TWS1922	4256
4	TWS1938	4722	14	TWS1937	4250
5	TW1902	4689	15	TWS1925	3944
6	TWS1962	4628	16	Anaj-17	3944
7	TW1911	4600	17	TWS1949	3283
8	TWS1917	4539	18	TWS1912	3222
9	TW1903	4489	19	TWS1953	3222
10	TW1906	4400	20	TWS1947	3111
$LSD_{0.05}$ = 370 kg / ha CV (%) = 9.00					

It was revealed from the analysis of variance (Table-3) that the differences among the means of entries were significant. The strain TWS1923 gave maximum grain yield 5133 kg /ha followed by TWS1966 and TWS1926 having grain yield values 5033 and 4739 kg /ha, respectively. Check varieties F-Bhakkar and Anaj-2017 gave the grain yield 4389 and 3944 kg /ha, respectively. The strain TWS1947 depicted the lowest yield with mean yield value of 3111 kg /ha. Seed of nine top yielding and disease tolerant with high agronomic score genotypes (TWS1923, TWS1966, TWS1926, TWS1938, TWS191902, TWS1962, TWS1911, TWS1917 and TWS1903) was reserved for layout of regular yield trial 2021-22.

1.5.4 REGULAR WHEAT YIELD TRIAL (B_2) 2020-21

A regular wheat yield trial-B_2 comprising twenty entries viz; TWS19145, TWS19146, TWS19149, TWS19153, TWS19154, TWS19155, TWS19156, TWS19157, TWS19158, TWS19159, TWS19169, TWS19170, TWS19171, TWS19172, TWS19173, TWS19174, TWS19175, TWS19176, Fakhar-e-Bhakkar and Anaj-17 was conducted in hot irrigated dry climate. The trial was laid out according to Randomized Complete Block Design with three replications. The sowing was done on 04-11-2020 with plot size 5.0m x 1.2m. All the cultural practices were carried out as and when required. The trial was harvested on 09-05-2021. The grain yield data are presented in Table-4.

Table- 4: Grain Yield of regular wheat yield trial-B_2 2020-21

Sr. No	Variety /Strain	Grain Yield (kg /ha)	Sr. No	Variety /Strain	Grain Yield (kg /ha)
1	TWS19172	5122	11	TWS19157	4478
2	TWS19173	5067	12	TWS19155	4417
3	TWS19169	4978	13	Fakhar-e-Bhakkar	4294
4	TWS19145	4911	14	TWS19159	4183
5	TWS19170	4883	15	Anaj-17	4097
6	TWS19154	4806	16	TWS19153	3833
7	TWS19171	4744	17	TWS19175	3489
8	TWS19158	4686	18	TWS19174	3389
9	TWS19176	4511	19	TWS19146	3333
10	TWS19156	4489	20	TWS19149	3278
$LSD_{0.05}$ = 338 kg / ha CV (%) = 8.00					

It was evident from the statistical analysis of the yield data given in the above Table-4 that the differences among the means of strains were significant. It was observed that the strain TWS19172 gave maximum grain yield 5122 kg /ha, followed by TWS19173 with grain yield 5067 kg /ha. However the check entries Fakhar-e-Bhakkar and Anaj-2017 gave grain yield 4294 and 4097 kg /ha, respectively. Seed of four top yielding and disease tolerant with high agronomic score genotypes (TWS19172, TWS19173, TWS19169 & TWS19145) was reserved for layout of adaptation yield trial 2021-22.

1.5.5 REGULAR WHEAT YIELD TRIAL (B_3) 2020-21

A regular wheat yield trial-B_3 comprising twenty entries viz; TWS1992, TWS1993, TWS1994, TWS1995, TWS1996, TWS1997, TWS1998, TWS1999, TWS19100, TWS19101, TWS19102, TWS19103, TWS19104, TWS19105, TWS19106, TWS19107, TWS19108, TWS19109, Fakhar-e-Bhakkar and Anaj-17 was conducted in hot irrigated dry climate. The trial was laid out according to Randomized Complete Block Design with three replications. The sowing was done on 04-11-2020 with gross plot size 5.0m x 1.2m. All the cultural practices were carried out as and when required. The trial was harvested on 11-05-2021. The grain yield data are presented in Table-5.

Table- 5: Grain Yield of regular wheat yield trial-B_3 2020-21

Sr. No	Variety /Strain	Grain Yield (kg /ha)	Sr. No	Variety /Strain	Grain Yield (kg /ha)
1	TWS19101	5367	11	TWS1998	4933
2	TWS19109	5272	12	Anaj-17	4733
3	TWS1993	5228	13	TWS1999	4556
4	TWS1994	5183	14	TWS19105	4233
5	TWS19106	5167	15	TWS19104	4167
6	TWS1996	5144	16	TWS1997	3889
7	TWS19100	5133	17	TWS19102	3722
8	TWS1992	5028	18	TWS19108	3722
9	TWS19103	5017	19	TWS19107	3556
10	Fakhar-e-Bkr	4994	20	TWS1995	3250
$LSD_{0.05}$ = 363 kg / ha CV (%) =8.00					

It was evident from statistical analysis of the yield data given in the above Table-5, that the differences among the means of strains were significant. It was observed that the strain TWS19101 gave maximum grain yield 5367 kg /ha followed by TWS19109 with grain yield 5272 kg /ha. However the check entries Fakhar-e-Bhakkar and Anaj-2017 gave grain yield 4994 and 4733 kg /ha, respectively. Seed of five top yielding and disease tolerant with high agronomic score genotypes (TWS19101, TWS19109, TWS1993, TWS1994 & TWS19106) was reserved for layout of adaptation yield trial 2021-22.

1.5.6 REGULAR WHEAT YIELD TRIAL (B_4) 2020-21

A regular wheat yield trial (B_4) comprising twenty entries viz; TWS19110, TWS19111, TWS19112, TWS19113, TWS19114, TWS19115, TWS19116, TWS19117, TWS19118, TWS19119, TWS19120, TWS19121, TWS19122, TWS19123, TWS19124, TWS19125, TWS19126, TWS19127, Fakhar-e-Bhakkar and Anaj-17 was conducted in hot irrigated dry climate. This trial was laid out according to Randomized Complete Block Design with three replications. Sowing was done on 10-11-2020 with plot size 5.0m x 1.2m. All the cultural practices were carried out as and when required. This trial was harvested on 11-05-2021. However threshing was carried out on 15-06-2021 and grain yield data are presented in Table-6.

Table- 6: Grain Yield of regular wheat yield trial-B_4 2020-21

Sr. No	Variety /Strain	Grain Yield (kg /ha)	Sr. No	Variety /Strain	Grain Yield (kg /ha)
1	TWS19112	4822	11	TWS19127	3989
2	TWS19125	4711	12	TWS19120	3917
3	TWS19114	4678	13	TWS19121	3889
4	TWS19116	4639	14	TWS19123	3639
5	TWS19110	4511	15	TWS19124	3594
6	TWS19117	4461	16	TWS19115	3500
7	TWS19111	4278	17	TWS19113	3444
8	Fakhar-e-Bkr	4228	18	TWS19118	3444
9	Anaj-17	4144	19	TWS19119	3444
10	TWS19122	4028	20	TWS19126	3222
$LSD_{0.05}$ = 442 kg / ha CV (%) =11					

It was evident from statistical analysis of the yield data given in the Table-6 that the differences among the means of strains were significant. It was observed that the strain TWS19112 gave maximum grain yield 4822 kg /ha, followed by TWS19125 with grain yield 4711 kg /ha. However the check entries Fakhar-e-Bhakkar and Anaj-2017 gave grain yield 4228 and 4144 kg /ha, respectively. Seed of five top yielding and disease tolerant with high agronomic score genotypes (TWS19112, TWS19125, TWS19114, TWS19116 & TWS19110) was reserved for layout of adaptation yield trial 2021-22.

1.5.7 WHEAT ADAPTATION YIELD TRIAL 2020-21

A wheat adaptation yield trial was conducted at three locations AZRI, Bhakkar, Adaptive Research Station, Karor and Farida Garden, Kallur kot. This trial had sixteen entries viz: TWS1839, TWS1836, TWS1846, TWS18100, TWS18102, TWS18104, TWS18114, TWS18135, TWS18127, TWS18126, TWS18143, TWS18128, TWS18134, TWS18140B, Fakhar-e-Bhakkar and Anaj-17 which were sown according to Randomized Complete Block Design with three replications. The plot size was kept 5m x 1.2m. All the cultural practices were carried out as and when required. The trial was harvested at three locations during the month of May 2021. Grain yield data are given in Table 7:

Table-7: Grain Yield of wheat Adaptation yield trial 2020-21

Sr. No.	Variety /Strain	Grain Yield (kg /ha)			Mean
		AZRI, Bkr (Timely Planting)	AZRI, Bkr (Late Planting)	ARS, Karor	Freeda Garden, K. KOT	
1	TWS18128	4903	4333	4840	4893	4743
2	TWS18127	4800	4290	4778	4837	4676
3	TWS18140	4980	3800	4798	5053	4658
4	TWS1839	4770	4283	4733	4833	4655
5	TWS1846	4760	4060	4765	4967	4638
6	TWS18102	4967	4100	4633	4820	4630
7	TWS18134	4753	3703	4800	5055	4578

8	Fakhar-e-	4650	3920	4660	4600	4458
9	TWS18143	4337	3946	4632	4636	4388
10	Anaj-17	4650	3970	4277	4323	4305
11	TWS18100	4217	3850	4442	4655	4291
12	TWS18126	4213	4083	4543	4033	4218
13	TWS18135	4287	4074	4083	4359	4201
14	TWS18114	3900	4410	4000	4233	4136
15	TWS1836	4000	3933	4000	4533	4117
16	TWS18104	4067	4377	4043	3967	4113
		$LSD_{0.05}$=307 CV(%)=07	$LSD_{0.05}$=288 CV(%)=08	$LSD_{0.05}$=352 CV(%)=9	$LSD_{0.05}$=350 CV(%)=8	

Wheat adaptation yield trial depicted significant differences among entries at all locations. Genotype TWS18128 was top yielder having overall mean grain yield 4743 kg /ha followed by strains TWS18127 and TWS18140 with grain yield figures 4676 and 4658 kg /ha, respectively. However check varieties Fakhar-e-Bhakkar and Anaaj-17expressed average. grain yield 4458 and 4305 kg /ha, respectively. Seed of four top yielding and disease tolerant with high agronomic score genotypes (TWS18128, TWS18127, TWS18140 and TWS1839) was reserved for incorporation in Punjab Uniform Wheat Yield trial 2021-22.

1.5.8 PUNJAB UNIFORM WHEAT YIELD TRIAL 2020-21
(Provincial Level Testing)

Punjab uniform wheat yield trial was coordinated by Wheat Research Institute Faisalabad. It was conducted all over the Punjab at 32 different locations during crop season 2020-21. Trial was laid out according to alpha lattice design with two replications. Arid Zone Research Institute Bhakkar offered three advanced lines (TWS17042, TWS17060 and TWS1849) for testing at provincial level and it extended services to conduct this trial at three different locations (AZRI Bhakkar, Farida Garden, Kallur Kot and ARS Karor). These trials were laid out during third week of November 2020. The plot size was 5.0m x 1.2m. All the cultural practices were carried out as and when required. The trial was harvested and threshed during the month of April / May 2021. Grain yield and other requisite data were recorded and sent to Wheat Research Institute Faisalabad for compilation.

Mean grain yield data of advance lines of this institute and check entries at twenty four irrigated and eight rain fed locations are presented in Table: 8.

8: Table- Grain Yield data of Punjab uniform wheat yield trial 2020-21

Sr. No.	Genotypes	Grain Yield (Kg /ha) Av. 24 locations
PUWYT (irrigated)		
1	**TWS1849**	**4538**
2	Akbar-19	4496
3	Anaj-17	4319
4	Pakistan-13	4229
PUWYT (Rain fed)		**Av. 08 locations**
1	**TWS17060**	**3805**
2	Pakistan-13	3742
3	Anaj-17	3748
4	Akbar-19	3707

It was evident from Table-8 that advance line TWS1849 performed better in irrigated condition in all over Punjab basis (Av. 24 locations) with grand mean grain yield 4538 kg /ha, while in rain fed condition advance line TWS17060 performed better (Av. 8 locations) with grand mean grain yield 3805 kg/ha respectively. However, provincial checks Akbar-19, Anaj-17, and Pakistan-13 gave mean grain yield 4496, 4319 and 4229 kg/ha in irrigated conditions and 3742, 3748 and 3707kg /ha in rain fed conditions respectively. Seed of two outperforming and disease tolerant genotypes (TWS1849 and TWS17060) with high agronomic score was reserved for incorporation in National Uniform Wheat Yield trial 2021-22.

