ANNUAL DETAILED / PROGRESS REPORT

FOR THE YEAR

2016-17

AGRONOMIC RESEARCH INSTITUTE FAISALABAD

OVERVIEW

Agronomy is a fountain-head of all the disciplines of agricultural sciences. It plays radical role in food production and food security as well as bridging over the gap in demand and supply of food. As the agro-environmental conditions in Punjab differ, therefore, in order to cater for the requirements of different ecological zones of Punjab, Agronomic Research Institute, Faisalabad was established during 1984 with four stations each at Farooqabad, Karor, Khanewal and Bahawalpur. The main focus of this Institute is to provide results of agronomic research on different field crops to the farming community through framing and developing comprehensive and adoptable production technologies. These production technologies have not only improved per acre yield of different field crops but also raised the living standard of the farming community. The current threat of abrupt climate change throughout the globe has changed the priorities of Agricultural Research institutes. Therefore, in order to re-orientate the agronomic research, different research trials have been planed and laid out to redress the problems of farming community in the perspective of climate change. Strenuous efforts are being made to develop new production technology containing the solutions of the growers in relation to climate change.

Forty wheat genotypes were screened for drought and heat tolerance under lab and field conditions. Soil and foliar application of Zinc improved Zn contents within wheat grains. Ridge planting through laser land leveling enhanced water use efficiency and the grain yield of wheat. Relay cropping of Bt cotton in standing wheat produced maximum net return than sole crop. Cotton planted on 75 cm apart ridges with planter produced similar results to that of cotton planted at 75 cm apart beds and cotton planted on 75 cm apart ridges with manual dibbling. Rice-wheat cropping system produced maximum net return under Khanewal conditions than other cropping systems. Sugarcane intercropping with mungbean produced higher net returns than sole crop. Foliar application of potassium and zinc improved grain yield of maize. Pendimethalin 330 E @ 3.750 l/ha with one hoeing 45 days after transplanting showed maximum weed control and enhancing bulb yield in onion. Planting of tomato in east to west direction produced higher yield than south to west at 45 degree under mulching effect. Herbicides were screened for medicinal plants, sugarcane, cotton, maize, rice and pulses. Research on sisal, vermicompost and organic farming has been initiated.

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A) Kharif

RICE

1. Comparison of different planting methods (techniques) in direct seeding rice (dsr)

Maximum grain yield (2582 kg ha^{-1}) was observed in flat sowing by drill after soil preparation followed by broadcast augmented with furrows (2342 kg ha^{-1}) and minimum grain yield **(**1639 kg ha^{-1}) was obtained from zero tillage drill method.

2. Comparison of different planting methods (techniques) in transplanted fine rice.

Maximum grain yield (3900 kg ha^{-1}) was observed in ridge planting with net return of rs. 60411/-

3. Yield response of various strains of fine rice under faisalabad conditions (transplanted)

Maximum grain yield (4235 kg ha^{-1}) was obtained from super basmati (check). However, among strains 99404 produced maximum grain yield of (3846 kg ha^{-1}) while minimum yield (3419 kg ha^{-1}) was obtained from strain 8833.

4. Screening of new herbicides for weed control in rice

This trial was conducted on july 20, 2016 with the objective to screen out new herbicides for weed control in rice crop. Trial was conducted by using randomized complete block design having three replications. Four new herbicide formulations viz. Fast –mix 60 ew (butachlor), sprinter 35 wp (pertilachlor + pyrazosulfuron), council activ 30 wg (triafamone + ethoxysulfuron methyl) and apiro forte 55.08 sc (pyriftalid + bensulfuron methyl) were tested against machete 60 ec (butachlor), rifit 500 ec (pertilachlor), kelion 50 wg (orthosulfamuron) and pyranex 60 wdg (bispyrabac + bensulfuron).the following results were obtained during this year of study:

Table: effect of herbicides on weeds and paddy yield

#	Herbicides	Dose ha^{-1}	Weed counts (m^2)	% control over untreated	Paddy yield (kg ha^{-1})	Increase in yield (%)
1	*Machete 60 ec (butachlor)*	2000 ml	32 c	61.90	3500 a	72.15
2	*Fast –mix 60 ew (butachlor)*	2000 ml	34 c	59.52	3483 a	71.32
3	*Rifit 500 ec (pertilachlor)*	1000 ml	26 d	69.04	3450 a	69.69
4	*Sprinter 35 wp (pertilachlor+ pyrazosulfuron)*	500 g	21 d	75.00	3466 a	82.98
5	*Kelion 50 wg (orthosulfamuron)*	150 g	06 f	92.85	3550 a	74.62

6	*Council activ 30 wg (triafamone + ethoxysulfuron methyl)*	185 g	03 f	96.42	3516 a	72.95
7	*Pyranex 30 wdg (bispyribac sodium + bensulfuron methyl)*	250 g	14 e	83.33	3333 b	63.94
8	*Apiro forte 55.08 sc (pyriftalid + bensulfuron methyl)*	400 ml	42 b	50.00	3116 c	63.10
9	Control (weedy check)	-	84 a	-	2033 d	-
lsd			5.69	-	110.83	-

Weed counts (m^{-2})

It is evident from the weed counts data that the pre-emergence candidate herbicide fast mix 60 ew (butachlor) gave weed control at par with the standard herbicide machete 60 ec (butachlor) standard with 31 and 30 weeds m^{-2}. The other candidate herbicide sprinter 35 wp (pertilachlor+ pyrazosulfuron) also gave weed control at par with the standard herbicide rifit 500 ec(pretilachlor) which left 22 and 27 weeds m^{-2} respectively. All these pre-emergence herbicides were found ineffective against *cyperus rotundus* (deela). The third candidate council activ 30 wg (ethoxy sulfuron + triasamon) gave weed control at par with the standard herbicide kelion 50 wg (orthosulfamuron) which left only 04 and 06 weeds m^{-2} respectively. The post emergence candidate herbicide apirofort 55.08 sc (pyriftalid+bensulfuron) gave poor performance and its weed control was significantly lesser than the standard herbicide pyranex 60 wdg (bispyrabac sodium + bensulfuron) at the recommended dose. These were found equally effective against dicot weeds but neither candidate nor standard herbicides controlled *dactyloctenum aegyptium* (madhana ghas). Apirofort 55.08 sc was found less effective against *echinochloa species* (swanki and dhiddan) when applied in the advanced stages.

Paddy yield (kg ha^{-1})

It is evident from the data that the pre-emergence candidate herbicides viz. Fast mix 60 ew (butachlor), sprinter 35 wp (pertilachlo r+ pyrazosulfuron) and council activ 30 wg (ethoxy sulfuron + triasamon) gave paddy yield at par with their respective standards viz. Machete 60 ec (butachlor), rifit 500 ec (pretilachlor) and kelion 50 wg (orthosulfamuron). The post emergence candidate herbicide apirofort 55.08 sc (pyriftalid+bensulfuron) gave statistically

lesser paddy yield (3116 kg ha^{-1}) than the standard herbicide pyranex 60 wdg (bispyrabac sodium +bensulfuron) with paddy yield 3333 kg ha^{-1}.

5. Water use efficiency of rice under different sowing methods

The experiment was conducted at research area of plant physiology section, ayub agricultural research institute, faisalabad during 2016 to assess the water use efficiency of rice under different sowing methods. The experiment was laid out in randomized complete block design having a plot size of one 18.5 m × 27 m. Basmati-515 was used as a test variety. Plant to plant and row to row distance of 22.5 cm was maintained. Npk @ 150-100-100 kg ha^{-1} was applied. Whole of the p, k and half of the n was applied at sowing. Remaining n was applied through split doses. All other agronomic practices were kept uniform. The following results were met during course of studies:

Table: effect of water use efficiency on different parameters of rice under different sowing methods

Treatments	**Chlorophyll fluorescence (fv/fm)**	**Number of tillers (m^{-2})**	**Number of kernels per panicle**	**1000-kernal weight (g)**	**Paddy yield (kg ha^{-1})**	**Wue (kg mm^{-1})**	**Cbr**
T_1: dry seeding (broadcast)	0.783	247 e	108 e	16.73 f	2995 f	1.70	1:1.55
T_2: dry seeding (drill)	0.748	325 c	137 c	19.88 c	3625 c	1.49	1:1.40
T_3: wet seeding (broadcast)	0.738	280 d	113 de	17.46 ef	3106 ef	1.52	1:1.34
T_4: watter seeding (broadcast)	0.744	283 d	121 de	18.47 de	3288 de	1.75	1:1.50
T_5: watter seeding (drill)	0.764	315 c	127 cd	18.93 cd	3378 d	1.66	1:1.41
T_6: sri (system of rice intensification)	0.756	375 b	169 b	22.99 b	4502 b	2.66	1:1.82
T_7: transplanting (conventional)	0.750	408 a	186 a	24.47 a	4740 a	2.91	1:2.04
Lsd	**N.s**	**25.68**	**15.68**	**1.22**	**214.68**	-	-

Chlorophyll fluorescence (fv/fm)

It is evident from the data given in the table that chlorophyll fluorescence was not affected significantly by various seeding methods of rice. However, maximum chlorophyll fluorescence (0.783) was recorded in dry seeding (broadcast).

Number of tillers (m^{-2})

The data regarding number of tillers m^{-2} presented in the table showed that the maximum tillers m^{-2} (408) were produced under transplanting (conventional) followed by sri (system of

rice intensification). Whereas the minimum no. Of tillers m^{-2} (247) was produced in dry seeding (broadcast).

Number of kernels per panicle

The data regarding number of kernels per panicle presented in the table showed that the maximum number of kernels per panicle (186) were produced under transplanting (conventional) followed by sri (system of rice intensification). Whereas the minimum number of kernels per panicle (108) was produced in dry seeding (broadcast).

1000-kernal weight (g)

The data regarding number of kernels per panicle presented in the table showed that the maximum 1000-kernal weight (24.47g) was produced under transplanting (conventional). Whereas the minimum 1000-kernal weight (16.73 g) was produced in dry seeding (broadcast).

Paddy yield (kg ha^{-1})

The data regarding paddy yield presented in the table showed that the maximum paddy yield (4740 kg ha^{-1}) was recorded in transplanting (conventional). Whereas, the minimum paddy yield (2995 kg ha^{-1}) was produced in dry seeding (broadcast).

Water use efficiency (kg mm^{-1})

The data regarding water use efficiency presented in the table showed that the maximum water use efficiency (2.91 kg mm^{-1}) was recorded in transplanting (conventional). Whereas the minimum water use efficiency (1.49 kg mm^{-1}) was recorded in dry seeding (drill).

Cost benefit ratio

The data regarding cost benefit ratio presented in the table showed that the maximum cost benefit ratio (1:2.04) was recorded in transplanting (conventional). Whereas the minimum cost benefit ratio (1:1.34) was recorded in wet seeding (broadcast).

Table: water applied to different sowing methods of rice

Treatments	**Number of irrigations**	**Depth of water (mm)**	**Rainfall (mm)**	**Total water applied (mm)**
T_1: dry seeding (broadcast)	20	1851.0	270.8	2121.8
T_2: dry seeding (drill)	20	1814.8	270.8	2085.6
T_3: wet seeding (broadcast)	20	1751.6	270.8	2022.4
T_4: watter seeding (broadcast)	19	1662.4	270.8	1933.2
T_5: watter seeding (drill)	19	1662.4	270.8	1933.2
T_6: sri (system of rice intensification)	17	1368.6	270.8	1639.4
T_7: transplanting (conventional)	15	1405.8	270.8	1676.6

Data regarding water application given in the table showed that maximum water was applied under dry seeding (broadcast) method. It was followed by dry seeding (dril)

6. Regional adaptability yield trial on fine rice varieties

This experiment was designed to test the yield potential of promising lines of basmati rice provided by the director, rice research institute, kala shah kaku. The experiment was laid out in randomized complete block design with 3 replications. Rice nursery was transplanted on 28th of july 2016. All agronomic practices and plant protection measures were kept uniform for all the treatment. Data on paddy yield were noted at maturity and is presented in table.

Table.

Name of varieties/lines	**Paddy yield (kg ha^{-1})**
Basmati515	3900
Rri3	3750
Pk9194	3403
Pk bv-15-1	3640
Pk-db15-6	4110
Pk-pb-8	4256
Data was non-significant	

Statistical analysis of the data showed that there was no statistically significant difference between different lines/ varieties. However, line pk-pb-8 gave the highest paddy yield (4256 kg ha^{-1}) followed by the line pk-db15-6 which gave the paddy yield of 4110 kg ha^{-1}. While minimum paddy yields (3403 kg ha^{-1}) was produced by the variety pk9194.

7. Regional adaptability yield trial on coarse rice varieties

An experiment was conducted to test the yield potential of promising lines of coarse rice varieties/lines provided by the director, rice research institute, kala shah kaku. The trial was laid out in randomized complete block design having 3 replications. Rice nursery was transplanted on 28th of july 2016. All agronomic practices and plant protection measures were kept uniform for all the treatment. Data on paddy yield were recorded at maturity and is presented in table.

Table.

Name of varieties/lines	**Paddy yield (kg ha^{-1})**
Ksk-133	5653
Ksk-343	5316
Ksk-476	5843
Ksk-480	5633
Ksk-481	5963
Pk-7688-1-1-2-2	5876
Pk-9388-45-1-4-1-1	5306
data was non significant	

Statistical analysis of the data showed that there was no statistically significant difference between different lines/ varieties. However, line ksk-481 gave the highest paddy yield (5963 kg ha^{-1}). While minimum paddy yields (5306 kg ha^{-1}) was produced by the line pk-9388-45-1-4-1-1.

