

**ANNUAL TECHNICAL REPORT  
2019-20**



**ARID ZONE RESEARCH INSTITUTE,  
BHAKKAR**

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# **1. WHEAT:**

## **1.1 VARIETY DEVELOPMENT:**

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

## **1.2 Collection And Maintenance of Wheat Germplasm 2019-20**

Introduction, collection, evaluation, maintenance and improvement of plant genetic resources play crucial role in the evolution of crop varieties. Five hundred 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 1.8m x 0.6m maintaining row to row distance 0.3m. Sowing was carried out on 15-11-2019 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 (Yellow rust) and poor performance. This experiment was harvested on 20-05-2020. 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 90-125, 130-175, 3-30, 60-145, 1-5, 30-53g and 2-52g, respectively.

## **1.3 Wheat Hybridization Programme 2019-20**

Two hundred 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 20-11-2019 and harvesting was carried out on 04-05-2020. One hundred and sixty five crosses were attempted among promising varieties/strains with basic objective to combine desirable attributes in single genotype. Seed of one hundred and fifty successful crosses was harvested to study  $F_1$  progenies during the next crop season 2020-21.

## **1.4 Evaluation Of Segregating Generations**

### **1.4.1 $F_1$ Generations**

Eighty eight  $F_0$  seeds (Crosses) were planted alongwith their parents for evaluation of  $F_1$  populations. The plot size was kept 1.8m x 0.9m by maintaining plant to plant distance 0.15m and row to row distance 0.30m. Sowing was carried out on 18-11-2019 and harvesting was carried out on 15-05-2020. All the agronomic practices were carried out as and when required. The seed was obtained from eighty desirable disease resistant  $F_1$  populations' alongwith parents to raise  $F_2$  generations during the next crop year 2020-21.

### **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. Ninety  $F_2$  segregating populations were studied alongwith parental lines during the year 2019-20. The plot size was kept 4m x 1.2m having row to row distance 0.30m. The sowing was done on 19-11-2019. Segregation

was observed in all populations. Twelve hundred single plant selections from eighty segregating populations were made on the basis of visual performance and disease incidence in field conditions on 28-04-2020 to raise F<sub>3</sub> generations during crop season 2020-21.

#### **1.4.3 F<sub>3</sub> Segregating Generations**

One hundred and seventy eight segregating populations being the descendants of F<sub>2</sub> progenies were planted to raise F<sub>3</sub> populations. Sowing was done on 19-11-2019 and gross plot size was maintained 3.5m x 1.2m. Selections of desirable plants were made from 07-05-2020 to 15-05-2020. One thousand single plant selections from one hundred and thirty segregating populations were made on the basis of visual performance and disease incidence in field conditions on 20-05-2020 to raise F<sub>4</sub> generations during crop season 2020-21.

#### **1.4.4 F<sub>4</sub> Segregating Generations**

One hundred and fourteen segregating populations connected through the ancestry line of F<sub>3</sub> populations of previous year were planted. The plot size of each progeny was 1.8m x 0.9m. Space planting was done by maintaining plant to plant and row to row 0.15m and 0.30m distance respectively on 19-11-2019. The segregation was observed in most of the populations and seven hundred and eighty single plants were selected and five hundred and forty 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<sub>5</sub> generations during crop season 2020-21.

#### **1.4.5 F<sub>5</sub> Segregating Generations**

Ninety five segregating progenies being the descendants of F<sub>4</sub> generations were laid out. The plot size for each progeny was maintained 3.5m x 0.6m. Sowing was carried out on 20-11-2019 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. Six hundred and fifty five single plants were selected on visual observation from field and five hundred and forty 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<sub>6</sub> generations during next sowing season 2020-21.

#### **1.4.6 F<sub>6</sub> Segregating Generations**

Eighty five populations collected from ancestry line of F<sub>5</sub> generations of previous year were planted. Plot size for each progeny was kept 3.5m x 0.6m. The sowing was carried out on 20-11-2019 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. Thirty uniform populations were selected on the basis of field observations and twenty five 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 2020-21.

## 1.5 REPLICATED WHEAT YIELD TRIALS 2019-20

### 1.5.1 Preliminary Wheat Yield Trial (A<sub>1</sub>) 2019-20

A preliminary wheat yield trial-A<sub>1</sub> comprising twenty entries viz; TW1901, TW1902, TW1903, TW1904, TW1905, TW1906, TW1907, TW1908, TW1909, TW1910, TW1911, TW1912, TW1913, TW1914, TW1915, TW1916, TW1917, TW1918, Fakhar-e-Bhakkar and Anaaj-17 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 07-11-2019 with gross plot size 5.0m × 1.2m. All the cultural practices were carried out as and when required. The trial was harvested on 05-05-2020. The grain yield data are given in Table-1.

**Table-1 Grain Yield of Preliminary Wheat Yield Trial (A<sub>1</sub>) 2019-20**

S. No	Variety /Strain	Grain Yield (kg ha <sup>-1</sup> )	S. No	Variety /Strain	Grain Yield (kg ha <sup>-1</sup> )
1	TW1913	4568	11	TW1912	3100
2	TW1917	4278	12	TW1911	3064
3	TW1902	4001	13	TW1916	3012
4	TW1907	3801	14	TW1915	2984
5	Fakhar-e-Bhakkar	3534	15	TW1918	2873
6	TW1914	3509	16	TW1908	2862
7	TW1903	3423	17	TW1905	2848
8	TW1909	3384	18	TW1901	2775
9	TW1906	3283	19	TW1910	2723
10	Anaaj-17	3112	20	TW1904	2546

LSD<sub>0.05</sub> = 387 kg/ha. CV (%) = 7.0

Statistical analysis of yield data revealed that the differences among the means of entries were significant (Table-1). The strain TW1913 was top yielder with yield figure 4568 kg ha<sup>-1</sup> followed by TW1917 having grain yield value 4278 kg ha<sup>-1</sup>. Check varieties F-Bhakkar and Anaj depicted grain yield 3534 and 3112 kg ha<sup>-1</sup>, respectively. The strain TW1904 gave the lowest yield with mean yield value 2546 kg ha<sup>-1</sup>. Seed of four top yielding and disease tolerant genotypes (TW1913, TW1817, TW1902 & TW1907) with high agronomic score was reserved for layout of regular yield trial in crop year 2020-21.

### 1.5.2 Preliminary Wheat Yield Trial (A<sub>2</sub>) 2019-20

A preliminary wheat yield trial-A<sub>2</sub> comprising twenty entries viz; TWS1921, TWS1922, TWS1923, TWS1924, TWS1925, TWS1926, TWS1927, TWS1928, TWS1929, TWS1930, TWS1931, TWS1932, TWS1933, TWS1934, TWS1935, TWS1936, TWS1937, TWS1938, Fakhar-e-Bhakkar and Anaaj-17 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 07-11-2019. All the cultural practices were carried out as and when required. The trial was harvested on 05-05-2020. The grain yield data are given in Table-2.

**Table-2: Grain Yield of Preliminary Wheat Yield Trial (A<sub>2</sub>) 2019-20**

Sr. No	Variety /Strain	Grain Yield (kg ha <sup>-1</sup> )	Sr. No	Variety /Strain	Grain Yield (kg ha <sup>-1</sup> )
1	TWS1926	4447	11	TWS1931	3716
2	TWS1923	4139	12	TWS1927	3656
3	TWS1937	4089	13	TWS1928	3614
4	TWS1938	4039	14	TWS1934	3506
5	TWS1930	4006	15	TWS1921	3372
6	Fakhar-e-Bhakkar	3962	16	TWS1925	3306
7	TWS1924	3789	17	Anaaj-17	3206
8	TWS1922	3762	18	TWS1932	3022
9	TWS1929	3722	19	TWS1933	2772
10	TWS1935	3722	20	TWS1936	2602
LSD <sub>0.05</sub> = 540 kg / ha      CV (%) = 9.0					

It is revealed from the analysis of variance (Table-2) that the differences among the means of entries were significant. The strain TWS1926 gave maximum grain yield 4447 kg ha<sup>-1</sup> followed by TWS1923 and TWS1937 having grain yield values of 4139, and 4089 kg ha<sup>-1</sup>, respectively. Check varieties F-Bhakkar and Anaj-2017 gave the yield 3962 and 3206 kg ha<sup>-1</sup>, respectively. The strain TWS1936 gave the lowest yield with mean yield value of 2602 kg ha<sup>-1</sup>. Seed of five top yielding and disease tolerant with high agronomic score genotypes (TWS1926, TWS1923, TWS1937, TWS1938 & TWS1930) was reserved for layout of regular yield trial in crop season 2020-21.

### 1.5.3 Preliminary Wheat Yield Trial (A<sub>3</sub>) 2019-20

A preliminary wheat yield trial-A<sub>3</sub> comprising twenty entries viz; TWS1946, TWS1947, TWS1948, TWS1949, TWS1950, TWS1951, TWS1952, TWS1953, TWS1954, TWS1955, TWS1959, TWS1960, TWS1961, TWS1962, TWS1963, TWS1964, TWS1965, TWS1966, Fakhar-e-Bhakkar and Anaaj-17 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 07-11-2019. All the cultural practices were carried out as and when required. The trial was harvested on 05-05-2020. The grain yield data are shown in Table-3.

**Table-3: Grain Yield of preliminary Wheat Yield Trial (A<sub>3</sub>) 2019-20**

Sr. No	Variety /Strain	Grain Yield (kg ha <sup>-1</sup> )	Sr. No	Variety /Strain	Grain Yield (kg ha <sup>-1</sup> )
1	TWS1949	3980	11	Anaaj-17	3130
2	TWS1954	3940	12	TWS1952	3097
3	TWS1962	3660	13	TWS1948	2863
4	TWS1947	3488	14	TWS1946	2820
5	Fakhar-e-Bhakkar	3480	15	TWS1963	2713
6	TWS1965	3380	16	TWS1955	2697
7	TWS1960	3230	17	TWS1961	2613
8	TWS1953	3213	18	TWS1951	2463
9	TWS1966	3197	19	TWS1959	2413
10	TWS1950	3133	20	TWS1964	2327
LSD <sub>0.05</sub> = 486 kg / ha      CV (%) = 9.52					

It is revealed from the analysis of variance (Table-3) that the differences among the means of entries were significant. The strain TWS1949 gave maximum grain yield 3980 kg ha<sup>-1</sup> followed by TWS1954 and TWS1962 having grain yield values 3940 and 3660 kg ha<sup>-1</sup>, respectively. Check varieties F-Bhakkar and Anaj-2017 gave the yield values 3480 and 3130 kg ha<sup>-1</sup>, respectively. The strain TWS1964 depicted the lowest yield with mean yield value of 2327 kg ha<sup>-1</sup>. Seed of nine top yielding and disease tolerant with high agronomic score genotypes (TWS1949, TWS1954, TWS1962, TWS1947, TWS1965, TWS1960, TWS1953, TWS1966 and TWS1950) was reserved for layout of regular yield trial 2020-21.

### 1.6 Regular Wheat Yield Trial (B<sub>1</sub>) 2019-20

A regular wheat yield trial-B<sub>1</sub> comprising twenty entries viz; TW1806, TW1809, TW1813, TW1815, TW1817, TWS1819, TWS1824, TWS1826, TWS1833, TWS1834, TWS1836, TWS1889, TWS183, TWS1839, TWS1843, TWS1846, TWS1859, TWS1881, Fakhar-e-Bhakkar and Anaaj-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 08-11-2019 with plot size 5.0m x 1.2m. All the cultural practices were carried out as and when required. The trial was harvested on 06-05-2020. The grain yield data are presented in Table-4.

**Table- 4: Grain Yield of Regular Wheat Yield Trial-B<sub>1</sub> 2019-20**

Sr. No	Variety /Strain	Grain Yield (kg ha <sup>-1</sup> )	Sr. No	Variety /Strain	Grain Yield (kg ha <sup>-1</sup> )
1	TWS1839	4253	11	Fakhar-e-Bhakkar	3364
2	TWS1881	3812	12	TWS1834	3137
3	TWS1843	3784	13	TWS1833	3120
4	TWS1859	3776	14	TW1813	3078
5	TWS1836	3753	15	TWS1826	2987
6	TW1806	3726	16	TWS1819	2945
7	TWS1889	3534	17	TW1815	2798
8	TW1809	3526	18	TW1817	2697
9	Anaaj-17	3464	19	TWS1837	2676
10	TWS1846	3451	20	TWS1824	2442
LSD <sub>0.05</sub> = 427 kg / ha      CV (%) = 7.79					

It is 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 TWS1839 gave maximum grain yield 4253 kg ha<sup>-1</sup>, followed by TWS1881 with grain yield 3812 kg ha<sup>-1</sup>. However the check entries Anaj-2017 and Fakhar-e-Bhakkar gave grain yield 3464 and 3364 kg ha<sup>-1</sup>, respectively. Seed of four top yielding and disease tolerant with high agronomic score genotypes (TWS1839, TWS1881, TWS1843 & TWS1859) was reserved for layout of adaptation yield trial 2020-21.

### 1.7 Regular Wheat Yield Trial (B<sub>2</sub>) 2019-20

A regular wheat yield trial-B<sub>2</sub> comprising twenty entries viz; TWS18100, TWS18102, TWS18103, TWS18104, TWS18105, TWS18106, TWS18107, TWS18108, TWS18109, TWS18110, TWS18111, TWS18112, TWS18113, TWS18114, TWS18115, TWS18116, TWS18117, TWS18118, Fakhar-e-Bkr and Annaj-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 08-11-2019 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 06-05-2020. The grain yield data are presented in Table-5.

**Table- 5: Grain Yield of Regular Wheat Yield Trial-B<sub>2</sub> 2019-20**

Sr. No	Variety /Strain	Grain Yield (kg ha <sup>-1</sup> )	Sr. No	Variety /Strain	Grain Yield (kg ha <sup>-1</sup> )
1	TWS18100	4663	11	Annaj-17	3574
2	TWS18108	4221	12	TWS18103	3524
3	TWS18113	4049	13	TWS18104	3482
4	TWS18114	3824	14	TWS18105	3424
5	TWS18106	3810	15	TWS18112	3407
6	TWS18118	3807	16	TWS18107	3402
7	TWS18102	3749	17	TWS18109	3391
8	Fakhar-e-Bkr	3739	18	TWS18111	3041
9	TWS18115	3699	19	TWS18116	2716
10	TWS18110	3682	20	TWS18117	2357
		LSD <sub>0.05</sub> = 692 kg / ha			CV (%) =11.71

It is 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 TWS18100 gave maximum grain yield 4663kg ha<sup>-1</sup> followed by TWS18108 with grain yield 4221 kg ha<sup>-1</sup>. However the check entries Fakhar-e-Bhakkhar and Anaj-2017 gave grain yield 3739 and 3574 kg ha<sup>-1</sup>, respectively. Seed of five top yielding and disease tolerant with high agronomic score genotypes (TWS18100, TWS18108, TWS18113, TWS18114 & TWS18106) was reserved for layout of adaptation yield trial 2020-21.

### 1.8 Regular Wheat Yield Trial (B<sub>3</sub>) 2019-20

A regular wheat yield trial (B<sub>3</sub>) comprising twenty entries viz; TWS18126, TWS18127, TWS18128, TWS18129, TWS18130, TWS18131, TWS18132, TWS18133, TWS18134, TWS18135, TWS18136, TWS18137, TWS18138, TWS18139, TWS18140, TWS18141, TWS18142, TWS18143, Fakhar-e-Bkr 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 08-11-2019 with plot size 5.0m x 1.2m. All the cultural practices were carried out as and when required. This trial was harvested on 06-05-2020. However threshing was carried out on 30-05-2020 and grain yield data are presented in Table-6.

**Table- 6: Grain Yield of Regular Wheat Yield Trial-B<sub>3</sub> 2019-20**

Sr. No	Variety /Strain	Grain Yield (kg ha <sup>-1</sup> )	Sr. No	Variety /Strain	Grain Yield (kg ha <sup>-1</sup> )
1	TWS18135	3926	11	TWS18134	3192
2	TWS18127	3859	12	TWS18133	3142
3	TWS18126	3759	13	TWS18141	2876
4	TWS18143	3751	14	Anaaj-17	2792
5	TWS18128	3726	15	TWS18136	2626
6	TWS18142	3726	16	TWS18131	2542
7	TWS18140	3359	17	TWS18137	2492
8	TWS18132	3309	18	TWS18129	2464
9	Fakhar-e-Bkr	3284	19	TWS18130	2426
10	TWS18138	3242	20	TWS18139	2409
LSD <sub>0.05</sub> = 665 kg / ha      CV (%) =12					

It is 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 TWS18135 gave maximum grain yield 3926 kg ha<sup>-1</sup>, followed by TWS18127 with grain yield 3859 kg ha<sup>-1</sup>. However the check entries Fakhar-e-Bhakkhar and Anaaj-2017 gave grain yield 3284 and 2792 kg ha<sup>-1</sup>, respectively. Seed of five top yielding and disease tolerant with high agronomic score genotypes (TWS18135 TWS18127, TWS18126, TWS18143 & TWS18128) was reserved for layout of adaptation yield trial 2020-21.

### 1.9 Wheat Adaptation Yield Trial 2019-20

A wheat adaptation yield trial was conducted at three locations AZRI, Bhakkar, Adaptive Research Station, Karor and Gram Breeding Research Substation, Kallur kot. This trial had sixteen entries viz: TWS1847, TWS1849, TWS1853, TWS1857, TWS1861, TWS1868, TWS1872, TWS1874, TWS1875, TWS1883, TWS1884, TWS17048, TWS17064, TWS17069, Fakhar-e-Bkr and Anaaj-17 was 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 2020. Grain yield data are given in Table 7:

**Table-7: Grain Yield of Wheat Adaptation Yield Trial 2019-20**

Sr. No.	Variety /Strain	Grain Yield (kg ha <sup>-1</sup> )			Mean
		AZRI, Bkr	ARS, Karor	GBRSS,K.KOT	
1	TWS1868	5147	4202	5804	5051
2	TWS17064	4776	3458	5079	4438
3	TWS1884	4251	2875	5763	4296
4	TWS16285	3960	3558	5263	4260
5	TWS16263	4756	3808	4071	4212
6	TWS16274	4297	3483	4788	4189
7	TWS17048	3935	3025	5596	4185
8	TWS1875	4926	3308	4179	4138

9	F. Bhakkar	4035	3808	4513	4119
10	TWS1849	4822	2850	4429	4034
11	TWS1857	3976	3217	4804	3999
12	TWS17069	4164	3300	4063	3842
13	TWS1861	3631	3442	3971	3681
14	TWS1874	3997	3025	3921	3648
15	TWS1853	3718	3033	3346	3366
16	Anaaj-17	2726	3175	4004	3302
		LSD <sub>0.05</sub> =701 CV(%)=10	LSD <sub>0.05</sub> =483 CV(%)=9	LSD <sub>0.05</sub> =917 CV(%)=12	

Wheat adaptation yield trial depicted significant differences among entries at all locations. Genotype TWS1868 was top yielder having overall Mean grain yield 5051 kg ha<sup>-1</sup> followed by strains TWS17064 and TWS1884 with grain yield figures 4448 and 4296 kg ha<sup>-1</sup>, respectively. However check varieties Fakhar-e-Bhakkar and Anaaj-17 expressed av. grain yield 4119 and 3302 kg ha<sup>-1</sup>, respectively. Seed of four top yielding and disease tolerant with high agronomic score genotypes (TWS1886, TWS17064, TWS1884 and TWS16285) was reserved for incorporation in Punjab Uniform Wheat Yield trial 2020-21.

#### 1.10 Punjab Uniform Wheat Yield Trial 2019-20 (Provincial Level Testing)

Punjab uniform wheat yield trial was coordinated by Wheat Research Institute Faisalabad. It was conducted all over the Punjab at 29 different locations during crop season 2019-20. Trial was laid out according to alpha lattice design with two replications. Arid Zone Research Institute Bhakkar offered three advanced lines (TWS15110, TWS1637 and TWS16164) for testing at provincial level and it extended services to conduct this trial at (AZRI Bhakkar, GBRSS, Kallur kot and ARS Karore). These trials were laid out during third week of November 2019. 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 2020. Grain yield and other data recorded were sent to Wheat Research Institute Faisalabad for compilation. Mean grain yield data of advance lines of this institute and check entries at twenty nine locations are presented in Table: 8.