1.5.9 NATIONAL UNIFORM WHEAT YIELD TRIAL AZRI, BKR 2020-21

National uniform wheat yield trial was coordinated by Wheat Coordinator PARC Islamabad. It was conducted all over the Pakistan at different locations during crop season 2020-21. Trial comprising 70 entries was laid out according to alpha lattice design with two replications. Arid Zone research Institute Bhakkar offered three advanced lines (TWS15110, TWS15137 and TWS15159) for testing at national level and cooperated in conducting this trial at three different locations (AZRI, Bhakkar, Farida Garden, Kallur kot and ARS, Karor). This trial was laid out during third week of November 2020. Plot size was maintained as 5.0m x 1.5m in all locations. All the cultural practices were carried out as and when required. The trial was harvested and threshed during the month of April/May, 2021 with net plot size 5.0 m x1 m. Grain yield and other requisite data were recorded and sent to National Wheat Coordinator PARC, Islamabad for compilation. Mean grain yield data of advance lines of this institute and test entries (Av. 21 locations in Punjab and Av. 31 locations in all over Pakistan) are presented in Table: 9 as given below.

Table-9: Grain Yield of National Uniform Wheat Yield Trial 2019-20.

Sr.No.	Genotypes	Grain Yield (Kg /ha)	
NUWYT (irrigated)		**Punjab (Av. 21 locations)**	**Pakistan (Av. 31 locations)**
1	TWS15110	4205	4264
4	Ghazi-19	4155	4179
5	Pakistan-13	4038	3992
NUWYT (Rain fed)		**Punjab (Av. 06 locations)**	**Pakistan (Av. 15 locations)**
1	TWS15159	4640	3950
2	TWS15110	4638	4006
4	Ghazi-19	4502	3859
5	Pakistan-13	4303	3570

It was evident from Table-9 that one advance line TWS15110 of this institute performed better both in irrigated and rain fed conditions with grand mean grain yield 4205 kg /ha on all over Punjab (Av. 21 locations) while in rain fed condition it gave grand mean grain yield of 4638 kg/ha in all over Punjab (Av. 06 locations) respectively. However, advance line TWS15159 performed better in rain fed conditions in all over Punjab basis (Av. 06 locations) with grand mean grain yield 4640 kg/ha and 3950 kg/ha in all over Pakistan (Av. 15 locations) respectively. Provincial checks Ghazi-19 and Pakistan-13 gave mean grain yield 4155 and 4038 kg/ha in all over Punjab and 4179 and 3992 kg/ha in all over Pakistan in irrigated conditions while in rain fed conditions gave mean grain yield 4502 and 4303kg/ha in all over Punjab and 3859 and 3570 kg /ha in all over Pakistan, respectively. Seed of one outperforming and disease tolerant genotypes (TWS15110) with high agronomic score was reserved for incorporation in National Uniform Wheat Yield trial 2021-22.

1.6 INTERNATIONAL TRIALS AND SCREENING NURSERIES

A- CIMMYT TRIALS

1.6.1 8th WHEAT YIELD CONSORTIUM YIELD TRIAL 2020-21.

Eighth wheat yield consortium yield trial 2020-21 comprising thirty three entries was sown on 18-11-2020. Trial was laid out according to alpha lattice design with two replications. Gross plot size was kept 2.5m ×0.9m. All the cultural practices were carried out as and when required. The trial was harvested on 25-05-2021. Grain yield data are presented in Table-10.

Table 10: Grain Yield of 8th wheat yield data consortium yield trial 2020-21

Sr. No.	Variety /Strain	Grain Yield (kg /ha)	Sr. No.	Variety /Strain	Grain Yield (kg /ha)
1	8th WYCYT-41	3787	12	8th WYCYT-26	2387
2	8th WYCYT-42	3627	13	8th WYCYT-25	2387
3	8th WYCYT-27	3627	14	8th WYCYT-44	2160
4	8th WYCYT-18	3587	15	8th WYCYT-13	1880
5	8th WYCYT-10	3267	16	8th WYCYT-02	1853
6	8th WYCYT-55	2907	17	8th WYCYT-09	1773
7	8th WYCYT-23	2880	18	8th WYCYT-37	1653
8	8th WYCYT-46	2747	19	8th WYCYT-38	1640
9	8th WYCYT-50	2640	20	8th WYCYT-03	1507
10	8th WYCYT-51	2613	21	8th WYCYT-15	1400
11	8th WYCYT-07	2413	22	8th WYCYT-01	1240

It was evident from the Table-10 that the variety/strain 8th WYCYT-41 gave maximum grain yield with mean yield of 3787 kg /ha followed by strain 8th WYCYT-42 with grain yield of 3627 kg /ha. However the strain No. 8th WYCYT-01 gave minimum grain yield value of 1240 kg /ha. Seed of ten top yielding and disease tolerant with high agronomic score genotype (8th WYCYT-41) was reserved for incorporation in regular wheat yield trial (B_2) 2021-22.

1.6.2 19th HIGH TEMPERATURE WHEAT YIELD TRIAL 2020-21.

Nineteenth high temperature wheat yield consortium yield trial 2020-21 comprising fifty entries was sown on 18-11-2020. Trial was laid out according to alpha lattice design with two replications. Gross plot size was kept 2.5m ×0.9m. All the cultural practices were carried out as and when required. The trial was harvested on 25-05-2021.Grain yield data are presented in Table-11.

Table 11: Grain Yield data of 19th high temperature wheat yield trial 2020-21

Sr. No.	Variety /Strain	Grain Yield (kg /ha)	Sr. No.	Variety /Strain	Grain Yield (kg /ha)
1	19th HTWYT-46	4613	15	19th HTWYT-70	2827
2	19th HTWYT-19	4587	16	19th HTWYT-41	2800
3	19th HTWYT-21	4160	17	19th HTWYT-39	2760
4	19th HTWYT-02	4040	18	19th HTWYT-62	2627
5	19th HTWYT-12	3947	19	19th HTWYT-90	2627
6	19th HTWYT-04	3853	20	19th HTWYT-07	2467
7	19th HTWYT-18	3613	21	19th HTWYT-67	2347
8	19th HTWYT-30	3600	22	19th HTWYT-96	2253
9	19th HTWYT-44	3280	23	19th HTWYT-06	2240
10	19th HTWYT-59	3267	24	19th HTWYT-75	1840
11	19th HTWYT-28	3027	25	19th HTWYT-80	1613
12	19th HTWYT-47	2920	26	19th HTWYT-86	1560
13	19th HTWYT-33	2867	27	19th HTWYT-01	1453
14	19th HTWYT-08	2853	28	19th HTWYT-98	1067

It was evident from the Table-11 that the variety/strain 19th HTWYT-46 gave maximum grain yield with mean yield of 4613 kg /ha followed by strain 19th HTWYT-19 with grain yield of 4587 kg /ha. However the strain No. 19th HTWYT-98 gave grain yield value of 1067 kg /ha. Seed of one top yielding and disease tolerant with high agronomic score genotype (19th HTWYT-46) was reserved for incorporation in regular wheat yield trial (B_2) 2021-22.

1.6.3 28th SEMI-ARID WHEAT YIELD TRIAL 2020-21 (CIMMYT)

Twenty eighth semi-arid wheat yield trial 2020-21 comprising fifty entries was laid out on 18-11-2020 following alpha lattice design with two replications. The plot size was kept 2.5m ×0.9m. All the cultural practices were carried out as and when required. The trial was harvested on 25-05-2021. Grain yield data are presented in Table-12.

Table 12: Grain Yield data of 28th Semi-arid Wheat Yield Trial 2020-21

Sr. No.	Variety /Strain	Grain Yield (kg /ha)	Sr. No.	Variety /Strain	Grain Yield (kg /ha)
1	28th SAWYT-341	3947	13	28th SAWYT-390	2640
2	28th SAWYT-336	3800	14	28th SAWYT-302	2520
3	28th SAWYT-312	3733	15	28th SAWYT-327	2453
4	28th SAWYT-314	3733	16	28th SAWYT-343	2347
5	28th SAWYT-320	3667	17	28th SAWYT-316	2333
6	28th SAWYT-330	3600	18	28th SAWYT-309	2333
7	28th SAWYT-332	3520	19	28th SAWYT-366	2133
8	28th SAWYT-306	3507	20	28th SAWYT-387	1533
9	28th SAWYT-379	3267	21	28th SAWYT-382	1507
10	28th SAWYT-342	2973	22	28th SAWYT-397	1293
11	28th SAWYT-386	2867	23	28th SAWYT-359	1187
12	28th SAWYT-355	2667	24	28th SAWYT-317	667

It was evident from the Table-12 that the variety/strain 28th SAWYT-341 gave maximum grain yield 3947 kg /ha followed by strain 28th SAWYT-336 with grain yield of 3800 kg /ha. However the strain coded as 28th SAWYT-317 gave grain yield of 667 kg /ha. Seed of five top yielding and disease tolerant with high agronomic score genotypes (28th SAWYT-341, 28th SAWYT-336, 28th SAWYT-312, 28th SAWYT-314 & 28th SAWYT-320) was reserved for incorporation in Regular Wheat Yield trial (B_2) 2021-22.

1.6.3 41st ELITE SPRING WHEAT YIELD TRIAL 2020-21.

41st elite spring wheat yield trial 2020-21 comprising fifty entries were laid out on 18-11-2020 according to alpha lattice design with two replications. The plot size was kept 2.5m×0.9m. All the cultural practices were carried out as and when required. The trial was harvested on 25-05-2021. Grain yield data are presented in Table-13.

Table 13: Grain Yield Data of 41st Elite Spring Wheat Yield Trial 2020-21.

Sr. No.	Variety /Strain	Grain Yield (kg /ha)	Sr. No.	Variety /Strain	Grain Yield (kg /ha)
1	41st ESWYT-163	4373	16	41st ESWYT-114	2440
2	41st ESWYT-142	4333	17	41st ESWYT-124	2347
3	41st ESWYT-177	4333	18	41st ESWYT-161	2213
4	41st ESWYT-112	4133	19	41st ESWYT-136	2173
5	41st ESWYT-149	3853	20	41st ESWYT-102	2080
6	41st ESWYT-155	3173	21	41st ESWYT-129	2053
7	41st ESWYT-143	3160	22	41st ESWYT-107	1893
8	41st ESWYT-158	3067	23	41st ESWYT-165	1733
9	41st ESWYT-133	3067	24	41st ESWYT-192	1667
10	41st ESWYT-115	3000	25	41st ESWYT-171	1640
11	41st ESWYT-121	2960	26	41st ESWYT-182	1547
12	41st ESWYT-198	2800	27	41st ESWYT-186	1480
13	41st ESWYT-189	2587	28	41st ESWYT-01	1027
14	41st ESWYT-104	2560	29	41st ESWYT-193	880
15	41st ESWYT-106	2533			

It was evident from the Table-13 that strain 41st ESWYT-163 gave maximum grain yield 4373 kg /ha followed by strain 41st ESWYT-142 with 4333 kg /ha. However, the strain 41st ESWYT-193 produced grain yield 880 kg /ha. Seed of nine top yielding and disease tolerant with high agronomic score genotypes (41st ESWYT-163, 41st ESWYT-142, 41st ESWYT-177, 41st ESWYT-112, 41st ESWYT-149, 41st ESWYT-155, 41st ESWYT-143, 41st ESWYT-158 and 41st ESWYT-133) was reserved for incorporation in Regular Wheat Yield trial (B_2) 2021-22.

1.6.4 31st HIGH RAINFALL WHEAT SCREENING NURSERY 2020-21

A 31st High Rainfall Wheat Screening Nursery 2020-21 comprising one hundred and fifty six entries was laid out on 18-11-2020 following plot size 1m ×0.3m. All the cultural practices were carried out as and when required. The trial was harvested on 25-05-2021. Grain yield per plot data are presented in Table-14.