8. Effect of different sowing times on yield and growth of fine rice under direct seeded rice culture.

To investigate the best sowing time for different rice varieties in direct seedling of rice a trial was laid out in split plot design having three replications. Treatments were comprised of two factors

sowing dates

1. 2nd week of may
2. 1st week of june
3. 3rd week of june

Varieties

1. Super basmati
2. Basmati-515
3. Ps-2

Sowing dates were kept in main plots while rice verities subjected in sub plots. All other agronomic practices were kept uniform for all treatments.

Data on paddy yield and yield components was recorded and presented in table.3

Table.

	Vi	**V2**	**V3**	**Average**
S_1	3102 bc	3270 b	3641 a	3338 a
S_2	2846 cd	2759 cd	2672 de	2759 b
S_3	2085 f	2112 f	2372 ef	2190 c
Average	2678 b	2714 b	2895 a	

Critical value for comparison of variety= 169.67

Critical value for comparison of sowing date= 266.10

Critical value for comparison of interaction=355.70

Statistical analysis of the data showed the significant differences among the treatment means. According to the data maximum paddy yield (3641kg ha^{-1}) was obtained from the plot where rice variety ps-2 was sown on 2nd week of may and followed by the plot where rice variety basmati-515 was sown in 2nd week of may 2016.

While the minimum paddy yield (2085 kg ha^{-1}) was obtained from the plots where rice variety super basmati was sown in 3rd week of june 2016

9. Effect of different sowing times on yield and growth of coarse rice under direct seeded rice culture

To investigate the best sowing time for different rice varieties in direct seedling of rice a trial was laid out in split plot design having three replications. Treatments were comprised of two factors

Sowing dates

1. 1st week of may
2. 3rd week of may
3. 1st week of june

Varieties

1. Ksk-133
2. Ksk- 434
3. Ir-6

Data on paddy yield and yield components was recorded and presented in table.

Table.

	V1	V2	V3	Average
S_1	3848a	3777a	2703 d	3443 a
S_2	3103 bc	3222b	2874 cd	3066 b
S_3	2711 d	2725 d	2118 e	2518 c
Average	3221 a	3241a	2565 b	

Critical value for comparison of variety=141.86

Critical value for comparison of sowing date=201.97

Critical value for comparison of interaction=282.6

Statistical analysis of the data showed the significant differences among the treatment means. According to the data maximum paddy yield (3848kg ha^{-1}) was obtained from the plot where variety ksk-133 was sown on 1st week of may 2016 and remain at par with the plot where the rice variety ksk-434 was sown in 1st week of may which gave the paddy yield of (3777 kg ha^{-1}).

While minimum paddy yield (2118 kg ha^{-1}) was obtained from the plots where rice variety ir-6 was sown in 1st week of june 2016.

10. Effect of different plant spacing and fertilizer amount on growth and yield of transplanted rice (*oryza sativa l*).

To explore the scope of rice intensification systems a trial was laid out in split plot design with three replication. Rice nursery was transplanted on 21st of july 2016. Experiment comprised of following treatments

Plant spacing

1. Plant-plant space 30 cm
2. Plant-plant space 22.5 cm
3. Plant-plant space 15 cm
4. Plant-plant space 10 cm

Fertilizer

1. Recommended dose of npk ((133-67-62 npk kg ha^{-1})
2. 75 % of recommended dose of npk.
3. 125 % of recommended dose of npk.

4. 150 % of recommended dose of npk

Data on paddy yield and yield related parameters were recorded on the time of harvesting and presented in table.

Table.

	Fi	**F2**	**F3**	**F4**	**Average**
Ps_1	3406 j	3158 k	3572 ghi	3558 ghi	3424 c
Ps_2	3835 ef	3521 hij	3894 ef	4231 bc	3870 b
Ps_3	4096 cd	3730 fg	4309 b	4519 a	4163 a
Ps4	3419 ij	3161 k	3616 gh	3973 de	3542 c
Average	3689 c	3392 d	3848 b	4070 a	

Critical value for comparison of fertilizer= 62.267

Critical value for comparison of plant spacing= 156.51

Critical value for comparison of interaction= 189.44

Statistical analysis of the data showed the significant differences among the treatment means. According to the data maximum paddy yield (4519kg ha^{-1}) was obtained from the where rice nursery was transplanted by maintaining 15 cm plant-plant distance and 150 % of recommended dose of npk was applied.

while minimum paddy yield (3158 kg ha^{-1}) was obtained from the treatment where rice nursery was transplanted by maintaining 30 cm plant-plant distance and 75 % of recommended dose of npk was applied.

11. Effect of foliar application of micro nutrients (zinc and boron) on rice (*oryza sativa*) growth and yield.

To find economic use of micro nutrients to increase the rice yield, a trial was laid out in randomized complete block design having three replications. Rice nursery was transplanted on 28th of july 2016 and rice variety basmati-515 was used as testing material. Treatments were as

1. 0.05 % zinc solution two sprays (after 10 & 20 days of transplanting)
2. 0.1 % zinc solution two sprays (after 10 & 20 days of transplanting)
3. 0.05 % boron solution two sprays (after 30 & 45 days of transplanting)
4. 0.1 % boron solution two sprays (after 30 & 45 days of transplanting)
5. 0.05 % zinc solution & 0.05 % boron solution two sprays (zinc after 10 & 20 and boron after 30 & 45 days of transplanting)
6. 0.1 % zinc solution & 0.1 % boron solution two sprays (zinc after 10 & 20 and boron after 30 & 45 days of transplanting)
7. 0.05 % zinc solution & 0.1 % boron solution two sprays (zinc after 10 & 20 and boron after 30 & 45 days of transplanting)
8. 0.1 % zinc solution & 0.05 % boron solution two sprays (zinc after 10 & 20 and boron after 30 & 45 days of transplanting)
9. Water spray only
10. Soil application of zinc (recommended),
11. Soil application of boron (recommended).
12. Soil application of zinc and boron (recommended)
13. Control

Data on yield and yield related parameters was recorded and presented in table

Table

Treatments	**Paddy yield (kg ha^{-1})**
0.05 % zinc solution two sprays (after 10 & 20 days of transplanting)	4053 g
0.1 % zinc solution two sprays (after 10 & 20 days of transplanting)	4155f
.05 % boron solution two sprays (after 30 & 45 days of transplanting)	3558 i
0.1 % boron solution two sprays (after 30 & 45 days of transplanting)	3630 h
0.05 % zinc solution & 0.05 % boron solution two sprays (zinc after 10 & 20 and boron after 30 & 45 days of transplanting)	4164 f
0.1 % zinc solution & 0.1 % boron solution two sprays (zinc after 10 & 20 and boron after 30 & 45 days of transplanting)	4335 e
0.05 % zinc solution & 0.1 % boron solution two sprays (zinc after 10 & 20 and boron after 30 & 45 days of transplanting)	4023 g
0.1 % zinc solution & 0.05 % boron solution two sprays (zinc after 10 & 20 and boron after 30 & 45 days of transplanting)	4425 d
Water spray only.	3453 j
Soil application of zinc (recommended).	4713 b
Soil application of boron (recommended)	4518 c
Soil application of zinc and boron (recommended)	4818 a
Control	3360 k
Critical value for comparison = 49.135	

Statistical analysis of the data showed the significant differences among treatment means. According to the data maximum paddy yield (4818 kg ha^{-1}) was obtained from the treatment soil application of zinc and boron (recommended)

While minimum paddy yields (3360 kg ha^{-1}) was obtained from the control.

Economic analysis

Table.

Treatments	**Gross income (pkr)**	**Expense (pkr)**	**Net return (pkr)**
T1	158573	107740	50833
T2	162564	108440	54124
T3	139206	107540	31666
T4	142023	108040	33983
T5	162916	108240	54676
T6	169606	109440	60166
T7	157399	108740	48659
T8	173128	108940	64188
T9	135098	107040	28058
T10	184396	105540	78856
T11	176766	107290	69476
T12	188504	106790	81714
T13	131460	105540	25920

Economic analysis showed the maximum net return (rs.81714) from the treatment soil application of zinc and boron (recommended) and control showed the minimum net return of (rs.25920).

COTTON

12. Provincial cotton coordinated trial Bt. (PCCT-I)

This experiment was conducted to find out the best suited high yielding bt cotton variety/line for sandy loam soil of thal irrigated area. This trial was conducted in collaboration with cotton research institute, multan. Thirty-three (33) cotton varieties/lines i.e.pc1 to pc33 were tested under thal irrigated conditions. The experiment was sown on 17-05-2016 in rcbd with three replications and plot size of 6 m× 3 m with line to line distance of 0.75m. Chemical fertilizer @120-60-62 npk kg ha^{-1} in the form of dap, urea and sop was applied. The all other agronomic practices were kept normal and uniform. The cotton crop was picked up on 17-10-2016 and 21-11-2016. The experiment was sown by hand drill and plant to plant distance was maintained 1 foot after thinning. The results showed that maximum seed cotton yield (2339 kg ha^{-1}) was obtained from pc-8 followed by pc-26 (2260 kg ha^{-1}). The minimum seed cotton yield of 652 kg ha^{-1} was obtained from variety/line pc-19.

(PCCT-I at boll opening stage)

13. Provincial cotton coordinated trial (PCCT-II)

This experiment was conducted to find out the best suited high yielding bt cotton variety/line for sandy loam soil of thal irrigated area. This trial was conducted in association with cotton research institute, multan. Four bt cotton varieties/lines i.e. Pc1 to pc4 were tested under thal irrigated conditions. The experiment was sown on 17-05-2016 employing rcbd with three replications and plot size of 6 m × 3 m in 75cm apart rows having four rows in each plot. Chemical fertilizer @ 120-60-62 npk kg ha^{-1} in the form of dap, urea and sop was applied. The experiment was sown through hand drill and plant to plant distance was maintained at 30 cm after thinning. The all other agronomic practices were kept normal and uniform. Yield data recorded after two pickings on 17-10-2016, and 21-11-2016 revealed that pc-1 gave maximum yield of 1833 kg ha^{-1} followed by pc-4 which yielded 1483 kg ha^{-1}.the minimum seed cotton yield of 1208 kg ha^{-1} was obtained from line/variety pc-3.

(PCCT-II at boll opening stage)

14. Provincial cotton coordinated trial non (PCCT-III)

This experiment was conducted to find out the best suited high yielding non-bt cotton variety/line for sandy loam soil of thal irrigated area. This trial was conducted in association with cotton research institute, multan. Three non bt cotton varieties/lines i.e. Pc1 to pc3 were tested under thal irrigated conditions. The experiment was sown on 16-05-2016 employing rcbd with three replications and plot size of 6.00 m × 3.00 m in 75cm apart rows having four rows in each plot. Chemical fertilizer @ 120-60-62 npk kg ha^{-1} in the form of dap, urea and sop was applied. The cotton crop was picked up on 17-10-16 and 21-11-16. The experiment was sown through hand drill and plant to plant distance was maintained 30 cm after thinning. The all other agronomic practices were kept normal and uniform. The maximum yield of 2606 kg ha^{-1} was obtained from pc3.the minimum seed cotton yield of 1456 kg ha^{-1} was obtained from line/variety pc-2.

(PCCT-III at boll opening stage)

15. Irrigation scheduling of cotton crop in sandy loam soil under thal irrigated conditions

This experiment was conducted to find out optimum number of irrigations in thal irrigated conditions. Five treatments i.e. I_1- (four irrigations = first irrigation after 15 days of sowing, second irrigation after 40 days of sowing, third irrigation at first white bloom, and fourth irrigation at first boll opening. I_2-(five irrigations = first irrigation after 15 days of sowing, second irrigation after 30 days of sowing, third irrigation at first squaring, fourth

irrigation at peak bloom, and fifth irrigation after first picking. I_3- (six irrigations = first irrigation after 15 days of sowing, second irrigation after 30 days of sowing, third irrigation after 40 days of sowing, fourth irrigation at first white bloom, fifth irrigation at first white bloom, and sixth irrigation at first boll opening. I_4- (seven irrigations = first irrigation after 15 days of sowing, second irrigation after 40 days of sowing, third irrigation at first white bloom, fourth irrigation at first white bloom, fifth irrigation at peak bloom, sixth irrigation at first boll opening and seventh irrigation after first picking. I_5- (seven irrigations = first irrigation after 15 days of sowing, second irrigation after 30 days of sowing, third irrigation after 40 days of sowing fourth irrigation at first squaring, fifth irrigation at first white bloom, sixth irrigation at peak bloom, seventh irrigation at first boll opening and eighth irrigation after first picking were kept for irrigations. The experiment was sown on 17-05-2016 employing rcbd with three replications and plot size of 3 m × 7.5 m in 75cm apart rows having four rows in each plot. Chemical fertilizer @ 120-60-62 npk kg ha^{-1} in the form of dap, urea and sop was applied. The cotton crop was picked up on 17-10-16 and 21-11-16. The experiment was sown through hand drill and plant to plant distance was maintained one foot after thinning. The all other agronomic practices were kept normal and uniform. The maximum seed cotton yield of 2159 kg ha-1 was obtained from i5 (seven irrigations = first irrigation after 15 days of sowing, second irrigation after 30 days of sowing, third irrigation after 40 days of sowing fourth irrigation at first squaring, fifth irrigation at first white bloom, sixth irrigation at peak bloom, seventh irrigation at first boll opening and eighth irrigation after first picking.).the minimum seed cotton yield of 963 kg ha^{-1} was obtained from i1 (four irrigations = first irrigation after 15 days of sowing, second irrigation after 40 days of sowing, third irrigation at first white bloom, and fourth irrigation at first boll opening.)

16. Effect of various plant populations on growth and yield of cultivars of cotton under sandy loam soils of thal

This experiment was conducted to find out the best plant population to get maximum seed cotton yield under thal irrigated conditions. Three plant populations i.e. 88925 cotton plants, 60747 cotton plants and 44462 cotton plants ha-1 were maintained to get optimum seed cotton yield. The cotton test variety was iub- 13. The results obtained elucidate that maximum seed cotton yield (1832 kg ha^{-1}) was obtained where plant population was kept maximum i.e. 88925 plants ha^{-1} followed by plant population of 60747 plants ha-1 which yielded 1756 kg seed cotton ha^{-1}. The minimum seed cotton yield of 1682 kg ha^{-1} was obtained from plant population 44462 plants ha_{-1}.