**Table 8- Grain Yield of Punjab Uniform Wheat Yield Trial 2019-20**

Sr. No.	Genotypes	Grain Yield (Kg ha <sup>-1</sup> ) (Av. 29 locations) Irrigated
1	TWS15110	4328
2	TWS16164	4230
3	TWS1637	4202
5	FSD-08	3894
6	JOUHAR-16	3797

It is evident from Table-8 that all three advance lines TWS15110, TWS16164 and TWS1637 performed better in all over Punjab basis (Av. 29 locations) with grand mean



grain yield 4328, 4230 and 4202 kg ha<sup>-1</sup>, respectively. However, provincial checks FSD-08 and Jouhar-16 gave mean grain yield 3894 and 3797 kg ha<sup>-1</sup>, respectively. Seed of three outperforming and disease tolerant genotypes (TWS15110, TWS16164 and TWS1637) with high agronomic score is reserved for incorporation in National Uniform Wheat Yield trial 2020-21.

### 1.11 National Uniform Wheat Yield Trial AZRI, BKR) 2019-20

National uniform wheat yield trial was coordinated by Wheat Coordinator PARC Islamabad. It was conducted all over the Punjab at different locations during crop season 2019-20. Trial comprising 60 test and three check entries was laid out according to alpha lattice design with two replications all over country. Arid Zone research Institute Bhakkar offered four advanced lines (TWS15105, TWS15137, TWS15145 and TWS15159) for testing at national level and cooperated in conducting this trial at three different locations (AZRI Bhakkar, GBRSS, Kallur kot and ARS Karore). This trial was laid out during third week of November 2019. Plot size was maintained as 5.0m x 1.8m 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 2020 with net plot size 5.0x1.2. 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. 20 locations in Punjab and Av. 33 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.**

Punjab (Av.20 locations)			Pakistan (Av.33 locations)		
Sr. No	Genotypes	Grain Yield (Kg/ha)	Sr. No	Genotypes	Grain Yield (Kg/ha)
1	TWS-15159	5017	1	TWS-15159	4603
2	TWS-15105	4957	2	TWS-15105	4572
3	TWS-15145	4856	3	TWS-15145	4568
4	TWS-15137	4712	4	TWS-15137	4474
5	Ghazi-19	4638	5	Ghazi-19	4369
6	PAK-13	4284	6	PAK-13	4100

It is evident from Table-9 that four advance lines TWS15159, TWS15105, TWS15145 and TWS15137 of this institute performed better in all over Punjab basis (20 locations) with grand mean grain yield 5017, 4957, 4856 and 4712 kg ha<sup>-1</sup> respectively. However, two national check varieties Ghazi-19 and Pakistan-13 gave mean grain yield 4638 and 4284 kg ha<sup>-1</sup> respectively on provincial basis.

Similarly same four advance lines TWS15159, TWS15105, TWS15145 and TWS15137 of this institute performed better in all over Pakistan basis (Av. 33 locations) with grand mean grain yield 4603, 4572, 4568 and 4474 kg ha<sup>-1</sup> respectively. However, two national check varieties Ghazi-19 and Pakistan-13 gave mean grain yield 4369 and 4100 kg ha<sup>-1</sup> respectively.

## International Trials and Screening Nurseries

### 1.11.1 7<sup>th</sup> Wheat Yield Consortium Yield Trial 2019-20.

Seventh wheat yield consortium yield trial 2019-20 comprising thirty five entries was sown on 27-11-2019. Trial was laid out according to alpha lattice design with two replications. Gross plot size was kept 2.0m ×1.2m. All the cultural practices were carried out as and when required. The trial was harvested on 23-05-2020. Fifteen high yielding and disease resistant genotypes were selected for inclusion in regular wheat yield trial 2020-21. Grain yield data are presented in Table-10.

**Table 10: Grain Yield of 7<sup>th</sup> Wheat Yield Consortium Yield Trial 2019-20 (CIMMYT)**

Sr. No.	Variety /Strain	Grain Yield (kg ha <sup>-1</sup> )	Sr. No.	Variety /Strain	Grain Yield (kg ha <sup>-1</sup> )
1	7 <sup>th</sup> WYCYT-38	4250	9	7 <sup>th</sup> WYCYT-36	3858
2	7 <sup>th</sup> WYCYT-12	4150	10	7 <sup>th</sup> WYCYT-51	3658
3	7 <sup>th</sup> WYCYT-28	4142	11	7 <sup>th</sup> WYCYT-63	3583
4	7 <sup>th</sup> WYCYT-10	4133	12	7 <sup>th</sup> WYCYT-61	3575
5	7 <sup>th</sup> WYCYT-29	4117	13	7 <sup>th</sup> WYCYT-43	3542
6	7 <sup>th</sup> WYCYT-48	4042	14	7 <sup>th</sup> WYCYT-70	3483
7	7 <sup>th</sup> WYCYT-20	4033	15	7 <sup>th</sup> WYCYT-67	3442
8	7 <sup>th</sup> WYCYT-52	3967		-	-

It is evident from the Table-10 that the variety/strain 7<sup>th</sup> WYCYT-38 gave maximum grain yield with mean yield of 4250 kg ha<sup>-1</sup> followed by strain 7<sup>th</sup> WYCYT-12 with grain yield of 4150 kg ha<sup>-1</sup>. However the strain No. 7<sup>th</sup> WYCYT-67 gave grain yield value of 3442 kg ha<sup>-1</sup>. Seed of one top yielding and disease tolerant with high agronomic score genotype (7<sup>th</sup> WYCYT-38) was reserved for incorporation in regular wheat yield trial (B<sub>2</sub>) 2020-21.

### 1.11.2 27<sup>th</sup> SEMI-ARID WHEAT YIELD TRIAL 2019-20 (CIMMYT)

Twenty seventh semi-arid wheat yield trial 2019-20 comprising fifty entries was laid out on 27-11-2019 following alpha lattice design with two replications. The plot size was kept 2.0m ×1.2m. All the cultural practices were carried out as and when required. The trial was harvested on 23-05-2020. Thirty high yielding and disease resistant genotypes were selected for inclusion in regular wheat yield trial 2020-21. Grain yield data are presented in Table-11.

**Table 11: Grain Yield of 27<sup>th</sup> Semi-arid Wheat Yield Trial 2019-20 (CIMMYT)**

Sr. No.	Variety /Strain	Grain Yield (kg ha <sup>-1</sup> )	Sr. No.	Variety /Strain	Grain Yield (kg ha <sup>-1</sup> )
1	27 <sup>th</sup> SAWYT-34	4575	16	27 <sup>th</sup> SAWYT-71	4025
2	27 <sup>th</sup> SAWYT-13	4383	17	27 <sup>th</sup> SAWYT-62	3933
3	27 <sup>th</sup> SAWYT-54	4383	18	27 <sup>th</sup> SAWYT-67	3933
4	27 <sup>th</sup> SAWYT-23	4333	19	27 <sup>th</sup> SAWYT-92	3933
5	27 <sup>th</sup> SAWYT-33	4250	20	27 <sup>th</sup> SAWYT-59	3875
6	27 <sup>th</sup> SAWYT-47	4250	21	27 <sup>th</sup> SAWYT-07	3783
7	27 <sup>th</sup> SAWYT-12	4225	22	27 <sup>th</sup> SAWYT-74	3750
8	26 <sup>th</sup> SAWYT-32	4167	23	27 <sup>th</sup> SAWYT-43	3683
9	27 <sup>th</sup> SAWYT-27	4133	24	27 <sup>th</sup> SAWYT-81	3558
10	27 <sup>th</sup> SAWYT-86	4108	25	27 <sup>th</sup> SAWYT-49	3552
11	27 <sup>th</sup> SAWYT-01	4083	26	27 <sup>th</sup> SAWYT-51	3500
12	27 <sup>th</sup> SAWYT-16	4083	27	27 <sup>th</sup> SAWYT-99	3483
13	27 <sup>th</sup> SAWYT-70	4058	28	27 <sup>th</sup> SAWYT-96	3233
14	27 <sup>th</sup> SAWYT-85	4050	29	27 <sup>th</sup> SAWYT-39	3192
15	27 <sup>th</sup> SAWYT-18	4025	30	27 <sup>th</sup> SAWYT-09	3158

It is evident from the Table-11 that the variety/strain 27<sup>th</sup> SAWYT-34 gave maximum grain yield 4575 kg ha<sup>-1</sup> followed by strain 27<sup>th</sup> SAWYT-13 with grain yield of 4383 kg ha<sup>-1</sup>. However the strain coded as 27<sup>th</sup> SAWYT-09 gave grain yield of 3158 kg ha<sup>-1</sup>. Seed of five top yielding and disease tolerant with high agronomic score genotypes (27<sup>th</sup> SAWYT-34, 27<sup>th</sup> SAWYT-13, 27<sup>th</sup> SAWYT-54, 27<sup>th</sup> SAWYT-23 & 27<sup>th</sup> SAWYT-33) was reserved for incorporation in Regular Wheat Yield trial (B<sub>2</sub>) 2020-21.

### 1.11.3 40<sup>th</sup> Elite Selection Wheat Yield Trial 2019-20.

40<sup>th</sup> elite selection wheat yield trial 2019-20 comprising fifty entries were laid out on 27-11-2019 according to alpha lattice design with two replications. The plot size was kept 2m×01.2m. All the cultural practices were carried out as and when required. Thirty five high yielding and disease resistant genotypes were selected for inclusion in regular wheat yield trial 2020-21. The trial was harvested on 23-05-2020. Grain yield data are presented in Table-12.

**Table 12: 40<sup>th</sup> Elite Selection Wheat Yield Trial 2019-20.**

Sr. No.	Variety /Strain	Grain Yield (kg ha <sup>-1</sup> )	Sr. No.	Variety /Strain	Grain Yield (kg ha <sup>-1</sup> )
1	40 <sup>th</sup> ESWYT-81	4475	19	40 <sup>th</sup> ESWYT-30	4067
2	40 <sup>th</sup> ESWYT-76	4408	20	40 <sup>th</sup> ESWYT-22	4058
3	40 <sup>th</sup> ESWYT-35	4358	21	40 <sup>th</sup> ESWYT-68	4042
4	40 <sup>th</sup> ESWYT-88	4350	22	40 <sup>th</sup> ESWYT-01	4033
5	40 <sup>th</sup> ESWYT-28	4317	23	40 <sup>th</sup> ESWYT-73	4008
6	40 <sup>th</sup> ESWYT-31	4183	24	40 <sup>th</sup> ESWYT-84	4008
7	40 <sup>th</sup> ESWYT-43	4183	25	40 <sup>th</sup> ESWYT-49	3983
8	40 <sup>th</sup> ESWYT-33	4167	26	40 <sup>th</sup> ESWYT-52	3983

9	40 <sup>th</sup> ESWYT-83	4158	27	40 <sup>th</sup> ESWYT-13	3967
10	40 <sup>th</sup> ESWYT-100	4158	28	40 <sup>th</sup> ESWYT-51	3900
11	40 <sup>th</sup> ESWYT-05	4142	29	40 <sup>th</sup> ESWYT-34	3858
12	40 <sup>th</sup> ESWYT-17	4133	30	40 <sup>th</sup> ESWYT-61	3775
13	40 <sup>th</sup> ESWYT-09	4100	31	40 <sup>th</sup> ESWYT-92	3717
14	40 <sup>th</sup> ESWYT-07	4092	32	40 <sup>th</sup> ESWYT-18	3542
15	40 <sup>th</sup> ESWYT-54	4092	33	40 <sup>th</sup> ESWYT-70	3525
16	40 <sup>th</sup> ESWYT-40	4083	34	40 <sup>th</sup> ESWYT-02	3500
17	40 <sup>th</sup> ESWYT-57	4083	35	40 <sup>th</sup> ESWYT-04	3408
18	40 <sup>th</sup> ESWYT-24	4067	-	-	-

It is evident from the Table-12 that strain 40<sup>th</sup> ESWYT-81 gave maximum grain yield 4475 kg ha<sup>-1</sup> followed by strain 40<sup>th</sup> ESWYT-76 with 4408 kg ha<sup>-1</sup>. However, the strain 40<sup>th</sup> ESWYT-04 produced grain yield 3408 kg ha<sup>-1</sup>. Seed of nine top yielding and disease tolerant with high agronomic score genotypes (40<sup>th</sup> ESWYT-81, 40<sup>th</sup> ESWYT-76, 40<sup>th</sup> ESWYT-35, 40<sup>th</sup> ESWYT-88, 40<sup>th</sup> ESWYT-28, 40<sup>th</sup> ESWYT-31, 40<sup>th</sup> ESWYT-43, 40<sup>th</sup> ESWYT-33 & 40<sup>th</sup> ESWYT-83) was reserved for incorporation in Regular Wheat Yield trial (B<sub>2</sub>) 2020-21.

#### 1.11.4 52<sup>nd</sup> International Wheat Screening Nursery 2019-20

A 52<sup>nd</sup> International Bread Wheat Screening Nursery 2019-20 comprising two hundred and eighty four entries was laid out on 27-11-2019 following plot size 2m × 0.6m. All the cultural practices were carried out as and when required. Forty five high yielding and disease tolerant entries were selected for further evaluation. The trial was harvested on 24-05-2020. Grain yield per plot data are presented in Table-13.

**Table 13: Grain Yield of 52<sup>nd</sup> International Bread Wheat Screening Nursery 2019-20 (CIMMYT)**

Sr. No.	Variety /Strain	Grain Yield (kg ha <sup>-1</sup> )	Sr. No.	Variety /Strain	Grain Yield (kg ha <sup>-1</sup> )
1	52 <sup>nd</sup> IBWSN-191	3280	24	52 <sup>nd</sup> IBWSN-126	2936
2	52 <sup>nd</sup> IBWSN-70	3256	25	52 <sup>nd</sup> IBWSN-47	2928
3	52 <sup>nd</sup> IBWSN-102	3164	26	52 <sup>nd</sup> IBWSN-58	2928
4	52 <sup>nd</sup> IBWSN-90	3152	27	52 <sup>nd</sup> IBWSN-16	2920
5	52 <sup>nd</sup> IBWSN-202	3152	28	52 <sup>nd</sup> IBWSN-155	2912
6	52 <sup>nd</sup> IBWSN-123	3140	29	52 <sup>nd</sup> IBWSN-169	2912
7	52 <sup>nd</sup> IBWSN-73	3124	30	52 <sup>nd</sup> IBWSN-30	2908
8	52 <sup>nd</sup> IBWSN-34	3116	31	52 <sup>nd</sup> IBWSN-51	2904
9	52 <sup>nd</sup> IBWSN-172	3108	32	52 <sup>nd</sup> IBWSN-14	2880
10	52 <sup>nd</sup> IBWSN-110	3080	33	52 <sup>nd</sup> IBWSN-135	2868
11	52 <sup>nd</sup> IBWSN-06	3076	34	52 <sup>nd</sup> IBWSN-89	2864
12	52 <sup>nd</sup> IBWSN-162	3076	35	52 <sup>nd</sup> IBWSN-87	2856
13	52 <sup>nd</sup> IBWSN-219	3072	36	52 <sup>nd</sup> IBWSN-119	2832
14	52 <sup>nd</sup> IBWSN-165	3048	37	52 <sup>nd</sup> IBWSN-174	2828
15	52 <sup>nd</sup> IBWSN-163	3016	38	52 <sup>nd</sup> IBWSN-251	2824

16	52 <sup>nd</sup> IBWSN-40	3004	39	52 <sup>nd</sup> IBWSN-99	2816
17	52 <sup>nd</sup> IBWSN-238	3004	40	52 <sup>nd</sup> IBWSN-09	2812
18	52 <sup>nd</sup> IBWSN-23	2992	41	52 <sup>nd</sup> IBWSN-142	2792
19	52 <sup>nd</sup> IBWSN-62	2980	42	52 <sup>nd</sup> IBWSN-278	2780
20	52 <sup>nd</sup> IBWSN-84	2972	43	52 <sup>nd</sup> IBWSN-227	2768
21	52 <sup>nd</sup> IBWSN-67	2964	44	52 <sup>nd</sup> IBWSN-277	2716
22	52 <sup>nd</sup> IBWSN-15	2952	45	52 <sup>nd</sup> IBWSN-198	2664
23	52 <sup>nd</sup> IBWSN-211	2940	-	-	-

It is revealed from the Table-13 that the variety/strain 191 gave maximum grain yield 3280 kg/ha followed by strain 70 with 3256 kg/ha. However, the strain 198 showed grain yield 2664 kg/ha. Seed of eighteen top yielding and disease tolerant with high agronomic score genotypes (191, 70, 102, 90, 202, 123, 73, 34, 172, 110, 06, 162, 219, 165, 163, 40, 238 & 23) was reserved for incorporation in Preliminary Wheat Yield trial 2020-21.

#### 1.11.5 HEAT YIELD TRIAL-100 (2019-20)

Heat Yield Trial-100 comprising one hundred entries was laid out on 25-11-2019. Trial was laid out according to randomized complete block design with two replications. The plot size was kept 3.5m×0.6m. All the cultural practices were carried out as and when required. Eighty two high yielding and disease resistant genotypes were selected for inclusion in regular wheat yield trial 2020-21. The trial was harvested on 25-05-2020. Grain yield data are presented in Table-14.

**Table 14: Heat Yield Trial-100 (2019-20).**

Sr. No.	Variety /Strain	Grain Yield (g/plot)	Sr. No.	Variety /Strain	Grain Yield (g/plot)
1	HYT-100-79	5071	42	HYT-100-76	3357
2	HYT-100-98	4929	43	HYT-100-53	3310
3	HYT-100-65	4667	44	HYT-100-31	3286
4	HYT-100-200	4571	45	HYT-100-62	3286
5	HYT-100-95	4524	46	HYT-100-149	3238
6	HYT-100-166	4500	47	HYT-100-196	3238
7	HYT-100-191	4381	48	HYT-100-22	3214
8	HYT-100-189	4357	49	HYT-100-38	3214
9	HYT-100-89	4286	50	HYT-100-42	3190
10	HYT-100-124	4286	51	HYT-100-94	3190
11	HYT-100-157	4238	52	HYT-100-134	3190
12	HYT-100-84	4214	53	HYT-100-11	3119
13	HYT-100-153	4214	54	HYT-100-43	3119
14	HYT-100-199	4190	55	HYT-100-82	3119
15	HYT-100-125	4143	56	HYT-100-112	3071
16	HYT-100-56	4095	57	HYT-100-155	3000
17	HYT-100-136	4071	58	HYT-100-28	2976
18	HYT-100-74	4024	59	HYT-100-64	2976
19	HYT-100-183	4024	60	HYT-100-120	2976

20	HYT-100-171	3952	61	HYT-100-161	2952
21	HYT-100-27	3929	62	HYT-100-142	2929
22	HYT-100-63	3905	63	HYT-100-14	2905
23	HYT-100-34	3881	64	HYT-100-96	2857
24	HYT-100-130	3857	65	HYT-100-150	2833
25	HYT-100-160	3833	66	HYT-100-69	2786
26	HYT-100-152	3810	67	HYT-100-146	2762
27	HYT-100-91	3786	68	HYT-100-01	2762
28	HYT-100-75	3762	69	HYT-100-23	2714
29	HYT-100-164	3762	70	HYT-100-08	2690
30	HYT-100-57	3714	71	HYT-100-25	2667
31	HYT-100-174	3714	72	HYT-100-02	2429
32	HYT-100-70	3690	73	HYT-100-19	2429
33	HYT-100-85	3690	74	HYT-100-138	2429
34	HYT-100-87	3643	75	HYT-100-07	2381
35	HYT-100-99	3595	76	HYT-100-115	2214
36	HYT-100-109	3571	77	HYT-100-24	2119
37	HYT-100-139	3548	78	HYT-100-12	2000
38	HYT-100-92	3500	79	HYT-100-13	1833
39	HYT-100-121	3476	80	HYT-100-110	1762
40	HYT-100-46	3405	81	HYT-100-108	1452
41	HYT-100-126	3381	82	HYT-100-20	952

It is evident from the Table-14 that strain HYT-100-79 gave maximum grain yield 5071 kg ha<sup>-1</sup> followed by strain HYT-100-98 with grain yield 4929 kg ha<sup>-1</sup>. However, the strain HYT-100-20 gave grain yield 952 kg ha<sup>-1</sup>. Seed of six top yielding and disease tolerant with high agronomic score genotypes (HYT-100-76, HYT-100-98, HYT-100-65, HYT-100-200, HYT-100-95 & HYT-100-166) was reserved for incorporation in Preliminary Wheat Yield trial 2020-21.