Table 14: Grain Yield data of 31st High Rainfall Wheat Screening Nursery 2020-21

Sr. No.	Variety /Strain	Grain Yield (kg /ha)	Sr. No.	Variety /Strain	Grain Yield (kg /ha)
1	31st HRWSN-2151	5667	13	31st HRWSN-2042	2333
2	31st HRWSN-2139	4067	14	31st HRWSN-2098	2200
3	31st HRWSN-2115	4067	15	31st HRWSN-2027	2000
4	31st HRWSN-2012	3933	16	31st HRWSN-2038	1733
5	31st HRWSN-2074	3467	17	31st HRWSN-2122	1333
6	31st HRWSN-5150	3000	18	31st HRWSN-2080	1200
7	31st HRWSN-2036	3000	19	31st HRWSN-2030	1100
8	31st HRWSN-2007	2867	20	31st HRWSN-2016	1100
9	31st HRWSN-2006	2667	21	31st HRWSN-2021	1000

10	31st HRWSN-2054	2533	22	31st HRWSN-2107	1000
11	31st HRWSN-2002	2467	23	31st HRWSN-2125	950
12	31st HRWSN-2003	2333	24	31st HRWSN-2051	900

It was revealed from the Table-14 that the variety/strain 31st HRWSN-2151 gave maximum grain yield 5667 kg/ha followed by strain 31st HRWSN-2139 with 4067 kg/ha. However, the strain 31st HRWSN-2051 showed grain yield 900 kg/ha. Seed of eighteen top yielding and disease tolerant with high agronomic score genotypes (2151, 2139, 2115, 2012, 2074, 5150, 2036, 2007, 2006, 2054, 2002, 2003, 2042, 2098, 2027, 2038, 2122 and 2080) was reserved for incorporation in Preliminary Wheat Yield trial 2021-22.

1.6.6 38th SEMI ARID WHEAT SCREENING NURSERY 2020-21

A 38th Semi-Arid Wheat Screening Nursery 2020-21 comprising two hundred and eighty four entries was laid out on 18-11-2020 following plot size 1m ×0.3m. All the cultural practices were carried out as and when required. The trial was harvested on 25-05-2021. Grain yield per plot data are presented in Table-15.

Table 15: Grain Yield data of 38th Semi-Arid Wheat Screening Nursery 2020-21

Sr. No.	Variety /Strain	Grain Yield (kg /ha)	Sr. No.	Variety /Strain	Grain Yield (kg /ha)
1	38th SAWSN-3060	5800	24	38th SAWSN-3016	1333
2	38th SAWSN-3260	5000	25	38th SAWSN-3024	1267
3	38th SAWSN-3240	4133	26	38th SAWSN-3075	1200
4	38th SAWSN-3090	3667	27	38th SAWSN-3152	1200
5	38th SAWSN-3071	3400	28	38th SAWSN-3165	1067
6	38th SAWSN-3064	3133	29	38th SAWSN-3221	1067
7	38th SAWSN-3191	3133	30	38th SAWSN-3031	1050
8	38th SAWSN-3034	2867	31	38th SAWSN-3224	1050
9	38th SAWSN-3181	2333	32	38th SAWSN-3223	1050
10	38th SAWSN-3231	2333	33	38th SAWSN-3253	1033
11	38th SAWSN-3190	2133	34	38th SAWSN-3220	1033
12	38th SAWSN-3050	2000	35	38th SAWSN-3195	1000
13	38th SAWSN-3003	1867	36	38th SAWSN-3156	1000
14	38th SAWSN-3243	1800	37	38th SAWSN-3171	980
15	38th SAWSN-3082	1733	38	38th SAWSN-3072	950
16	38th SAWSN-3162	1667	39	38th SAWSN-3148	930
17	38th SAWSN-3147	1667	40	38th SAWSN-3061	930
18	38th SAWSN-3101	1667	41	38th SAWSN-3004	900
19	38th SAWSN-3042	1600	42	38th SAWSN-3102	900
20	38th SAWSN-3161	1533	43	38th SAWSN-3113	895
21	38th SAWSN-3005	1500	44	38th SAWSN-3230	895
22	38th SAWSN-3022	1333	45	38th SAWSN-3206	850
23	38th SAWSN-3134	1333	-	-	-

It was revealed from the Table-15 that the variety/strain 38th SAWSN-3190 gave maximum grain yield 5800 kg/ha followed by strain 38th SAWSN-3050 with 5000 kg/ha. However, the strain 38th SAWSN-33206 showed grain yield 850 kg/ha. Seed of eighteen top yielding and disease tolerant with high agronomic score genotypes (3060, 3260, 3240, 3090, 3071, 3064, 3191, 3034, 3181, 3231, 3190, 3050, 3003, 3243, 3082, 3162, 3147 and 3101) was reserved for incorporation in Preliminary Wheat Yield trial 2021-22.

1.6.7 53rd INTERNATIONAL BREAD WHEAT SCREENING NURSERY 2020-21

A 53rd International Bread Wheat Screening Nursery 2020-21 comprising two hundred and eighty four entries was laid out on 18-11-2020 following plot size 1m ×0.3m. All the cultural practices were carried out as and when required. This trial was harvested on 25-05-2021. Grain yield per plot data are presented in Table-16.

Table 16: Grain Yield data of 53rd Int. Bread Wheat Screening Nursery 2020-21

Sr. No.	Variety /Strain	Grain Yield (kg /ha)	Sr. No.	Variety /Strain	Grain Yield (kg /ha)
1	53rd IBWSN-1022	5333	22	53rd IBWSN-1123	1368
2	53rd IBWSN-1177	4333	23	53rd IBWSN-1221	1367
3	53rd IBWSN-1131	3000	24	53rd IBWSN-1262	1350
4	53rd IBWSN-1006	3000	25	53rd IBWSN-1220	1330
5	53rd IBWSN-1060	2667	26	53rd IBWSN-1023	1310
6	53rd IBWSN-1099	2333	27	53rd IBWSN-1036	1300
7	53rd IBWSN-1062	2167	28	53rd IBWSN-1028	1280
8	53rd IBWSN-1261	2000	29	53rd IBWSN-1073	1280
9	53rd IBWSN-1011	2000	30	53rd IBWSN-1139	1270
10	53rd IBWSN-1260	2000	31	53rd IBWSN-1240	1250
11	53rd IBWSN-1101	1833	32	53rd IBWSN-1090	1200
12	53rd IBWSN-1141	1833	33	53rd IBWSN-1037	1160
13	53rd IBWSN-1219	1833	34	53rd IBWSN-1284	1140
14	53rd IBWSN-1109	1667	35	53rd IBWSN-1066	1133
15	53rd IBWSN-1061	1500	36	53rd IBWSN-1018	1133
16	53rd IBWSN-1154	1400	37	53rd IBWSN-1222	1120
17	53rd IBWSN-1035	1450	38	53rd IBWSN-1193	1050
18	53rd IBWSN-1104	1450	39	53rd IBWSN-1138	1050
19	53rd IBWSN-1025	1400	40	53rd IBWSN-1155	1000
20	53rd IBWSN-1100	1390	41	53rd IBWSN-1009	900
21	53rd IBWSN-1021	1390			900

It was revealed from the Table-16 that the variety/strain 53rd IBWSN-1022 gave maximum grain yield 5333 kg/ha followed by strain 53rd IBWSN-1177 with 4333 kg/ha. However, the strain 53rd IBWSN-1009 showed grain yield 900 kg/ha. Seed of eighteen top yielding and disease tolerant with high agronomic score genotypes (1022, 1177, 1131, 1060, 1099, 1062, 1261, 1011, 1260, 1101, 1141, 1219, 1109, 1061, 1154, 1035, 1104) was reserved for incorporation in Preliminary Wheat Yield trial 2021-22.

1.6.8 HEAT YIELD TRIAL-90 (2020-21)

Heat Yield Trial-90 (Timely Planting) comprising ninety entries was laid out on 25-11-2020. Trial was laid out according to randomized complete block design with two replications. The plot size was kept 5m×0.6m. All the cultural practices were carried out as and when required. The trial was harvested on 26-05-2021. Grain yield data are presented in Table-17.

Table 17: Grain Yield Data of Heat Yield Trial-90 (2020-21).

Sr. No.	Variety /Strain	Grain Yield (kg//ha)	Sr. No.	Variety /Strain	Grain Yield (kg//ha)
1	HYT-90-178	3667	13	HYT-90-143	2067
2	HYT-90-142	3067	14	HYT-90-131	2040
3	HYT-90-49	3053	15	HYT-90-123	2000
4	HYT-90-148	2667	16	HYT-90-130	2000
5	HYT-90-154	2667	17	HYT-90-14	1753
6	HYT-90-61	2580	18	HYT-90-21	1533
7	HYT-90-78	2480	19	HYT-90-179	1467
8	HYT-90-76	2467	20	HYT-90-11	1367
9	HYT-90-113	2400	21	HYT-90-133	1200
10	HYT-90-127	2300	22	HYT-90-109	1033
11	HYT-90-93	2267	23	HYT-90-147	953
12	HYT-90-175	2167	24	HYT-90-22	867

It was evident from the Table-17 that strain HYT-90-178 gave maximum grain yield 3667 kg /ha followed by strain HYT-90-142 with grain yield 3067 kg /ha. However, the strain HYT-90-22 gave grain yield 867 kg /ha. Seed of six top yielding and disease tolerant with high agronomic score genotypes (HYT-90-178, HYT-90-142, HYT-90-49, HYT-90-148, HYT-90-154 & HYT-90-61) was reserved for incorporation in Preliminary Wheat Yield trial 2021-22.

2.0 PULSES

2.1.1 CHICKPEA:

2.1.1 Variety development:

A new high yielding, *Aschochyta* disease and terminal heat stress tolerant and bold seeded chickpea candidate variety in the name of **THAL-2020** was got approved for general cultivation from Punjab Seed Council on 28-01-2021.

Moreover, one chickpea candidate variety TG1305 was evolved. The spot examination was successfully conducted on 30-03-2021 and recommended by Experts Sub Committee in the 81th meeting held on 12-07-2021 for submission in the Punjab Seed Council for final approval.

2.1.2 Chickpea Hybridization Program

Eight crosses among desirable parents were attempted to develop high yielding, good quality, insect pest and disease tolerant varieties. Seeds from successful crosses were collected for generation enhancement and further evaluation. Parentage of successful crosses is given in Table-18.

Table 18 List of Crosses

Sr.No.	Crosses	Characteristics	Successful pods
Desi Chickpea Crosses			
1	TG1424 x Bittle-2016	Blight tolerant more pods / plant, high yielding x Early flowering, high yielding,	12
2	TG1410×TG1424	Blight resistant , early maturing x More pods / plant, bold seeded, high yielding	13
3	Bittle-2016 x Bhakkar-2011	High yielding x wilt resistant, early flowering, bold seeded	11
4	CH32/10 x TG1410	High yielding, Bold seeded x Blight tolerant, Bold seeded	09
5	NIAB-CH-2016 x Bhakkar-2011	Early flowering, more pods / plant, high yielding x wilt resistant, bold seeded	10
Kabuli Chickpea Crosses			
6	NCK 1801 x Noor-2013	More pods / plant, high yielding x early flowering, bold seeded	07
7	PCK 15019 x Noor-2019	High yielding ×Bold seeded, drought tolerant	10
8	Noor-2019 x Noor-2013	High yielding ×Bold seeded, High yielding	05

2.1.3 Evaluation of Filial Generations

Chickpea segregating generations viz, 6 F_1, 42 F_2, 278 F_3, 113F_4,102 F_5,30 F_6 and 26 F_7 populations were studied. 548 single plants/ progenies were selected from F_2 to F_6 populations for further evaluation. Fourteen uniform lines were selected from F_7 for further evaluation in preliminary yield trials.