Relay cropping of bt cotton in wheat

The experiment was conducted at agronomic research station, bahawalpur on clay loam soil to see the impact of relay cropping on total income of farm. Due to the introduction of bt cotton in cotton-wheat cropping system, the area under wheat was reducing which is a

threat to our national food security. The present study was designed to adjust the bt cotton crop in standing wheat to get optimum yield from bt-cotton-wheat cropping system improving the system profitability. On the other hand, by planting cotton as relay crop in standing wheat crop, the reduction in the incidence of clcv disease was also hypothesized. The trial was laid out in rcbd with three replications having a plot size of 4.5m x 8m. The wheat variety galaxy was planted on 07.12.2015 on ridges and was fertilized as 120-100-60 npk kg ha^{-1}. All pk & 1/3 n was applied at sowing while remaining 2/3 n was applied at 1st irrigation. The cotton variety iub-13 planted on 20.03.2016 as relay crop in standing wheat crop and normal cotton crop was sown on 21. 05. 2016 after the field preparation having a seed rate of 25 kg ha^{-1} and was fertilized @ 150-60-00 npk kg ha^{-1}. All pk & 1/3 n was applied at sowing while remaining 2/3 n was applied in two equal splits i.e., at flowering and boll formation. . The data on wheat grain yield and seed cotton yield was recorded, analyzed and presented in the following table.

It is evident from the table 2 that significantly maximum seed cotton yield 5085 kg ha^{-1} was recorded from early bt cotton alone (p_5, march sowing) whereas lowest seed cotton yield 3081 kg ha^{-1} from may sowing cotton after wheat (p_4). However, seed cotton yield produced by p_2 (4721 kg ha^{-1}), p_3 (4806 kg ha^{-1}) and p_1 (4555 kg ha^{-1}) was apparently at par with that of p_5 indicating that cotton planted as relay crop in wheat in patterns as in p_1, p_3 and p_2 can yield normally with additional yield of wheat thus increasing the system productivity.

Table: Economic analysis of relay cotton in wheat crop experiment at Agronomic Research Station, Bahawalpur during Rabi 2015-16 to Kharif 2016

Treatment	Yield (kg ha^{-1})		Gross income (rs ha^{-1})				Cost of production (rs ha^{-1})			Net income (rs ha^{-1})	Bcr
	Cotton	Wheat	Cotton	Wheat	Wheat straw	Total	Cotton	Wheat	Total		
P_1:wheat planted on ridge and cotton dibbling on both sides of each alternate furrow (row x row = 75cm)	4555	3777	387175	122753	23606	547644	187008	67582	254590	293054 (+17.69%)	2.15
P_2: wheat planted on ridge and cotton dibbling on both sides of every 3rd furrow (paired row of cotton in 150cm)	4721	3900	401285	126750	24375	538300	187008	67582	254590	283710 (+14.98%)	2.11
P_3: wheat planted on flat in 90cm strips and 60cm space after each strip for cotton dibbling (double row) i.e. Paired row after 150cm space	4806	3967	408510	128928	24794	562231	187008	66593	253601	308630 (+21.84%)	2.22
P_4:cotton (after wheat and wheat after cotton)	3081	4267	261885	138678	26669	427231	191008	66593	257601	169630 (-42.2%)	1.66
P_5: bt-cotton alone (early on beds)	5085	0	432225	0	0	432225	191008	-	191008	241217	2.26
Cotton rate rs. 3400/40kg = rs 85/kg			Wheat rate rs 1300/40 = rs 32.5/kg				wheat straw rate = rs 250/40 = rs 6.25/kg				

The data presented in table showed that highest bcr 1:2.22 (with maximum net income of rs. 308630/- per hectare) was recorded from p_3 (wheat planted on flat in 90cm strips and 60cm space after each strip for cotton dibbling (double row) i.e. Paired row in 150cm space) followed by p_1 (wheat planted on ridge and cotton dibbling on both sides of each alternate furrow (row x row = 75cm)] and by p_2 (:wheat planted on ridges and cotton dibbling on both sides of every 3rd furrow (paired row of cotton in 150cm).) With 1:2.11 and 2.15 bcr and rs. 283710/- and 293054/- as net income per hectare which was after all (+21.84%), (+17.69%) and (+14.98%) more than the conventional early bt cotton planting system indicating the increased efficiency of the relay cropping system over conventional system.

Thus cotton planting patterns p_1, p_2 and p_3 as relay crop in wheat have higher bcr values than conventional checks p_4 and p_5 (table 2). It can be concluded that cotton as a relay crop in standing wheat can successfully be grown ensuring the food security as well as for additional income from the cropping system.

The data regarding wheat crop sown for relay cotton during 2016-17 is presented in table 2a below, the cotton crop is in the field:

Table: Relay cropping of early bt cotton in standing wheat crop at ars, (wheat crop data) during rabi 2016-17

Methods of planting	**1000-grains weight (g)**	**No. of fertile tillers (m^{-2})**	**No. of grains per spike (#)**	**Grain yield (kg/ha^{-1})**
P_1:wheat planted on ridge and cotton dibbling on both sides of each alternate furrow (row x row = 75cm)	42.9	406.3	53.1	4737 b
P_2: wheat planted on ridge and cotton dibbling on both sides of every 3rd furrow (paired row of cotton in 150cm)	42.3	411.7	55.7	4923 ab
P_3: wheat planted on flat in 90cm strips and 60cm space after each strip for cotton dibbling (double row) i.e. Paired row after 150cm space	42.5	404.7	52.5	4654 b
P_4:cotton (after wheat and wheat after cotton)	41.8	421.3	58.3	5251 a
P_5: bt-cotton alone (early on beds)	0.0	0.0	0.0	0.0
Mean	**42.4**	**411.0**	**50.6**	**4891**
Lsd at 5% for treatments				363.39

17. Mechanical planting of cotton

The experiment was conducted at Agronomic Research Station, Bahawalpur on clay loam soil to study the feasibility of mechanization in cotton planting by new multi-crop bed planter. The trial was laid out in RCBD with three replications having a plot size of 6m x 9m. Fertilizer was applied @ 150-60-60 NPK kg ha^{-1}. Cotton variety iub 13 was planted on 20. 05. 2016 using a seed rate of 25 kg ha^{-1}.

Table: seed cotton yield (kg ha^{-1}) in different methods of mechanical planting at agronomic research station, bahawalpur

	Treatments	**Yield (kg ha^{-1})**		
		2015	**2016**	**Mean**
P_1	Cotton plating on 75 cm apart beds with planter	2131ab	3180 a	2656
P_2	Cotton plating on 75 cm apart beds (45cm bed + 30cm furrow) with manual dibbling	2007 ab	3148 a	2578
P_3	Cotton planting on 75cm apart ridges with planter	2016 ab	3209 a	2694
P_4	Cotton planting on 75 cm apart ridges with manual dibbling	1974 b	3109 a	2563
P_5	Cotton plating on 75 cm wide beds with manual dibbling (check)	2179 a	3132 a	2553
P_6	Flat planting in 75 cm spaced rows by drill (check)	1681 c	2436 b	2059
	Lsd at 5% for treatments	**178.46**	**253.43**	

It is evident from the table 3 that on the basis of two years average data, significantly maximum seed cotton yield of 2694 kg ha^{-1} was obtained from p_3 where cotton planting on 75cm apart ridges with planter whereas as the lowest seed cotton yield 2059 kg ha^{-1} from flat planting (check). However, the p_1 (cotton plating on 75 cm apart beds with planter), p_2 (cotton plating on 75 cm apart beds (45cm bed + 30cm furrow) with manual dibbling) and p_4 (cotton planting on 75 cm apart ridges with manual dibbling) and p_5 (cotton plating on 75 cm wide beds with manual dibbling) were statistically at par with that of p_3 (cotton planting on 75cm apart ridges with planter) by producing 2656, 2578, 2563 and 2553 kg ha^{-1}, respectively. Thus it can be concluded that cotton can be planted mechanically by multi-crop bed planter saving time and labor.

18. Adaptation of advanced cotton lines/ varieties to various planting dates in cotton-wheat cropping system

The experiment was conducted at Agronomic Research Station, Bahawalpur on clay loam soil to find out the phenological behavior of newly evolved cotton varieties/strains and yield potential under different planting dates in the agro-ecological conditions of this zone. The trial was laid out in split plot arrangement under three replications having a plot size of 3m x 9m. Sowing dates were in main plots while varieties were randomized in sub plots. Fertilizer was applied @ 150-60-60 NPK kg ha-1. The experiment was planted on bed and furrows and comprised of the following treatments.

A) sowing dates

D_1= 15th april
D_2= 1st may
D_3= 15th may
D_4= 1st june
d_5 = 15th june

b) cultivars / strains

v_1= iub-13
v_2= fh-142
v_3= bh-185
v_4= cim-616

The data on seed cotton yield were collected, analyzed and are presented as under.

Table: seed cotton yield (kg ha^{-1}) of advanced cotton lines/ varieties under various planting dates.

Sowing dates	Year	Iub-13	Fh-142	Bh-185	Cim-616	Grand mean for sowing dates
D_1 (15/4)	2015	2725	2742	2615	2606	2672 a
	2016	3817	4049	3755	3791	3853 a
	Mean	**3271**	**3396**	**3185**	**3199**	**3263**
D_2 (01/5)	2015	2506	2556	2483	2404	2487 b
	2016	3628	3692	3526	3423	3567 b
	Mean	**3067**	**3124**	**3004**	**2913**	**3027**
D_3 (15/5)	2015	2067	2116	2024	1907	2029 c
	2016	3116	3178	3116	3073	3121 c
	Mean	**2591**	**2647**	**2570**	**2490**	**2575**
D_4 (01/6)	2015	1173	1273	1184	1153	1196 d
	2016	2298	2342	2180	2105	2231 d
	Mean	**1736**	**1808**	**1682**	**1629**	**1714**
D_5 (15/6)	2015	757	872	732	751	778 e
	2016	1611	1866	1818	1749	1761 e
	Mean	**1184**	**1369**	**1275**	**1250**	**1270**
Grand mean for varieties		**2370**	**2469**	**2343**	**2296**	**2907**

Lsd at 5% (2015) for varieties= 119.55 for sowing time = 166.56 for v x d = 267.33
Lsd at 5% (2016) sd = 176.39 var = 82.727 sd* var = 184.98

Table: seed cotton yield (kg ha^{-1}) of advanced cotton lines/ varieties under various planting dates during 2016 at ars, bahawalpur.

	Varieties				
Planting dates	**Iub-13**	**Fh-142**	**Bh-185**	**Cim-616**	**Grand mean for sowing dates**
D_1 (15/4)	3817 b	4049 a	3755bc	3791 b	3853 a
D_2 (1/5)	3628bc	3692bc	3526 cd	3423 d	3567 b
D_3(15/5)	3116 e	3178 e	3116 e	3073 e	3121 c
D_4(1/6)	2298 f	2342 f	2180fg	2105 g	2231 d
D_5(15/6)	1611i	1866 h	1818 h	1749 hi	1761 e
Grand mean for variety	**2894 b**	**3025 a**	**2879 b**	**2828 b**	**2907**
Lsd 5% sd = 176.39 var = 82.727 **sd* var = 184.98**					

Table: seed cotton yield (kg ha^{-1}) of advanced cotton lines/ varieties under various planting dates 2015.

Varieties	**Planting dates**					
	15th april	1st may	15th may	1st june	15th june	**Mean**
Iub-13	2725	2506	2067	1173	757	**1845.6 ab**
Fh-142	2742	2556	2116	1273	872	**1911.7 a**
Bh-185	2615	2483	2024	1184	732	**1807.7 ab**
Cim-616	2606	2404	1907	1153	751	**1764.3 b**
Mean	**2672.0 a**	**2487.3 b**	**2028.7 c**	**1195.7 d**	**778.0 e**	
Lsd at 5% for varieties= 119.55 for sowing time = 166.56 for v x d = 267.33						

Seed cotton yield data presented in table-4 showed that on the basis of two years average, cotton variety fh-142 gave significantly the highest mean seed cotton yield of 2469 kg ha^{-1}, whereas lowest seed cotton yield of 2296 kg ha^{-1} were recorded from cotton variety cim-616. As for as the sowing dates were concerned, cotton sown on 16th april gave the highest mean seed cotton yield of 3263kg ha^{-1}. Yield of all varieties/strains sown beyond the month of april reduced significantly.

So it is clear from the results that most suitable time for cotton sowing is 16th april to 1st may (optimum time 15th april to 15th may) and rest of the planting dates does not suit because of linear reduction in seed cotton yield.

19. Irrigation frequency trial on cotton

The experiment was conducted at Agronomic Research Station, Bahawalpur on clay loam soil to find out the most suitable method of irrigation and optimum level of irrigation for cotton crop in the agro-ecological conditions of this zone. The trial was laid out in split plot arrangement with three replications having a plot size of 6m x 7.5m. **Irrigation methods** were kept in main plots while **irrigation levels** were randomized in sub plots. Fertilizer was applied @ 200-115-95 NPK kg ha^{-1} and seed rate was used @ 25 kg ha^{-1}. The cotton variety iub-13 was planted on 03.06. 2016 in flat field conditions and earthing up was done after first irrigation 40 days after sowing. The subsequent irrigations were applied as per treatments. The trial comprised of the following treatments.

A)	**irrigation methods**	**b)**	**irrigation levels**
Im_1=	alternate row irrigation 100, 120	i_1=	5- irrigations (40, 60, 80, das)
Im_2=	standard irrigation 100,	i_2=	6- irrigations (40, 55, 70, 85, 115 das)
		I_3= 100,	7- irrigations (40, 55, 70, 85, 115, 130 das)
		I_4=	8- irrigations (40, 50, 60, 70, 80, 90, 100, 110, das)

The data on seed cotton yield were collected, analyzed and are presented as under.