## 2.0 PULSES

### 2.1 CHICKPEA:

#### 2.1.1 Variety development:

One chickpea candidate variety was evolved and was offered for spot examination. The sowing of advance line TG-1410 was done on 21.10.2019 and the spot examination was successfully conducted on 24.03.2020 by the experts and recommended for presentation in Expert Sub-Committee meeting.

#### 2.1.2 Collection and Maintenance of Chickpea Germplasm

Germplasm is a gene complex reservoir for selection of parent material for better grain yield, drought and temperature stress tolerance, resistance to insect pests and diseases. It could serve as a source of elite breeding material to be utilized in breeding programme. 302 chickpea genotypes (Desi-187 & Kabuli-115) including four check varieties were planted in augmented design. Sowing was done on 29-10-2019. The data regarding days to 50% flowering, plant stand, root rot and wilt diseases reaction (RRW), plant height (cm), number of pods/plant, days to maturity and grain yield (kg/ha) were recorded. Trial was harvested on 25-04-2020.

**Table 15. Characterization of chickpea germplasm Desi under Irrigated condition**

Sr. No	Character studies	Mean Range
1	Days to 50% flowering	74-119
2	Plant height (cm)	56-84
3	No. of pods/plant	47-186
4	Days to maturity	163-171
5	Grain yield (kg/ha)	208-4625

**Table 16. Classification of germplasm on yield basis (Irrigated)**

Sr. No	Yield range (kg/ha)	No. of entries
1	4000-4625	1
2	3000-4000	1
3	2000-3000	24
4	1000-2000	112
5	200-1000	49

**Table 17. Characteristics of chickpea germplasm Desi under Rainfed conditions**

Sr. No	Character studies	Mean Range
1	Days to 50% flowering	71-112
2	Plant height (cm)	36-69
3	No. of pods/plant	31-109
4	Days to maturity	151-165
5	Grain yield (kg/ha)	175-3250

**Table 18. Classification of germplasm on yield basis (Rainfed)**

Sr. No	Yield range (kg/ha)	No. of entries
1	3000-3250	1
2	2000-3000	8
3	1000-2000	57
4	175-1000	121

187 entries of chickpea Germplasm Desi were studied in two different environmental conditions (irrigated and rainfed). In irrigated conditions, entry coded as TG1426 performed best and gave highest grain yield of 1110 gram/plot, while the entry 92A230 showed lowest yield only 50 gram/plot. Maximum yield was recorded as 4625 kg/ha under irrigated conditions and maximum yield under rainfed conditions was recorded as 3250 kg/ha and lowest yield recorded was 175 kg/ha.

**Table 19. Characteristics of chickpea germplasm Kabuli (Irrigated)**

Sr. No	Character studies	Mean Range
1	Days to 50% flowering	69-116
2	Plant height (cm)	49-81
3	No. of pods/plant	45-147
4	Days to maturity	165-173
5	Grain yield (kg/ha)	146-3313

**Table 20. Classification of germplasm on yield basis (Irrigated)**

Sr. No	Yield range (kg/ha)	No. of entries
1	3000-3313	1
2	2000-3000	6
3	1000-2000	53
4	146-1000	54
5	Abolished	1

**Table 21. Characterization of chickpea germplasm Kabuli (Rainfed)**

Sr. No	Character studies	Mean Range
1	Days to 50% flowering	57-109
2	Plant height (cm)	34-63
3	No. of pods/plant	5-65
4	Days to maturity	149-167
5	Grain yield (g/plot)	146-1667

**Table 22. Classification of germplasm on yield basis (Rainfed)**

Sr. No	Yield range (kg/ha)	No. of entries
1	1000-1667	2
2	500-1000	58
3	140-500	55



In chickpea (Kabuli) Genepool, total 115 entries were studied in two different conditions (irrigated and rainfed). In irrigated conditions, entry coded as GGP-32 gave maximum grain yield 3313 kg/ha, while the entry TGK 1520 remained at bottom with respect to yield value of 146 kg/ha. In rainfed conditions the entry coded as TGK1604 gave highest grain yield of 400 grams /plot and entry coded as COOP-4-B-K gave lowest grain yield 146 kg/. Only one entry yield above the limit of 3000 kg/ha in rainfed conditions.

### 2.1.3 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-2.2.

**Table 23. List of Crosses**

Sr.No.	Crosses	Characteristics	Successful pods
<b>Desi Chickpea Crosses</b>			
1	TG1424 x Bittle-16	Blight resistant, more pods / plant, high yielding x Early flowering, high yielding,	02
2	TG1410×TG1424	Blight tolerant , early maturing x More pods / plant, bold seeded, high yielding	01
3	NIAB-Channa-2016 x Bhakkar-2011	High yielding x wilt resistant, early flowering, bold seeded	04
4	D-14005 x Thal-2006	Blight tolerant, high yielding x Bold seeded	03
5	CH32/10 x Bhakkar-2011	Early flowering, more pods / plant, high yielding x wilt resistant, bold seeded	02
<b>Kabuli Chickpea Crosses</b>			
6	K-14006 x Noor-2013	More pods / plant, high yielding x early flowering, bold seeded	02
7	CH54/07 x 15-KCC-106	High yielding ×Bold seeded, drought tolerant	-
8	Noor-2009 x Noor-2013	High yielding ×Bold seeded, High yielding	03

### 2.1.4 Evaluation of Filial Generations

Chickpea segregating generations viz, 6F<sub>1</sub>, 5F<sub>2</sub>, 10F<sub>3</sub>, 10F<sub>4</sub>, 08F<sub>5</sub>, 10F<sub>6</sub> and 06F<sub>7</sub> populations were studied. 409 single plants/ progenies were selected from F<sub>3</sub> to F<sub>6</sub> populations for further evaluation. 18 uniform lines were also selected from F<sub>7</sub> for further evaluation in preliminary yield trials.

**Table 24 F<sub>1</sub> Generation**

Sr. No	Crosses	Population
1	TG1415 x Bittle-16	Bulk population
2	TG1410 x TG1415	Bulk population
3	NIAB Channa x Bk-11	Bulk population
4	Thal-06 x D-14005	Bulk population
5	Bittle-16 x CH32/10	Bulk population
6	Noor--13 x K-14006	Bulk population

**Table 25. F<sub>2</sub> Generation**

Sr. No	Crosses	Single plant/ progenies planted	Single plant/ progenies selected
1	CH40/08 x CH39/09	06	Bulk population
2	CH28/07 x DCD	10	Bulk population
3	D-1008xCH49/09	08	Bulk population
4	K-01216 x K-01211	01	Bulk population
5	CH55/09 x TG12K07	01	Bulk population

**Table 26. F<sub>3</sub> Generation**

Sr. No	Crosses	Single plant/ progenies planted	Single plant/ progenies selected
1	K0902 x Noor-13	04	15
2	K09015 x CM1235/08	08	17
3	CH24/07 x CH104/06	10	14
4	Noor-2013 x TG12K07	09	13
5	D09027 x D-10008	10	15
6	CH39/08 Bhakkar-2011	10	16
7	CH104/06xBittle-2016	16	21
8	Noor-13x K09015	16	20
9	D09027 x D09013	16	22
10	K0039/10 x CH54/07	30	13
<b>Total</b>			<b>166</b>

**Table 27. F<sub>4</sub> Generation**

Sr. No	Crosses	Single plant /progenies planted	Single plant /progenies selected
1	FG0902 x K0065-09	09	15
2	K0039-09 x K0021-09	07	11
3	D096-09 x D072-09	08	13
4	D090-09 x Bhakkar-2011	06	04
5	Thal-2006 x Punjab-2008	11	09
6	K-004-10 x K012-10	05	13
7	K-005-10 x Noor-2009	10	09
8	Bhakkar-2011 x D-0097-10	03	06
9	08AG016 x D0075-10	10	11
10	Punjab-2008 x 1977	13	12
<b>Total</b>			<b>103</b>

**Table 28. F<sub>5</sub> Generations**

Sr. No	Cross	Single plant /progenies sown	Single plants/progenies selected
1	D098-09 × D084-09	09	08
2	01067 × CH20/02	08	05
3	Bhakkar-2011 × D084-09	07	09
4	K004-10 × Noor-91	08	11
5	Noor-91 × K0069-10	10	13
6	D084/09× D096-09	11	10
7	CH39/04 × CH87/02	07	09
8	Noor-91 × Noor-2009	06	07
<b>Total</b>			<b>72</b>

**Table 29. F<sub>6</sub> Generation**

Sr. No	Crosses	Single plants / progenies sown	Single plants/progenies selected
1	BKK02209× D094-09	07	04
2	K70008 × Noor-2009	03	06
3	Bhakkar2011× D094-09	04	05
4	Bhakkar-2011× D0097-10	02	07
5	Punjab-2008× BKK02209	02	09
6	K0069-10 × D0085-10	03	04
7	08AG016 × D0075-10	04	12
8	Bhakkar-2011 × Thal-2006	05	10
9	08AG004× D084-09	05	06
10	08AG004 × D0085-10	03	05
<b>Total</b>			<b>68</b>

**Table 30. F<sub>7</sub> Generation**

Sr. No	Crosses	Single plant /progenies sown	Single plants/lines selected
1	08AG015 × D0096-10	5	18 Uniform lines
2	D0096-10 x BK-2011	6	
3	08AG015 × D0096-10	4	
4	D0096-10 x BK-2011	6	
5	K0019 x K0026-10	5	
6	K0019-10 x K0031-10	3	

**2.1.5 Chickpea Preliminary Yield Trial –Desi**

The trial comprising sixteen entries was laid out in RCBD with three replications under irrigated and rainfed conditions. The sowing was done on 23-10-2019 in rainfed and 28-10-2019 in irrigated conditions, respectively. The plot size was maintained as 4 x 1.2m. The trial was harvested in the mid of April, 2020.

**Table 31. Yield data of Chickpea Preliminary Yield Trial –Desi**

Sr. No.	Name of Entry	Yield (kg /ha )		Av. Yield (kg/ha)
		Irrigated	Rainfed	
1	TG1910	2791	951	1871
2	TG1912	2548	965	1757
3	TG1903	2253	1226	1740
4	TG1902	2493	974	1734
5	TG1904	2041	1174	1608
6	TG1911	2233	854	1544
7	TG1908	2220	783	1502
8	TG1901	1991	1008	1500
9	Bittle-2016	1935	875	1405
10	Bhakkar-2011	1939	778	1359
11	TG1914	1835	795	1315
12	TG1913	1718	912	1315
13	TG1907	1847	781	1314
14	TG1909	1724	899	1312
15	TG1906	1410	1004	1207
16	TG1905	1400	757	1079
		CV (%)= 8.92 LSD <sub>0.05</sub> = 301	CV(%)= 10.05 LSD <sub>0.05</sub> = 154.41	

Statistical analysis of yield data Table-31 showed that the differences among the means of entries were significant. Entry named as TG1910 gave the highest average yield 1871 kg/ha, followed by TG1912 and TG1903 with yield 1757 and 1740 kg/ha, respectively. The check variety Bittle-2016 gave the yield of 1405 kg/ha and lowest yield was recorded as 1079 kg/ha by TG1905.

### 2.1.6 Chickpea Preliminary Yield Trial-Kabuli

The trial comprising sixteen entries was laid out in RCBD with three replications under irrigated and rainfed conditions. The sowing was done on 23-10-2019 in rainfed and 28-10-2019 in irrigated conditions. The plot size was maintained as 4 x 1.2m. The trial was harvested in the mid of April, 2020.

It is observed from statistical analysis of yield data Table-32 that the differences among the means of entries were significant. Entry coded as TGK1903 gave the highest yield 1432 kg/ha, followed by TGK1904 and TGK1914 with yield 1207 and 1124 kg/ha, respectively. The standard check entries Noor-2009 and Noor-2013 gave the average yield of 731 and 701 kg/ha, respectively while the lowest yield was depicted as 625 kg/ha by TGK1909. It was observed that due to continuous rain from January to April-2020, crop attained more height under irrigated conditions, less podding and ultimately low yield as compared to rainfed conditions

**Table 32 Yield data of Chickpea Preliminary Yield Trial-Kabuli**

Sr. No.	Name of Entry	Yield (kg /ha )		Av. Yield (kg/ha)
		Irrigated	Rainfed	
1	TGK1903	2082	781	1432
2	TGK1904	1618	795	1207
3	TGK1914	1022	1226	1124
4	TGK1906	1022	1174	1098
5	TGK1913	950	912	931
6	TGK1901	834	1004	919
7	TGK1910	955	757	856
8	TGK1912	583	1008	796
9	Noor-2009	510	951	731
10	Noor-2013	436	965	701
11	TGK1911	520	854	687
12	TGK1902	400	974	687
13	TGK1908	586	783	685
14	TGK1907	489	875	682
15	TGK1905	558	778	668
16	TGK1909	351	899	625
		CV(%) = 12.52 LSD <sub>0.05</sub> = 168.50	CV(%) = 10.05 LSD <sub>0.05</sub> = 154.41	

**2.1.7 Chickpea Regular Yield Trial-Desi**

Chickpea regular yield trial comprising twenty entries was laid out according to RCBD with three replications both under irrigated and rainfed conditions. The sowing was done on 23-10-2019 in rainfed and 28-10-2019 in irrigated conditions. The plot size was maintained as 4 x 1.2 m. The trial was harvested in the mid April, 2020.

**Table 33. Yield data of Chickpea Regular Yield Trial-Desi**

Sr. No.	Name of Entry	Yield (kg /ha )		Av. Yield (kg/ha)
		Irrigated	Rainfed	
1	TG1818	2410	1385	1898
2	TG1801	2322	1384	1853
3	TG1817	2108	1563	1836
4	TG1826	2298	1340	1819
5	TG1802	2011	1424	1718
6	TG1806	2070	1288	1679
7	TG1823	2089	1089	1589
8	Bittle-2016	<b>1875</b>	<b>1254</b>	1565
9	TG1814	1946	1038	1492
10	TG1805	1945	1028	1487
11	TG1815	<b>1746</b>	<b>1211</b>	1479
12	TG1824	1910	1038	1474

13	Bhakkar-2011	1724	1139	1432
14	TG1808	1576	1277	1427
15	TG1825	2074	726	1400
16	TG1812	1642	1125	1384
17	TG1803	1682	868	1275
18	TG1820	1754	740	1247
19	TG1813	1333	1132	1233
20	TG1809	1235	917	1076
		CV(%) = 10.056 LSD <sub>0.05</sub> = 329.46	CV(%) = 11.04 LSD <sub>0.05</sub> = 209.57	

It is obvious from the Table 33 that the differences among the means of entries were significant. Entry TG1818 gave the highest yield 1898 kg/ha followed by TG1801 and TG1817 with yield 1853 and 1836 kg/ha where as check varieties Bittle-2016 and Bhakkar-2011 gave the yield 1565 and 1432 kg/ha, respectively. The entry TG1809 gave the lowest yield of 1076 kg/ha.

### 2.1.8 Chickpea Regular 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 23-10-2019 in rainfed and 28-10-2019 in irrigated conditions. The plot size was maintained as 4x 1.2 m. The trial was harvested in the mid April, 2020.

**Table 34. Yield data of Chickpea Regular Yield Trial-Kabuli**

Sr. No.	Name of Entry	Yield (kg /ha )		Av. Yield (kg/ha)
		Irrigated	Rainfed	
1	TGK1803	1886	805	1346
2	TGK1802	1983	695	1339
3	TGK1801	1868	736	1302
4	TGK1804	1774	813	1294
5	TGK1807	1764	750	1257
6	TGK1809	1654	858	1256
7	Noor-2013	1811	698	1255
8	TGK1805	1722	743	1233
9	TGK1808	1556	888	1222
10	Noor-2009	1835	555	1195
		CV(%) = 6.12 LSD <sub>0.05</sub> = 187.39	CV(%) = 14.47 LSD <sub>0.05</sub> = 187.12	

It is obvious from the data Table 34 that the differences between the means of entries were significant. Entry coded as TGk1803 gave the highest yield 1346 kg/ha followed by TGk1802 and TGK1801 with yield 1339 and 1302 kg/ha, respectively. The check variety Noor-2013 gave the yield of 1255 kg/ha while Noor-2009 remained lowest yielder with average yield of 1195 kg/ha.

### 2.1.9 Chickpea Micro Yield Trial (Desi).

Chickpea Micro Yield Trial comprising 13 entries was laid out according to RCBD with three replications at different locations viz AZRI (Two sets), GBRSS. Kalurkot and farmer's field Mankera.

**Table 35. Yield Performance of Chickpea Advance Line Micro Yield Trial (Desi 2019-20)**

Sr. No	Entries	Yield Kg/ha				
		AZRI Rainfed	AZRI Irrigated	GBRSS K KOT	Mankera	Average
1	TG 1708	1153	959	1736	228	1019
2	TG 1715	667	1191	1701	332	973
3	TG1703	979	1024	1444	270	929
4	TG 1707	951	878	1576	194	900
5	TG1717	756	837	1653	249	874
6	BK 2011	951	797	1139	271	790
7	TG1716	1042	698	1049	281	768
8	Bittal 2016	778	743	1306	210	759
9	TG 1710	632	673	1319	265	722
10	TG1702	639	706	1167	350	716
11	TG 1713	1128	594	823	277	706
12	TG 1714	745	719	1076	283	706
13	NIAB Chana 2016	694	646	1115	311	692
	CV (%)	19.82	2.7	7.05	4.99	
	LSD <sub>0.05</sub>	284.72	35.30	156.94	22.79	

It is obvious from the data that the differences between the means of entries were significant. The entry TG-1708 gave the highest average yield 1019 kg/ha followed by TG-1715 and TG-1703, with yield of 973 and 929 kg/ha, respectively. Whereas check varieties Bhakkar-2011, Bittle-2016 and Niab Channa 2016 gave the yield 790 and 692 kg/ha respectively.

### 2.1.10 Chickpea Micro Yield Trial (Kabuli).

Chickpea Micro Yield Trial comprising 12 entries was laid out according to RCBD with three replications at different locations viz AZRI (Two sets), GBRSS. Kalurkot and farmer's field Mankera with plot size of 4.8m<sup>2</sup>

**Table 36. Yield performance chickpea advance lines in MYT (Kabuli).**

Sr. No	Entries	Yield Kg/ha				
		AZRI Rainfed	AZRI Irrigated	GBRSS K Kot	Mankera	Average
1	TGK 1761	368	549	1000	231	537
2	TGK 17 62	465	625	1313	199	650
3	TGK 1763	524	778	1549	187	759

4	TGK 1764	500	348	1076	240	541
5	Noor-2009	503	722	1215	142	645
6	TGK 1765	363	632	799	178	493
7	TGK 17 66	379	597	1535	186	674
8	TGK 17 67	394	549	1340	190	618
9	TGK 17 68	375	424	1549	210	639
10	Noor-2013	375	590	1604	154	681
11	TGK 17 69	413	431	1785	223	713
12	TGK 17 70	295	528	1542	173	634
LSD <sub>0.05</sub> CV (%)		12.52 87.540	6.60 63.091	4.59 106.17	10.19 33.271	

It is obvious from the data that the differences between the means of entries were significant. The entry TGK-1763 gave the highest average yield 759 kg/ha followed by TGK-1769 and TGK-1766 with yield of 713 and 674 kg/ha whereas check varieties Noor-2009 and Noor-2016 gave the yield 645 and 681 kg/ha respectively.