Table 19 F_1 Generation

Sr. No	Crosses	Population
1	TG1415 x Bittle-2016	Bulk population
2	NIAB Channa-2016 x Bhakkar-2011	Bulk population
3	D-14005 x Thal-2006	Bulk population
4	CH32/10 x Bhakkar-2011	Bulk population
5	Noor-2009 x Noor-2013	Bulk population
6	TG1429 x TG1518	Bulk population

Table 20 F_2 Generation

Sr. No	Crosses	Single plant/ progenies planted	Single plant/ progenies selected
1	TG1415 x Bittle-16	15	10
2	TG1410 x TG1415	8	5
3	NIAB Channa x Bk-11	10	6
4	Thal-06 x D-14005	25	15
5	Bittle-16 x CH32/10	7	4
6	Noor--13 x K-14006	5	2
		Total	**42**

Table 21 F_3 Generation

Sr. No	Crosses	Single plant/ progenies planted	Single plant/ progenies selected
1	CH40/08 xCH39/09	41	55
2	CH28/07 x DCD	45	39
3	D-1008xCH49/09	56	70
4	K-01216 x K-01211	66	76
5	CH55/09 x TG12K07	70	60
		Total	**300**

Table 22 F_4 Generation

Sr. No	Crosses	Single plant /progenies planted	Single plant /progenies selected
1	K0902 x Noor-13	19	15
2	K09015 x CM1235/08	12	19
3	CH24/07 x CH104/06	8	10
4	Noor-2013 x TG12K07	7	5
5	D09027 x D-10008	11	13
6	CH39/08 Bhakkar-2011	10	15
7	CH104/06xBittle-2016	16	13
8	Noor-13x K09015	14	17
9	D09027 x D09013	11	9
10	K0039/10 x CH54/07	5	10
		Total	**126**

Table 23 F_5 Generations

Sr. No	Cross	Single plant /progenies sown	Single plants/progenies selected
1	FG0902 x K0065-09	11	12
2	K0039-09 x K0021-09	13	16
3	D096-09 x D072-09	21	9
4	D090-09 x Bhakkar-2011	15	13
5	Thal-2006 x Punjab-2008	5	3
6	K-004-10 x K012-10	7	6
7	K-005-10 x Noor-2009	10	8
8	Bhakkar-2011 x D-0097-10	6	7
9	08AG016 x D0075-10	9	9
10	Punjab-2008 x 1977	5	5
		Total	**88**

Table 24 F_6 Generation

Sr. No	Crosses	Single plants / progenies sown	Single plants/progenies selected
1	D098-09 × D084-09	6	5
2	01067 × CH20/02	4	3
3	Bhakkar-2011 × D084-09	5	5
4	K004-10 × Noor-91	2	3
5	Noor-91 × K0069-10	1	1
6	D084/09× D096-09	5	4
7	CH39/04 × CH87/02	3	5
8	Noor-91 × Noor-2009	4	2
		Total	**28**

Table 25 F_7 Generation

Sr. No	Crosses	Single plant /progenies sown	Single plants/lines selected
1	BKK02209× D094-09	2	1
2	K70008 × Noor-2009	3	2
3	Bhakkar2011× D094-09	5	2
4	Bhakkar-2011× D0097-10	3	1
5	Punjab-2008× BKK02209	1	1
6	K0069-10 × D0085-10	3	2
7	08AG016 × D0075-10	5	2
8	Bhakkar-2011 × Thal-2006	1	1
9	08AG004× D084-09	2	1
10	08AG004 × D0085-10	1	1

Total	**14**

2.1.4 Preliminary Yield Trials

2.1.4.1 Preliminary Yield Trial -Desi

The trial comprising twenty entries laid out in RCBD with three replications under irrigated and rainfed conditions. The sowing was done on 23-10-2020 in rainfed and 04-11-2020 in irrigated conditions, respectively. The plot size was maintained as 4 x 1.2m. The trial sown in rainfed conditions was harvested on 25-03-2021 whereas the trial sown in irrigated conditions was harvested on 08-04-2021.

Table 26 Yield data of preliminary yield trial –Desi

Sr. No.	Name of Entry	Yield (kg/ha)		Av. Yield (kg/ha)
		Irrigated	Rainfed	
1	TG2016	1958	618	1288
2	TG2005	1958	444	1201
3	TG2010	1889	458	1174
4	TG2012	1771	556	1164
5	TG2004	1729	531	1130
6	TG2015	1875	349	1112
7	TG2007	1854	313	1084
8	**Bhakkar-2011**	**1785**	**379**	**1082**
9	TG2003	1646	174	910
10	TG2002	1348	458	903
11	TG2014	1167	639	903
12	TG2006	1521	243	882
13	TG2008	1320	431	876
14	TG2009	1208	493	851
15	TG2001	1302	368	835
16	**Bittle-2016**	**1333**	**313**	**823**
17	TG2017	1010	632	821
18	TG2018	1083	351	717
19	TG2013	674	558	616
20	TG2011	792	427	610
	$LSD_{0.05}$	99.84	72.84	
	CV (%)	4.13	10.09	

It is observed from statistical analysis of yield data depicted in the above Table-2.4.2 that the differences among the means of entries are significant. Entry named as TG2016 gave the highest yield 1288 kg/ha, followed by TG2005and TG2010 with yield 1201kg/ha and 1174 kg/ha, respectively. The entry coded as TG2011gave the lowest yield of 610 kg/ha.

2.1.4.2 Preliminary Yield Trial-Kabuli

The trial comprising ten entries laid out in RCBD with three replications under irrigated and rainfed conditions. The sowing was done on 23-10-2020 in rainfed and 04-11-2020

in irrigated conditions. The plot size was maintained as 4 x 1.2m. The trial sown in rainfed conditions was harvested on 25-03-2021 whereas the trial sown in irrigated conditions was harvested on 08-04-2021.

Table 27 Yield data of preliminary yield trial-Kabuli

Sr. No.	Name of Entry	Yield (kg/ha)		Av. Yield (kg/ha)
		Irrigated	Rainfed	
1	TGK2002	1458	354	906
2	TGK2006	1368	396	882
3	TGK2008	719	740	730
4	TGK2003	1010	361	686
5	TGK2007	875	344	610
6	TGK2004	972	219	596
7	TGK2005	896	271	584
8	**Noor-2009**	**719**	**250**	**485**
9	TGK2001	500	424	462
10	**Noor-13**	**521**	**382**	**452**
	$LSD_{0.05}$	84.45	61.57	
	CV (%)	5.45	9.59	

It is observed from statistical analysis of yield data depicted in the above Table-2.4.4 that the differences among the means of entries are significant. Entry coded as TGK2002 gave the highest yield 906 kg/ha, followed by TGK2006 and TGK2008 with yield 882 and 730 kg/ha, respectively. The approved variety Noor-2013 gave the lowest yield of 452 kg/ha.

2.1.5.1 Regular Chickpea Yield Trial-Desi

Chickpea regular yield trial comprising twelve entries was laid out according to RCBD with three replications both under irrigated and rainfed conditions. The sowing was done on 23-10-2020 in rainfed and 04-11-2020 in irrigated conditions. The plot size was maintained as 4 x 1.2 m. The trial sown in rainfed conditions was harvested on 25-03-2021 whereas the trial sown in irrigated conditions was harvested on 08-04-2021.

Table 28 Yield data of regular chickpea yield trial-Desi

Sr. No.	Name of Entry	Yield (kg/ha)		Av. Yield (kg/ha)
		Irrigated	Rainfed	
1	TG1910	2000	549	1275
2	TG1901	1823	611	1217
3	TG1911	1833	479	1156
4	TG1903	2000	309	1155
5	TG1908	1778	452	1115
6	TG1912	1469	597	1033
7	**Bhakkar-2011**	**1563**	**465**	**1014**
8	TG1914	1618	240	929
9	TG1905	1320	521	921
10	**Bittle-2016**	**1458**	**328**	**893**

11	TG1904	1042	458	750
12	TG1902	1222	229	726
	LSD $_{0.05}$	166.25	61.70	
	CV (%)	6.16	8.35	

It is obvious from the Table 2.5.1 that the differences between the means of entries were significant. Entry TG1910 gave the highest yield 1275 kg/ha followed by TG1901 and TG1911 with yield 1217 and1156 kg/ha where as check varieties Bhakkar-2011and Bittle-2016 gave the yield 1014 and 893kg/ha, respectively. The TG1902 gave the lowest yield of 726 kg/ha.

2.1.5.2 Regular chickpea yield trial-Kabuli

Chickpea regular yield trial comprising ten entries was laid out according to RCBD with three replications under irrigated and rainfed conditions. The sowing was done on 23-10-2020 in rainfed and 04-11-2020 in irrigated conditions. The plot size was maintained as 4x 1.2 m. The trial sown in rainfed conditions was harvested on 25-03-2021 whereas the trial sown in irrigated conditions was harvested on 08-04-2021.

Table 29 Yield data of regular chickpea yield trial-Kabuli

Sr. No.	Name of Entry	Yield (kg/ha)		Av. Yield (kg/ha)
		Irrigated	Rainfed	
1	TGK1912	1385	715	1050
2	TGK1901	1347	354	851
3	TGK1914	1021	549	785
4	TGK1903	740	729	735
5	TGK1906	1021	382	702
6	**Noor-13**	**792**	**458**	**625**
7	TGK1913	458	445	452
8	TGK1904	604	250	427
9	TGK1910	413	323	368
10	**Noor-2009**	**302**	**264**	**283**
	LSD $_{0.05}$	118.24	62.51	
	CV (%)	8.53	8.15	

It is obvious from the Table 2.5.3 that the differences between the means of entries were significant. Entry coded as TGk1912 gave the highest yield 1050 kg/ha followed by TGk1901 and TGK1914 with yield 851 and785 kg/ha, respectively. The check variety Noor-2009 gave the lowest yield of 283 kg/ha.

2.1.6 Chickpea Micro Yield Trials

2.1.6.1 Chickpea Micro Yield Trial-Desi PRI- Faisalabad

Chickpea trial comprising sixteen coded entries was laid out according to RCBD with three replications under irrigated and rainfed conditions. The plot size was kept as 4 × 1.2m. The sowing was done on 23-10-2020 in rainfed and 04-11-2020 in irrigated conditions at Arid Zone Research Institute, Bhakkar. The trial sown in rainfed conditions was harvested on 25-03-2021 whereas the trial sown in irrigated conditions was harvested on 08-04-2021.

Table 30 Micro Yield Trial-Desi PRI- Faisalabad

Sr.#	Entry	PRI, Fsd	GBRSS, K.Kot	AZRI Bkr	RARI, B.Pur	K.Kot (Barani)	AZRI. Bkr (Barani)	Average (Kg/ha)
1	D-18004	4317	2583	1674	1389	2674	340	2163
2	D-18032	3569	2604	1910	1875	2479	424	2144
3	**TG-1427**	**3322**	**2778**	**1653**	**2014**	**2601**	**403**	**2128**
4	D-18036	3529	2465	1792	1389	2604	340	2020
5	BRC-446	3449	2292	1688	1424	2788	469	2018
6	D-18026	3354	2674	1563	1563	2500	271	1987
7	**Bittal-2016**	**3504**	**2299**	**1618**	**1181**	**2771**	**448**	**1970**
8	D-18007	3876	2292	1479	1528	2104	396	1946
9	TG-1424	3692	2104	1653	1146	2569	458	1937
10	BRC-474	3923	2188	1292	1201	2403	453	1910
11	D-18025	3344	2708	1549	1111	2257	309	1880
12	D-18020	3097	2500	1597	1701	2035	344	1879
13	D-18027	3643	2465	1146	1354	2153	319	1847
14	D-18008	2751	1896	1833	1285	2340	340	1741
15	D-18017	2892	2049	1156	1563	2142	493	1716
16	D-18009	2284	2153	1410	1389	2042	281	1593

It is evident from the Table --- that the differences among the means of yield value of entries were significant. Test entry TG1427 and TG1424 contributed by AZRI, Bhakkar gave grain yield 2128 and 1937 kg/ha, respectively. While the standard check Bittle-2016 gave 1970 kg/ha. The entry D-18004 gave the maximum average yield 2163 kg / ha followed by D-18032 with grain yield 2144kg/ha while lowest yield of 1593 kg/ha was given by advance line D-18009.

2.1.6.2 Chickpea Micro Yield Trial-Kabuli, PRI, Faisalabad

Chickpea trial comprising sixteen entries was laid out according to RCBD with three replications. The plot size was kept as 4 x 1.2m. The sowing was done on 23-10-2020 in rainfed and 04-11-2020 in irrigated conditions at Arid Zone Research Institute, Bhakkar. The trial sown in rainfed conditions was harvested on 25-03-2021 whereas the trial sown in irrigated conditions was harvested on 08-04-2021.

Table 31 Yield data of chickpea Micro yield trial-Kabuli

Sr. No	Entry	PRI, Fsd (N)	PRI, Fsd (Drought)	PRI, Fsd (Irrigated)	K. Kot (Barani)	K. Kot Irrigated	Bhakkar (Barani)	Bhakkar (Irrigated)	Chakwal	RARI Bahawalpur	Yield (kg /ha)
1	PCK-18006	1802	1463	1875	2611	2096	375	1042	1542	1493	1589
2	PCK-18028	1282	1407	1450	3118	2014	563	1410	1347	1458	1561
3	PCK-18005	1769	1322	1502	2458	2486	330	1083	1500	1493	1549
4	PCK-18022	1618	1439	1313	2455	2180	368	1500	1500	1493	1541
5	PCK-18023	1354	1050	1529	2298	2444	330	1667	1472	1535	1520
6	PCK-18007	1464	1199	1431	2191	2528	406	1500	1472	1250	1493
7	Noor 2019	1102	1315	1245	2753	1819	417	1361	1403	1701	1457
8	PCK-18025	1421	1169	1455	2257	2236	378	1250	1389	1354	1434
9	PCK-18004	1390	1205	1599	1917	2042	339	938	1500	1424	1373
10	PCK-18020	1038	1180	1120	2604	1917	285	1313	1542	1354	1372
11	TGK-1508	833	968	884	2347	2146	538	1229	1417	1771	1348
12	TGK-1504	958	1131	641	2437	2417	438	896	1458	1597	1330

It is evident from the Table 2.8.2 that the differences among the means of yield value of entries were significant. Entry coded as PCK-18006 gave the maximum yield 1589 kg/ha followed by PCK-18005 with yield 1549 kg/ha while lowest yield 1330 kg/ha was given by entry coded as TGK-1504.