Table: seed cotton yield (kg ha^{-1}) of irrigation frequency trial on cotton during 2016 at ars, bwp.

Irrigation methods	**Irrigation levels**				
	I_1 (5 irrig.)	**I_2 (6 irrig.)**	**I_3 (7 irrig.)**	**I_4 (8 irrig.)**	**Mean**
Alternate row irrigation	3036 b	3133 ab	3250 ab	3254 ab	3168 a
Standard irrigation	3091 ab	3211 ab	3363 a	3310 ab	3244 a
Mean	**3063 b**	**3172 ab**	**3306 a**	**3282 a**	**3206**

Lsd at 5% for irrign. Level = 203.84 for irrign. M = 186.53 im*il = 288.28

Table: irrigation frequency trial on cotton during at ars, bwp.						
Irrigation methods	Year	**Irrigation levels**				
		I_1 (5 irrig.)	**I_2 (6 irrig.)**	**I_3 (7 irrig.)**	**I_4 (8 irrig.)**	**Mean**
Alternate row irrigation	2015	1728	1735	1703	1704	1718
	2016	3036	3133	3250	3254	3168
	Mean	**2382**	**2434**	**2477**	**2479**	**2443**
Standard irrigation	2015	1733	1771	1760	1717	1745
	2016	3091	3211	3363	3310	3244
	Mean	**2394**	**2457**	**2511**	**2493**	**2464**
	G. Mean	**2388**	**2546**	**2494**	**2486**	

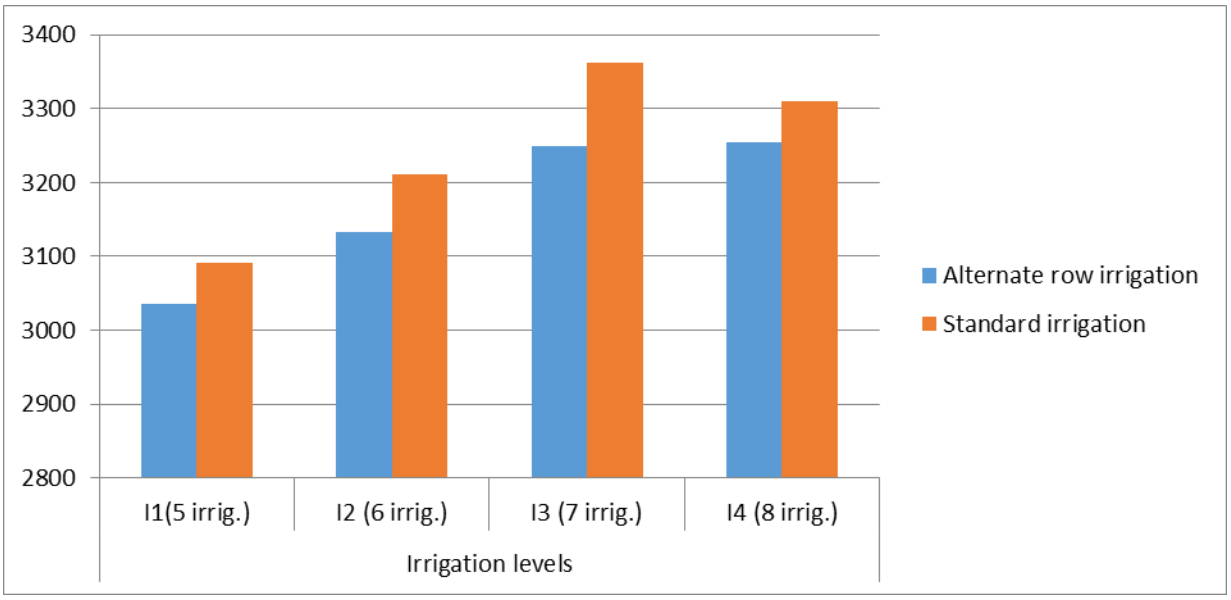


Figure: seed cotton yield (kg ha^{-1}) of irrigation frequency trial on cotton

Seed cotton yield data presented in table-5 showed that non-significantly the highest mean seed cotton yield of 3306 kg ha^{-1} was obtained from irrigation levels **i_3 (7 irrig.)** Followed by **i_4 (8 irrig.) And i_2 (6 irrig.)** With seed cotton yield of 3282 and 3172 kg ha^{-1} whereas lowest seed cotton yield of 2388 kg ha^{-1} were recorded from irrigation levels **i_1 (5 irrig.)**. As for as the **irrigation methods** were concerned, non-significant response towards irrigations methods was observed. On the basis of two years average data (table-5a), it is clear that maximum seed cotton yield (2546 kg ha^{-1}) was obtained in case of **i_2 (6 irrig.).** So for the same level of seed cotton

yield need not to irrigate more than economic level. Hence irrigation can be applied from 6 to 7 irrigations according to the need of the crop.

Although the treatment means show non-significant response yet the graphical presentation of the data show an increasing trend of seed cotton yield with increasing no. Of irrigations up to 7 irrigations with similar trend in both methods of irrigations but the alternate furrow irrigation method getting the edge of water saving.

Conclusion:

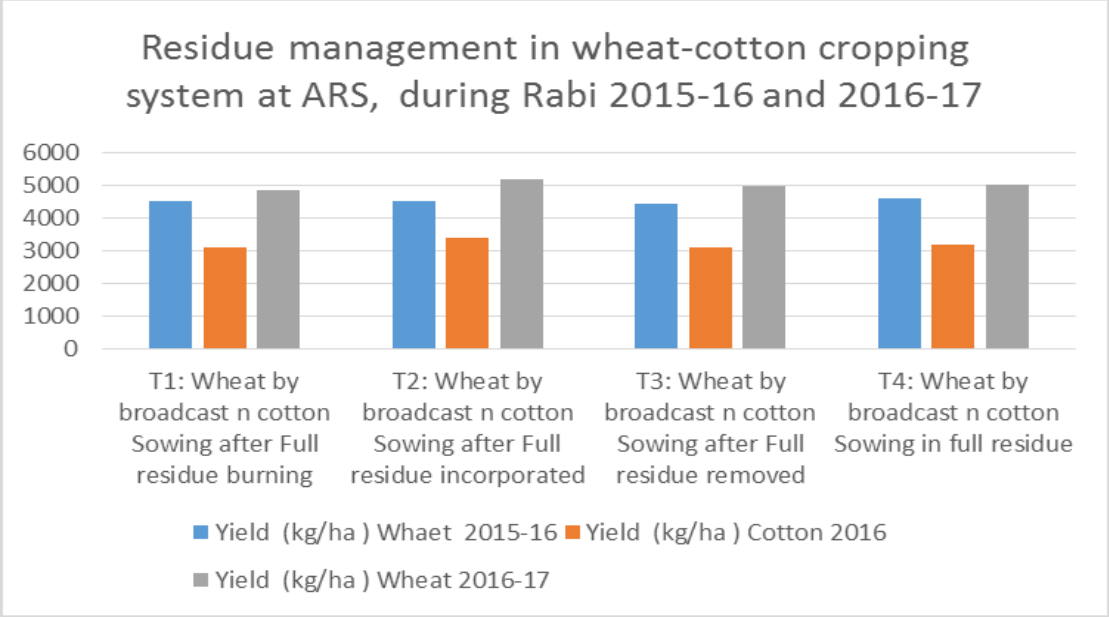
So it is clear from the results that most suitable irrigation levels for cotton range between 6 to 7 irrigations and best irrigation method is alternate furrow irrigation. This is because that apparently for same level of seed cotton yield we are using less quantity of irrigation water which is an edge to this method (alternate furrow irrigation).

20. Residue management in wheat-cotton cropping system.

The study was conducted at agronomic research station, bahawalpur to see the effect of residue on the productivity of cotton crop. The trial was laid out in rcbd with three replications having a net plot size of 6m x 7m. The trial was planted on 25.11.2015 using aas-11 wheat variety. The cotton variety fh-142 was planted in the following season on 25. 05.2016. Fertilizer was applied @ 150-60-00 npk kg ha^{-1}. However, a starter dose of nitrogen was applied @ 57 kg / ha^{-1} at *rouni* to cotton crop after wheat. Again aas-11 was used as test variety of wheat and was sown on 25.11.2016. Wheat crop was fertilized @ 120-100-60 npk kg ha^{-1} during both the years treatments and grain yield data are presented in the following table: 6.

From the wheat grain yield data presented in the table 6, it was evaluated that the difference of means were statistically non-significant however, apparently among various methods of planting, yield level of wheat in t_4 (wheat planting on flat by broadcast and **full residue left**/retained after wheat harvesting and cotton planting by new planter) and t_2 (wheat by broadcast n cotton sowing after full residue incorporated) got raised in both treatments with grain yield 5184and 5052 kg ha^{-1} as compared to t_1 (wheat planting on flat by broadcast and **full residue burning** after wheat harvesting and cotton planting on furrow beds) and t_3 (wheat planting on flat by broadcast and **full residue removed** after wheat harvesting and cotton planting on furrow beds) with grain yields 4873and 4981 kg ha^{-1}, respectively. The effect of different treatments of residue will be evaluated after the following cotton crop.

Table: Residue management in wheat-cotton cropping system at ars, bahawalpur during rabi 2015-16 and 2016-17			
Methods of planting	**Yield (kg/ha)**		
	Wheat 2015-16	**Cotton 2016**	**Wheat 2016-17**
T_1: wheat by broadcast and cotton sowing after full residue burning	4549	3094	4873
T_2: wheat by broadcast and cotton sowing after full residue incorporated	4526	3424	5184
T_3: wheat by broadcast and cotton sowing after full residue removed	4431	3104	4981
T_4: wheat by broadcast and cotton sowing in full residue	4600	3199	5052
Mean	**4527**	**3205**	**5023**
Lsd at 5%	**ns**		



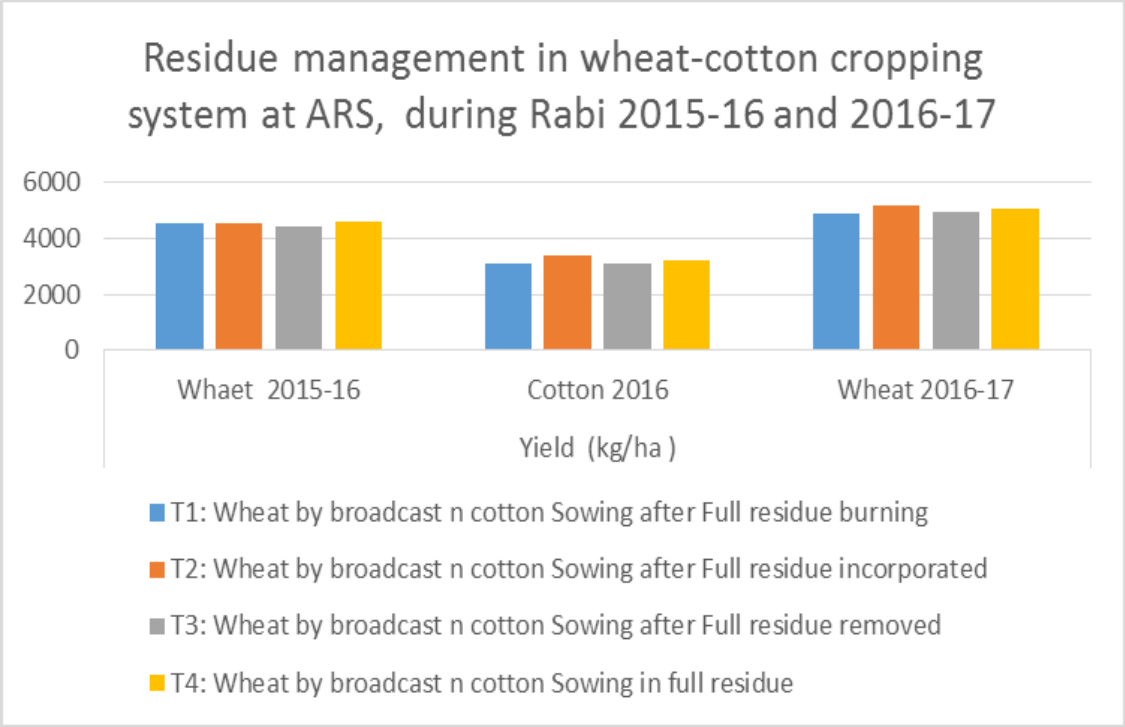


Fig The graphical presentation (fig 6a) also show that yield level in third crop season began to increase due to crop residue incorporation or retention in the soil.

21. Comparative efficacy of pre and post emergence herbicides in cotton under Bahawalpur conditions.

The experiment was conducted at the research area of agronomic research station, bahawalpur to find out the most suitable herbicide to control weeds in cotton crop. The trial was laid out in rcbd with three replications having a plot size of 5.25m x 8m. The crop (cotton variety iub-13) was planted on 20.05.2016. Fertilizer was applied @ 150-60-00 npk kg ha^{-1}. All p & 1/3 n was applied at sowing, while remaining 2/3 n was applied in 2 split doses, 1st at flowering and 2nd at boll formation. The experiment was planted on bed and furrows and the data on seed cotton yield were recorded, analyzed and presented along with treatments in the following table .

Table-1: Seed cotton yield as affected by different pre & post emergence herbicides to control weeds in cotton 2015 and 2016.