#### 2.1.11 Chickpea Advance Yield Trial (Desi)-NIAB, Faisalabad

This trial comprising 16 test entries was laid out according to RCBD with three replications. The trial was sown on 17-10-2019 with the plot size of 4 x 1.2m. The trial was harvested in the mid April, 2020

**Table 37. Yield Data of Chickpea Advance Yield Trial-Desi**

Sr. No.	Name of Entry	Yield (kg /ha )	Sr. No.	Name of Entry	Yield (kg /ha)
1	DCH55-14	2933	9	DCH20-14	1678
2	BITTLE-16	2658	10	DCH41-14	1588
3	DCH44-14	2469	11	DCH26-14	1542
4	DCH58-14	2302	12	DCH1-14	1351
5	DCH51-14	2146	13	DCH52-14	1330
6	BHAKKAR-11	2111	14	DCH32-14	1303
7	DCH78-14	1705	15	DCH38-14	1285
8	DCH11-14	1694	16	DCH21-14	1264
		CV (%) = 10.03			LSD <sub>0.05</sub> = 306.84

It is obvious from the data Table-37 that the differences among the means of entries were significant. The entry DCH55-14 gave the highest yield 2933 kg/ha followed by Bittle-2016 gave the yield 2658 kg/ha. The entry DCH21-14 gave the lowest yield of 1264 kg/ha.

#### 2.1.12 Chickpea Advance Yield Trial (Kabuli)-NIAB, Faisalabad

This trial comprising 12 test entries was laid out according to RCBD with three replications. The trial was sown on 28-10-2019 with the plot size of 4 x 1.2m. The trial was harvested in the mid April, 2020.



**Table 38. Yield Data of Chickpea Advance Yield Trial-Kabuli**

Sr. No.	Name of Entry	Yield (kg /ha )	Sr. No.	Name of Entry	Yield (kg /ha)
1	KCH17-14	1897	7	KCH18-14	1389
2	Noor-2013	1698	8	KCM77/12	1382
3	KCH86/13	1635	9	KCM1788/12	1376
4	KCH19-14	1567	10	KCM1859/12	1370
5	KCH82/13	1497	11	KCH13-14	1343
6	KCH87/13	1418	12	CM-2008	1241
		CV (%) = 7.52	LSD <sub>0.05</sub> = 188.91		

It is obvious from the data Table-38 that the differences among the means of entries were significant. The entry KCH17-14 gave the highest yield 1897 kg/ha followed by check variety Noor-2013 with yield of 1698 kg/ha. The check variety CM-2008 gave the lowest yield of 1241 kg/ha.

### 2.1.13 Chickpea Advance Yield Trial (Kabuli)-NARC, Islamabad

This trial comprising 20 test entries was laid out according to (RCBD) with three replications. The trial was sown on 04-11-19 with a plot size of 4 x 1.2m. The trial was harvested on 16-04-2020.

**Table 39. Yield Data of Chickpea Advance Yield Trial-Kabuli**

Sr. No.	Name of Entry	Yield (kg /ha )	Sr. No.	Name of Entry	Yield (kg /ha)
1	NCSK-1915	1678	11	NCSK-1905	1042
2	NCSK-1908	1500	12	NCSK-1907	1031
3	NCSK-1918	1323	13	NCSK-1906	990
4	NCSK-1912	1208	14	NCSK-1909	990
5	NCSK-1914	1178	15	NCSK-1923	980
6	NCSK-1917	1167	16	NCSK-1921	969
7	NCSK-1916	1109	17	NCSK-1920	948
8	NCSK-1919	1104	18	NCSK-1911	934
9	NCSK-1910	1073	19	NCSK-1913	917
10	Noor-2019	1063	20	NCSK-1922	906
		CV (%) = 14.88	LSD <sub>0.05</sub> = 344.19		

It is obvious from the data Table-39 that the differences among the means of entries were significant. The entry NCSK-1915 gave the highest yield 1678 kg/ha followed by NCSK-1908, NCSK-1918 with yield 1500, and 1323 kg/ha, respectively where as NCSK-1922 gave the lowest yield 906 kg/ha.

### 2.1.14 Chickpea Cooperative Yield Trial-Desi (Set-I)

Chickpea trial comprising sixteen entries was laid out according to RCBD with three replications under irrigated and rainfed conditions. The plot size was kept as 4 × 1.2m. All the cultural practices were same carried out.

**Table 40 Consolidated Results of Cooperative Yield Trial-Desi (Set-I)**

Sr.#	Entry	PRI, Fsd	NIAB Fsd	K.Kot	AZRI. Bkr	B.Pur	K.Kot (Barani)	AZRI. Bkr (Barani)	K.Kot (F. Field)	K.Kot (F. Field)	Rakhutra (Barani)	AZRI. Bkr F. Field	AZRI. Bkr F.Field	Ave. (kg/h)
1	CH21/13	762	1767	2583	2069	3438	1514	580	229	319	188	751	1554	1313
2	D-17028	457	1607	2097	1813	3576	1465	767	510	455	201	863	1516	1277
3	D-17006	537	1793	2139	1976	3507	1375	682	250	299	243	1201	1299	1275
4	D-17019	767	1560	2375	1196	3576	1597	806	476	497	313	847	1167	1265
5	CH28/13	463	1621	2069	2298	3229	1618	547	392	580	188	910	1235	1262
6	D-17003	774	1429	2250	1758	2951	1799	493	517	344	208	1168	1389	1257
7	TG-1427	867	1395	1826	1969	3785	1299	739	302	306	292	1142	1153	1256
8	CH30/12	118	1248	2528	2182	2986	1500	721	413	413	271	1028	1278	1224
9	CH39/13	299	1250	2063	2174	2882	1576	567	524	486	181	1121	1361	1207
10	TG-1504	479	1558	1705	1712	2743	1306	838	292	278	271	1008	1179	1114
11	Bittal-16	370	1002	2056	1821	2431	1535	744	392	431	347	760	1303	1099
12	BRC-474	490	1206	1438	1819	3021	1521	560	375	382	236	664	1386	1091
13	TG-1510	358	1309	1861	2072	2257	896	835	306	361	285	1145	1381	1089
14	D-17015	160	1068	1688	1507	3229	1076	972	226	323	222	969	1357	1066
15	CH-2016	448	1012	1576	1851	3958	514	607	170	365	139	816	1301	1063
16	TG-1430	412	1147	1670	1865	1701	1694	551	174	260	160	997	1374	1001

It is evident from the Table 40 that the differences among the means of yield value of entries were significant. Test entry TG1427 and TG1504 contributed by AZRI, Bhakkar gave grain yield 1256 and 1114 kg/ha, respectively. While the standard check Bittle-2016 gave 1099kg/ha. The entry CH21/13 gave the maximum average yield 1313 kg / ha followed by CH21/13 with grain yield 1277 kg/ha while lowest yield of 1001 kg/ha was given by advance line TG1430.

### 2.1.15 Chickpea Cooperative Yield Trial-Desi (Set-II)

Chickpea Cooperative Yield Trial Desi (Set-II) consisting of 16 entries was laid out according to RCBD with three replications. The plot size was maintained as 4 x 1.2 m. Arid Zone Research Institute, Bhakkar contributed three advance lines TG 1305, TG 1428 and TG 1501 for the Chickpea Cooperative yield Trial-Desi (Set-II) 2019-20.

Consolidated yield data showed that the differences among the means of entries were highly significant. Test entry TG 1305 and TG 1428 exhibited the mean yield of 1363 and 1321 kg/ha. While standard check Bittle-2016 gave the average yield 1180 kg/ha.

**Table 41. Consolidated Results of Cooperative yield trial (Dsei)**

Sr.#	Entry	PRI, Fsd	NIAB Fsd	K.Kot	AZRI. Bkr	B.Pur	K.Kot (Barani)	AZRI. Bkr(Barani)	K.Kot(Farmer Field)	K.Kot(Farmer Field)	Rakhutra (Barani)	AZRI. Bkr(Farmer Field)	AZRI. Bkr(Farmer Field)	Ave. (Kg/h)
		1	2	3	4	5	6	7	8	9	10	11	12	
1	CH30/13	753	2429	2681	2458	3403	1174	908	382	587	340	1567	1600	1523
2	CH26/13	719	2073	1910	2253	3299	1882	1021	347	448	323	1640	1438	1446
3	D-17016	771	2017	2410	1976	2882	1990	1458	375	580	306	1136	1396	1441
4	TG-1305	389	2490	1674	2299	2965	1403	1061	431	552	431	1653	1011	1363
5	D-17005	754	2219	1476	2135	2354	1958	1038	493	493	264	1476	1444	1342
6	TG-1428	417	2229	2076	2358	3076	813	1060	378	396	378	1540	1135	1321
7	D-17002	289	2875	1559	2628	2674	1674	949	215	274	122	1128	1122	1292
8	D17035	282	2371	1222	2458	2569	1646	1044	326	361	194	1645	1267	1282
9	D-17027	424	1725	1896	1874	2847	1236	1431	403	410	403	1049	1528	1269
10	CH15/13	431	1771	1899	1828	2500	1778	1085	396	399	385	1125	1145	1228
11	Bittal-16	456	1871	1809	2058	2125	1222	868	354	486	326	1406	1177	1180
12	CH13/12	726	1573	1569	1805	2535	1396	1279	344	538	135	951	1313	1180
13	D-17014	247	1844	1597	2094	2271	1104	1431	368	385	368	1034	1319	1172
14	TG-1501	166	2115	1660	2110	1653	1188	1388	260	295	240	1578	1410	1172
15	CH-2016	347	1750	1750	1792	2833	792	1000	257	295	257	1417	1444	1161
16	BRC-446	179	1406	1403	1791	2674	1479	840	392	444	264	1206	1035	1093

### 2.1.16 Chickpea Cooperative Yield Trial-Kabuli

Chickpea Cooperative Yield Trial consisting of 20 entries was laid out according to RCBD with three replications. The sowing was done on 28-10-2019 at AZRI, Bhakkar with a plot size of 4 x 1.2 m and harvesting was done on 17-04-2019. Arid Zone Research Institute, Bhakkar contributed three advance lines for the Chickpea Cooperative yield Trial (Kabuli) 2019-20.

Consolidated yield data showed that the differences among the means of entries were highly significant. Test entry TGK1504, contributed by AZRI, Bhakkar got top position across all locations, it exhibited the mean yield of 1160 kg/ha. Other entry of AZRI, Bhakkar TGK1503 stood at fifth having mean grain yield of 1086 kg ha<sup>-1</sup> and test entry TGK1508 of AZRI, Bhakkar having grain yield 1041 kg ha<sup>-1</sup>, while the check entry Noor-2013 gave grain yield 1020 kg ha<sup>-1</sup>.

**Table 42 Yield data of chickpea cooperative yield trial-Kabuli**

Sr No	Varieties/ Lines	PRI, Fsd	Locations									Yield (Kg/ha)
			PRI Fsd	PRI Fsd	NIA B	RAR I	BARS	AZRI	GBRS, K. Kot	GBRS K. Kot	Rakh utra	
		Normal	Zero Irri	01 Irri	FSD	BWP	Fateh Jang	BKR	(Baran i)	(Irri)		
1	TGK1504	931	632	962	1003	2208	723	1794	1069	2083	198	1160
2	BRC408	552	524	757	867	2687	684	1611	1347	1819	326	1117
3	PCK-16027	810	531	625	878	2083	681	1633	1507	2055	260	1106
4	Noor-2019	854	597	924	985	1910	719	1751	1042	1923	333	1104
5	TGK1503	861	479	757	909	2431	733	1618	896	1979	201	1086
6	CH73/13	806	639	861	985	2118	686	1635	1062	1795	260	1085
7	PCK-16010	783	694	1054	1029	1528	671	1764	1368	1729	201	1082
8	PCK17002	479	406	465	899	2500	663	1758	1680	1604	365	1082
9	CH74/13	719	365	670	929	2243	710	1844	1472	1465	306	1072
10	PCK17001	809	517	687	868	2187	693	1666	618	2035	458	1054
11	CH51/12	736	424	545	866	2194	699	1375	1389	2014	187	1043
12	CH69/09	758	441	719	887	1806	696	1550	1354	1951	271	1043
13	TGK1508	600	893	802	879	2083	707	1610	1229	1274	333	1041
14	CH72/13	854	611	715	912	1944	660	1554	875	1899	340	1036
15	CH47/13	753	413	809	910	1937	716	1646	972	1941	201	1030
16	Noor-2013	658	545	663	892	1826	681	1522	1417	1764	229	1020
17	PCK17018	649	319	469	852	2292	683	1436	1510	1743	187	1014
18	PCK17030	540	368	490	876	1465	676	1719	1660	2014	312	1012
19	PCK17024	490	223	587	915	2326	703	1217	1406	1736	208	981
20	CH56/12	549	515	715	898	1701	729	1681	868	1736	212	960

### 2.1.17 Chickpea National Uniform Yield Trial (Desi)

Chickpea National Uniform Yield Trial consisting of 19 entries coded as 1 to 19 was laid out according to RCBD with three replications. The sowing was done on 01-11-2019 at AZRI, Bhakkar with a plot size of 4 x 1.2 m and harvesting was done on 23-04-2020.

**Table 43. Results of Chickpea (Desi) National Uniform yield Trail 2019-20**

Consolidated results of Chickpea (Desi) National Uniform yield Trail 2019-20

S No	Code	Entries	Institute	Blight Rating	Locations*											Mean
					1	2	3	4	5	6	7	8	9	10	11	
1	CD19095	CH-11/12	NIAB, Faisalabad	7	629	1015	1194	2014	1425	626	1833	2117	1136	2427	2257	1516
2	CD19071	BRC-474	RARI, Bahawalpur	7	624	1886	1147	2778	794	543	1108	1549	1225	2313	2708	1516
3	CD19058	D-16029	PRI, Faisalabad	7	918	1082	1885	1632	471	673	2243	1546	979	2653	2222	1482
4	CD19080	D-15024	PRI, Faisalabad	5	656	957	1544	1806	978	600	2444	2281	1148	2139	1597	1468
5	CD19053	TG-1427	AZRI, Bhakkar	5	652	798	1545	1875	1239	628	1406	2352	1259	2465	1806	1457
6	CD19085	CH35/10	NIAB, Faisalabad	9	561	1599	1299	1910	1456	635	1215	1994	841	2681	1806	1454
7	CD19070	CH-12/12	NIAB, Faisalabad	7	705	1007	1931	1771	606	618	1958	2176	1061	2326	1806	1451
8	CD19084	D-16004	PRI, Faisalabad	7	1071	1052	1264	1944	1317	581	1396	1628	978	2250	2188	1424
9	CD19060	SL05-53	ARS, Karak	7	1126	1950	1226	2014	385	665	1715	1653	1017	2250	1597	1418
10	CD19051	CH-32/10	NIAB, Faisalabad	5	633	1213	928	1736	1417	627	1365	2304	1121	2201	2049	1418
11	CD19069	TG-1510	AZRI, Bhakkar	7	976	1132	875	1597	1354	644	1559	2469	1041	2431	1458	1412
12	CD19055	D-16003	PRI, Faisalabad	5	625	757	1170	1910	838	591	1667	2372	1043	2639	1806	1402
13	CD19088	TG1305	AZRI, Bhakkar	3	592	643	1217	1632	890	593	2403	2004	939	2472	1979	1397
14	CD19065	D-15033	PRI, Faisalabad	5	210	990	1323	1875	1274	653	1722	1956	963	2444	1632	1367
15	CD19090	CH24/11	NIAB, Faisalabad	5	304	1200	1136	1910	725	682	1868	2027	958	2347	1771	1357
16	CD19072	D-16020	PRI, Faisalabad	7	240	1048	1105	1979	1197	575	1597	2075	956	2354	1736	1351
17	CD19067	INDUS-19	CHECK	7	319	1077	1077	1875	914	535	1681	1966	1029	2181	1736	1308
18	CD19064	BRC-446	RARI, Bahawalpur	9	219	1111	1069	1694	697	663	1104	2335	897	2486	1632	1264
19	CD19076	TG-1430	AZRI, Bhakkar	7	340	913	1068	1597	803	649	1167	2141	967	2181	1764	1235
Location Mean					600	1128	1263	1871	988	620	1655	2050	1029	2381	1871	

LOCATIONS										
1	2	3	4	5	6	7	8	9	10	11
ARI, AARI Faisalabad	ARS Karak	AZRI Bhakkar	AZRI Bahawalpur	AZRC D.I.Khan	BARS Fateh Jhang	GRS Klur Kot	NARC Islamabad	NIAB Faisalabad	QAARI Larkana	RARI Bahawalpur

Note: Trial sent to 14 locations. Grain yield data received from 11 locations. At three locations crop was damaged due to hailstorms and snowfall.

  
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Arid Zone Research Institute, Bhakkar contributed four (TG 1305, TG 1427, TG 1430 and TG 1510) advance lines for the Chickpea National Uniform Yield Trial (Desi) 2019-20. The yield data showed that the differences among the means of entries were significant. Test entry TG1427, TG1510 and TG1305 gave the av. Yield 1457, 1412 and 1397 kg/ha respectively while check variety Indus -19 gave av. Yield value of 1308 kg/ha.

### 2.1.18 Chickpea National Uniform Yield Trial (Kabuli)

Chickpea trial comprising sixteen coded entries was laid out according to RCBD with three replications. The sowing was done on 01-11-2019 at AZRI, Bhakkar with a plot size of 4 x 1.2 m. All cultural practices were carried out as when required and harvesting was done on 23-04-2020.

**Table 44. Yield data of Chickpea (Kabuli) National Uniform yield Trail 2019-20**

Consolidated results of Chickpea (Kabuli) National Uniform yield Trail 2019-20

S.No	Code	Entry Name	Institute	Blight Rating	Locations										Mean
					1	2	3	4	5	6	7	8	9	10	
1	CK19005	BRC-408	RARI Bahawalpur	9	976	1283	1090	250	760	1656	1989	852	2438	2049	1334
2	CK19022	15 KCC-112	BARI, Chakwal	7	969	1175	824	476	711	1563	2314	968	2604	1354	1296
3	CK19009	15FCK16	BARS Fatehjang	5	924	1007	1008	482	742	1424	2175	932	2479	1736	1291
4	CK19011	TGK1504	AZRI, Bhakkar	9	965	1659	1251	601	667	1146	1698	922	2389	1250	1255
5	CK19030	TGK1508	AZRI, Bhakkar	5	872	1779	740	488	742	1316	1918	906	2493	1285	1254
6	CK19001	NCK-1801	PRP,NARC, Islamabad	3	861	827	1038	499	660	1184	1731	1106	2479	2000	1238
7	CK19020	CH64/11	NIAB, Faisalabad	9	908	831	795	556	768	1611	1501	911	2479	2014	1237
8	CK19003	CH66/10	NIAB, Faisalabad	9	753	1265	831	576	779	1368	1933	863	2438	1563	1237
9	CK19007	PCK-15001	PRI, Faisalabad	9	667	1595	872	588	723	1000	1740	888	2410	1806	1229
10	CK19027	CH47/12	NIAB, Faisalabad	9	917	1701	769	507	730	1576	1054	999	2111	1736	1210
11	CK19013	Noor-2013 (CHECK)		9	674	1398	840	522	726	927	1874	931	2729	1458	1208
12	CK19025	14FCK02	BARS Fatehjang	7	764	792	847	431	784	1358	1978	1008	2306	1354	1162
13	CK19029	CH48/12	NIAB, Faisalabad	9	665	1278	949	388	698	1236	1546	885	2583	1007	1123
14	CK19015	TGK1503	AZRI, Bhakkar	9	1250	1423	738	239	679	785	1174	978	2646	1285	1120
15	CK19018	PCK-15019	PRI, Faisalabad	3	750	906	986	194	714	899	2097	1105	2326	1076	1105
16	CK19035	CH53/12	NIAB, Faisalabad	9	931	1061	918	455	731	1253	749	933	2160	1285	1048
<b>Location Mean</b>					<b>865</b>	<b>1249</b>	<b>906</b>	<b>453</b>	<b>726</b>	<b>1269</b>	<b>1717</b>	<b>949</b>	<b>2442</b>	<b>1516</b>	

LOCATIONS									
1	2	3	4	5	6	7	8	9	10
PRI, AARI Faisalabad	ARS Karak	AZRI Bhakkar	AZRC D.I.Khan	BARS Fateh Jhang	GRS Ktur Kot	NARC Islamabad	NIAB Faisalabad	QAARI Larkana	RARI Bahawalpur

Note: Note: Trial sent to 13 locations. Grain yield data received from 10 locations. At three locations crop was damaged due to hailstorms and snow fall.