2.2 Mungbean

2.2.1 Variety Development

A mungbean new high yielding, bold seeded, *Cercospora* leaf spot and heat tolerant candidate variety in the name of **AZRI MUNG 2021** was got approved as commercial variety for general cultivation from Provincial Seed Council on 28-01-2021.

One mungbean candidate variety **13TM14** was evolved and offered for spot examination. The spot examination was successfully conducted on 0-08-2020 by the experts. This candidate variety has been recommended by Expert Sub-Committee AARI/PSC in 81th meeting held on12-07-2021 to be submitted in the Punjab Seed Council for final approval.

2.2.2 Collection, Maintenance & Characterization of Mungbean Germplasm

One hundred and ten entries were characterized and maintained in Germplasm to select the desirable parents for Hybridization programme. The sowing was done on 14.5.2020 with plot size 4 x 0.6m. Data regarding agronomic parameters, diseases and yield were recorded.

Table 32 Characteristic of Mungbean Germplasm

Sr. No	Characters	Range
1	Days to 50% flowering	32-46
2	Plant height (cm)	38-68
3	Pod length (cm)	2.20-7.5
4	No. of Pods Plant^{-1}	24-45
5	Days to maturity	80-92
6	Seed yield (kg/ha)	425-2250

2.2.3 Hybridization

Hybridization was carried out to create the genetic variability to get the desirable recombinant by testing in filial generation. Eight crosses were attempted and seed from successful cross combatants were collected for further study in segregating generations. Mungbean segregating generation comprised 198 populations were studies in hot dry irrigated climate of Arid Zone. 155 single plant/ progenies were selected from F_3- F_6 population for generation enhancement on the basis of plant type, number of pods, pod length, 100 grain weight and disease incidence. Twelve uniform lines were selected from F_7 for assessing yield potential in preliminary yield Trials.

Table 33 Cross combinations

Sr. No	Cross combinations	Characteristics
1	TM-1627 x AZRI-Mung-2006	High yielding x Yellow mosaic resistant
2	AZRI-Mung-2006 x 13 TM-04	Yellow mosaic resistant x high yielding
3	TM-1418 x AZRI-Mung-2018	Bold seeded, early maturing x high yielding
4	TM-1706 x TM-1711	High yielding x bold seeded
5	AZRI Mung-2018 x NM-2016	High yielding, yellow mosaic resistant, x bold seeded
6	TM1627 x NM-2016	High yielding x bold seeded & high yielding
7	AZRI Mung-2018 x TM-1601	High yielding, heat tolerant x bold seeded & high yielding
8	NM-11 x 13TM-04	Bold seeded, high yielding, x Yellow mosaic resistant

3.0 PLANT PROTECTION
3.1 ENTOMOLOGY

3.1.1 IPM STUDIES OF GRAM POD BORER AT BHAKKAR

Experiment was conducted at Arid Zone Research Institute, Bhakkar with plot size of 20 x 100 m. Light traps were installed @ 3/ hectare. Pheromone traps installed @ 6/acre and the data was recorded on daily basis. Pheromone lures were changed at fortnightly intervals. Adult moths of pod borer and other insects collected from traps were counted on daily basis. Larval population was recorded at pre flowering till pod formation stage on fortnightly basis. Yield and pod infestation data was also recorded at maturity.

Table. No. 34 Response of differnet IPM components on Gram Pod Borer & Yield

IPM Components	Damage (%)			Larva/ Plant	Grain Yield (kg/ha)	Yield increase over control (%)
	Foliage	Pod	Grains			
T_1= Light Traps	2.58a	0.88a	0.41a	0.31a	765 a	42.54
T_2= Pheromone Traps	4.87bc	2.16b	3.00b	0.79bc	670 ab	32.84
T_3= Manual collection and killing	3.14ab	3.59b	3.89b	0.71b	523 b	10.84
T_4= Control	6.48d	7.45 d	6.36c	1.21c	426 c	

Results proved the light trap technique the most effective among other IPM techniques with minimum damage to foliage, pods and grains i.e 2.58, 0.88 and 3.00 %, respectively. This trend of minimum damage was because of low larval population (0.31/plant) and ultimately it gave maximum grain yield of 765 kg/ha which surpassed 42.54 % yield over control followed by pheromone traps and Handpicking. However these were better than control. Control treatment was not satisfactory as it had maximum foliage damage 6.48 %, pod damage 7.45 % grain damage 6.36 % and larval population 1.21/plant.

3.1.2 INTEGRATED PEST MANAGEMENT OF WHEAT APHID

The trial was conducted at Arid Zone Research Institute, Bhakkar with plot size of 30 x 100 m. Power sprayer was used to spray water at tillering and heading stage as well as the rope dragging. Neem extract was applied at borders when 1st generation comes to lay their young ones. Intercropping of canola –wheat was sown to develop a predator bank of lady bird beetle for biological control of aphids.

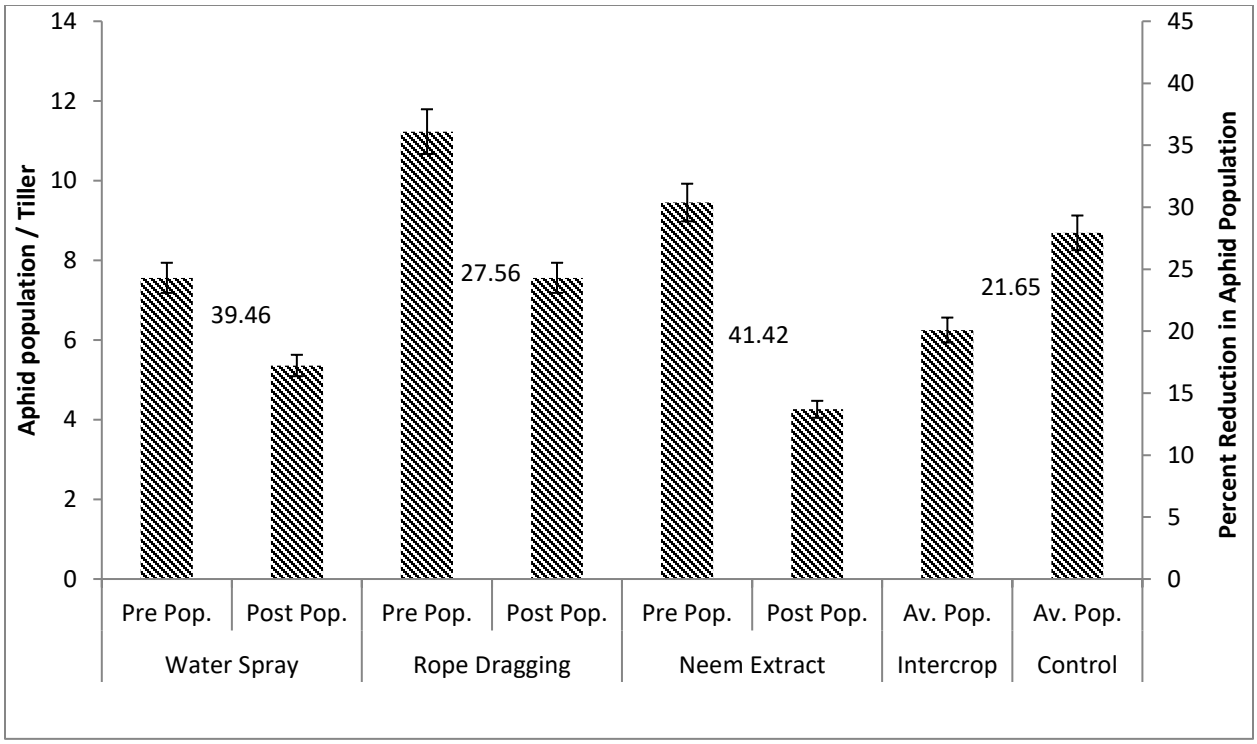

Figure 1 Response of different treatments on Aphid / filler Population

Results revealed that spray of Neem extract significantly reduced aphid population 41.42 % followed by water spray, rope dragging and intercropping with 39.46, 27.56, 21.65 % population reduction respectively.

3.1.3 SCREENING OF ADVANCE LINES OF GRAM AGAINST POD BORER

The trial was conducted at Arid Zone Research Institute, Bhakkar under augmented design with plot size 4 m x 1.2 m. *Helicoverpa* eggs and larvae were counted per 6 inches terminal shoot from 5 plants/plot on weekly basis from the time of pre flowering to pod formation stage.

COMPARATIVELY RESISTANT LINES (Pod Borer Population less than 0.5/plant)	SUSCEPTIBLE LINES (Pod Borer Population 0.5-1.0/plant)	HIGHLY SUSCEPTIBLE LINES (Pod Borer Population 1.0-2.0/plant)
TG-1704	TG-1712	TG-1702
TG-1806	TG-1713	TG-1710
TG-1820	TG-1703	TG-1708
TG-1815	TG-1715	TG-1817
	TG-1718	TG-1818
	TG-1714	TG-1825
	TG-1707	TG-1812
	TG-1618	TG-1805

	TG-1617	TG-1802
	TG-1613	TG-1813
	TG-1623	TG-1814
	TG-1717	TG-1801
	TG-1711	TG-1622
		TG-1621

Results showed that advance lines TG-1704, TG-1806, TG-1820, TG-1815 found relatively resistant against pod borer due pods more intact on TG-1806, TG-1820 and early pod bearing of TG-1704 and TG-1815.

3.1.4. Role of Light Traps in Attracting, Killing and Biodiversity Studies of Insect Pests in Thal

Three light traps were installed at research area of the institute. The moth counts /light trap were maintained on daily.

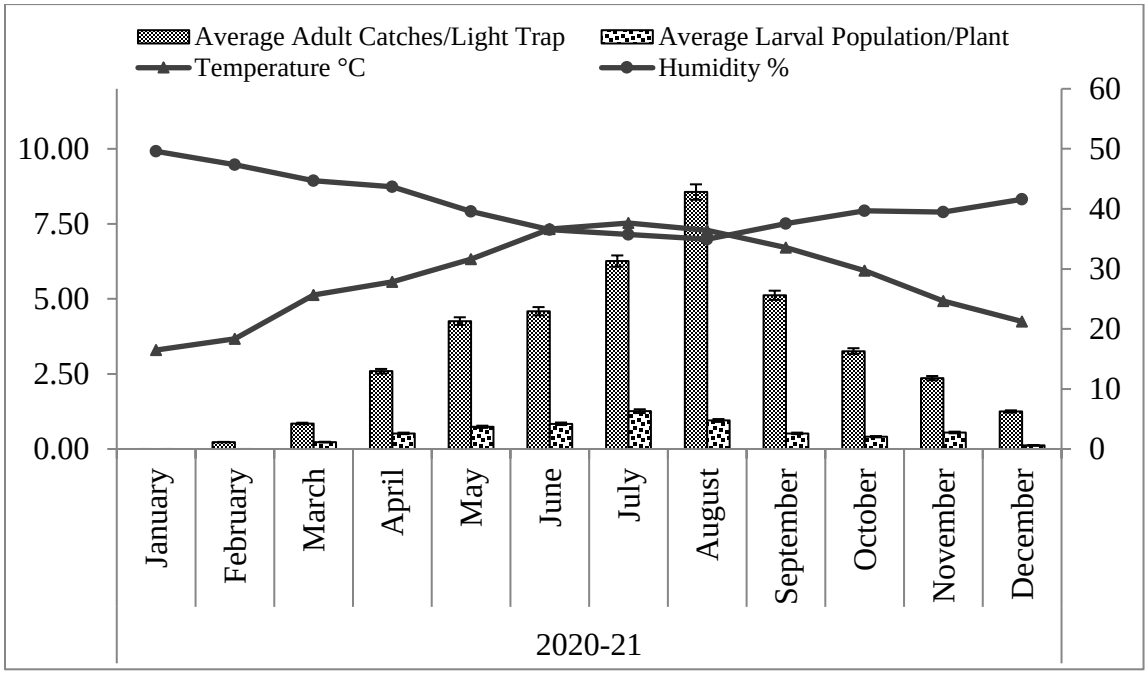

Figure 2: Population trends of moth catches in light traps

The very objective of the study was to attract and kill adult population of pod borer on gram. There was a positive and significant correlation of temperature on adult moth catch while it was found significant correlation with adult catch and larval population in the field as shown in figure. By increasing the adult catches of light traps, thereby decreased the larval population on chickpea.

3.1.5 SCREENING OF ADVANCE LINES OF MUNGBEAN AGAINST THRIPS

The trial was conducted following RCBD with three repeats with plot size of 4 m x 1.2 m. Thrips population was recorded at weekly intervals from 6 cm length of 5 flowering shoots with each taken from 5 random plants/plot. The pest population was compared statistically.