Treatments		**Seed cotton yield (kg ha^{-1})**		
		2015	**2016**	**Mean**
T1	Dual gold @ 2 lit./ha (pre emerg.)	1654 a	3180 a	2417

T2	Pendimethlin @ 3 lit/ha (pre emerg.)	1606 a	3159 a	2382
T3	Hadaf (oxyflour) @ 1000ml ha^{-1}(post emergence, broad spectrum)	1535 a	2829 b	2182
T4	Calm (quizalofop) @ 625 ml ha^{-1} (post emergence, grasses)	1083 b	2585 bc	1834
T5	Pendimethlin @ 3 lit/ha + calm(quizalofop) @ 625 ml ha^{-1}	1646 a	3222 a	2434
T6	Control	863 b	2436 c	1650
Lsd at 0.05		**285.92**	**257.44**	

Table: Efficacy of pre and post emergence herbicides in cotton, at A.R.S., Bwp.

Treatment		**Kinds of weeds**		**Weed count (m^{-2})**	**Weed dry biomass (g m^{-2})**	**Yield (kg/ha)**
		Bl	**Nl**			**2016**
T_1	Dual gold 2 l/ha (pre-emergence)	4.4	4.0	8.4	17.3	3180 a
T_2	Pendimethline 3 l/ha (pre-emergence)	2.5	9.0	11.5	24.6	3159 a
T_3	Hadaf*(oxyflour)* 1000 ml/ha (post-emergence) broad spectrum	6.6	12.0	18.6	35.2	2829 b
T_4	Calm *(quizalofop*) 625ml/ha (grasses)	18.0	6.0	24.0	45.4	2585 bc
T_5	Pendimethline 3 l/ha (pre-emergence)+ calm *(quizalofop*) 625ml/ha (grasses)	2.5	11.0	13.5	31.0	3222 a
T_6	Control	30.0	7.6	37.6	85.8	2436 c
Lsd at 5% for treatment						**257.44**

Table: Economic analysis of comparative efficacy of pre and post emergence Herbicides in cotton 2015 and 2016

Treatment		Seed cotton yield	Gross income	Cost that vary	Net income	Increase over control
		Kg ha^{-1}	Rs. Ha^{-1}	Rs. Ha^{-1}	Rs. Ha^{-1}	%
T_1	Dual gold 2 l/ha (pre-emergence)	2417	205445	3100	202345	+30.72
T_2	Pendimethline 3 l/ha (pre-emergence)	2383	202527	2650	199877	+29.86

T_3	Hadaf *(oxyflour)* 1000 ml/ha (post-emergence) broad spectrum	2182	185456	3100	182356	+23.12
T_4	Calm *(quizalofop*) 625ml/ha (grasses)	1834	155876	2000	153876	+8.89
T_5	Pendimethline 3 l/ha (pre-emergence)+ calm *(quizalofop*) 625ml/ha (grasses)	2434	206876	4400	202476	+30.76
T_6	Control	1649	140193	0	140193	0

it is evident from the table 1 that significantly maximum seed cotton yield 2417 and 2434 kg ha^{-1} were recorded from plots where (t_5) pendimethline 3 l/ha (pre-emergence) + calm *(quizalofop*) 625ml/ha and (t_1) dual gold were applied @ 2 lit./ha, whereas t_2,(pendimethline 3 l/ha (pre-emergence)) remained statistically at par with seed cotton yield of 2382 kg ha^{-1} . The lowest seed cotton yield of 1650 kg ha^{-1} was recorded from (t_6) control plots. A perusal of table 1a also indicates the same trend of net income level as that of seed cotton yield.

22. Provincial cotton co-ordinated trial

In pcct set-1 (bt.) 33 genotypes were evaluated for seed cotton yield. Genotype rh-668gave maximum seed cotton yield of 3209 kg ha^{-1}, which was also statistically similar with niab-778b and cim-622with seed cotton yield of 3098 kg ha^{-1} and 3173 kg ha^{-1},respectively. However lowest seed cotton yield was recorded from sitara-15 with seed cotton yield of 1111 kg ha^{-1}.

In pcct set-ii (bt.) 3 genotypes were evaluated for seed cotton yield. Genotype bpc-11 with seed cotton yield of 3136 kg ha^{-1} was the highest yielder along with fh-142 (3062 kg ha^{-1}). While the lowest was recorded from btc-10 with seed cotton yield of 2605 kg ha^{-1}.

In pcct set-i (non bt.), a total of four genotypes were evaluated. There was no significant difference for seed cotton yield among the four genotypes.

23. Evaluation of resource conservation practices in cotton-wheat cropping system

Experiment was conducted to assess the effect of zero tillage, minimum tillage and conventional tillage practices on the productivity of cotton-wheat cropping system. It was observed that higher seed cotton yield was obtained from conventional tillage system and yield decreased as the amount of tillage decreased (zero tillage).

24. Testing of new herbicides for cotton

This trial was conducted to find out new herbicides for effective weed control in cotton crop. The trial was sown on May 22, 2016 in randomized complete block design having a plot size of 3.0 m × 8.0 m. Cotton variety fh-lalazar was used in the study. New pre-emergence herbicide *pert plus 96 ec (s-metolachlor + pendimethaline)* was tested to control cotton weeds with standard *topmax 96 ec (metolachlor + pendimethaline)@* 2250 ml ha^{-1} respectively. Also one new post-emergence herbicide viz. *Fusilade 125 ec (fluzifop-p-butyl)* @ 3200 ml ha^{-1} was tested along with standard percept 10.8 ec @ 875 ml ha^{-1}. The following results were met during this year of study.

Table: effect of herbicides on weed counts, weed biomass, average boll weight, seed cotton yield and cbr

Treatments	**Dose Ha^{-1}**	**Weed count (m^2)**				**Weed biomass (gm^{-2})**		**Av. Boll weight (g)**	**Seed cotton yield (kg ha^{-1})**	**Cbr**
		Broad leaf weeds	**% weed control**	**Narrow leaf weeds**	**% weed control**	**Broad leaf weeds**	**Narrow leaf weeds**			
Topmax 96 ec (metolachlor + pendimethaline)	2250 ml	11 c	88.04	13 d	84.52	173 e	78 d	4.31 a	2348 a	1:1.69
Pert plus 96 ec (s-metolachlor + pendimethaline)	2250 ml	10 c	89.13	10 d	88.09	156 f	72 d	4.32 a	2360 a	1:1.71
Percept 10.8 ec (haloxyfop-p-methyl)	875 ml	51 b	29.16	24 b	71.42	316 b	148 b	3.85 c	1995 c	1:1.41
G-max lite15 ec (quizalofop-p-ethyl)	625 ml	52 b	27.80	17 c	79.76	288 c	99 c	4.09 b	2125 b	1:1.58
Fusilade 125 ec (fluzifop-p-butyl)	3200 ml	50 b	30.55	19 c	77.38	264 d	105 c	4.10 b	2090 b	1:1.55

Control (weedy check)	-	72 a	-	84 a	-	353 a	296 a	3.28 d	1075 d	-
Lsd		**2.61**	**-**	**4.24**	**-**	**14.84**	**12.39**	**0.067**	**57.29**	-

Broad leaf weeds count (m^{-2}) and weed biomass (gm^{-2})

It is obvious from the data that pre-emergence candidate herbicide pert plus 96 ec @ 2250 ml ha^{-1} gave broad leaf weed control (19.0) and and also produced weed biomass (156.0 gm^{-2}) statistically at par with its standard topmax 96 ec @ 2250 ml ha^{-1}. Both the herbicides were found less effective against *cyperus rotundus* (deela).

Narrow leaf weeds count (m^{-2}) and weed biomass (g m^{-2})

Both the candidate herbicides g-max lite 15 ec @ 625 ml $ha^{-1}$and fusilade 125 ec @ 3200 ml ha^{-1} gave efficient and effective control of grassy weeds (17 and 19) as compared to standard percept 10.8 ec which results in 24 m^{-2} grassy weeds. It was also manifested from the data that both post emergence candidate herbicides g-max lite 15 ec @ 625 ml ha^{-1} and fusilade 125 ec @ 3200 ml ha^{-1} also gave less weed biomass of narrow leaf weeds (99 and 105 g m^{-2}) against the standard (148 gm^{-2}).

Average boll weight (g)

It is clear from the data that pert plus 96 ec @ 2250 ml ha^{-1} produced higher but statistically at par average boll weight of 4.32 g against its standard topmax 96 ec @ 2250 ml ha^{-1} which produced average boll weight of 4.31 g. G-max lite 15 ec @ 625 ml ha^{-1} was tested against percept 10.8 ec @ 875 ml ha^{-1}. Candidate herbicides g-max lite 15 ec @ 625 ml $ha^{-1}$and fusilade 125 ec @ 3200 ml ha^{-1} gave higher average boll weight of 4.09 and 4.10 g as compared to its standard which produced average boll weigh of 3.85 g. The lowest average boll weight (3.28 g) is recorded in weedy check treatment.

Seed cotton yield (kg ha^{-1})

It is clear from the data that pre-emergence candidate herbicide pert plus 96 ec @ 2250 ml ha^{-1} produced higher (2360 kg ha^{-1}) but statistically at par seed cotton yield with its standard topmax 96 ec @ 2250 ml ha^{-1} which produced (2348 kg $ha^{-1)}$. Both post emergence candidate herbicides g-max lite 15 ec @ 625 ml ha^{-1} and fusilade 125 ec @ 3200 ml ha^{-1} produced higher seed cotton yield (2125 and 2090 kg ha^{-1}) against the standard herbicide percept 10.8 ec (1995 kg ha^{-1}). The minimum seed cotton yield 1075 kg ha^{-1} was recorded in control where no herbicides were sprayed.

Cost benefit ratio (cbr)

As for as cbr is concerned, highest cost benefit ratio was recorded in pre-emergence candidate herbicide pert plus @ 2250 ml ha^{-1} i.e., 1:1.71, as compared to its standard topmax @ 2250 ml ha^{-1} (1:1.69).

25. Fruit shedding study on the promising cotton varieties under Khanewal conditions

This study was conducted to evaluate the effect of plant population and environment on fruit shedding of cotton crop. Cotton varieties mnh-992, cyto-179, fh-lalazar and fh-142 were sown on 10-05-2016 at three different plant spacing i.e. 15, 30 and 45 cm using randomized complete block design with three replications. Net plot size was 2.7 m × 7.2 m. Fertilizer was applied @ 200-115-95 kg ha^{-1}. All other agronomic practices were kept uniform.

Results of this study showed that cotton variety fh-lalazar gave maximum seed cotton yield of 2281 kg ha^{-1} followed by mnh-992 with 2183 kg ha^{-1}, while minimum was recorded in cim-179 with 2073 kg ha^{-1}. Whereas among plant spacing, maximum yield was recorded where plant spacing was 30 cm, followed by 15 cm while minimum yield was recorded where plant spacing was 45 cm. Same trend was recorded in other two recorded parameters i.e. Number of bolls per plant and plant population.

In conclusion good crop yield of cotton can be obtained by keeping pant to plant distance at 30 cm, moreover cotton variety fh-lalazar showed good performance under khanewal conditions.

Seed cotton yield (kg ha^{-1})				
Varieties	**Plant spacing (cm)**			**Mean**
	15	**30**	**45**	
Fh-lalazar	2253	2559	2030	2281 a
Mnh-992	2120	2470	1960	2183 b
Fh-142	2067	2430	1957	2151 c
Cim-179	2038	2323	1857	2073 d
Mean	2120 b	2446 a	1951 c	
Lsd for varieties =21 Lsd for plant spacing = 28				

Number of bolls/ plant				
Varieties	**Plant spacing (cm)**			**Mean**
	15	**30**	**45**	
Fh-lalazar	23	29	28	27 a
Mnh-992	22	28	27	26 b
Fh-142	20	27	27	25 c

Cim-179	21	25	26	24 d
Mean	22 b	27 a	27 a	
Lsd for varieties =0.51 Lsd for plant spacing =0.64				

Plant population (acre)				
Varieties	**Plant spacing (cm)**			**Mean**
	15	**30**	**45**	
Lalazar	34716	17820	12097	21544
Mnh-992	33500	17767	11633	20967
Fh-142	34400	18433	12633	21822
Cim-179	34897	17663	12167	21576
Mean	34378 a	17921 b	12133 c	
Lsd for varieties =0.51 Lsd for plant spacing =0.64				

26. Intercropping of mungbean in cotton sown under different planting methods

This study was conducted to evaluate the potential of mungbean intercropping in cotton in enhancing farm productivity. Trial was sown on 10-05-2016 employing strip plot design, with three replications; in plots measuring 6.0 m × 15 m. Cotton variety fh-142 and mungbean variety azri-2006 were used in this experiment. Row and plant spacing of 75 cm and 30 cm respectively, were maintained for cotton while mungbean spacing of 30 cm was maintained. Npk @ 200-115-95 kg ha^{-1} was applied. All other agronomic practices were kept uniform.

Results showed that cotton crop sown at 75 cm spaced rows + one line of mungbean between two consecutive rows of cotton and cotton crop sown at 75 cm spaced rows + 30 cm spaced two rows of mungbean between two consecutive rows of cotton gave the maximum seed cotton yield of 2397 and 2367 kg ha^{-1} respectively. Similarly these treatments also gave maximum yield of mungbean i.e. 480 and 460 kg ha^{-1} respectively. However lowest yield of both cotton (2317 kg ha^{-1}) and mungbean (263 kg ha^{-1}) was recorded where cotton was sown at 75 cm spaced rows + mungbean broadcasted.