Arid Zone Research Institute, Bhakkar contributed three (TG 1503, TGK 1504 and TGK 1508) advance lines for the Chickpea National Uniform yield Trial (Kabuli) 2019-20. The yield data showed that the differences among the means of entries were highly significant. Test entry TGK1504 and TGK1508 gave av. Yield value of 1255 and 1254 kg/ha respectively whereas, Noor-2013 (Check) gave the av. Yield of 1208 kg / ha. The minimum yield value was recorded as 1048 kg/ha by CH53/12.

### 2.1.19 Seed Multiplication of Candidate Lines:

The seed of 23 chickpea candidate lines were multiplied for testing in Provincial and at national level. The sowing of chickpea lines were completed on 22.10.2019. The test entry TG1620, TG1621, TG1614 and TG 1617 gave the better yield and expected to perform latter at next stage of evaluation.

### 2.1.20 Seed Production:

BNS, Pre Basic and Basic seed of approved varieties were produced during Rabi 2019-20. The detail of seed production is given as under:-

**Table 45. BNS & Pre Basic Seed Production Of Chickpea**

Variety	BNS (kg)	Pre-Basic (kg)	Basic (kg)
Bhakkar-2011	90	2200	-
Thal-2006	40	500	-
NIAB-CH-2016	-	-	2650
Bittle-2016	-	-	4050

## 2.2 MUNGBEAN:

### 2.2.1 Variety development:

One Mungbean candidate variety was evolved and was offered for spot examination. The sowing of advance line 13TM-04 was done on 09.05.2019 and the spot examination was successfully conducted on 05.08.2019 by the experts.

### 2.2.2 DUS Study:

The Distinguish Uniformity Study were completed regarding Mungbean candidate lines 13TM-04 and 13TM-14. The sowing was done on 09.05.2019 and were characterized alongwith by the FSC&RD team. The data was sent to the Director General FSC&RD for acquiring the DUS certificate. DUS certificate Mungbean advance line 13TM-04 was issued by the FC&RD for further proceeding to variety approval.

### 2.2.3 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 crosses made is given as

**Table 46 List of Crosses**

Sr. No	Cross combinations	Characteristics	Successful pods
1	NM-16 x AZRI-Mung-06	High yielding x Yellow mosaic resistant	04
2	AZRI-Mung-06 x 13 TM-04	Yellow mosaic resistant x high yielding	-
3	NM-2011 x AZRI-Mung-2018	Bold seeded, early maturing x high yielding	03
4	TM-1706 x TM-1711	High yielding x bold seeded	
5	AZRI Mung-2018 x NM-2016	High yielding x Yellow mosaic resistant, bold seeded	04
6	TM1627 x NM-2016	High yielding x bold seeded & high yielding	02
7	AZRI Mung-2018 x AZRI-Mung-06	High yielding, heat tolerant x bold seeded & high yielding	05
8	NM-11 x TM1627	Bold seeded, Yellow mosaic resistant x high yielding, bold seeded	02

### 2.2.4 Collection and Maintenance of Mungbean Germplasm

Two hundred entries /strain collected from different sources were sown in observational plots to screen out elite lines. Sowing was done on 27-05-19 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.



**Table 47 (a) Characterization of germplasm**

Sr. No	Characters	Range
1	Days to 50% flowering	36-45
2	Plant height (cm)	35-60
3	Pod length (cm)	2.30-7.7
4	No. of Pods Plant <sup>-1</sup>	22-40
5	Days to maturity	80-90
6	Seed yield (kgha <sup>-1</sup> )	325-2050

**Table 47 (b) Characterization of germplasm**

Sr. No	Yield range (kg/ha)	No. of entries
1	1801-2050	30
2	1501-1800	40
3	1001-1500	50
4	325-1000	60
5	Abolish	20

**2.2.5 Evaluation of segregating generations**

Mungbean segregating generations viz, 4F<sub>1</sub>, 6F<sub>2</sub>, 5F<sub>3</sub>, 4F<sub>4</sub>, 6F<sub>5</sub>, 5F<sub>6</sub> and 4F<sub>7</sub> populations were planted to raise the next generation and further evaluation. 77 single plants / progenies were selected from F<sub>2</sub> to F<sub>6</sub> populations for further evaluation. 12 uniform lines were selected from F<sub>7</sub> for further evaluation in preliminary yield trials.

**Table 48. Segregating generations**

Filial generation	No. of crosses/progenies	Single plant/ lines selected
F <sub>1</sub>	04	Bulk population
F <sub>2</sub>	06	Bulk population
F <sub>3</sub>	05	12SPS/progenies
F <sub>4</sub>	04	20SPS/progenies
F <sub>5</sub>	06	25SPS/progenies
F <sub>6</sub>	05	20SPS/progenies
F <sub>7</sub>	04	12 uniform lines were selected for preliminary yield trials.

**2.2.6 Mungbean preliminary yield trial A**

Preliminary yield trial comprising fifteen entries was laid out according to RCBD with three replications. Plot size 4 x 1.2m was maintained. Sowing was done on 11-05-2019 and harvested on 03-09-2019.



**Table 49. Yield data of mungbean preliminary yield trial-A**

Sr. No	Name of entry	Yield (kg/ha)	Sr. No	Name of entry	Yield (kg/ha)
1	TM 1907	1260	9	TM 1903	906
2	TM 1911	1045	10	AM 2006	894
3	TM 1910	1035	11	TM1908	888
4	TM 1906	1007	12	TM 1902	870
5	TM 1901	1003	13	TM 1904	842
6	TM 1909	986	14	NM 2016	823
7	AM 2018	951	15	TM 1912	813
8	TM 1905	944			
<b>LSD<sub>(0.05)</sub> = 64 CV (%)=8.41</b>					

Data showed that results were statistically significant. The entry TM1907 gave the highest yield with mean yield value of 1260 kg/ha followed by TM1911 and TM1910 with mean yield of 1045 and 1035 kg/ha, respectively. The check entry AM-2018 gave the yield value of 951 kg/ha.

### 2.2.7 Mungbean Regular Yield Trial-B I

Mungbean regular yield trail-BI consisting of fourteen entries was laid out according to RCBD with three replications. Plot size was maintained as 4 x1.2m. Sowing was done on 11-05-2019 and trial was harvested on 02-09-2019.

**Table 50. Mungbean Regular Yield Trial-B I**

Sr. No	Name of entry	Yield (kg/ha)	Sr. No	Name of entry	Yield (kg/ha)
1	TM 1820	1243	8	AM 2018	993
2	TM 1802	1228	9	TM 1426	944
3	TM 1825	1184	10	NM 2016	943
4	TM 1807	1052	11	TM 1806	931
5	TM 1801	1035	12	TM 1808	920
6	AM 2006	1017	13	TM 1804	882
7	TM 1810	1000	14	TM 1817	823
<b>LSD<sub>(0.05)</sub> = 93 CV (%)= 11.38</b>					

Data showed that results were statistically significant. The entry TM 1820 gave the highest yield with mean yield value of 1243 kg/ha followed by TM1802 and TM1825 with mean yield of 1228 and 1184 kg/ha, respectively. The check entry NM-2016 gave the yield value of 943 kg/ha.

### 2.2.8 Mungbean Regular Yield Trial-B II

Mungbean regular yield trail-BII consisting of fourteen entries was laid out according to RCBD with three replications. Plot size was maintained as 4 x1.2m. Sowing was done on 11-05-2019 and trial was harvested on 02-09-2019.

**Table 51. Yield Data of Mungbean Regular Yield Trial B-II**

Sr. No	Name of entry	Yield (kg/ha)	Sr. No	Name of entry	Yield (kg/ha)
1	TM 1822	1524	8	AM 2006	1108
2	TM 1821	1388	9	TM 1814	1099
3	TM 1824	1249	10	NM 2016	1094
4	TM 1813	1160	11	AM 2018	1072
5	TM 1812	1151	12	TM 1816	1027
6	TM 1818	1149	13	TM 1803	1003
7	TM 1815	1142	14	TM 1823	969
<b>LSD<sub>(0.05)</sub> = 63.25 CV (%)= 6.81</b>					

Data showed that differences among the means were significant and test entry TM1822 gave the highest yield of 1524 kg/ha followed by entry TM1821 with yield of 1388 kg/ha while the check variety NM2016 gave the average yield of 1094 kg/ha.

### 2.2.9 Mungbean Micro Yield Trial

The trial consisting of thirteen entries was laid out according to RCBD with three replications at Arid Zone Research Institute, Bhakkar, Gram Breeding Research Sub Station, Kalurkot and Agronomic Research station Karor, Layyah respectively. Plot size was maintained as 4 x1.2m. Sowing was done on 11-05-2019 and trial was harvested on 02-09-2019.

**Table-52 Yield Data of Mungbean Micro Yield Trial**

S. No	Name of entry	AVERAGE Yield (kg/ha)			
		AZRI, BKR	GBRSS K.KOT	ARS Karor	Average
1	TM 1719	889	441	733	688
2	TM 1714	803	316	911	677
3	TM 1711	747	313	816	625
4	TM 1710	948	271	605	608
5	NM 2016	635	316	628	526
6	TM 1418	483	326	745	518
7	TM 1720	587	278	664	510
8	TM 1713	531	368	630	510
9	TM 1627	429	274	758	487
10	AM2018	549	347	514	470
11	AM 2006	528	260	578	455
12	TM 1706	653	257	400	437
13	TM 1701	410	243	569	407
<b>LSD<sub>(0.05)</sub></b>		<b>64</b>	<b>36</b>	<b>199</b>	
<b>CV (%)</b>		<b>8.41</b>	<b>14.53</b>	<b>17.97</b>	

Analysis of variance of the Table-50 showed that results were statistically significant. The entry TM 1719 gave the highest average yield 688 kg/ha followed by TM1714 and

TM1711 with mean yield of 677 and 625 kg/ha respectively. The check entry NM 2016 gave the yield 526 kg/ha.

### 2.2.10 Mungbean National Uniform Yield Trial 2019.

National Yield Trial comprising 15 entries was laid out according to RCBD. Two advance line TM-1418 & TM-1627 were contributed in the national uniform yield trial. Sowing was done on 17.06.2019. The test entries TM-1418 & TM-1627 contributed by Arid Zone Research Institute Bhakkar gave the yield 844 & 793 kg ha<sup>-1</sup> respectively. However, check varieties NM-11 and AZRI Mung 2018 gave grain yield of 771 & 772 kg ha<sup>-1</sup> respectively.

**Table 53. Consolidated Results of Mungbean National Uniform Yield Trial- across the Country**

S. No.	Decoding	LOCATIONS YIELD (Kg/ha)							Mean
		AARI FSD	AZRI BWP	AZRI BKR	AZRC D.IKhan	BARS F. Jang	NIAB FSD	NARC, ISB	
1	NCM-13	284	1570	229	1197	351	2173	724	933
2	MH-16054	433	1153	294	706	799	2349	747	926
3	MPP-15039	327	1060	247	1022	757	2229	640	897
4	15006	328	1066	185	1265	486	2122	789	892
5	AZRC-Mung-E5	408	1026	246	1403	524	1770	744	874
6	MH-13091	293	1296	344	1138	434	1858	681	863
7	TM-1418	335	1199	171	978	587	2178	463	844
8	MSPS-119	348	1175	247	852	354	2030	627	805
9	NIFA Mung-6	312	1256	293	867	472	2006	418	804
10	TM-1627	451	1154	236	1163	333	1626	585	793
11	MPP-15024	291	1120	206	699	622	1858	699	785
12	AZRI Mung 2018	359	1094	219	1013	403	1506	809	772
13	NM-11	339	1140	152	635	427	1955	747	771
14	14005	404	1144	235	613	597	1765	609	767
15	AZRC-E2-18	358	1082	210	1013	451	1450	517	726
	Mean	351	1169	234	971	506	1925	653	830
	LSD 0.05	89.90	41.50	64.69	75.35	32.30	225.6	165.5	-
	CV (%)	18.42	2.56	19.87	5.59	4.59	8.44	18.24	-

Coefficient of variation=10.32 % Genotypes (G), Location (L) and G x L interactions are highly significant (P<0.01)

**Note: Trial sent to 15 locations. Grain yield data received from 07 locations. So far grain yield data is not received from 08 locations**

Whole picture of trial showed that NCM-13 gave the maximum average yield value of 933 kg/ha closely followed by MH-16054 and MPP 15039 with average yield of 926 and 897 kg/ ha respectively which standard check AZRI Mung-2018 and NM-2011 with average yield of 772 and 771 kg/ha.

**2.2.11 Seed Multiplication of Candidate Lines:**

The seed of 12 Mungbean candidate lines were multiplied for testing in Provincial and at national level. The sowing of Mungbean line were completed on 10.05.2019. The test entry TM1607, TM1627 gave the better yield.

**2.2.12 Seed Production:**

BNS and Pre Basic seed of approved varieties were produced during Kharif 2019. The detail of seed production is given as under:-

**Table:-54 BNS & Pre Basic Seed Production of Mungbean**

<b>Variety</b>	<b>BNS (kg)</b>	<b>Pre-Basic (kg)</b>
AZRI-MUNG-2018	40	2000
AZRI-MUNG_2006	20	650

### 3.0 PLANT PROTECTION

#### 3.1 ENTOMOLOGY

##### 3.1.1 IPM STUDIES OF GRAM POD BORER UNDER AGRO-ECOLOGICAL ZONE OF THAL

The trial was conducted at Arid Zone Research Institute, Bhakkar under RCBD on gram variety Bhakkar-2011 with plot size of 25 x 120 m. Pheromone traps data was recorded on daily basis @ 6/acre. Light traps were installed @ 2/ hectare. Data of adult moth catches and others was collected on daily basis. Parasite cards were installed from seedling stage till harvesting. Data of larval population was recorded from pre flowering stage till pod formation on fortnightly basis. Yield and pod infestation data was also recorded at maturity.

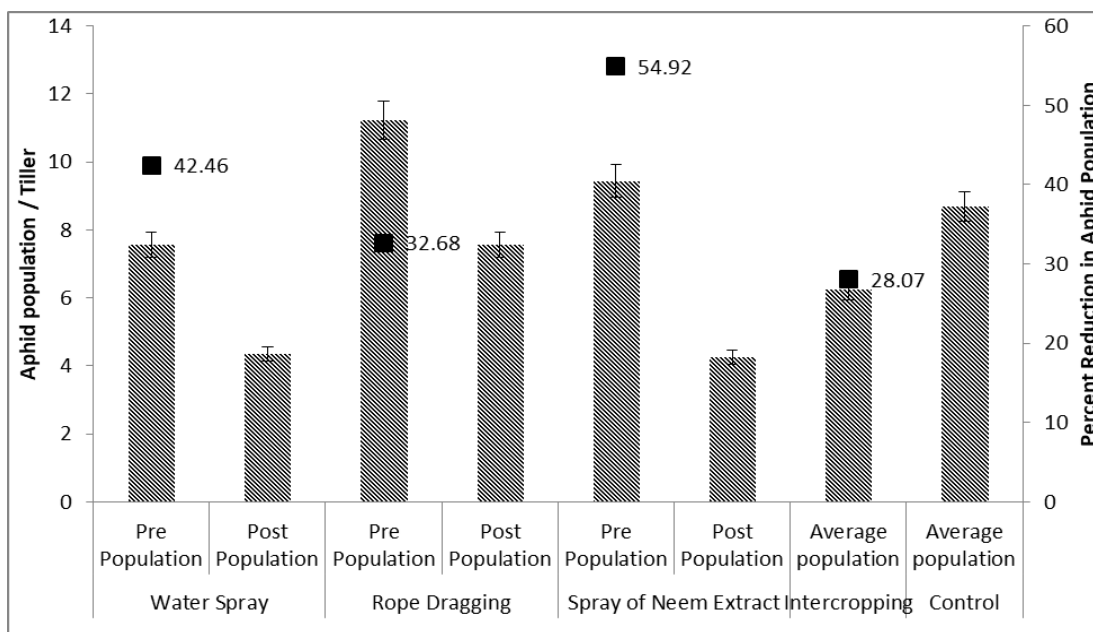
**Table-55. IPM Studies of Gram Pod Borer Under Agro-Ecological Zone of Thal**

Treatments	Average Foliage damage (%)	Pod Damage (%)	Grains Damage (%)	Average Larval Population/ Plant	Grain Yield (kg/ha)	Yield increase over control (%)
T <sub>1</sub> = Pheromone Traps	5.27bc	3.56b	3.49b	0.82bc	756.0ab	41.46
T <sub>2</sub> = Light Traps	2.09a	0.71a	0.29a	0.11a	825.0a	56.14
T <sub>3</sub> = Trichogramma cards	6.96c	7.92c	6.81b	0.92b	482.0c	8.58
T <sub>4</sub> = T-Bird Perches	6.28c	7.28c	12.42c	1.03c	588.0bc	10.50
T <sub>5</sub> = Hand Picking	3.69ab	4.95b	5.34b	0.63b	659.0b	19.57
T <sub>6</sub> = Control	9.18d	11.43 d	12.08c	0.96c	566.0c	

Results showed that Light trap was best technique among other IPM techniques with minimum damage to foliage, pods and grains with low larval population (0.11/plant), maximum grain yield of 825 kg/ha and maximum increase in yield 56.14 % over control followed by pheromone traps, Handpicking and T-Bird perches. Control treatment was not satisfactory as it had maximum foliage damage 9.18 %, pod damage 11.43 % grain damage 12.08 % and larval population 0.96/plant.

##### 3.1.2 . INTEGRATED PEST MANAGEMENT OF WHEAT APHID

The trial was conducted at Arid Zone Research Institute, Bhakkar under RCBD on wheat variety Fakhre Bhakkar-2018 with plot size of 30m x 140m. 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 1<sup>st</sup> 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.



Results revealed that spray of Neem extract significantly reduced aphid population 54.92 % followed by water spray, rope dragging and intercropping with 42.46, 32.68, 28.07 % population reduction respectively.

### 3.1.3 SCREENING OF ADVANCE LINES OF GRAM AGAINST POD BORER

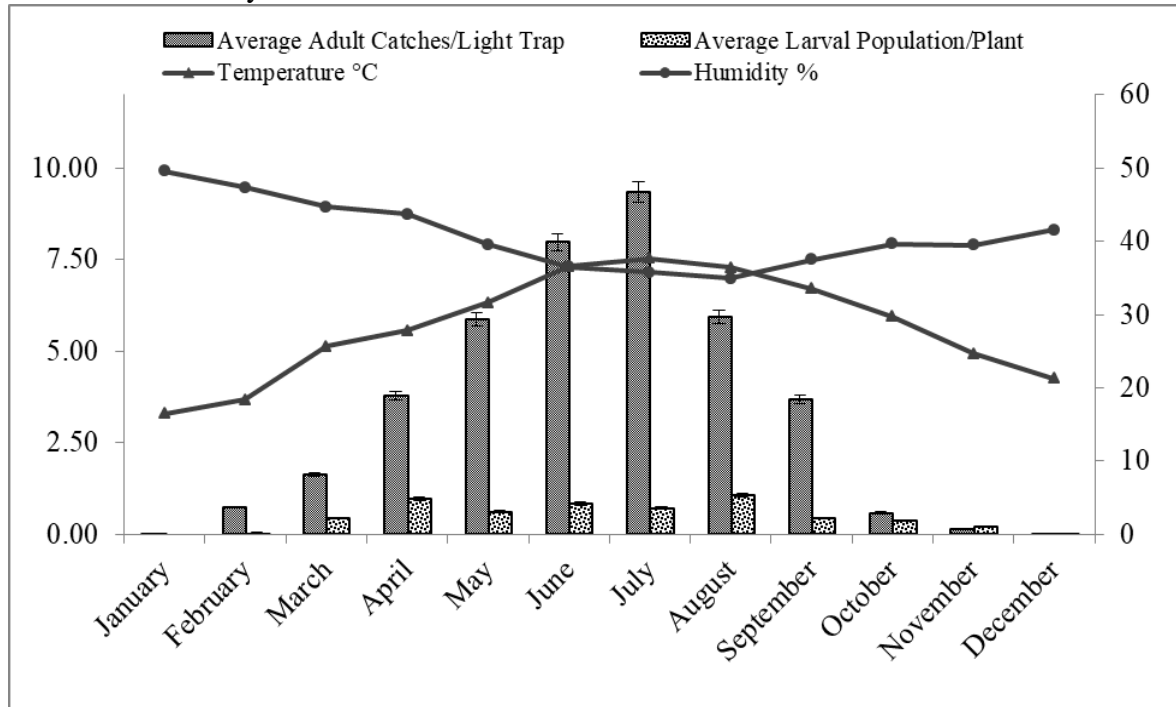
The trial was conducted at Arid Zone Research Institute, Bhakkar under augmented design with plot size 4 m x 1.2 m. *Helicoverpa* eggs and larval population was recorded per 6 inches terminal shoot from 5 plants/plot on weekly basis from the time of pre flowering to pod formation stage.