Table No. 36 Response of different advance lines on Thrips Population

S. No	Advance Lines	Average Thrips Population/plant at weekly intervals							Average Pop./ season
		7-Jun-20	15-Jun-20	23-Jun-20	1-Jul-20	9-Jul-20	17-Jul-20	25-Jul-20	
1	**TM 1601**	0.78	1.69	0.30	1.27	0.15	0.65	0.31	**0.74**
2	**TM 1615**	0.52	1.30	1.25	0.88	1.25	0.41	0.14	**0.82**
3	**TM 1607**	0.00	1.00	0.94	1.26	1.69	1.25	0.00	0.88
4	**TM 1611**	0.25	0.28	1.26	0.95	1.26	0.68	0.23	**0.70**
5	**TM 1605**	0.67	0.64	0.28	1.26	1.25	1.95	1.15	1.03
6	**TM 1608**	0.29	1.26	0.25	1.36	0.96	2.45	0.95	1.07
7	**TM-1511**	0.29	0.68	1.26	2.14	2.85	0.89	0.25	1.19
8	**TM 1418**	0.26	0.54	0.64	0.58	3.36	1.95	0.43	1.11
9	**TM 1627**	0.95	1.35	0.67	3.25	1.26	3.68	0.36	1.65
10	**TM-1609**	0.54	1.27	1.27	1.29	0.89	1.58	2.69	1.36
11	**TM 1616**	0.95	0.94	1.36	0.98	2.15	1.29	3.18	1.55
12	**TM 1501**	0.64	0.64	2.26	3.36	3.67	3.25	0.64	2.07
13	**TM-1513**	1.26	1.64	3.29	1.95	1.26	4.95	0.36	2.10
14	**TM-1508**	2.64	1.26	1.29	2.64	3.22	3.69	0.48	2.17
15	**TM 1602**	0.58	0.64	0.94	1.26	3.69	1.26	0.73	1.30
Temperature °C		37.3	38.5	39.3	40.3	40.6	39.3	39.3	
Humidity %		46.3	49.3	41.3	45.4	45.4	36.3	30.3	

Results shows that advance lines TM-1601, TM-1615 and TM-1611 found comparatively resistant due to early flower bearing and escaped the pest attack. While rest of the lines were highly susceptible with population more than 5-6/flower. Temperature had highly significant and positive correlation with thrips population while humidity had negative and non-significant correlation.

3.1.6 INFESTATION LEVELS OF ESPINOLA BUG ON MUNGBEAN PLANTING AT DIFFERENT TIME

Espinola Bug is major sucking pest mungbean pods. AZRI Mung-2018 was planted at 15 days intervals. Thrips was kept under control during the crop season. Espinola bug population was recorded from 15 random plants at fortnightly intervals from each sowing date, starting from flowering till maturity. The population recorded was correlated and meteorological factors as well.

Table No. 37 Effect of different sowing dates on Espinola Bug Populations

Sowing Dates		Average Espinola Bug Population/plant						Average Pop./ season	Yield kg/acre
		15-Jun-20	30-Jun-20	14-Jul-20	28-Jul-20	11-Aug-20	25-Aug-20		
SD 1	5-May-20	0.00	0.00	0.63	0.57	1.23	0.52	0.49	463.00
SD 2	15-May-20	0.00	0.00	0.56	3.59	2.36	0.41	1.15	423.00
SD 3	25-May-20	0.00	0.00	0.00	3.65	4.59	2.58	1.80	298.00
SD 4	4-Jun-20	0.00	0.00	0.00	5.69	3.47	0.98	1.69	150.00
SD 5	14-Jun-20	0.00	0.00	0.00	0.26	0.95	1.26	0.41	102.00

SD 6	24-Jun-20	0.00	0.00	0.02	0.56	0.75	2.69	0.67	43.00
SD 7	4-Jul-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.00
Temperature °C		40.36	40.95	41.68	42.26	42.07	39.64		
Humidity %		28.15	30.69	29.65	35.65	37.15	40.26		

Results showed the sowing dates 05 and 15 May exhibited least infestation of Espinola bug. The data indicated that mungbean sowing must be completed upto 05-May to ensure good crop yield. While sowing dates 25 May and 04 June resulted in higher infestation of the pest and decreased yield. However sowing dates 14 June, 24 June and 04 July were intermediate with attack of Espinola bug with low yield. Temperature and humidity had positive and non significant effect on pest dwellers.

4.0 Development Projects
4.1 PARB PROJECT NO. 913

PARB Project No. 913 titled Enhancement of Mungbean &Gram Production in Thal through Development of Improved Genotypes and Technologies to Reduce Pulses Import Bill

4.1.1: Screening of local germplasm for identification of new source of resistance against drought and disease

215 chickpea genotypes (Desi=125 & Kabuli=90) were laid out in simple augmented design with 02 rows of each entry having plot size 4m x 0.6m during Rabi 2020-21. The objective of the experiment was to identify source of resistance cum tolerance, terminal heat stress and diseases (*Ascochyta* blight, *Fusarium* wilt, root rot). Data regarding plant population, days taken to 50% flowering, numbers of pods per plant, plant height, days to maturity were recorded. Agronomic scoring was also done to determine the pre harvest field performance of different genotypes. The same set of genotypes /entries were also laid out in tunnel to identify source of resistance / tolerance against *Ascochyta* blight under controlled conditions. On the basis of disease resistance and better agronomic scoring, 40 lines were selected for further evaluation.
155 mungbean genotypes were sown in simple augmented design with 02 rows of each entry having plot size 4m x 0.6m on 27-05-2021. Data on germination %age, days to 50% flowering, days to maturity, plant stand and disease resistance against 3 major diseases mainly *cercospora* leaf spot, yellow mosaic virus and urdbean crinkle virus were recorded. On the basis of disease resistance and better agronomic scoring, 20 lines were selected for further evaluation.

4.1.2 : Hybridization Program and evaluation of desirable recombinants from different filial generations

08 new chickpea cross combinations among selected parents were attempted to create genetic variability to develop new recombinants with desirable attributes. Crossing block was laid out in two sowing dates for maximum synchronization with plot size 12m x 0.6m. F_0 seed from successful crosses were collected for generation enhancement and further evaluation. Population were bulked from F_1 and F_2. 550 single plant / progenies from F_3 to F_6 were selected for further evaluation. 30 uniform lines were selected from F_7 for further evaluation in replicated trial during next year.
08 crosses of promising parent were attempted to create genetic variability to develop new recombinants with desirable attributes. Seed of 06 out of 08 crosses has been picked whereas two did not produce any seed. F_0 seed from successful crosses were collected for generation enhancement and further evaluation. 135 single plants / progenies were selected from F_2 to F_6 populations for further evaluation. 15 uniform lines were selected from F_7 for further evaluation in preliminary yield trial.

4.1.3: Field evaluation of advance material against prevailing insect pest and diseases in dry land conditions of Thal

50 gram genotypes (30 Desi & 20 Kabuli) selected from previous 200 genotypes of germplasm were laid out in natural field condition and as well as in tunnel to screen these lines against

Ascochyta blight and *Fusarium* wilt. The sowing was done in simple design with plot size of 4m x 1.2m. Disease and agronomic scoring was done. Disease conditions in tunnel were developed according to scientific protocol. Genotypes which showed resistance against blight were selected for further evaluation in replicated yield trials. 16 genotypes viz., TG1428, TG1420, TG1616, TG1714, TG1708, TGK1914, PARB913/CHK03, PARB913/CHK04, PARB913/CH05, PARB913/CH06, PARB913/CH07, PARB913/CH08, PARB913/CH09, PARB913/CH010, PARB913/CH11 and PARB913/CH12 showed resistance against *Ascochyta* blight and *Fusarium* wilt and selected for further evaluation in multi-location replicated trials.
32 mungbean advance lines selected from previous year screening work were sown on 28-05-2021 for disease screening. Plot size was maintained as 4x 1.2m. Disease data against 3 major diseases mainly *cercospora* leaf spot, yellow mosaic virus and urdbean crinkle virus were recorded. Data regarding plant population, days to 50% flowering, numbers of pods per plant, plant height, days to maturity were also recorded.16 genotypes viz, TM1806, TM1810, 13TM14, TM1812, PARB-Mung01, PARB-Mung02, PARB-Mung03, PARB-Mung04, PARB-Mung05, PARB-Mung06, PARB-Mung07, PARB-Mung08, PARB-Mung09, PARB-Mung10, PARB-Mung11 and PARB-Mung12 were selected for further evaluation in adaptation yield trial.

4.1.4 : Adaptation yield trial

11 genotypes / entries were laid out at five different locations of Thal Zone viz., AZRI, Bhakkar, Mankera, Choubara (Nawan Kot), Kallurkot, Karor and Noor Pur in randomized complete block design (RCBD) with three replications for their wider adaptability studies alongwith yield performance, disease, drought and terminal heat response. Plot size was maintained as 4m x 1.2m. Data regarding plant population, days taken to 50% flowering, numbers of pods per plant, plant height, days to maturity were recorded. Agronomic scoring was also done to determine the pre harvest field performance of different genotypes. Entry TG 1410 gave the highest yield 1770 kg/ha, followed by TGK1508 and TG1424 with yield 1390 and 1266 kg/ha, respectively. The check varieties Bittle-2016 and Bhakkar-2011 gave the yield 1350 and 1229 kg/ha, respectively.
20 genotypes selected from disease screening nursery alongwith three check varieties namely NM-2021,Abbas Mung, AZRI Mung-2021 were sown at four different locations viz., AZRI, Bhakkar, GBRSS Kallurkot, 49/TDA and Chak 53 TDA for adaptability testing. Entries coded as PARB Mung-I gave highest average yield 1222kg/ha. The check variety AZRI-Mung-2021 and NM-2021 gave the yield of 965 and 885 kg/ha, respectively.

4.1.5 : Determination of suitable planting time in chickpea

A sowing date trial comprising five sowing was laid out in randomized complete block design (RCBD) with two replications. The plot size was maintained as 12m x 1.2m. The purpose of the experiment was to determine optimum sowing date for better quality and yield. All agronomic practices were carried out in all sowing dates. The 2nd sowing date 22-10-2020 gave the maximum yield of 1750kg/ha followed by the sowing date 6th November-2020 with the average yield of 1655kg/ha.

4.1.6 : Evaluation of fertilizer requirement

Four gram genotypes viz., TG1305, TG1424, TG1410 and Bhakkar-2011 were evaluated for their irrigation and fertilizer requirements in RCBD with split split plot arrangement. Genotypes were maintained in Sub sub plot as 7m x1.2m and fertilizer in sub plot with irrigation in main plot. The purpose of the experiment was to determine the optimum moisture and fertilizer requirements for different gram genotypes. It was concluded that genotypes behave better at two irrigation level.

4.1.7 : Production of BNS and Pre-Basic Seed for Dissemination to Seed Production Agencies and Progressive Farmers

1000 single plant progenies 500 each of Thal-2020 and Bhakkr-2011 commercial varieties were sown in experimental area of AZRI Bhakkar for production of Breeder Nucleus Seed (BNS).
100 family blocks, 50 each of Thal-2020 and Bhakkr-2011 were also maintained in experimental area of AZRI Bhakkar for production of Breeder Nucleus Seed (BNS). Observations for uniform lines / progenies will be carried out through growing season. Off type plants / progenies will be rejected.10 acre of both varieties were planted for production of pre-basic seed under irrigated conditions to achieve the seed production target of the project. Rogueing of off type plants from seed multiplication block will be carried out to ensure the harvest of uniform and true to type genotypes.
Detail of variety wise Gram BNS and Pre-basic seed is as under:-
Bhakkar-2011 BNS=150kg
Thal-2020 BNS=50kg
Bhakkar-2011 Pre-Basic=1550kg
Thal-2020 Pre-Basic=3550kg

500 single plant progenies 250 each of AZRI-Mung-2021 and AZRI-Mung-2018 commercial varieties were sown on 25-05-2021 in experimental area of AZRI Bhakkar for production of Breeder Nucleus Seed (BNS). 120 family blocks, 60 each of AZRI-Mung-2021 and AZRI-Mung-2018 were also planted on 23-05-2021 in experimental area of AZRI Bhakkar for production of Breeder Nucleus Seed (BNS). Observations for uniform lines / progenies were carried out throughout growing season. Off type plants / progenies were rejected.08 acre of three varieties were planted for production of pre-basic seed under irrigated conditions to achieve the seed production target of the project. Rogueing of off type plants from seed multiplication block was carried out to ensure the harvest of uniform and true to type seed production
Detail of variety wise Mungbean BNS and Pre-basic seed is as under:-
AZRI-Mung-2021 BNS=50kg
AZRI-Mung-2018 BNS=50kg
AZRI-Mung-2021 Pre-Basic=885kg
AZRI-Mung-2018 Pre-Basic=950kg

4.1.8 : Capacity Building

A farmers field day entitled "**Integrated Pest Management for Food Security**" was conducted at Arid Zone Research Institute, Bhakkar on 11-11-2020. Farmers participated in the

program. The main theme of the training workshop was to highlight the IPM package for chickpea in light of current food security and nutrition related challenges in the country. This training workshop would speed up the benefits of this promising technology that is eco-friendly, cost-effective and income augmenting. Farming community was glad at this moment. They expressed that this training workshop was successfully organized with aspects like integrated pest management (IPM) and modern production technology. It was great thrust of the area for chickpea productivity enhancement on sustainable basis. In all, more than 100 farmers and other stakeholders attended the training workshop.