In conclusion cotton and mungbean can be sown by cotton crop sown at 75 cm spaced rows + one line of mungbean between two consecutive rows of cotton and cotton crop sown at 75 cm spaced rows + 30 cm spaced two rows of mungbean between two consecutive rows of cotton to get more yield of both crops

Yield (kg ha^{-1}) and income			
Treatment	**Cotton**	**Mung**	**Income (rs./ acre)**

	(kg ha^{-1})	(kg ha^{-1})	
75 cm spaced rows + mungbean broadcast	2316 b	864 a	74112+12960=87072
75 cm spaced rows + one line of mung	2396 a	640 c	76672+10240=86912
75 cm spaced rows + two lines of mung	2366 a	784 b	75712+11760=87472
75 cm spaced raised beds rows + two lines mung	2331 b	826 ab	74592+12390=86982
Lsd for cotton = 30.38 Lsd for mung = 31.55			

Soil analysis report			
Treatment	**Ph**	**Organic Matter**	**Available p (ppm)**
75 cm spaced rows + mungbean broadcast	**8.0**	**0.80**	**6.5**
75 cm spaced rows + one line of mung	**8.1**	**0.78**	**6.1**
75 cm spaced rows + two lines of mung	**8.2**	**0.78**	**6.4**
75 cm spaced raised beds rows + two lines mung	**8.2**	**0.68**	**6.3**

27. Economic evaluation of different cropping systems under Khanewal condition

This study was conducted to evaluate the suitable cropping system that can provide maximum income per year. Seven different cropping systems were evaluated i.e. T_1= cotton-wheat-cotton-wheat-cotton–wheat, t_2=cotton/wheat-cotton/wheat-cotton/wheat (relay), t_3=rice-wheat-rice-wheat-rice-wheat, t_4=cotton-fallow-cotton-wheat-cotton-fallow, t_5=cotton/berseem-cotton/wheat-cotton-fallow, t_6= cotton/raya-cotton/wheat-cotton/raya (relay) and t_7= mung-wheat-cotton -wheat-mung-wheat. Treatments were sown at three sowing dates i.e. T_4 at 4-04-2016, t_5 and t_6 at 11-05-2016 and t_1, t_2, t_7 at 12-05-2016. Crop was sown using rcbd in plots measuring 1 kanal. Cotton variety fh-142 and rice variety super kaynat were used in this experiment. Row and plant spacing of 75 cm and 30 cm respectively, were maintained for cotton while rice spacing of 22.5 cm was maintained. Npk @ 200-115-95 kg ha^{-1} was applied in cotton. All other agronomic practices were kept uniform.

Maximum yield was recorded in t_3 (rice-wheat-**rice**-wheat-rice-wheat) 2600 kg ha^{-1} followed by t_1 (cotton – wheat – **cotton** –wheat-cotton-wheat) 2350 kg ha^{-1} while minimum was recorded in t_5 [cotton/berseem-**cotton**/wheat-cotton/berseem (relay)] 2285 kg ha^{-1}.

Cotton yield	
Cropping system	**Yield (kg ha^{-1})**
Cotton – wheat – **cotton** –wheat-cotton-wheat	2350
Cotton/wheat – **cotton**/wheat- cotton/wheat (relay)	2345
Rice-wheat-**rice**-wheat-rice-wheat	2600
Cotton- fallow-**cotton**-wheat-cotton-fallow	2290
Cotton/berseem-**cotton**/wheat-cotton/berseem (relay)	2285
Cotton/raya-**cotton**/wheat-cotton/raya (relay)	2310
Mung-wheat-**cotton** -wheat-mung-wheat	51129

28. Minimizing square/flower shedding in bt. Cotton with nutrient management

This study was conducted to find out the best suitable nutrient management to control flower / square shedding of new Bt. varieties / strains under khanewal conditions. Cotton variety fh-142 was sown with 3 different levels of boron i.e. 1, 1.5, 2 kg ha^{-1} and potassium 95, 110 kg ha^{-1}. The trial was conducted in RCBD under factorial arrangement, with three replications; in plots measuring 3.0 m × 7.5 m. Cotton was sown in raised beds in 75 cm spaced rows maintaining p × p distance of 30 cm. NP @ 200-115 kg ha^{-1} was applied. All other agronomic practices will be kept uniform. Pre-sowing soil analysis including b concentrations was done.

maximum seed cotton yield of 2482.7 kg ha^{-1} was recorded where 2 kg b ha^{-1} was applied followed by seed cotton yield of 2389.3 kg-ha^{-1} where 1.5 kg ha^{-1} was applied however minimum seed cotton yield of 2288.3 kg ha^{-1} was recorded where 1 kg b ha^{-1} was applied. However in case of potassium, application of 110 kg k ha^{-1} gave more seed cotton yield as compared with 95 kg k ha^{-1}. Same trend was observed in case of number of bolls per plant.

Seed cotton yield (kg ha^{-1})			
Treatments	**95 kg ha^{-1}**	**110 kg ha^{-1}**	**Mean**
B 1 kg ha-1	2145	2432	2288.3 c
B 1.5 kg ha^{-1}	2236	2543	2389.3 b
B 2 kg ha^{-1}	2331	2635	2482.7 a
Mean	2237 b	2536 a	
Lsd for b = 19 Lsd for p = 15			

Bolls per plant			
Treatments	**95 kg ha^{-1}**	**110 kg ha^{-1}**	**Mean**
B 1 kg ha-1	24	26	25 c
B 1.5 kg ha^{-1}	27	29	28 b
B 2 kg ha^{-1}	28	30	29 a
Mean	26 b	28 a	
Lsd for b = 0.24 Lsd for p = 0.30			

29. Adaptation of new bt-cotton varieties/strains under different planting times

The experiment was conducted to find out the best time of sowing to get the maximum seed cotton yield potential of three promising varieties / strains of cotton under khanewal conditions. The strains / varieties viz. Fh-992, cim-179 and fh-lalazar were tested on 15/03, 02/04, 18/04, 02/05, 16/05. Sowing was laid out in split plot design in three replications on beds, keeping sowing dates in main plots and varieties / strains in sub-plots of size 6m×3m.the fertilizer was applied @ 145-56-62 NPK kg ha^{-1}. All the agronomic practices and plant protection measures were kept uniform.

The experiment revealed that the variety / strain fh-lalazar gave the highest seed cotton yield of 1961 kg ha^{-1} followed by fh-992 with seed cotton yield of 1861 kg ha^{-1}. The lowest yield of 153 kg ha^{-1} was recorded from cim-179. Among sowing dates the treatment d_3 produced maximum seed cotton yield of 2122 kg ha^{-1}, followed by seed cotton yield of 1932 kg ha^{-1} obtained in d_4 while lowest seed cotton yield of 1640 kg ha^{-1} was recorded in d_1.

In conclusion optimum time of cotton to attain maximum yield is 3rd week of april while fh-lalazar gave good performance under khanewal conditions.

Seed cotton yield (kg ha^{-1})				
Treatment	**Yield (kg ha^{-1})**			
	V1 = Fh-992	**V2= Cim-179**	**V3 =fh-lalazar**	**Mean**
D1=3rd week of march	1634	1470	1816	1640 e
D2=1st week of april	1834	1785	1969	1863 c
D3=3rd week of april	2158	1980	2227	2122 a
D4=1st week of may	1941	1868	1989	1932 b
D5=3rd week of may	1736	1661	1806	1734 d
	1861 b	153 c	1961 a	

Lsd for sowing dates = 41 Lsd for varieties = 40

30. Provincial coordinated cotton trial (pcct) for yield performance under khanewal conditions

The study was conducted to see the performance of different varieties / strains of cotton under khanewal conditions for yield performance. Experiment was conducted in RCBD with three replications and net plot size of 10 × 20 m. The experiment was sown on 15.05.16. Three sets of varieties / strains i.e. Set-1; thirty three promising varieties / strains; v_1-v_{33}, set-2; three promising varieties / strains; v_1-v_3 and set-3; four promising varieties / strains; v_1-v_4 were tested for yield performance under khanewal conditions. The fertilizer was applied @ 145-56-62 npk kg ha^{-1}. All the agronomic practices and plant protection measures were kept uniform.

In set-1; the variety / strain v_{17} gave best results with seed cotton yield of 2517 kg $ha^{-1,}$ followed by variety / strain v_8 with seed cotton yield of 2395 kg ha^{-1}. The lowest seed cotton yield of 1035 kg ha^{-1} was recorded by variety v_{29}. In set-2; the variety / strain v_3 gave best results with seed cotton yield of 2141 kg ha^{-1}, followed by variety / strain v_1 with seed cotton yield of 2001 kg ha^{-1}. The lowest seed cotton yield of 1872 kg ha^{-1} was recorded by variety / strain v_2. In set-3; the variety / strain v_1 gave best results with seed cotton yield of 2332 kg ha^{-1}, followed by variety / strain v_4 with seed cotton yield of 1946 kg ha^{-1}. The lowest seed cotton yield of 1701 kg ha^{-1} was recorded by variety / strain v3.

Hence, it can be concluded from results that in set 1, 2 and 3 the best performing varieties/ strains were v_{17}, v_3 and v_1 respectively.

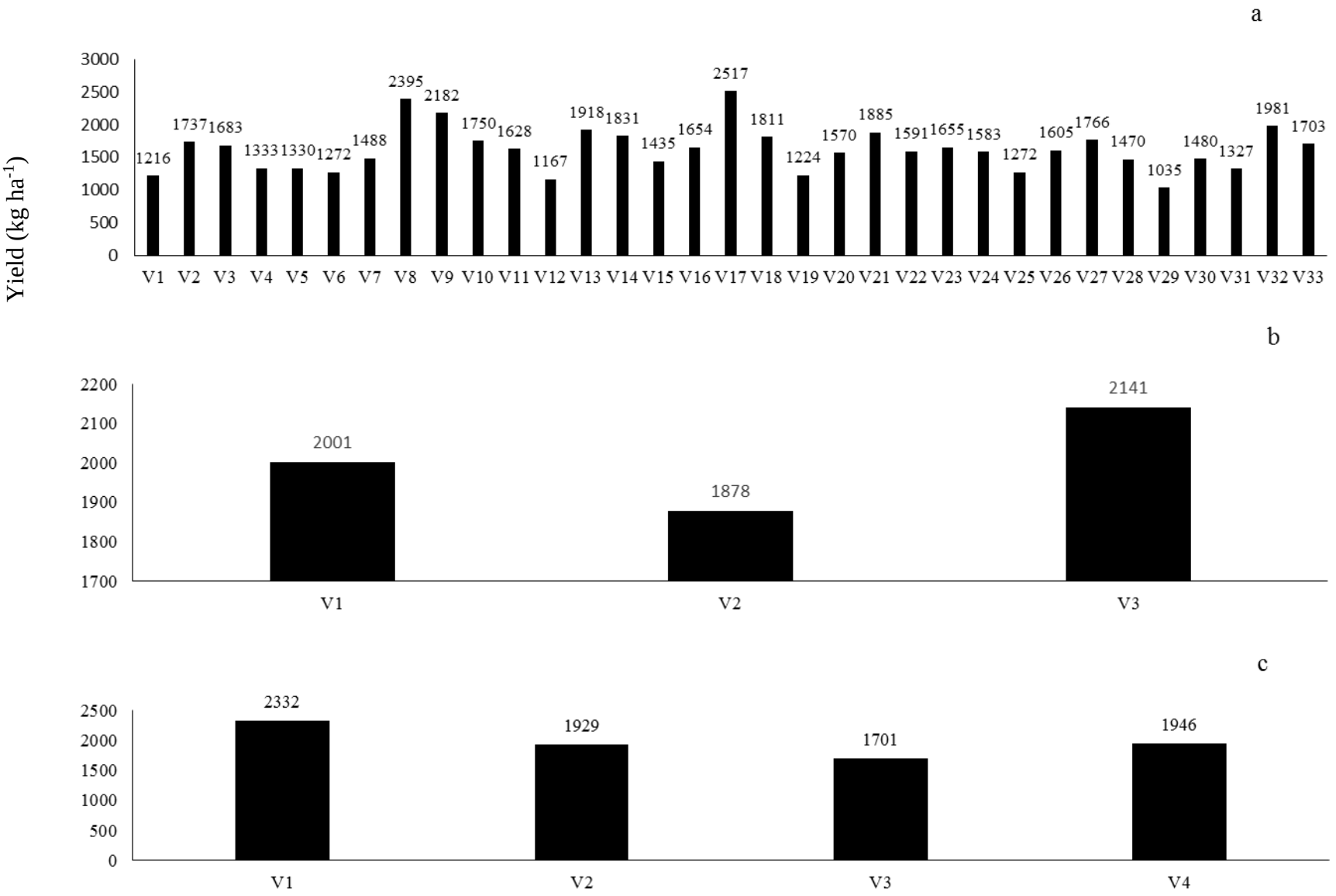

a
Yield (kg ha-1)
3000
2500
2000
1500
1000
500
0
1216 1737 1683 1333 1330 1272 1488 2395 2182 1750 1628 1167 1918 1831 1435 1654 2517 1811 1224 1570 1885 1591 1655 1583 1272 1605 1766 1470 1035 1480 1327 1981 1703
V1 V2 V3 V4 V5 V6 V7 V8 V9 V10 V11 V12 V13 V14 V15 V16 V17 V18 V19 V20 V21 V22 V23 V24 V25 V26 V27 V28 V29 V30 V31 V32 V33
b
2200
2100
2000
1900
1800
1700
2001
1878
2141
V1
V2
V3
c
2500
2000
1500
1000
500
0
2332
1929
1701
1946
V1
V2
V3
V4

Figure: yield performance of provincial coordinated cotton trial (pcct) under khanewal conditions

A) set 1 b) set 2 c) set 3

31. Performance of Bt-cotton varieties/strains under khanewal conditions

The trial was conducted to find out the best seed cotton yield of ten bt-cotton strains / varieties viz. Fh-142, fh-lalazar, bh-184, bh-185, vh-305, vh-319, vh-327, cim-616, cim-179, and mnh-992 under khanewal conditions. The experiment was sown on 12.05.2016 and laid out in RCBD with three replications having a plot size of 10 ft.×20 ft. Fertilizers @ 145-56-62 kg ha^{-1} were applied. The sowing was done 30 cm apart beds. All agronomic practices and plant protection measures were kept uniform.

Results showed that maximum seed cotton yields of 2456 and 2381 kg ha^{-1} were recorded in fh-lalazar and cim-616 respectively followed by fh-142 produced 2281 kg ha^{-1} yield. While minimum seed cotton yield of 2051 kg ha^{-1} was recorded in bh-185.