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-1711	TG-1712	TG-1702
TG-1704	TG-1713	TG-1710
TG-1806	TG-1703	TG-1708
TG-1820	TG-1715	TG-1817
TG-1815	TG-1718	TG-1818
TG-1621	TG-1714	TG-1825
TG-1623	TG-1707	TG-1812
	TG-1618	TG-1805
	TG-1617	TG-1802
	TG-1613	TG-1813
		TG-1814
		TG-1801
		TG-1622
		TG-1717

Results showed that advance lines TG-1711, TG-1704, TG-1806, TG-1820, TG-1815, TG-1621, TG-1623 found comparatively resistant against pod borer due to hardness of pod on TG-1711, TG-1704, TG-1806, TG-1820 and early pod bearing of TG-1815, TG-1621, TG-1623.

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

Two light traps were installed at research area of the institute. The moth catches /night were recorded daily.



**Table 56. Role of Light Traps in Attracting, Killing and Biodiversity Studies of Insect Pests in Thal**

Sr. No.	Name of Insect/Pest species	Total captures /ha	Crop Specific Pest
1	American Bollworm ( <i>Helicoverpa armigera</i> )	1513	Mungbean, Gram, Wheat, Vegetables, Cotton, Maize etc
2	Armyworm ( <i>Spodoptera litura</i> )	5055	Mungbean, Gram, Wheat, Vegetables, Cotton etc
3	Cutworm ( <i>Agrotis Sp.</i> )	1635	Seedlings of Mungbean, Gram, Wheat, Vegetables, Cotton etc
4	Whitefly ( <i>Bemesia sp.</i> )	2258	Mungbean, Cotton etc
5	Termites ( <i>Microtermes Spp.</i> )	1681	All crops, vegetables and ornamentals
6	Hairy Catterpillar ( <i>Euproctis lunata</i> )	186	Oilseed and fodder crops
7	Aphids ( <i>R. padi, S. graminum, S.</i> )	13154	Wheat, Ornamentals

	<i>avenae, M. rosae</i> )		
8	Leafminer ( <i>Phyllocnistis citrella</i> )	394	Citrus, Vegetables
9	Till hawk moth ( <i>Acherontia Spp.</i> )	79	Weeds, Ornamentals
10	Dung Beetle ( <i>Onthophagus gazelle</i> )	728	-
11	Ground Beetle ( <i>Calosoma Spp.</i> )	673	-
12	Green Bug ( <i>Chinavia hilaris</i> )	349	Mungbean, Gram, Vegetables, Cotton
13	Stink Bug ( <i>Halyomorpha halys</i> )	291	Mungbean, Gram, Vegetables, Cotton
14	Grey weevil ( <i>Myloccerus virdidanus</i> )	188	Mungbean, Cotton
15	Others (ants, grasshopper, cockroach, damselfly, click beetle, earwig, water beetle etc)	3891	-

During current studies main focus was to attract and kill adult population of Mungbean, Gram and Wheat pests. More than 26 insect species including 4 species of natural enemies were attracted through light traps. 30475 adult catches of insects were made during 2019-20 of which 16086 were important pests of gram, mungbean and other pulses. These pests were *Helicoverpa armigera*, *Spodoptera litura*, *Agrotis Sp.*, *Bemisia tabaci*, *Microtermes Spp.*, *Chinavia hilaris*, *Halyomorpha halys* and *Myloccerus virdidanus* with 1513, 5055, 1635, 6250, 1681, 349, 291, and 188 captures respectively. Population captures of different pests were increased by increasing the environmental temperature. More hot temperature had attracted more populations. Population captures were decreased during cold months as shown in figure.

### 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 and AZRI Mung-2018 will be used as check. Thrips population was recorded at weekly intervals from 6 cm length of 5 flowering shoots each taken from 5 random plants/plot. The pest population was compared statistically.

Results shows that advance lines 13TM-14 and 13TM-04 found comparatively resistant against pod borer due to hairiness of the pods and leaves. While advance lines 09TM-11, TM-1501 and AM-18 found susceptible while rest of lines were highly susceptible with population <5/plant. Temperature had highly significant and positive correlation with thrips population while humidity had negative and non-significant correlation with fluctuations in thrips population.

### 3.1.6 Infestation Levels of Espinola Bug on Mungbean Planting at Different Time

Espinola Bug is major sucking pest of which damages the 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 57. Infestation Levels of Espinola Bug on Mungbean Planting at Different Time**

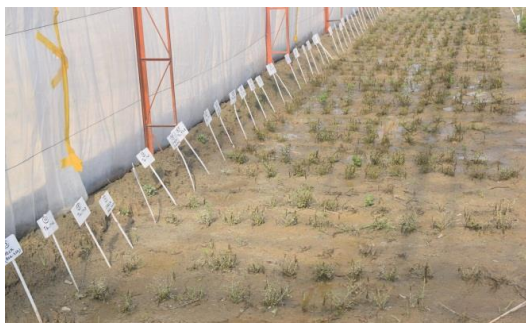
Sowing Dates		Average Espinola Bug Population/plant							Average Pop./season	Yield kg/acre
		15-Jun-19	30-Jun-19	14-Jul-19	28-Jul-19	11-Aug-19	25-Aug-19	8-Sep-19		
SD 1	25-Apr-19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	246.00
SD 2	5-May-19	0.00	0.00	0.00	0.00	0.56	0.88	0.65	0.30	256.00
SD 3	15-May-19	0.00	0.00	0.00	0.00	0.95	0.23	0.11	<b>0.18</b>	<b>356.00</b>
SD 4	25-May-19	0.00	0.00	0.00	0.00	1.23	2.36	0.00	0.51	321.00
SD 5	4-Jun-19	0.00	0.00	0.00	0.23	2.26	1.23	0.68	0.63	175.00
SD 6	14-Jun-19	0.00	0.00	0.00	0.25	1.05	0.68	0.36	0.33	136.00
SD 7	24-Jun-19	0.00	0.00	0.02	0.56	0.75	1.36	0.23	0.42	55.00
SD 8	4-Jul-19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.00
Temperature °C		40.36	40.95	41.68	42.26	42.07	39.64	37.15		

Results showed that sowing dates of 25 April, 05 May and 15 May were found least infestations with Espinola bug. While sowing dates 25 May and 04 June were found medium infestation. However sowing dates 14 June, 24 June and 04 July had found maximum attack of Espinola bug. Thus it is concluded that sowing before 15 May will be ideal having maximum yield and minimum pod infestation. Sowing dates after 15 May also have minimum population but they were very low yielded. Temperature and humidity had positive and non significant correlation with population.

## 3.2 PLANT PATHOLOGY

### 3.2.1 Screening of Chickpea advance lines against Ascochyta blight in tunnel.

Screening of Chickpea advance lines/ varieties against Ascochyta blight was conducted at Arid Zone Research institute , Bhakkar in plastic tunnel. The 61 Advance line/varieties were tested against Ascochyta blight experiment was sown on 28.10.2019 with help of dibbler. Each entry was sown in single row of one meter length. A susceptible variety Aug-424 was used as check and repeated after two test entries. The temperature and humidity was controlled by spraying simple water and by covering with transparent plastic sheet. Spore suspension was sprayed at 3 days interval till the initiation of disease (Fig). The maximum blight disease was developed at 14- 18C<sup>0</sup> and more than 80% humidity.



**BLIGHT TRIAL**



**BLIGHT SYMPTOM**

The incidence of the disease was recorded using international standard scale 1-9 (ICARDA).

Among the 61 lines/ varieties, only three varieties, Bittal 2016, NIAB-16 and Bhakkar-2011 were found moderately resistant at given inoculum pressure. The rest 58 line were found susceptible and highly susceptible. The Table is given below:

**3.2.2 Screening of chickpea advance lines against Ascochyta blight**

**Table 58 Screening of chickpea advance lines against Ascochyta blight**

1	Highly resultant (HR) 0
2	Resistant (R) 0
3	Moderately resistant (MR) 3 (Bittal-16 NIAB-16, and Bhakkar-2011.)
4	Moderately susceptible (MS) = 0
5	Susceptible (S) 16 (S= 17 =1613 MYT (A), 1613 MYT (B), 1617 MYT, 1618 MYT, TG-1711, TG-1713, TG- 1801, TG- 1802, TG-1812, TG-1815, TG 1817, TG-1818, TG- 1820, TG-1825, TG 1826 and TG 1829
6	Highly susceptible (HS) 42 (1621MYT, 1622MYT, 1623 MYT,1626 MYT, TG 1702, TG-1703, TG-1704, TG-1707, TG- 1708, TG- 1710, TG-1712, TG- 1714, TG 1715, TG-1716, TG-1717, TG-1718, TG-1805, TG-1806, TG-1808, TG-1813, TG-1814 and 21 lines of Aug-424 (check)

**3.2.3 Evaluation of Chickpea Germplasm against Fusarium Wilt**

The experiment of screening of chickpea advance lines / varieties were planted in dry climate of Arid Zone Research Institute, Bhakkar. The experiment was sown on 31.10.2019. The plot size of the experiment was 4 meter having single row. The susceptible variety AUG 424 was used as check and repeated after two test entries. Sixty one (61) advance lines / verities alongwith checks were screened against Fusarium wilt.



### WILT SYMPTOM

### WILT TRIAL

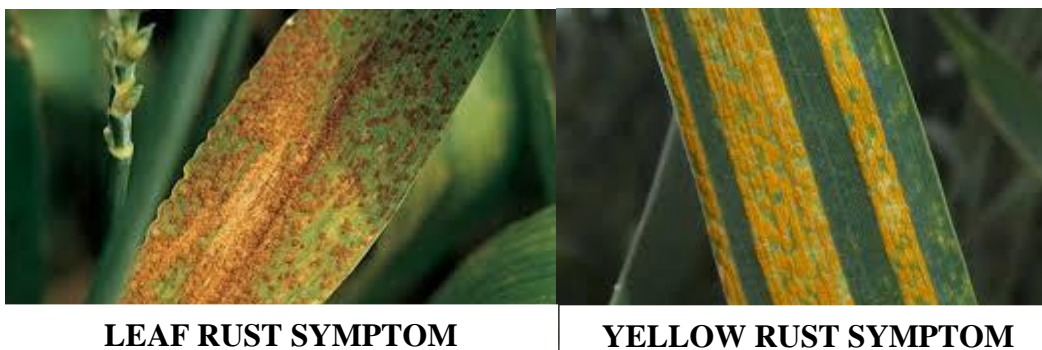
Mass culture of pathogen was added in the soil in the month of September. Before sowing, seed germplasm were also infested with the culture of pathogen. One row of check was sown after two test entries. On the appearance of wilt symptoms the data was recorded (Fig). The disease data was recorded from seedling to maturity stage by using the international scale 1-9 (ICARDA) Among the 61 lines only four lines showed resistant type of reaction, 14 lines were found moderately resistant and the rest 43 lines were found susceptible to highly susceptible (Table.)

**Table 59. Screening of chickpea advance lines against Ascochyta blight**

1	Highly resistant (HR) 0
2	Resistant (R) 4 (TG-1708, TG-1710, TG1712 and TG- 1808)
3	Moderately resistant (MR) 14(1613 MYT, (B) TG- 1702, TG 1703, TG 1704, TG 1714, TG-1716, TG 1718, TG1801, TG 1802, TG 1812, TG 1817, TG 1826, B-2016 and NIAB-16
4	Susceptible (S) 12 ( 1622MYT, TG 1707, TG 1711, TG1713, TG 1715, TG 1717, TG 1805, TG 1806, TG 1808, TG 1813, TG 1814 and TG 1815
5	Highly susceptible (HS) 31 1613MYT(A), 1617MYT, 1618MYT, 1621MYT, 1623MYT, 1626MYT, TG1818, TG1820, TG1829, Bhakkar2011 and 21 lines of AUG-424( check)

#### 3.2.4 Screening of wheat varieties / lines against leaf and yellow rust.

The experiment was sown on 11.11.2019 having plot size 4 meter with single row. Forty five (45) advance lines of wheat along with check were tested against leaf and yellow rust. The susceptible variety Morocco was used as check. The check was repeated after 4 entries and also as border as spreader . On the appearance of leaf and yellow rust symptoms (Fig), the disease data was recorded according to modified Cobb's scale (Peterson Et al, 1948).



**LEAF RUST SYMPTOM**

**YELLOW RUST SYMPTOM**

Maximum yellow rust was recorded after the end of January, 2020 at low temperature and high humidity. The leaf rust did not appear due to low temperature. Among 45 advance lines with check only two lines were found highly resistant, 23 lines were found resistant, 11 moderately resistant and the rest 9 lines of Morocco (check) were found highly susceptible (Table No.)

**Table. 60. Screening of wheat varieties/ lines against yellow rust**

1	Highly resultant (HR) 2 (WS 17060, WS 1836)
2	Resistant (R) 23 (WS 15110, WS 1637, WS17041, WS17042, WS17069, WS 1826, WS 1837, WS 1839, WS 1846, WS 1847, WS1847, WS1849, WS 1853, WS 1857, WS 1859, WS 1868, WS 1872, WS 1874, WS 1879, WS 1883, WS 1884, WS 1889, Annaj and fakhar Bhakkar
3	Moderately resistant-Moderately susceptible (MR-MS ) 11= WS 16164, WS 16263, WS 17048, WS 1809, WS 1813, WS 1815, WS 1817, WS 1819, WS 1833, WS 1861 and WS 1875,
4	Highly susceptible (HS) 9 lines of Morocco (Check)

**3.2.5 Chemical control of yellow rust of wheat:**

Susceptible variety Morocco was sown on dated 11.11.2019 at Arid zone Research institute, Bhakkar. The experiment was designed as Randomized Complete Block Design (RCBD) with 4 replications. The plot size of the experiment was 4 meter having single row. Three fungicides (Treatments) were applied when the disease cross the ETL(Fig No). Three fungicides were applied at three times at seven days interval.





### **YELLOW RUST OF WHEAT IN MOROCCO**

The yellow rust data was recorded pretreatment and post treatment of fungicides. The modified Cobb's scale (Paterson's, 1948) was used for measurement of disease severity. The Nativo 75% WG Fungicide was found best for the control of yellow rust @ gram/liter of water.

**Table.61 Chemical control of yellow rust of wheat**

Sr.No	Treatments	Variety (Morocco)	Yellow rust data before spray (Avg)	Yellow rust data after spray (Avg)
1	Score 250 Ec ( 1ml/ 1 liter of water)	Morocco	100s	20 MRMs
2	Nativo 75% WG (1gram/ 1 liter of water)	Morocco	90s	5R
3	Cabrio top (1gram/ 1 liter of water)	Morocco	80s	15 MRMs
4	Water	Morocco	100s	100S

#### **4.0 Other Miscellaneous Trials**

##### **4.1 National Uniform Rapeseed Yield Trial 2019-20**

The national trial of rapeseed consisted of 21 test entries received from National Coordinator Oil Seed NARC, Islamabad for testing at AZRI, Bhakkar. The sowing was done on 11.10.2019 with Randomized Complete Block Design having 3 replications. The data of all the parameters were recorded and sent to concern quarter. Four test entries surpass the check varieties S. canola. Test entry 1900186 gave maximum yield of 900 kg/ha followed by 1900187 with yield potential of 25 kg/ha.

**Table:-62. Rapeseed National Uniform Yield Trial (NUYT 2019-20)**

Sr. No.	Test Entry	Yield (kg/ha)	Sr. No.	Test Entry	Yield (kg/ha)
1	190081	347	12	190098	211
2	190082	700	13	190099	278
3	190091	625	14	190101	397
4	190092	439	15	S.Canola	605
5	190093	531	16	Hyola-401	639

6	190094	594	17	1900185	372
7	1900183	564	18	1900186	900
8	1900184	555	19	1900187	725
9	190095	481	20	1900188	386
10	190096	550	21	1900100	603
11	190097	350			
LSD (0.05):		346	CV (%):		32

#### 4.2 National Uniform Mustard Yield Trial 2019-20

The national trail of Mustard consisted of 35 test entries received from National Coordinator Oil Seed NARC, Islamabad for testing in Thal. The sowing was done on 11.10.2019 with Randomized Complete Block Design having 3 replications. The data of all the parameters were recorded and sent to quarter concern. Two test entries 190081 and 190058 surpass the check variety Super Raya with yield of 644 & 622 kg/ha. Check varieties gave 614 kg/ha.

**Table:- 63 Mustard National Uniform Yield Trial (NUYT) 2019-20**

Sr. NO.	Test Entry	Yield (kg/ha)	Sr. NO.	Test Entry	Yield (kg/ha)
1	190061	219	19	190079	237
2	190062	414	20	190080	477
3	190063	458	21	190081	644
4	190064	325	22	190082	304
5	190065	414	23	190083	359
6	190066	606	24	190084	500
7	190067	350	25	190085	478
8	190068	275	26	190086	531
9	190069	300	27	190050	516
10	190070	303	28	super Raya	614
11	190071	384	29	coral-432	297
12	190072	292	30	190053	339
13	190073	321	31	190054	439
14	190074	316	32	190059	419
15	190075	370	33	190058	622
16	190076	356	34	190052	361
17	190077	508	35	190056	311
18	190078	347			
LSD (0.05):		334	CV (%):		15

#### 4.3 National Uniform Taramera Yield Trial 2019-20

The national trail of Mustard consisted of 6 test entries received from National Coordinator Oil Seed NARC, Islamabad for testing in Thal region. The sowing was done on 11.10.2019 following Randomized Complete Block Design having 3 replications. The test entry 19002 gave maximum yield of 381 kg/ha followed by 19004 with recorded yield of 319 kg/ha.

**Table 64. Taramera NUYT 2019-20**

Sr. No.	Test Entry	Yield (kg/ha)
1	19001	264
2	19002	381
3	19003	317
4	19004	319
5	19005	278
6	19006	266
LSD (0.05):		39
CV (%):		7

#### 4.4 Lentil National Uniform Yield Trial

Lentil trial comprising twenty one 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 04-11-2019. Trial was harvested on 16-4-2020.