A farmers field day entitled "IPM and mechanical harvesting of mungbean crop in Thal" was conducted at Farmer field Chak No. 184/TDA, Bhakkar on 27-08-2021. Farmers actively participated in the program. The main theme of the training workshop was to highlight the IPM package for mungbean in light of current food security and nutrition related challenges in the country. This training workshop would speed up the benefits of this promising technology that is eco-friendly, cost-effective and income augmenting. Mechanical harvesting through combine harvester- a cost effective technological new intervention was introduced and promoted in Thal area to address the labor-shortage issues and to mitigate the weather hazards by timely completion of harvesting and threshing processes Farming community was glad at this moment. They expressed that this training workshop was successfully organized with aspects like integrated pest management (IPM) and mechanized harvesting. It was great thrust of the area for mungbean productivity enhancement on sustainable basis. In all, more than 100 farmers and other stakeholders attended the training workshop. Brochures were also distributed among farmers.

4.2 ACIAR Pulse Project

Increasing productivity and profitability of pulse production in cereal based cropping system in Pakistan (CIM/2015/41)

4.2.1 Demonstration Plot with Improved Production Practices

65 (Chickpea=50 & Lentil=15) Demonstration plots of 01 acre each were laid out at farmer's field with improved production practices like use of certified seed of new approved varieties, *rhizobium* inoculation for nodulation, better growth, yield and yield components and pre-emergence weedicides for effective control of weeds. Insecticides like Emmamectin benzoate and Lambda cyhalothrin @ 620 ml/ha were sprayed at maturity to control pod borer.

Table No. 38 Chickpea and Lentil Seed Multiplication with GCRs Growers

Chickpea	Area planted	50 Acres
	Variety multiplied	Bittle-2016, Bhakkar-2011, NIAB Channa-2016
	Yield (kg/ha)	1100-1790 (Irrigated)
	Seed retained by farmers for next season	30 Tones
Lentil	Area planted	15 Acres
	Variety multiplied	Punjab-Masoor-2009
	Yield (kg/ha)	880-1650
	Seed retained by farmers for next season	08 Tone

4.2.2 COMPARATIVE STUDY OF WEEDING TECHNIQUES ON YIELD AND YIELD COMPONENTS OF CHICKPEA

1. **Objective of the trial:**
   The experimental field was conducted to evaluate and demonstrate effective use of pre-emergence herbicides on weed control, yield components, yield, and their economic feasibility for cost effective weed control in chickpea.
2. **Methodology**:
   A trial was conducted at Rakh Mankera (Site-3) to control broad and narrow leaved weeds using pre emergence herbicide (stomp). Earlier no herbicide was being used in this area for weeds management. Therefore, the purpose of this demonstration trial was to create awareness among farming community about effective use of pre-emergence herbicide to enhance their productivity and profitability by minimizing input cost. This trial will be used to make comparison among effective use of herbicide, manual weeding and with no weeding (as a control). The pre emergence treatment was applied immediately at the time of sowing.

   Location and farmer name

   Mr. Habib Ullah Mureed Ahmd Saneeka, Rakh Mankera (Site-3)

a. Trial layout design:

No. of treatments = 04
Treatment No. 01 = Hand weeding after 30 days and 60 days of sowing.
Treatment No. 02 = Application of pre emergence weedicide (Stomp)
Treatment No. 3 = Application of pre emergence weedicide (Stomp) with one time weeding after 60days.
Treatment No. 04 = Control

Design	=	RCBD
Number of Replication	=	3
Number of Rows Per Plot	=	4
Row Length	=	4 m
Row Spacing	=	30 cm
Plot Size	=	4 x 1.2m
Fertilizer Application (DAP)	=	50kg/Acre
Sowing Date	=	15-11-2020
Date of harvesting	=	03-04-2021

b. Parameter for Data recording

To be assessed for crop safety and weed control (using weed counts, % cover of each weed species, % overall plot cover of all weeds) at four times as below
2 weeks after planting
4 weeks after treatment application
8 weeks after treatment application
12 weeks after treatment application
16 weeks after treatment application

3. Results:

Table-39: Total number of weeds and their dry weight in meter per square of area

	Weed count per m^2(DAE*)						**Weed dry weight(g) per m^2 (DAE)**					
Treatment	30	60	90	120	150	Harvest	30	60	90	120	150	Harvest
Pre emergence weedicide (Stomp) with manual weeding	6	9	4	4	3	2	45	82	42	40	35	25
Manual weeding	11	17	5	4	3	4	125	160	55	50	35	32
Pre emergence weedicide	5	10	14	15	18	22	49	108	120	140	175	195
Control	20	28	34	40	44	49	200	290	300	410	450	505

*DAE = Days after emergence

Table-40: Effect of different weeding techniques on yield and yield component of chickpea

Treatment	DFLR	Plant height (cm)	Branches per plant	Pods per plant	Grain yield kg/ha
Pre emergence weedicide (Stomp) with manual weeding	90	70	18	75	1330
Manual weeding	92	65	16	68	1220
Pre emergence weedicide (Stomp)	94	50	12	60	1090
Control	97	55	8	40	680

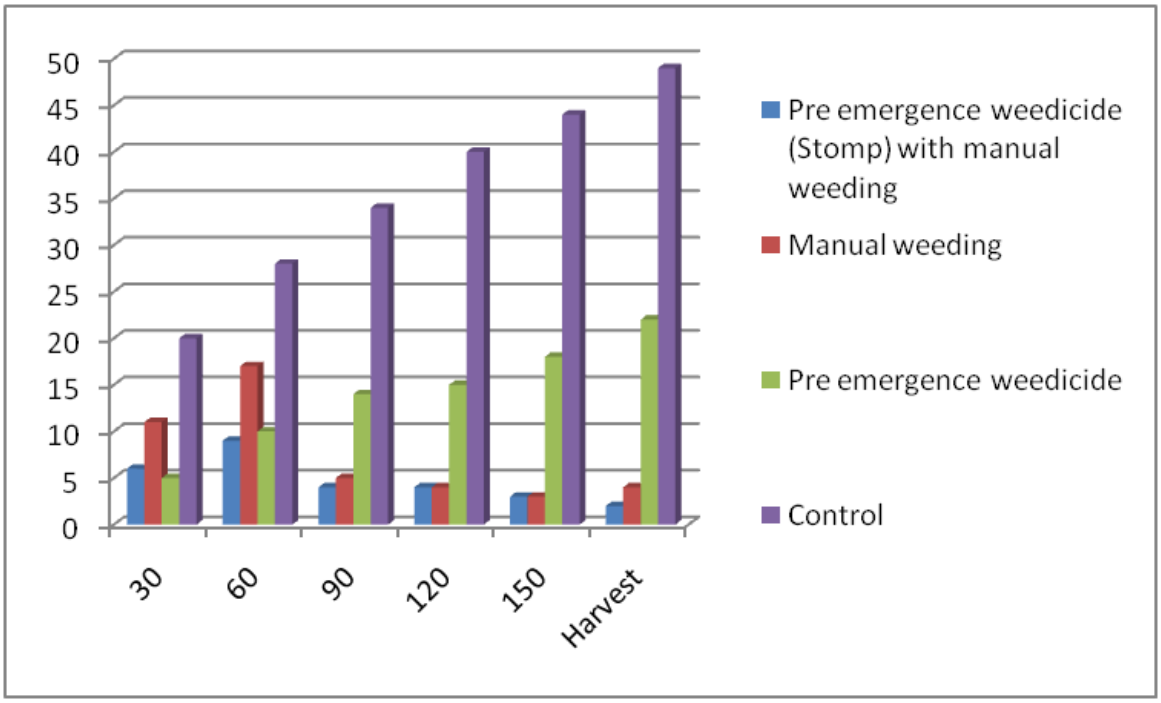

Figure-3: Total Number of weeds count in per meter square of area in different interval of time

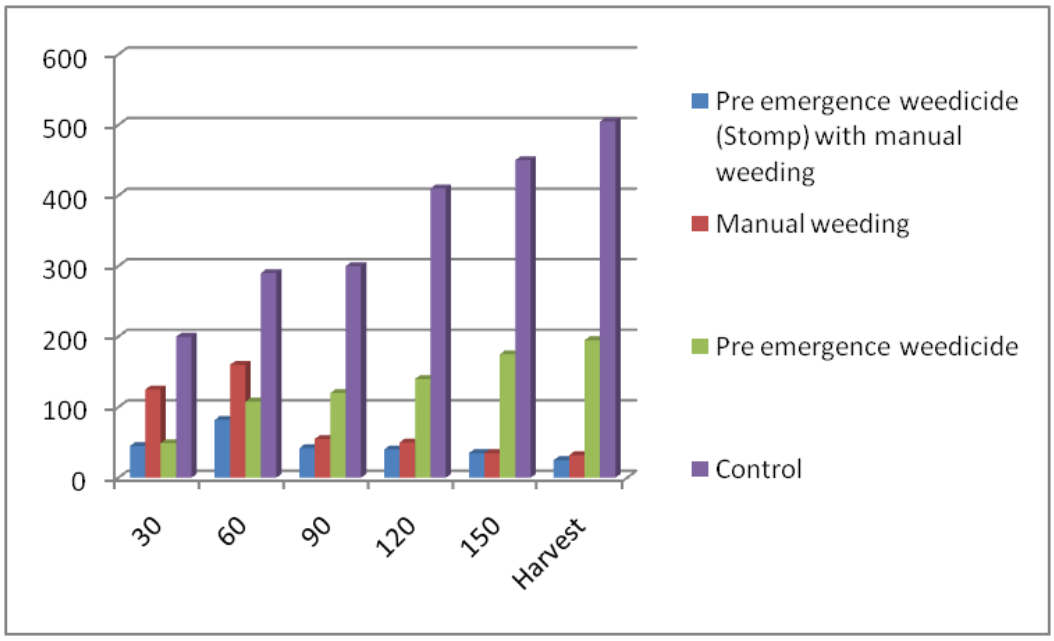

Figure-4: weeds dry weight collected in per square meter of area

Interpretation of Result:

This field study was conducted on the farmer field at Rakh Mankera to evaluate the application of pre-emergence in comparison with manual eradication of weeds, a traditional practice and to examine the effects of herbicide on days to flowering, plant height, number of pods per plant, grain yield and total biomass. This trial will help farmer to select those interventions which will be convincible to him for increasing profitability by reducing input cost. Chickpea grain yield was significantly influenced by the site, weed management practices and their interaction. The highest grain yield (1330kg/ha) was obtained from plot where pre-emergence weedicide was applied with manual weeding after 60days of sowing was carried out followed by manual weeding(1220kg/ha) and pre emergence herbicide treated plot (1090kg/ha). Minimum grain yield was recorded in check plot (680kg/ha) respectively.

Weed Density:

The weed density after 30days of interval after spray was analyzed (Table-1) revealed that use of pre emergence herbicide treatment controlled weed density significantly as compared to weedy check where no treatment was used. However, minimum weeds infestation was recorded where pre-emergence herbicide was applied with manual hoeing after 60 days of sowing was done. Maximum weed density was found in weedy check due to unchecked weed growth as no weed control practices were applied.

Observations/comments of farmer about trial/intervention

The farmers were not aware about application of pre-emergence herbicides before this experiment. The experiment provided them a great opportunity about pre-emergence application for effective weeds control.

Conclusion

The early emergence and fast growth of weeds lead to severe crop-weed competition for light, moisture, nutrients and space, which culminates in heavy reduction in growth and yield of chickpea and lessens the profitability. About 48% reduction in yield of chickpea due to severe infestation of weeds was estimated in this experiment. If proper control measures are not taken, then the loss in terms of yield may increase up to 75 per cent in chickpea. The initial 60 days period considered to critical for weed crop competition in chickpea but continuously facing of the scarcity of labour and increase in labour cost, manual weed control has become a difficult task. Suitable herbicide for effective control of weeds is required for better adoption in chickpea. Introduction of herbicides has made it possible to control a wide spectrum of weeds in pulses effectively at a remunerative cost. However, later flushes of weeds can only be control manually. So application of pre-emergence herbicides alone cannot gave better results. However, pre-emergence use in combination with one time manual weeding can provide effective weed control in chickpea with less input cost.