In conclusion fh-lalazar and cim-616 bt cotton varieties can perform well under khanewal conditions.

Treatment	**Plant height (cm)**	**Bolls / plant**	**Boll weight (g)**	**Seed cotton yield (kg ha^{-1})**
Fh-lalazar	160	27	3.5	2460 a
Cim-616	140	26	3.0	2381 a
Fh-142	155	25	3.4	2281 b
Mnh-992	170	24	3.3	2227 bc
Cim-179	165	26	3.0	2198 cd
Vh-327	150	24	3.1	2168 cde
Vh-305	140	25	3.1	2138 def
Vh-318	150	23	2.9	2116 efg
Bh-184	140	22	2.8	2081 fg
Bh185	130	21	2.9	2051 g
Lsd at 0.05=80				

32. Nitrogen uptake and crop yield of cotton as affected by organic and inorganic n-fertilizers

The experiment was sown on 12.05.16. Various combinations of farmyard manure, poultry manure and slurry were used to observe there optimal level suitable for nitrogen uptake and yield improvement. The experiment was laid out in rcbd with three replications having a plot size of 3m × 6m on cotton variety fh-142. Recommended dose of p&k was applied. Soil analysis was carried out. All agronomic practices and plant protection measures were kept uniform.

The treatment urea @ 30 kg ha^{-1}+ farm yard manure @ 8 tons ha^{-1} and urea @ 30 kg ha^{-1}+ slurry @ 8 tons ha^{-1} gave the highest seed cotton yield of 2458 and 2467 kg ha^{-1} respectively,

followed by urea @ 60 kg ha^{-1}+ slurry @ 4 tons ha^{-1} with seed cotton yield 2352 kg ha^{-1}. While the lowest seed cotton yield of 19250 kg $ha^{-1}$was recorded in control.

in conclusion urea @ 30 kg ha^{-1}+ farm yard manure @ 8 tons ha^{-1} and urea @ 30 kg ha^{-1}+ slurry @ 8 tons ha^{-1} had potential to boost the cotton yield.

Treatments	**Plant height (cm)**	**Sympodial branches**	**Bolls per plant**	**Boll weight (g)**	**Yield (kg ha^{-1})**
Control (145-56-62 npk kg ha^{-1})	97.33 g	24.67 e	25.33 f	3.00 f	1925.00 f
Poultry manure (8 t ha^{-1})	103.33 ef	27.33 cd	27.67 e	3.13 ef	2261.70 de
Farm yard manure (10 t ha^{-1})	104.00 ef	29.00 bc	29.67 cd	3.18 def	2300.00 cd
Slurry (10 t ha^{-1})	106.67 ef	28.00 bc	28.67 de	3.27 cde	2303.30 cd
Urea (30 kg ha^{-1}+ poultry manure 6 t ha^{-1})	102.00 fg	25.67 de	26.00 f	3.12 ef	2255.00 e
Urea 30 kg ha^{-1}+ farm yard manure 8 t ha^{-1}	118.33 ab	33.33 a	34.33 a	3.53 ab	2458.30 a
Urea 30 kg ha^{-1}+ slurry 8 t ha^{-1}	122.33 a	34.00 a	35.33 a	3.57 a	2466.70 a
Urea 60 kg ha^{-1}+ poultry manure 3 t ha^{-1}	107.33 de	28.67 bc	29.33 cd	3.30 cde	2323.30 bc
Urea 60 kg ha^{-1}+ farm yard manure 4 t ha^{-1}	111.67 cd	29.67 b	30.67 bc	3.37 bcd	2336.70 bc
Urea 60 kg ha^{-1}+ slurry 4 t ha^{-1}	115.67 bc	32.00 a	31.67 bc	3.43 abc	2351.70 b
Lsd at 0.05	4.92	2.25	1.59	0.19	43.16

Soil analysis report at sowing			
Treatment	**Ph**	**Organic Matter**	**Available p (ppm)**
T1=recommended(control)	8.1	0.70	5.5
T2= poultry manure (8t ha^{-1})	8.0	0.68	6.1
T3= farm yard manure (10 t ha^{-1})	8.4	0.70	6.0
T4= slurry (10 t ha^{-1})	8.4	0.68	5.3
T5= urea (30 kg ha^{-1}+ poultry manure 6 t ha^{-1})	8.3	0.69	5.3
T6= urea 30 kg ha^{-1}+ farm yard manure 8 t ha^{-1}	8.1	0.64	6.3
T7= urea 30 kg ha^{-1}+ slurry 8 t ha^{-1}	8.1	0.68	5.8
T8= urea 60 kg ha^{-1}+ poultry manure 3 t ha^{-1}	8.2	0.69	6.4
T9= urea 60 kg ha^{-1}+ farm yard manure 4 t ha^{-1}	8.0	0.65	6.3
T10=urea 60 kg ha^{-1}+ slurry 4 t ha^{-1}	8.2	0.68	5.5
Soil analysis report after harvesting			

Treatment	Ph	Organic Matter	Available p (ppm)
T1=recommended(control)	8.1	0.68	5.1
T2= poultry manure (8t ha^{-1})	8.3	0.65	6.1
T3= farm yard manure (10 t ha^{-1})	8.6	0.68	6.0
T4= slurry (10 t ha^{-1})	8.5	0.65	5.1
T5= urea (30 kg ha^{-1}+ poultry manure 6 t ha^{-1})	8.5	0.64	5.1
T6= urea 30 kg ha^{-1}+ farm yard manure 8 t ha^{-1}	8.4	0.60	6.0
T7= urea 30 kg ha^{-1}+ slurry 8 t ha^{-1}	8.4	0.64	5.4
T8= urea 60 kg ha^{-1}+ poultry manure 3 t ha^{-1}	8.0	0.65	5.9
T9= urea 60 kg ha^{-1}+ farm yard manure 4 t ha^{-1}	8.0	0.62	5.8
T10=urea 60 kg ha^{-1}+ slurry 4 t ha^{-1}	8.1	0.64	5.1

TOMATO

33. Effect of planting geometry on the fruit yield of tomato (lth-169)

The experiment was conducted to find out the most suitable planting geometry and bed size to enhance fruit yield of tomato. The experiment was laid out in rcbd factorial having a plot length 6.0 m with plant to plant distance 40cm.the treatments planting geometry transplanting on one side(1.0,1.125,1.250 m) and both side (1.125,1.250,1.375 m) of the bed. The fertilizer was applied @ 225-90-125 npk kg ha^{-1}.the highest fruit yield 27.1 t ha^{-1} was recorded from the treatment when planting was done on 1.250 meter bed width and both side of the bed. The minimum fruit yield 17.9 t $ha^{-1}$was recorded where the planting was done on 1.250 meter bed width and one side of the bed.

34. Effect of bio and synthetic shading on the fruit yield of tomato

The experiment was conducted to find out the most suitable shading material for tomato to mitigate the effect of high temperature during summer season to get maximum fruit yield of tomato. The experiment was laid out in rcbd with four replication having a plot size 6.0 m × 1.25 m with plant to plant distance 40cm.the treatments were tomato alone, tomato + sesbania (pxp=15cm), tomato + sesbania (pxp=30cm), tomato + sesbania (pxp=45cm) and tomato under green net cover. The crop was transplanted on 04-12-2015. The highest fruit yield 9.99 t ha^{-1} was recorded from the treatment when tomato crop wastransplanted alone.

35. Effect of planting orientation nd mulch on the growth and yield of tomato(09070)

The experiment was conducted to find out the most suitable planting direction and mulching to get maximum fruit yield of tomato. The experiment was laid out in rcbd having a plot length 6.0 m × 1.25 m with plant to plant distance 50 cm. The treatments were normal (east to west), normal plus mulching (black polyethylene paper), transplanting at 45 degree (south to west) and transplanting at 45 degree (south to west) plus mulching. The fertilizer was applied @ 225-90-125 kg ha^{-1} npk. The highest fruit yield 24.6 t ha^{-1} was recorded from the treatment when planting was done in normal direction with mulching. The minimum fruit yield 17.5 t $ha^{-1}$was recorded where the planting was done on at 45 degree (south to west) with no mulching.

JUTE

Research on agronomic and breeding aspects of jute crop are in progress.for high yielding variety development for general cultivation, selection and breeding programme has been launched with a goal of sustained supply of raw jute fiber to the industry and higher income to farmers.

36. Evaluation of resource conservation practices in jute-wheat cropping system

Zero tillage practice was evaluated in jute-wheat cropping system for both *c. Olitorious*and*c. Capsularis*species of jute. Results suggest that significantly taller jute plants (3.64 m) with more diameter (1.78 cm) were recorded by conventional method of sowing against zero tillage which recorded 3.26 m tall plant and 1.73 cm diameter. However fiber was not extracted due to unavailability of irrigation waterowing to canal closure from january to june.

37. Nutrient management for higher fiber yield of jute

The objective of this study was to find out the appropriate nitrogen and phosphorus doses for jute to get higher fiber yield. Results revealed that n and p alone and in combination, significantly affect the plant height and stem diameter of jute. Results reveal that higher plant height (4.09 m) was obtained at 30 kg ha^{-1} p and 45 kg ha^{-1} n which was also similar (4.08 m) to 30 kg ha^{-1} p and 60 kg ha^{-1} n, respectively. However maximum stem diameter (2.78 cm) was obtained at 30 kg ha^{-1} p and 45 kg ha^{-1} n, respectively. However fiber was not extracted due to unavailability of water.

Breeding programme of jute

38. Characterization of jute germplasm

The objective was characterization of jute crop for desired morpho-agronomic traits to select breeding materials for further crop improvement. Nineteen jute lines were sown in progeny to row trial. Results suggest that line no. 14 gave taller plants. Similarly lines no. 12, 16 and 19 are the potential breeding material for further breeding program.

39. Study of filial (f_1) generation of jute (*c. Olitorius*)

This study as a component of jute variety development program with the objective to select desirable recombinants for the development of high yielding varieties. The trial was carried out in progeny (cross) to row trial. A total of 11 entries in f_3 generation and 3 entries in f_4 generation were raised.resultantly, the seed of 11 crosses in f_3 and 3 crosses in f_4 were harvested in bulk.

SISAL

Research on development and maintenance of sisal nursery for hedge plantation and fiber extraction is in progress.

40. Establishment of sisal (*agave sisalana*) nursery

The objective of this study was to develop and maintain a nursery of sisal through bulbils and suckers for hedge plantation and fiber extraction. Nursery is being maintained by transplanting the suckers and bulbils.

TULSI

41. Enhancing tulsi yield by the foliar application of chemicals (*ocimum sanctum*)

Medicinal plants play a vital role in the maintenance of human health, generation of income and improvement in the livelihood throughout the world. A field experiment was conducted at plant physiology research area, agronomic research institute, faisalabad during the year 2016 to evaluate the influence of different chemicals as foliar sprays viz. Ba (6-benzyl aminopurine) @ 0.08 mgl^{-1} at 30 + 50 days after sowing, solubor @ 750 g ha^{-1} at 30 and 50 das, potassium borate @ 125 g ha^{-1} at 30 + 50 das, potassium citrate @ 125 g ha^{-1} at 30 + 50 das, fertigrain @ 750 ml ha^{-1} at 30 + 50 das, isabion @ 500 ml ha^{-1} at 30 + 50 das, cmm @ 625 g ha^{-1} at 30 + 50 das, potassium borate @ + potassium citrate each @ 125 g ha^{-1} + fertigrain @ 750 ml ha^{-1} at 30 + 50 das, potassium borate @ + potassium citrate each @ 125 g ha^{-1} + isabion @ 500 ml ha^{-1} at 30 + 50 das, potassium borate @ + potassium citrate each @ 125 g ha^{-1} + solubour @ 750 g ha^{-1} at 30 + 50 das, potassium borate @ + potassium citrate each @ 125 g ha-1 + cmm @

625 g ha^{-1} at 30 + 50 das, water spray @ 250 l ha^{-1} at 30 + 50 das and control (no spray)) on growth and yield of tulsi. The trial was sown on march 20, 2016 in randomized complete block design having a plot size of 1.8 m × 8.0 m, using seed rate 7.5 kg $ha^{-1}ha^{-1}$. The row to row and plant to plant distance was maintained 60 × 22 cm respectively in all the treatments and crop was fertilized @ 60-60 np kg ha^{-1}. All the growth, yield and yield parameters were significantly affected by the applications of chemicals.