**Table 65. Yield Data of Lentil National Uniform Yield Trial**

Consolidated results of Chickpea (Kabuli) National Uniform yield Trial 2019-20

S.No	Code	Entry Name	Institute	Blight Rating	Locations										Mean
					1	2	3	4	5	6	7	8	9	10	
1	CK19005	BRC-408	RARI Bahawalpur	9	976	1283	1090	250	760	1656	1989	852	2438	2049	1334
2	CK19022	15 KCC-112	BARI, Chakwal	7	969	1175	824	476	711	1563	2314	968	2604	1354	1296
3	CK19009	15FCK16	BARS Fatehjang	5	924	1007	1008	482	742	1424	2175	932	2479	1736	1291
4	CK19011	TGK1504	AZRI, Bhakkar	9	965	1659	1251	601	667	1146	1698	922	2389	1250	1255
5	CK19030	TGK1508	AZRI, Bhakkar	5	872	1779	740	488	742	1316	1918	906	2493	1285	1254
6	CK19001	NCK-1801	PRP,NARC, Islamabad	3	861	827	1038	499	660	1184	1731	1106	2479	2000	1238
7	CK19020	CH64/11	NIAB, Faisalabad	9	908	831	795	536	768	1611	1501	911	2479	2014	1237
8	CK19003	CH66/10	NIAB, Faisalabad	9	753	1265	831	576	779	1368	1933	863	2438	1563	1237
9	CK19007	PCK-15001	PRI, Faisalabad	9	667	1595	872	588	723	1000	1740	888	2410	1806	1229
10	CK19027	CH47/12	NIAB, Faisalabad	9	917	1701	769	507	730	1576	1054	999	2111	1736	1210
11	CK19013	Noor-2013 (CHECK)		9	674	1398	840	522	726	927	1874	931	2729	1458	1208
12	CK19025	14FCK02	BARS Fatehjang	7	764	792	847	431	784	1358	1978	1008	2306	1354	1162
13	CK19029	CH48/12	NIAB, Faisalabad	9	665	1278	949	388	698	1236	1546	885	2583	1007	1123
14	CK19015	TGK1503	AZRI, Bhakkar	9	1250	1423	738	239	679	785	1174	978	2646	1285	1120
15	CK19018	PCK-15019	PRI, Faisalabad	3	750	906	986	194	714	899	2097	1105	2326	1076	1105
16	CK19035	CH53/12	NIAB, Faisalabad	9	931	1061	918	455	731	1253	749	933	2160	1285	1048
Location Mean					865	1249	906	453	726	1269	1717	949	2442	1516	

LOCATIONS									
1	2	3	4	5	6	7	8	9	10
PRI, AARI Faisalabad	ARS Karak	AZRI Bhakkar	AZRC D.I.Khan	BARS Fateh Jhang	GRS Khur Kot	NARC Islamabad	NIAB Faisalabad	GAARI Larkana	RARI Bahawalpur

Note: Note: Trial sent to 13 locations. Grain yield data received from 10 locations. At three locations crop was damaged due to hailstorms and snowfall.

It is evident from the data that the differences among the means of yield value of entries were significant. Entry Markaz-09 gave the maximum yield 1159 kg/ ha followed by advance strain LS-18-2 with yield value of 1078 kg /ha. While minimum yield was recorded 666 kg / ha by advance line NLS-19-1.

## 5.0 DEVELOPMENT PROJECTS

### 5.1 PSDP Pulses Project:

#### Promoting Research for Productivity Enhancement in Pulses

##### A- Chickpea:

#### 5.1.1 Evaluation of Local and Exotic Germplasm of Chickpea to Identify Resistant Sources for Biotic and Abiotic Stresses and Plant Type Suitable for Mechanical Harvesting

Germplasm is a gene complex reservoir for selection of parental material for better grain yield, drought and temperature stress tolerance, resistance to insect pests and diseases. It serves as a source of elite breeding material which can be utilized in breeding programme. 187 desi chickpea genotypes including four check varieties were planted in augmented design. Sowing was done on 31-10-2019. The data regarding days to 50% flowering, plant stand, root rot and wilt diseases reaction (RRW), plant height (cm), number of pods/plant, days to maturity and grain yield (kg/ha) were recorded. Trial was harvested on 28-04-2020.

**Table. 66. Chickpea Germplasm**

Sr. No	Character studied	Range (Means)
1	Days to 50% flowering	78-112
2	Plant height (cm)	50-77
3	No. of pods/plant	39-185
4	Days to maturity	163-170
5	Grain yield (g/plot)	265-980

**Table. 67. Yield Parameters**

Sr. No	Yield range (kg/ha)	No. of entries
1	3000-4083	17
2	2000-3000	68
3	1000-2000	65
4	> 1000	22
5	Abolished	15

Total 187 entries of chickpea (Desi) germplasm were studied in irrigated conditions. Entry no. 07, coded as TG1811 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.

#### 5.1.2 Chickpea Hybridization Programme:

Hybridization is the key of the breeding program in which crosses are attempted among genotypes with desirable attributes to create genetic variation and recombinants for the development of chickpea varieties with higher yield, insect pest and disease tolerance/resistance and as well as then adaptation to Arid Region.



Eight crosses among desirable parents were attempted to achieve the objectives as to develop high yielding, good quality, insect pest and disease tolerance/resistance and then suitability to Arid region. Seeds from successful crosses were collected for generation enhancement and further evaluation. Parentage of successful crosses is given in Table-68.

**Table. 68. Chickpea Hybridization**

Sr. No.	Parents	Characteristics
<b>Desi Chickpea Crosses</b>		
1	TG1424 x Bittle-16	Blight resistant, more pods / plant, high yielding x Early flowering, high yielding,
2	TG1410×TG1424	Blight tolerant , early maturing x More pods / plant, bold seeded, high yielding
3	NIAB-Channa-2016 x Bhakkar-2011	High yielding x wilt resistant, early flowering, bold seeded
4	D-14005 x Thal-2006	Blight tolerant, high yielding x Bold seeded
5	CH32/10 x Bhakkar-2011	Early flowering, more pods / plant, high yielding x wilt resistant, bold seeded
<b>Kabuli Chickpea Crosses</b>		
6	K-14006 x Noor-2013	More pods / plant, high yielding x early flowering, bold seeded
7	CH54/07 x 15-KCC-106	High yielding ×Bold seeded, drought tolerant
8	Noor-2009 x Noor-2013	High yielding ×Bold seeded, High yielding

### 5.1.3 Agronomic Trials for Refinement of Production & Protection Technology:

- i. Variety Seed
- ii. Sowing Date
- iii. Irrigation

#### **Variety Seed Trials:**

Varietal seed trial was sown at the Institute, on 27.10.2019 comprising two chickpea varieties Bhakkar-2011 and Bittal-2016. These varieties were planted separately with all agronomic practices. The trial harvested on 02.05.2020. The approved variety Bhakkar 2011 out yield the Bittal-2016 with yield of 413 and 380 kg/ha respectively.

#### **Sowing Date Trials:**

Sowing date trials of chickpea were planted at AZRI Bhakkar. Five sowing dates were tested in two replications. Detail information is given in the table 1.4.

**Table. 69. Sowing Dates**

Sowing dates	Date of sowing	Replications	Yield (kg/ha)
Sowing date-1	10.10.2019	2	1150
<b>Sowing date-2</b>	<b>25.10.2019</b>	<b>2</b>	<b>1777</b>
Sowing date-3	04.11.2019	2	1720
Sowing date-4	13.11.2019	2	1612
Sowing date-5	23.11.2019	2	1150

Chickpea advance line TG-1410 was sown in all sowing dates. All the agronomic practices were kept same in all sowing dates. The 2<sup>nd</sup> sowing date 25 October-2019 gave the maximum yield of 1777kg/ha followed by the sowing date 4 Nov- 2019 with yield of 1720 kg/ha.

**Irrigation trials:**

The irrigation trial was sown on 15 November 2019 with two replications at AZRI Bhakkar. Plot size was 12mx1.2m. Four irrigation levels were kept as main plot. 1<sup>st</sup> irrigation was applied at 30 days after sowing while 2<sup>nd</sup> irrigation was applied during the mid of January. While 3<sup>rd</sup> irrigation was applied at flowering and podding, respectively. Due to heavy rains the results obtained were not reliable and hence the experiment will be repeated in next crop season.

**5.1.4 BNS, Pre-Basic & Basic Seed Production of Chickpea Varieties.**

Breeder Nucleus Seed is the key of the seed production. To obtain the purity of system seed family rows/blocks are the main source. These trials were sown on 23.10.2019. The detail of seed production during 2019-20 is given in table 1.5.

**Table. 70. BNS, Pre basic and Basic seed produced during the year 2019-20**

Sr. No.	Seed Category	Progeny Rows	Progeny Blocks	Varieties	Production (00 kg)
1	BNS Production	650	450	Bhakkar-2011, Thal-2006 & TG 1410	04
2	Pre-basic	8 acres		Bhakkar-2011 & Thal-2006	27
3	Basic	14 acres		Bittle-2016 & NIAB-CH-2016	50
4	Certified	3 acres		Bittle-2016 & NIAB-CH-2016	17

Certified seed produced will be provided to PSDP pulses components and seed multiplying agencies.

### 5.1.5 Chickpea Demonstration Plots sown at different Farmers Field to disseminate new technologies.

Five demonstration plots with new technologies were sown in agro ecological zones of the Thal. Seed of approved varieties was provided by this institute to the farmers as given below in the table.

**Table 71. Demo plots at farmer's field in the year 2019-20**

Sr. No.	Name of Farmer	Location
1	Muhammad Rafique	Kot Sukhera (Mankera)
2	Habib Ullah	Rakh Mankera
3	Muhammad Qasim Bhatti	Mankera
4	Ghualm Fareed	Litten (Mankera)
5	Mohammad Ramzan	Haider Abad Thal

### 5.1.6 On Farm Demonstration Plots

Two varieties, Bhakkar 2011 and Bittle 2016 were sown at Arid Zone Research Institute, Bhakkar with tractor driven drill. Sowing was done on 05.11.2020. Each variety was sown on area of one acre with graded certified seed. All the cultural practices were equally given to both varieties. The commercial variety Bittle 2016 out yielded the Bhakkar 2011 with the yield of 423 and 390 kg/acre respectively.

### 5.1.7 Farmer Field Days/Seminars /Workshops

One field day/seminar was arranged at farmers filed on 9<sup>th</sup> March-2020 on “Integrated Pest Management for pod borer in chickpea crop” at Mankera. One hundred and thirty participants attended the workshop. All other stake holders like Agriculture extension department and different pesticides companies attended the seminar and appreciated the efforts of the AZRI Bhakkar.

#### **B- Mungbean:**

Sowing of all the trails of Mungbean were completed during the month of May and June-2020.

#### **C- Miscellaneous Activities:**

##### **(i) Publications:**

- One booklet was got published in Urdu on “Thal m Mung ki munafa bakhsh kasht”.

##### **(ii) Seed Distribution:**

- 3000 kg chickpea seed of approved varieties was provided to PSDP partners for multiplications

## 5.2 ALP Project

### Genetic Improvement of Chickpea for Better Nodulation, Root Length and Yield through Hybridization and Mutation Breeding

#### 5.2.1 Chickpea Hybridization Program:

Four cross combinations among desirable parents were attempted in chickpea hybridization program. Sowing was done on 30.10.2019 and harvested on 26-05-2020.

**Table 72. Parentage of Crossing Block 2019-2020**

Sr. No.	Crosses	Characteristics
	<b>DESI</b>	
1	TG1410 × D-14005	High yielding × Wilt tolerant
2	D-15024 × CH 32/10	High yielding × Bold seeded
	<b>KABULI</b>	
3	K-14004 × N00r-2013	Bold seeded × Wilt tolerant
4	CH 68/08 × Noor-2013	Bold seeded × Wilt tolerant

F<sub>0</sub> seed of successful crosses were collected and stored for next generation.

#### i). F<sub>1</sub> Generation Studies

Five F<sub>1</sub> generations (Desi = 3, Kabuli = 2) from F<sub>0</sub> seed of previous year's cross combinations were raised for further evaluation.

#### ii). F<sub>2</sub> Generation Studies

Four F<sub>2</sub> generations (Desi = 2, Kabuli 2) from F<sub>1</sub> of previous year were raised for further evaluation as bulk populations.

#### 5.2.2 Chickpea Mutation Breeding

Bhakkar-2011, TG1218, TG1221 and Bittle-2016 were got radiated from NIAB, Faisalabad at 30Kr and 40Kr to create variability for better nodulation, root length and yield. The seeds of M<sub>2</sub> were sown along with non-radiated checks under rainfed conditions, desirable plants from the radiated blocks showing different superior morphological traits were selected and seed was reserved in M<sub>3</sub> for further evaluation.

**Table 73. Mutated plants selected for further evaluation in M<sub>3</sub> Population.**

Sr. No	Genotypes	No of plant selected		Total
		30 kr	40 kr	
1	Bhakkar-2011	189	169	358
2	Bittal-2016	326	255	581
3	TG-1218	265	283	548
4	TG-1221	304	383	687
<b>Grand Total</b>				<b>2174</b>

### 5.2.3 Screening of Genetic Material against Diseases

277 entries of chickpea (Desi=167, Kabuli=110) were sown on 19.10.2019 under plastic tunnel with repeated susceptible check having plot size 3.3 x 0.3m in augmented design. All the agronomic practices were carried out as and when required. Inoculum of *Ascochyta rabiae* was collected from NIAB, Faisalabad and multiplied at AZRI Bhakkar. The same was sprayed three times to spread infection. Disease spread protocol was maintained in tunnel. Disease incidence in each test genotype was calculated using the following formula,

$$\text{Disease Incidence (\%)} = \frac{\text{No. of infected plants}}{\text{Total no. of plants}} \times 100$$

Disease rating scale based on plant mortality due to *Ascochyta blight* in a defined plant population. The tested genotypes were divided into four categories, Resistant (<10.0% plant mortality), moderately Resistant (10.1–20.0% plant mortality), susceptible (20.1–40.0% plant mortality), and highly susceptible (>40.0% plant mortality).

167 Entries of Desi germplasm were screened against *aschochyta blight* in tunnel by controlling relative humidity, temperature and inoculum concentration. Among these, 37 were marked as resistant (E-2, NES0613, TG 1424, TG 1410, F, 06A0555 and 05A005). 11 were ranked as moderately resistant (GGP1460, GGP 1483, CH18/D/121, E-21, O-5, AO 28, K, O5A056, GGP 1515, O3A035, GGP 1440 and O6A126) 43 were identified as highly susceptible. 40 were screened as susceptible. 36 were ranked moderately susceptible.

110 Entries of kabuli germplasm were screened against *Aschochyta blight* in control tunnel. Among these, 23 were marked as resistant (GGP 36, Noor2013, E1, and TGK 1604). 12 were ranked as moderately resistant, 28 were identified as highly susceptible. 47 were screened as susceptible. Disease resistance is the most important attribute, the highly disease resistant entries could be used in hybridization program to evolve disease resistant recombinants.

### 5.2.4 Screening of Chickpea against Wilt (*Fussarium oxysporum*).

60 Entries were evaluated against chickpea wilt disease. Among these 4 were ranked resistant (O9AGOO6, DOAO25, CH16/06, TG1410,). 6 were identified as moderately resistant, 3 moderately susceptible, 34 were susceptible and 13 were evaluated highly susceptible.

### 5.2.5 Study of Response of Pathogen to Different Chemicals (Fungicides).

Ten fungicides viz, Thrill, Ridomill Gold, Antracol, Curzate, Diathane M-45, Topsin M, Copper oxychloride, Melody Dew, Success and Supha were used as seed treatment along with control against soil borne diseases of chickpea. Thal-2006 was used as test variety in Randomized Complete Block Design (RCBD) replicated three times having plot size 4 x 1.2m. The data regarding disease incidence, plant height (cm), number of pods per plant and yield (kg/ha) were recorded.

Fungicides against disease at early crop stage were effective but these failed to control disease in later stages. Chickpea diseases appeared at two stages, one at early stage (40-50days) after sowing and 2<sup>nd</sup> disease incidence 120-130 days after sowing.

**Table 74. Efficacy of 10 Fungicides for Control of Soil Borne Diseases of Chickpea.**

Sr. No.	Fungicides	Disease Incidence (%) 30 DAS	Plant Height (cm)	Pods plant <sup>-1</sup>	Disease Incidence (%) 125 DAS	Yield (kg/ha)
1	Thrill	10	56	84	3	2129
2	Topsin M	12	53	86	5	2035
3	Antracol	13	50	95	7	1972
4	Supha	15	53	111	6	1865
5	Ridomill Gold	10	53	99	7	1847
6	Curzate	12	53	88	7	1833
7	Copper oxychloride	14	49	80	8	1767
8	Success	15	56	87	8	1767
9	Diathane M-45	10	52	80	7	1635
10	Melody dew	15	55	83	8	1635
11	Control	20	50	79	12	1517
LSD <sub>0.05</sub>			2.65	3.76		154.56
CV (%)			8.55	5.26		11.41

### 5.2.6 Testing of Advance Lines in Different Site of Thal:

Chickpea yield trial comprising 13 advance lines was laid out in to Randomized Complete Block Design (RCBD) with three replicates at 4 locations viz. AZRI Bhakkar, GBRSS. Kallurkot, ARS. Karor and farmer's field Mankera.

**Table 75. Yield performance of chickpea advance lines at different ecological zones**

Sr. No	Genotypes	DF	Plant height	Pods plant <sup>-1</sup>	100 grain weight	Yield (kg/ha)			Average (kg/ha)
						AZRI. BKR	Mankera	GBRSS K.KOT	
1	TG 1708	95.00	53.53	119.67	28.67	2451	1660	1438	1850
2	TG 1707	97.67	42.73	106.00	28.41	2472	1152	1201	1608
3	TG 1702	88.67	53.10	116.67	27.80	2646	1059	938	1548
4	BK 2011	87.67	41.67	115.33	25.40	2425	1201	1000	1542
5	TG1703	88.67	56.70	117.00	28.12	2719	1052	778	1516
6	TG 1715	93.67	38.70	100.67	25.77	2042	1694	792	1509
7	TG 1716	89.67	54.13	109.67	25.33	2462	1368	653	1494
8	TG 1717	88.67	54.60	102.3	26.38	2083	1270	1049	1467
9	NIAB Chana	89.67	43.17	97.67	23.5	1990	1163	896	1350
10	TG 1710	96.67	53.37	107.67	25.74	1899	1246	792	1312
11	TG 1713	88.67	46.23	103.67	27.57	1799	1250	531	1193
12	Bittal 2016	95.67	41.33	92.67	23.12	1719	1024	807	1183
13	TG 1714	98.67	56.70	106.67	26.51	1674	1253	410	1112
CV (%)		3.50	9.47	3.21	5.94	6.92	10.80	10.41	
LSD <sub>0.05</sub>		4.91	7.81	5.76	2.6359	254.7	229.61	152.29	

Data for days to 50% flowering, plant height (cm), number of pods plant<sup>-1</sup>, 100 grain weight (g) and yield kg/ha were recorded (Table 11). It was observed that Bhakkar-2011 attained 50% flowering in 87.67 days followed by TG 1713 with 88.67 to flowering. Entries TG 1714, TG1707 and TG 1710 were marked late in flowering and took 98, 97.67 and 96.67 days to flowering, respectively. The material screened could be used in hybridization program as per breeding objectives.

Entries TG1708, TG1702, Bk-2011 and TG 1703 were ranked as having maximum pods per plant (119.67, 116.67, 115.33 and 117), respectively. The entries which depicted the highest pods per plant could be used in breeding program as per objective in future.

Plant height in chickpea is also an important character and ideal plant height ranged in 45-55cm, tolerant against lodging and could be used in hybridization program for high input responsive chickpea varieties evolution. It was observed that chickpea advance line TG1708 gave highest yield 1850 kg/ha followed by TG-1707 and TG-1702 with average yield 1608, and 1548 kg/ha, whereas check variety Bhakkar-2011 and Niab Channa gave 1542 and 1350 kg/ha, respectively. Whereas TG1417 gave the lowest average yield value 1112 kg/ha.

### 5.2.7 Studies to Assess the Effect of Phosphatic Fertilizer on Nodulation, Nitrogen Uptake and Protein Analysis.

Different doses of N: P were used, phosphorus was kept variable starting from 30, 58, 88, and 115 kg/ha while nitrogen as a starter dose (23 kg/ha) was used in all treatments except control where no fertilizer were used. Urea and single super phosphate were used as nitrogen and phosphorus source, respectively. Chickpea advance line TG-1410 was used as test material in Randomized Complete Block Design (RCBD). The plot size of kept was 7m × 3m. The data regarding plant height (cm), number of pods/plant, Number of nodules per plant, Fresh weight of nodules, dry weight of nodules, 100 grain weight (g) and grain yield (kg/ha) were recorded.