4.2.3 EFFICACY OF DIFFERENT INSECTICIDES TO CONTROL GRAM POD BORER

Objective of the trial:

Pod borer, *Helicoverpa armigera* (Hubner) is the major pest and has great economic impact (Ahmed and Awan, 2013). Environmental conditions during the late vegetative and reproductive growth period (February to Mid-March) are particularly conducive to pod borer development. Grain yield losses due to *H. armigera* are reported upto 37-50% and in severe cases up to 90% (Lal, 1996; Sarwar *et al*., 2009). Its infestation starts on chickpea usually a fortnight after germination and becomes serious just after the initiation of flower bud coupled with cloudy and humid weather. The low yield of chickpea is attributed to the regular outbreaks of pod borer. Its attack is a great threat to livelihood of farmers and food security for Pakistan. Therefore, the present investigation was designed to find out the most effective insecticide for the effective control of pod borer.

Methodology:

An experiment was conducted involving three insecticides (Table-41) to investigate their effects on gram pod borer during Rabi season at farmer field Rakh Mankera. Chickpea variety Bhakkr-2011 was used as test genotypes. Similar agronomic practices were applied to all treatment from sowing to harvesting. First spray was applied on pod formation stage on 1st March-2021 and 2nd spray was applied after 15 days of 1st spray on 16th March-2021. Observations from five guarded plants were recorded from each plot 24 hr before spray and after 3,7 and 14 days of first and second spray. All the insecticides were sprayed 24 hr after recording the observations followed by the second application after 15 days of the first spray.

Location and farmer name

Qasim Mehmood Bhatti, Rakh Mankera Site -3

Trial layout design:

No. of treatments = 04
Treatment No. 01 = Emamectin benzoate 1.9 EC
Treatment No. 02 = Bifenthrine 10% EC
Treatment No. 03 = Lambda cyhalothrine 2.5 EC
Treatment No. 04 = Control

Design = RCBD
Number of Replication = 3
Number of Rows Per Plot = 6
Row Length = 4 m
Row Spacing = 30 cm
Plot Size = 4 x 1.2m
Fertilizer Application (DAP) =50kg/Acre
Sowing Date = 25-11-2020
Date of harvesting = 06-04-2021

Table No. 41 EFFICACY OF DIFFERENT INSECTICIDES TO CONTROL GRAM POD BORER

Sr. No	Name of Insecticide	Dose/ha (ml)	Group
1	Emamectin benzoate 1.9 EC	500	Avermectin
2	Bifenthrine 10% EC	500	Pyrethroid
3	Lambda cyhalothrine 2.5 EC	620	Pyrethroid
4	Control (No spray)	-	-

4. Results:

Table-42: Response of different chemicals against gram pod borer

Sr. No.	Treatments	Damaged Pods/500pods	Damaged %age	Yield (kg/ha)
1	Emamentin benzoate	18	3.6	1610
2	Bifenthrine	22.60	4.5	1450
3	Lambda cyhalothrine	26.20	5.24	1320
4	Control	130	26	980

Interpretation of Result:

This field study was conducted on farmer field at Rakh Mankera site-3 to evaluate the efficiency of different insecticide against pod borer. This trial will help farmer to select those interventions which will be convincible to him for increasing profitability by reducing input cost. Chickpea grain yield was significantly influenced by attack of pod borer. The highest grain yield (1610kg/ha) was obtained from plot where Ememectin Benzoate was applied followed by Bifenthrin (1450kg/ha) and Lambdacyhalothrin sparyed plot (1320kg/ha). Minimum grain yield was recorded in check plot (980kg/ha)

a. observations/comments of farmer about trial/intervention

The farmers were quite unaware about chemical control of pod borer before this experiment. The experiment provided them a great opportunity to farming community about application of suitable insecticide against pod borer to enhance their profitability and profitability.

b. Conclusion

In the present investigation it was observed, pod borer is a notorious pest of chickpea causing heavy damage to the crop. Yield loss due to pod borer is estimated at 39 per cent in this experiment. From the results it is concluded that Emamectin Benzoate is a safe and best insecticide for the effective control of pod borer.

4.2.4 Capacity building

Capacity building for use all the intervention introduced in the project including use of inoculum, pre-emergence, insect pest and disease management, crop harvesting and threshing, seed cleaning, grading and storage and technical assistance for seed multiplication were conveyed to farmers during individual, group meeting and farmers training program.

Table No. 43: Pre Sowing Farmers Day

Theme of the farmers day	Demonstration of New Interventions In Chickpea a Lentil Crops to Enhance Productivity and Profitability at Farm Level
Date	26-10-2021
Venue	Arid Zone Research Institute, Bhakkar.
No. of participants	105

4.3 PSDP Pulses Project "Promoting Research for Productivity Enhancement in Pulses"

OBJECTIVES OF THE PROJECT:

- To enhance pulses production through input subsidy and mechanization
- To develop pulses seed system for sustainable production
- To demonstrate improved pulse production packages for promotion and training.
- To share information on new knowledge and technology by using print and electronic media.
- Capacity building of farmer's community.

Research activities

MUNG BEAN

4.3.1 Collection, evaluation and maintenance of germplasm

One hundred and ten entries /strain collected from different sources were sown in observational plots to screen out elite lines. Sowing was done on 21-05-2020 with plot size of 4 x 0.6m. Data regarding germination, days to 50% flowering, plant height, No. of pods/plant, pod length, days to maturity and yield (kg/ha) were recorded. The trial was harvested on 11.08.2020.

Table 44 Characterization of germplasm

Sr. No	Characters	Range
1	Days to 50% flowering	33-45
2	Plant height (cm)	32-57
3	Pod length (cm)	2.5-7
4	No. of pods plants^{-1}	19-39
5	Seed yield (g/plot)	45-395
6	Seed yield (kgha^{-1})	188-1646
7	Disease scoring	15 entries were abolished due to disease incidence and low yield

Table. 45 Yield Parameters

Sr. No	Yield range (kg/ha)	No. of entries
1	862-1350	15
2	700-1100	35
3	650-930	29
4	> 500	13
5	Abolished	18

AGRONOMIC STUDIES

4.3.2. Optimization of Planting Time

Sowing date trial was conducted to check the best and suitable time of Mungbean during Kharif-2020. Three test entries along with one commercial variety was sown in four different dates.

All the cultural practices were carried out uniform in all sowing dates. Data regarding yield and yield related parameters were recorded from all the sowing dates. Sowing date on 20.05.2020 (SD-1) performed well with maximum yield of 1605 kg/ha followed by the sowing date 30.05.2020 (SD2) which gave 1445 kg/ha.Whereas sowing date 19.06.2020 (SD4) represented the lowest yield of 880 kg/ha. It is concluded that 2nd fortnight of the month of is here be recommended for the sowing of Mungbean in Thal area.

Table 46 impact of sowing dates

Sr. No.	Sowing dates	Replications	Yield kg/ha
1	20.05.2020 (SD1)	2	1605
2	30.05.2020 (SD2)	2	1445
3	12.06.2020 (SD3)	2	939
4	19.06.2020 (SD4)	2	880

4.3.3 Study of Planting Geometry and its effects

The spacing trail was conducted to identify the suitable planting density of Mungbean to get the maximum yield. The experiment was laid out at three different row spacing (30, 45 & 60cm). The sowing was done on 23.05.2020 with commercial variety AZRI MUNG 2021. Manual hoeing was done in all the treatments. The row spacing of 45 cm with maximum yield of 1050 kg/acre proved the best, more number of pods per plant were observed in this treatment. Whereas more frequent and dense vegetative growth in 30 cm apart rows resulted in less yield (i.e.650kg/ha). Row spacing of 45 cm is recommended for the Mungbean production in sandy loam soils.

Table 47 Effect of planting geometry on yield

Sr. No.	Variety	Row spacing (cm)	Yield (kg/ha)
1	AZRI MUNG 2021	30	1625
2	AZRI MUNG 2021	45	2625
3	AZRI MUNG 2021	60	1250

4.3.3 Demonstration of improved production technology in field for Mungbean crop

Five demo plots of one acre each was sown at farmer's field with improved production technology. Certified seed of two newly approved varieties (AZRI-MUNG-2006 & AZRI-MUNG-2018) were sown at farmer's field to multiply the seed and to develop the seed bank in the community so that grain should be replaced with seed to get maximum yield potential. Phosphatic fertilizer was also applied. Integrated pest management was ensured to get the maximum yield.

Table 48: List of beneficiaries

S. No.	Name of farmer	Address	Variety	Area (kanlas)	Yield (kg/ha)
1	Ghulam Abbas	Chak No.35/TDA	AZRI-MUNG-18	08	1125
2	Mohammad Asghar	Chak No.19/TDA	AZRI-MUNG-18	08	1250
3	Basheer Ahmed	Chak No. 211/TDA	AZRI-MUNG-18	08	1350
4	Inayat Ullah	Chak No. 35/TDA	AZRI-MUNG-06	08	1925
5	Ghulam Yasin	Mouza Dalla	AZRI-MUNG-06	08	1375

4.3.5 Seed Production of Mungbean (BNS and Pre- basic)

Seven hundred and eighty progeny rows and one hundred and eighty five family blocks were laid out at AZRI, Bhakkar on dated 21.05.2020. Purity was maintained by regular inspection and data collection. Off type plants were rough out as regular practice. IMP adopted to get good crop quality. Harvesting of the trial was done on 04.08.2020.

Table. 49 BNS and Pre basic seed production

Name of variety	BNS (kg)	Pre-basic (kg)
AZRI-Mung-2018	25	200
AZRI-Mung-2006	10	70
AZRI-Mung-2021	60	1340

RABI SEASON

4.3.6 Collection, evaluation and maintenance of germplasm

One hundred and twenty five entries /strain collected from different sources were sown in observational plots to screen out elite lines. Sowing was done on 16.10.2020 with plot size of 4 x 0.6m. Data regarding germination, days to 50% flowering, plant height, No. of pods/plant, pod length, days to maturity and yield (kg/ha) were recorded. The trial was harvested on 25.03.2021. Entry no. 85, coded as TG-1713 performed best and gave highest grain yield of 964 grams/plot. Total Seventeen entries showed best performance under irrigation region and their grain yield ranged from 3000-4083 kg/ha. Nineteen entries were rejected due to low yield and disease susceptible.

Table. 50 Characterization of germplasm

Sr. No	Character studied	Range (Means)
1	Days to 50% flowering	78-112
2	Plant height (cm)	50-70
3	No. of pods/plant	39-185
4	Days to maturity	163-170
5	Grain yield (g/plot)	265-980
6	Disease incidence	19 abolished due to disease and low yield.

Table. 51 Yield Parameters

Sr. No	Yield range (kg/ha)	No. of entries
1	3000-4083	17
2	2000-3000	46
3	1000-2000	30
4	> 1000	13
5	Abolished	19

Fig-3:- Chickpea germplasm field view

Fig-4:- Chickpea portable solar irrigation system & IPM demonstration under PSDP at Rakh Mankera

1. A seminar/training workshop was organized at Arid Zone Research Institute, Bhakkar on dated 18th March-2021 on "**Improved Mungbean production technology**". The scientists from all over the Agriculture departments (Research & Extension) of Pakistan participated in the workshop. Dr. Khalid Hussain, Principal Scientist, AZRI, Bhakkar welcomed all the participants and briefly describe the research activities and achievements of the institute. Dr. Muhammad Mansoor Joyia, PD, PSDP, Pulses describe about the project activities, achievements and prospective of the pulses crop in Pakistan.

Fig 5-:- Improved mungbean production technology under PSDP at Arid Zone research institute Bhakkar

2. One day training workshop/seminar was arranged at farmer's field Chak No.42-43 TDA, Bhakkar on "**Climate smart production technology of Mungbean crop**" dated 12th June, 2021. Dr. Muhammad Zafar Iqbal, Chief Scientist/DG, Agri. Research attended the seminar as chief guest. Dr. Khalid Hussain, Principal Scientist, AZRI, Bhakkar, Dr. Muhammad Mansoor Joyia, PD, PSDP, Pulses and other stake holders like farmers, Agriculture extension department and different pesticides companies attended the seminar and appreciated the efforts of the PSDP pulses project activities.

Fig-6:- climate smart production technology of mungbean crop under PSDP at Chak No. 42-43 TDA