**Table 76. Effect of phosphatic fertilizer on nodules, nitrogen uptake and protein content.**

Treatments (N:P kg/ha <sup>-1</sup> )	No nodules plant <sup>-1</sup>	Fresh weight of nodules plant <sup>-1</sup> (g)	Dry weight of nodules plant <sup>-1</sup> (g)	Plant Height (cm)	100 Grain weight (g)	Yield (kg/ha)	Protein %
0:0	40.66	0.5567	0.2467	62.33	23.34	1447.2	19.35
23:0	44.31	0.5967	0.2867	64.00	23.40	1483.3	19.88
23:30	52.00	0.6233	0.3133	67.33	23.81	1511.1	20.00
23:58	64.67	0.8367	0.5267	77.00	28.80	1726.8	22.00
23:88	63.44	0.8033	0.4933	79.00	25.96	1611.1	20.21
23:115	47.34	0.6000	0.2933	76.33	26.07	1508.3	20.26
<b>CV (%)</b>	<b>3.12</b>	<b>5.45</b>	<b>10.02</b>	<b>10.34</b>	<b>1.68</b>	<b>2.22</b>	<b>0.80</b>
<b>LSD<sub>0.05</sub></b>	<b>2.9556</b>	<b>0.0664</b>	<b>0.0656</b>	<b>13.352</b>	<b>0.771</b>	<b>62.418</b>	<b>0.30</b>

It is depicted from the data that maximum number of nodules per plant, fresh and dry weight of nodules were recorded in fertilizer dose 23:58 N: P kg/ha. Similarly 100 grain weight and yield were also maximum in same treatment. While minimum yield and yield component were recorded in control treatment where no fertilizer was used. It might be

recommended that 23:58 N: P kg/ha must be used for maximum yield and quality grain production.

### 5.2.8 Response of N-fixing bacteria, PSB and PGPR Isolated from chickpea Nodules, Rhizoplane and Rhizospheric soil of Thal Desert towards nodulation in chickpea.

Symbiotic relationship of chickpea with N-fixing bacteria, PSB and PGPR Isolated from chickpea Nodules, Rhizoplane and Rhizospheric soil of Thal Desert was studied in RCBD with split plot arrangements The chickpea genotypes [TG 1410 ( $V_1$ ), Bhakkar-2011 ( $V_2$ )] were kept in main plot while eight rhizobium consortium (Table 2) maintained in subplots. The sub plot size was 7 m x 1.2 m. Seeds were inoculated at a rate of 60g of PGPR consortium per kg of seed using sugar solution as a sticker. Inoculation was done under shade and the inoculated seeds were kept for few minutes until air drying before planting. The graded seed at the rate of 75 kg ha<sup>-1</sup> was sown with a single row drill. The recommended dose of fertilizer (22 Kg N and 57 Kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>) was applied at the time of seed bed preparation. The crop was inter-cultured thrice at 35, 45 and 70 days after sowing. Average weights of three samples were recorded for 100 grain randomly taken from grain yield of each treatment whereas grain yield (kg ha<sup>-1</sup>) was recorded on plot basis.

#### Grain yield (kg ha<sup>-1</sup>)

It was observed that different treatments significantly affected the grain yield in chickpea (Table 18). Maximum grain yield of 3732 kg ha<sup>-1</sup> was recorded in  $V_1 \times I_1$  (TG1410) followed by treatment combination  $V_1 \times I_3$  with yield value of 3607 kg ha<sup>-1</sup>. On average,  $V_1$  gave 5.38 % edge in yield of chickpea over  $V_2$ . It might be due to different yield potential of genotypes. This increase in yield may be due to effective nodulation which in turn enhanced the utilization of atmospheric nitrogen and availability of phosphorus towards higher yield.

The interaction of genotypes plus PGPR consortium  $I_1$  gave the maximum average yield of 3634 kg ha<sup>-1</sup> against 2614 kg ha<sup>-1</sup> in uninoculated plot. The microbial activities were optimum which increased the nodules N-supply to crop plants and hence increased crop growth, number of pods plant<sup>-1</sup>, grains pod<sup>-1</sup> and grain yield. It may be concluded from the present study that the use of PGPR consortiums should be encouraged in order to get profitable yield of chickpea under prevailing agro-climatic conditions.

**Table 77. Grain Yield (kg ha<sup>-1</sup>) affected by symbiotic relationship of chickpea varieties/lines and PGPR Consortium**

Genotypes	$I_0$	$I_1$	$I_2$	$I_3$	$I_4$	$I_5$	$I_6$	$I_7$	$I_8$	Average
TG1410	2617	3732	3167	3607	3292	3360	3188	3095	2935	3175
BKR-2011	2610	3516	3088	3123	3306	3116	3215	3125	2986	3013.4
Average	2614	3624	3127	3365	3298	3233	3101	3110	2959	
<b>LSD<sub>0.05</sub>(Varieties) = 101.05, LSD<sub>0.05</sub> (PGRP) = 121.38, LSD<sub>0.05</sub> (Varieties × PGRP) = 171.66</b>										



### **5.3 PARB Project No. 913**

#### **Enhancement of Mungbean And Gram Production in Thal Through Development of Improved Genotypes and Technologies to Reduce Pulses Import Bill**

##### **5.3.1 Screening of local germplasm for identification of new source of resistance against drought and disease**

200 chickpea genotypes (Desi=120 & Kabuli=80) were laid out in simple augmented design with 02 rows of each entry having plot size 4m x 0.6m during Rabi 2019-20. 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, 50 lines were selected for further evaluation.

100 local and 200 exotic mungbean genotypes were sown in simple augmented design with 02 rows of each entry having plot size 4m x 0.6m on 25-05-2019. 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, 45 lines were selected for further evaluation.

##### **5.3.2 Hybridization Program and evaluation of desirable recombinants from different filial generations**

15 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<sub>0</sub> seed from successful crosses were collected for generation enhancement and further evaluation. Population were bulked from F<sub>1</sub> and F<sub>2</sub>. 409 single plant / progenies from F<sub>3</sub> to F<sub>6</sub> were selected for further evaluation. 18 uniform lines were selected from F<sub>7</sub> 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 07 out of 08 crosses has been picked whereas one did not produce any seed. F<sub>0</sub> seed from successful crosses were collected for generation enhancement and further evaluation. 77 single plants / progenies were selected from F<sub>2</sub> to F<sub>6</sub> populations for further evaluation. 12 uniform lines were selected from F<sub>7</sub> for further evaluation in preliminary yield trial.

##### **5.3.3 Field evaluation of advance material against prevailing insect pest and diseases in dry land conditions of Thal**

55 gram genotypes (30 Desi & 25 Kabuli) selected from previous 284 genotypes of gramplasm 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. 18 genotypes viz., 05A156, CH-18-D-126, CH-18-D-114, CH-18-D-32, CH-32-18, 93A138, TG1504, 06A061, GGP-29, TGK1502, TGK1507, GGP-09, GGP-28, GGP-17, GGP-08, TGK1504, TG1410 and TGK1728 showed resistance against *Ascochyta* blight and *Fusarium* wilt and selected for further evaluation in multi-location replicated trials. 32 advance lines selected from previous year screening work were sown on 25-05-2019 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. 18 genotypes viz., TM1936, TM1608, TM1938, TM1929, TM1934, TM1918, TM1932, TM1607, TM1922, TM1915, TM1914, TM1919, TM1937, 13TM04, 13TM14, TM1611, TM1602 and TM1627 were selected for further evaluation in adaptation yield trial.

#### **5.3.4 Evaluation of selected drought and disease tolerant chickpea advance lines under different water regimes**

16 selected genotypes / entries of desi gram were laid out at experimental area of Arid Zone Research Institute, Bhakkar in randomized complete block design (RCBD) with three replications under 04 treatments of water regimes i.e. 1-irrigation, 2-irrigation, 3-irrigation and rainfed condition to identify their response towards drought and water requirements. . Data regarding plant population, days taken to 50% flowering, numbers of pods per plant, plant height, days to maturity were recorded. Entries coded as TG1826, TG1710 and TG1713 performed better under 2-irrigation treatment.

#### **5.3.5 Adaptation yield trial**

16 genotypes / entries were laid out at six 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 1415 gave the highest yield 1678 kg/ha, followed by TG1620 and TG1417 with yield 1323 and 1277 kg/ha, respectively. The check varieties Bittle-2016 and Bhakkar-2011 gave the yield 1226 and 1129 kg/ha, respectively.

16 genotypes selected from re-evaluation of 42 lines of first year alongwith three check varieties namely AZRI-2006 ,AZRI-2018 and NIAB -2016 were sown at four different locations viz., AZRI, Kallurkot, Karor and Chak 50 TDA for adaptability testing. Entries coded as TM1806 gave highest average yield 1022kg/ha. The check variety AZRI-Mung-2018 and NM-2016 gave the yield of 855 and 795 kg/ha, respectively.

### 5.3.6 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 2<sup>nd</sup> sowing date 25-10-2019 gave the maximum yield of 1850kg/ha followed by the sowing date 4<sup>th</sup> November-2019 with the average yield of 1710kg/ha.

### 5.3.7 Evaluation of fertilizer requirement

Four gram genotypes viz., TG1424, TG1415, TG1410 and Bhakkar-2011 were evaluated for their irrigation and fertilizer requirements in RCBD with 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.

### 5.3.8 Production of BNS and Pre-Basic Seed for Dissemination to Seed Production Agencies and Progressive Farmers

1000 chickpea single plant progenies 500 each of Thal-2006 and Bhakkr-2011 commercial varieties were sown in experimental area of AZRI Bhakkar for production of Breeder Nucleus Seed (BNS). 200 family blocks, 100 each of Thal-2006 and Bhakkr-2011 were also maintained in experimental area of AZRI Bhakkar for production of Breeder Nucleus Seed (BNS). Observations for uniform lines / progenies were carried out through growing season. Off type plants / progenies were 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. Rouging of off type plants from seed multiplication block were carried out to ensure the harvest of uniform and true to type genotypes.

Single plant progenies of AZRI- Mung-2006, AZRI-Mung-2018 and 13TM04 were sown on 27-05-2019 for production of Breeder Nucleus Seed (BNS). Rouging of off type plants has been completed. Crop will be harvested within August, 2019. Progeny block of AZRI- Mung-2006, AZRI-Mung-2018 and 13TM04 were sown on area of 06 kanals at AZRI on 27-05-2019 for production of Pre-basic seed.

**Table -78 BNS and Pre-Basic Seed Produced During 2019-2020**

Sr. No.	Crop	Seed category	Variety	Production (kg)
1	Chickpea	BNS	TG1410	450
2			Bhakkar-2011	90
3			Thal-2006	50
4		Pre-basic	Bhakkar-2011	2200
5			Thal-2006	500
6	Mungbean	BNS	13TM04	170
7			AZRI-Mung-2018	40
8			AZRI-Mung-2006	20
9		Pre-basic	AZRI-Mung-2018	2000
10			AZRI-Mung-2006	650

## 5.4 ACIAR PULSES

### ACIAR Pulse Project Increasing productivity and profitability of pulse production in cereal based cropping systems in Pakistan

#### Experiment No. 01

#### 5.4.1 Comparative Study of Weeding Techniques on Yield and Yield Components of Chickpea

A trial comprising four weeding techniques viz; Hand weeding after 30 days and 60 days of sowing, Application of pre emergence weedicide (Stomp), Application of pre emergence weedicide (Stomp) with one time weeding after 60days and control was conducted at Chak No. 4 Rakh Mankera (Site-3) following the RCBD design having three replications. Plot size maintained as 4 x 1.2m 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.

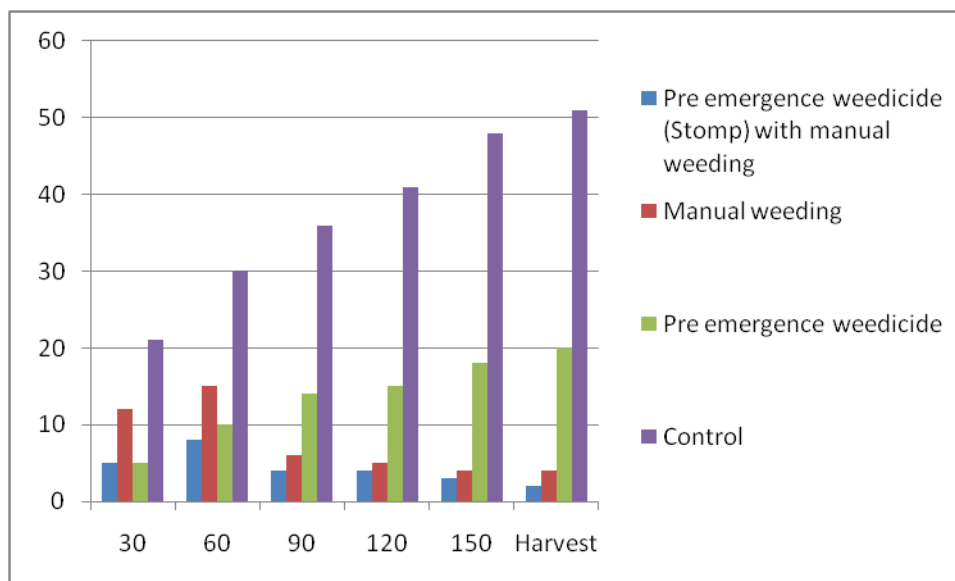
**Table-79. Total number of weeds and their dry weight in meter per square of area**

Treatment	Weed count per m <sup>2</sup> (DAE*)						Weed dry weight(g) per m <sup>2</sup> (DAE)					
	30	60	90	120	150	Harvest	30	60	90	120	150	Harvest
Pre emergence weedicide (Stomp) with manual weeding	5	8	4	4	3	2	48	79	40	41	33	22
Manual weeding	12	15	6	5	4	4	120	150	62	55	42	39
Pre emergence weedicide	5	10	14	15	18	20	50	100	140	150	180	200
Control	21	30	36	41	48	51	219	310	365	420	472	516

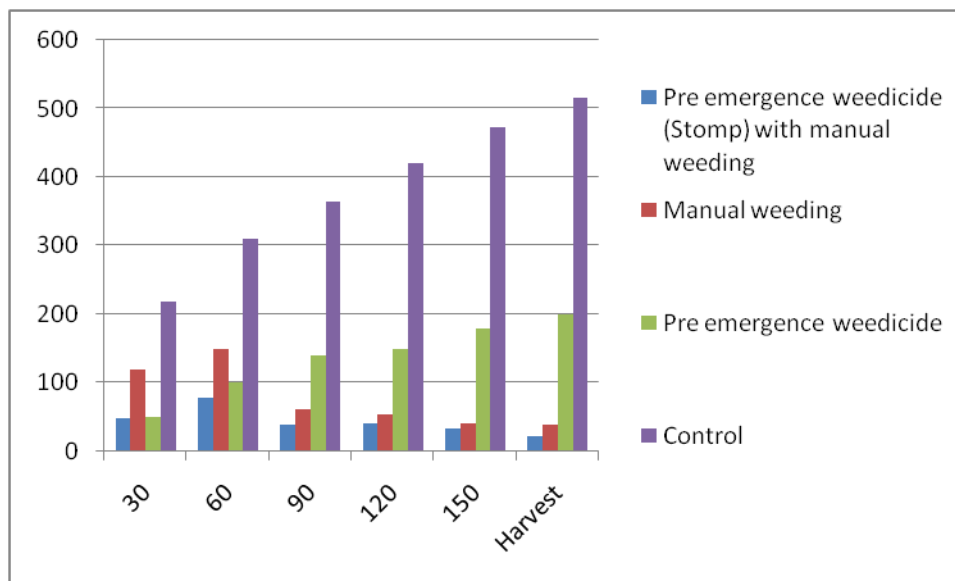
\*DAE = Days after emergence

**Table-80 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	92	68	15	70	1310
Manual weeding	91	60	14	66	1240
Pre emergence weedicide (Stomp)	95	52	11	58	1050
Control	98	48	9	45	710



**Figure-1:** Total Number of weeds count in per meter square of area in different interval of time



**Figure-2:** 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 convincing 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 (1310kg/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(1240kg/ha)

and pre emergence herbicide treated plot (1050kg/ha). Minimum grain yield was recorded in check plot (710kg/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 40% 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.

**5.4.2 Effect of *Rhizobium* Inoculation on Nodulation, Growth, Yield and Components in Chickpea**

A trial comprising three *Rhizobium* inoculations strains viz; New Edge Inoculant, Alaska Inoculant, Biozate alongwith control was conducted at site 3 Mankera. Two step method was adopted in this experiment. In the first step, seeds are evenly coated with the sticker solution. In the second step, the powdered inoculant was added to the sticky seeds. To evaluate the efficiency of different *Rhizobium* inoculants. Therefore, the purpose of this demonstration trial was to create awareness among farming community about effective use of *Rhizobium* inoculants to enhance their productivity and profitability by minimizing input cost. The trial was conducted following the RCB design with three replications, plot size was maintained 4m x 1.2m. Data recorded were Plant height, root length per plant, No. of nodules per plant, root fresh weight per plant, root dry weight per plant, No. of pods per plant and yield per plant were studied.

**Table-81: Impact of Rhizobium Inoculation strains on yield and yield components of chickpea**

Treatment	Plant Height (cm)	Root length/plant (cm)	No. of nodules /plant	Root fresh wt/plant (g)	Root dry wt/Plant (g)	Pods /plant	Yield kg/ha
New edge	68	40	77	14.50	6.50	82	1490
Biozoate	64	36	70	13.20	5.00	75	1280
Alsaka	62	33	62	12.40	5.50	70	1200
Control	57	28	48	9.50	3.50	55	888

**Interpretation of Result:**

This field study was conducted on the farmer field at Dera Mohajran wala, Mankera site-3 to evaluate the efficiency of different *Rhizobium* inoculants and to examine the effects of *Rhizobium* inoculants on plant height, root length per plant, No. of nodules per plant, root fresh weight per plant, root dry weight per plant, No. of pods per plant and grain yield. This trial will help farmer to select those interventions which will be convincing to him for increasing profitability by reducing input cost. Chickpea grain yield was significantly influenced by *Rhizobium* inoculants. The highest grain yield (1490kg/ha) was obtained from plot where *Rhizobium* inoculants-New Edge was applied followed by Biozoate inoculants (1280kg/ha) and Alaska inoculant treated plot (1200kg/ha). Minimum grain yield was observed in and check plot (888kg/ha).

**Observations/comments of farmer about trial/intervention**

The farmers were quite unaware about application of *Rhizobium* inoculants before this experiment. The experiment provided them a great opportunity about application of *Rhizobium* inoculants to enhance their profitability on sustainable basis.

**Conclusion**

In the present scenario, Sustainability of agriculture has become a major issue of global concern as the intensive use of chemical inputs has an adverse impact on the environment. Use of biofertilizers such as *Rhizobium* inoculants can reduce the need for chemical fertilizers and decrease adverse environmental effects. This investigation have shown positive effect of *Rhizobium* inoculation on growth attributes, symbiotic parameters, yield and yield components, nutrient uptake and quality in chickpea.

**5.4.3 Efficacy of Different Insecticides to Control Gram Pod Borer**

An experiment was conducted to find out effective insecticide for the economical control of pod borer involving three insecticides Emamectin benzoate 1.9 EC, Bifenthrine 10% EC, Lambda cyhalothrine 2.5 EC and control during Rabi season at farmer field Rakh Mankera. Chickpea variety Bhakkr-2011 was used as test genotypes. The trial was laid out in RCB design replicated three times having plot size 4m x1.2 m. Recommended agronomic practices were applied to all treatment from sowing to harvesting. First spray was applied on pod formation stage on 1<sup>st</sup> March-2020 and 2<sup>nd</sup> spray was applied after 15 days of 1<sup>st</sup> spray on 16<sup>th</sup> March-2020. 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.

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)	-	-

**Table-82: Response of different chemicals against gram pod borer**

Sr. No.	Treatments	Damaged Pods / 500 pods	Damaged %age	Yield (kg/ha)
1	Emamectin benzoate	20	4	1510
2	Bifenthrine	25.2	5.4	1400
3	Lambda cyhalothrine	30.1	6.2	1290
4	Control	104	20.8	1030

#### **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 convincing to him for increasing profitability by reducing input cost. Chickpea grain yield was significantly influenced by attack of pod borer. The highest grain yield (1510kg/ha) was obtained from plot where Emamectin Benzoate was applied followed by Bifenthrin (1400kg/ha) and Lambdacyhalothrin sprayed plot (1290kg/ha). Minimum grain yield was recorded in check plot (1030kg/ha).

#### **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.

#### **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 21 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.



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