Table: effect of foliar application of chemicals on yield and yields components of Tulsi

#	Treatment	Total no. Of racemes per plant	Total no. Of seeds per raceme	1000-seed weight (g)	Seed yield (kg ha^{-1})
T_1	Ba @ 0.08 mgl^{-1} at 30 + 50 das	307 efg	50.34 d	1.02 bcde	870 fg
T_2	Solubor @ 750 g ha^{-1} at 30 and 50 das	319 bcd	56.22 a	1.03 bcd	1040 c
T_3	Potassium borate @ 125 g ha^{-1} at 30 + 50 das	306 efg	52.21 c	1.02 bcde	925 e
T_4	Potassium citrate @ 125 g ha^{-1} at 30 + 50 das	306 efg	49.84 d	1.01 cde	860 fg
T_5	Fertigrain @ 750 ml ha^{-1} at 30 + 50 das	310 defg	51.97 c	1.02 bcde	890 ef
T_6	Isabion @ 500 ml ha^{-1} at 30 + 50 das	304 fg	49.58 d	1.01 cde	840 g
T_7	Cmm@ 625 g ha^{-1} at 30 + 50 das	314 cdef	52.44 bc	1.02 bcde	920 e
T_8	Potassium borate @ 125 g ha^{-1} + potassium citrate @ 125 g ha^{-1} + fertigrain @ 750 ml ha^{-1} at 30 + 50 das	325 abc	53.43 b	1.05 abc	1000 d
T_9	Potassium borate @ 125 g ha^{-1} + potassium citrate @ 125 g ha^{-1} + isabion @ 500 ml ha^{-1} at 30 + 50 das	317 bcde	52.97 bc	1.03 bcd	970 d
T_{10}	Potassium borate @ 125 g ha^{-1} + potassium citrate @ 125 g ha^{-1} solubor @ 750 g ha^{-1} at 30 + 50 das	335 a	57.13 a	1.09 a	1160 a
T_{11}	Potassium borate @ 125 g ha^{-1} + potassium citrate @ 125 g ha^{-1} + cmm@ 625 g ha-^{1} at 30 + 50 das	328 ab	56.57 a	1.06 ab	1080 b

T_{12}	Water spray @ 250 l ha^{-1} at 30 + 50 das	301 gh	49.59 d	1.00 de	800 h
T_{13}	Control (no spray)	291 h	45.92 e	0.98 e	750 i
Lsd		**11.57**	**1.11**	**0.047**	**38.17**

Discussion:

Total no. Of racemes per plant:

All the chemicals under study significantly affected total number of racemes per plant. The application of potassium borate @ 125 g ha^{-1} + potassium citrate @ 125 g ha^{-1} + solubor @ 750 g ha^{-1} at 30 + 50 das produced significantly maximum number of racemes per plant (335). On the other hand minimum numbers of racemes per plant (291) were recorded where no chemical was sprayed.

Total no. Of seeds per raceme:

The entire chemicals under study significantly affected number of seeds per raceme. The application of potassium borate @ 125 g ha^{-1} + potassium citrate @ 125 g ha^{-1} + solubor @ 750 g ha^{-1} at 30 + 50 das produced significantly maximum number of seeds per plant (57.13). Whereas, minimum number of seeds per raceme (45.92) was recorded where no chemical was sprayed.

1000-seed weight (g)

100-seed weight is a prime factor in determining yield of crops. 1000-seed weight of stulsi was significantly affected by various chemicals. The application of potassium borate @ 125 g ha^{-1} + potassium citrate @ 125 g ha^{-1} + solubor @ 750 g ha^{-1} at 30 + 50 das produced significantly maximum 1000-seed weight (1.09 g). On the other hand minimum 1000- seed weight (0.98 g) where no chemicals were sprayed.

Seed yield (kg ha^{-1})

all the chemicals under discussion affected seed yield of tulsi. Significantly maximum seed yield (1160 kg ha^{-1}) was recorded where potassium borate @ 125 g ha^{-1} + potassium citrate @ 125 g ha^{-1} + solubor @ 750 g ha^{-1} at 30 + 50 das was applied. On the other hand minimum seed yield of (750 kg ha^{-1}) was recorded in treatment where no chemicals were sprayed.

GRAM

42. Weed management in black gram (*vigna mungo l.*)

The trial was laid out using randomized complete block design with three replications having a plot size of 3.0 m × 8.0 m. Crop was drill sown with row to row distance of 25 cm. Pre-emergence herbicides were soil applied at the sowing time and post emergence herbicides 21 days after sowing. Fertilizer was applied @ 100-50-00 npk kg ha^{-1}. All other agronomic practices were kept uniform as in case of mash bean. The following results were obtained during this year of study.

Table: effect of herbicides on weeds and grain yield of black gram

#	**Treatments**	**Dose Ha^{-1}**	**Germi-nation counts m^{-2}**	**Weed counts m^{-2}**	**Legumes $Plant^{-1}$**	**Yield Kg ha^{-1}**
1	Top 33 ec (pendimethalin) As (pre-emergence)	3000 ml	16 a	12 b	18 a	450 a
2.	Dual gold 960 ec (s-metola) (pre-emergence)	2000 ml	12 b	11 b	17 a	350 bc
3.	Percept 10.8 ec (haloxyfop) (post emergence)	875 ml	15 a	13 b	16 ab	360 bc
4.	Calm 15 ec (qizalofop) (post emergence)	625 ml	15 a	12 b	16 ab	390 b
5.	Percept + conquest (post emergence)	875 ml+ 750 ml	16 a	02 c	15 bc	410 b
6.	Calm plus conquest (post emergence)	625 ml + 750 ml	15 a	03 c	16 ab	410 b
7.	Top (pre-emergence) + conquest (post emergence)	3000 ml + 750 ml	15 a	02 c	16 ab	450 a
8.	Dual gold (pre-emergence) + conquest post emergence	2000 ml+ 750 ml	12 b	02 c	17 a	450 a
9.	Weed free throughout		16 a	01 c	16 ab	480 a
10.	Control (weedy check)		15 a	41 a	10 d	200 d
Lsd			**1.8**	**3.5**	**1.15**	**34.0**

Discussion:

Germination counts and weeds count (m^{-2})

It is evident from germination counts (m^{-2}) data that application of dual gold 960 ec (pre-emergence) and dual gold 960 ec (pre-emergence) + conquest (post emergence) affected

germination of black gram and in each case 12 plants were recorded. .all other herbicides viz. Top 33 ec (pendimethalin) as (pre-emergence), percept (haloxyfop) 10.8 ec (post emergence), calm (qizalofop) 15 ec (post emergence) individually or in combination with conquest gave at par and safe germination. Weed counts data indicated that both the pre-emergence herbicides viz. Top 33 ec (pendimethalin) and dual gold 960 ec (s-metolachlor) gave equally effective weed control with 12 and 11 weeds m^{-2} respectively. Combined application of top (pre-emergence) + conquest (post emergence) and dual gold (pre-emergence) + conquest (post emergence) gave more effective weed control than pre emergence herbicides alone. They left only 2 weeds m^{-2} in each case. It was further recorded that calm 15 ec (post emergence) gave better control of *dactyloctenum aegyptium* (madhana ghas) than percept 10.8 ec (post emergence).

Grain yield (kg ha^{-1})

Poor yield was obtained due to poor germination. As regards the grain yield, the maximum yield was produced in case of weed free treatment. It was followed by top 33 ec (pre-emergence), percept + conquest (post emergence) and dual gold (pre-emergence) + conquest (post emergence) all of which yielded 450 kg ha^{-1}. Dual gold 960 ec (pre-emergence), percept 10.8 ec (post emergence) and calm 15 ec (post emergence) gave statistically at par seed yield of 350, 360 and 390 kg ha^{-1} respectively.

MUNG BEAN

43. Weed management in mung bean (*vigna radiate l.*)

The trial was laid out using randomized complete block design with three replications having a plot size of 3.0 m × 8.0 m. Crop was drill sown with row to row distance of 25 cm. Pre-emergence herbicides were soil applied at the sowing time and post emergence herbicides 21 days after sowing. Fertilizer was applied @ 100-50-00 npk kg ha^{-1}. All other agronomic practices were kept uniform. The following results were obtained during this year of study.

Table-1: effect of herbicides on weeds and yield of green gram/mung bean

#	**Treatments**	**Dose Ha^{-1}**	**Germi-nation counts m^{-2}**	**Weed counts m^{-2}**	**Legumes $Plant^{-1}$**	**Yield Kg ha^{-1}**
1	Top 33 ec (pendimethalin) As (pre-emergence)	3000 ml	14 ns	18 b	15 b	515 a
2.	Dual gold 960 ec (s-metola) (pre-emergence)	2000 ml	13	11 c	15 b	450 b
3.	Percept 10.8 ec (haloxyfop) (post emergence)	875 ml	15	13 c	12 c	360 c

4.	Calm 15 ec (qizalofop) (post emergence)	625 ml	15	11 c	12 c	350 c
5.	Percept + conquest (post emergence)	875 ml+ 750 ml	16	02 d	13 c	415 bc
6.	Calm plus conquest (post emergence)	625 ml + 750 ml	14	02 d	11 d	460 b
7.	Top (pre-emergence) + conquest (post emergence)	3000 ml + 750 ml	15	04 d	12 c	450 b
8.	Dual gold (pre-emergence) + conquest post emergence	2000 ml+ 750 ml	14	02 d	12 c	450 b
9.	Weed free throughout		16	02 d	16a	550 a
10.	Control (weedy check)		15	52 a	09 f	280 d
Lsd				**4.11**	**1.15**	**50.5**

Weed counts (m^{-2}) and germination count (m^{-2})

Poor germination of the trial was recorded due to improper soil moisture which gave poor yield. Application of dual gold 960 ec (s-metolachlor) pre-emergence partly affected its germination, but overall results were found non-significant. Weed counts data indicated that herbicide dual gold 960 ec (s-metolachlor) pre-emergence gave better weed control than top 33 ec (pendimethalin) as pre-emergence which left 11 and 18 weeds m^{-2} respectively. Percept + conquest post emergence, calm + conquest (post emergence) , top (pre-emergence) + conquest (post emergence) and top (pre-emergence) + conquest (post emergence) gave equally effective weed control with only 2, 2, 4 and 2 weeds m^{-2} respectively. However, calm 15 ec was found as more effective on *dactyloctenum aegyptium (madhana ghas*) than percept 10.8 ec. Post emergence herbicides percept and calm were found safe on mung bean crop.

Grain yield (kg ha^{-1})

as regards the seed yield of mung bean, the maximum yield of 550 kg ha^{-1} was produced in case of weed free (throughout) which was followed by top 33 ec (pre-emergence) with at par yield of 515 kg ha^{-1}. Percept + conquest (post emergence), calm + conquest (post emergence), top (pre-emergence) + conquest (post emergence) and dual gold 960 ec (pre-emergence) + conquest (post emergence) gave at par seed yield of 415, 460, 450 and 450 kg ha^{-1} respectively. Untreated plot gave as the lowest seed yield of 280 kg ha^{-1}

CUCURBITS (water melon, musk melon, bitter gourd, bottle gourd)

44. Chemical weed management in cucurbits (water melon, musk melon, bitter gourd, bottle gourd)

This experiment was conducted with the objective to find out herbicidal solution of weeds in the water melon. Experiment was conducted by using randomized complete block design having three replications. No fertilizer was applied because the experiment was to be plow up 45 days after sowing i.e. After collecting the data of weeds, plant population and plant height or wine length. Herbicidal treatments were tested against the weedy check and hand weeding. The following results were met during the first year of study.

Water melon (*citrulus lanatus l.*)

Table: effect of herbicides on the germination, weeds and plant height of watermelon

Treatments	**Dose Ha^{-1}**	**Germination counts/4m Length**	**Weed counts^{-2}**	**Plant height (cm) 45 das**	**Difference (%) over hw**
T_1: top 33 ec (pendimethalin)	1750 ml	10ns	71c	25 c	-38
T_2: dual gold 960 ec (s-metolachlor)	1250 ml	10	06 e	22 c	-45
T_3: topmax (pendimethalin+ Metolachlor)	1750 ml	09	09 e	27 c	-33
T_4: machete 60 ec (butachlor)	3000 ml	11	77 c	23 d	-43
T_5: gramoxone 20 ec (paraquat)	1250 ml	10	59 d	36 b	-10
T_6: percept 10.8 ec (haloxyfop)	750 ml	11	85 b	38 a	-05
T_7: calm 15 ec (qizalofop)	625 ml	11	90 b	37 a	-07
T_8: weed free through out		13	08 e	40 a	00
T_9: control (weedy check) -		12	113a	27 c	-33
Lsd		-	9.5	3.8	

Discussion:

it is evident from the germination counts data that there was a non significant difference. However, 10-20% more germination was recorded in case of untreated plots. As regards the weed counts data herbicidal application of dual gold 960 ec (s-metolachlor), topmax (pendi.+ metola) and weed free (throughout) gave effective and at par weed control and left only 6,9 and 8 weeds m^{-2} respectively. Percept 10.8 ec (haloxyfop) and calm 15 ec (qizalofop) the selective post

emergence grass killers gave at par weed control with 85 and 90 weeds. These were found ineffective against *cyperus rotundus* (deela). Top 33 ec (pendimethalin) and machete 60 ec (butachlor) gave at par results with 71 and 77 weeds m^{-2} respectively. Plant height data indicated that all the pre-emergence herbicides retarded the plant growth from 33 to 45% against weed free (throughout). However, the post emergence grass killers herbicides viz. Percept 10.8 ec (haloxyfop) and calm 15 ec (qizalofop) were found safe on water melon which gave plant height of 38 and 37 cm respectively.

Musk melon (*cucumis melo*)

Table: effect of herbicides on the weeds, germination and plant height of musk melon

Treatments	**Dose Ha^{-1}**	**Germination counts/4m Length**	**Weed counts m^{-2}**	**Plant height (cm) 45 das**	**difference (%) over hw**
T_1: top 33 ec (pendimethalin)	1750 ml	14 ns	20 d	30 c	-23
T_2: dual gold 960 ec (s-metolachlor)	1250 ml	12	09 e	26 d	-33
T_3: topmax (pendimethalin + Metolachlor)	1750 ml	16	15 de	32 c	-18
T_4: machete 60 ec (butachlor)	3000 ml	17	28 c	32 c	-18
T_5: gramoxone 20 ec (paraquat)	1250 ml	18	20 d	35 b	-04
T_6: percept 10.8 ec (haloxyfop)	750 ml	17	75 b	35 b	-04
T_7: calm 15 ec (qizalofop)	625 ml	18	70 b	35 b	-04
T_8: weed free through out		17	05 e	39 a	00
T_9: control (weedy check)		17	90 a	32 c	-18
Lsd		-	6.5	2.9	-

Discussion:

It is evident from the germination counts data that herbicides did not affected germination significantly. As regards the weeds data application of dual gold 960 ec and topmax (pendi + metola) gave effective and at par control of with only 09 an 15 weed counts m^{-2} comparable with the hand weeding (05 weeds) against 90 weeds in control. Top 33 ec (pendimethalin), machete 60 ec (butachlor) and gramoxone 20 ec (paraquat) ineffective against *cyperus rotundus* (deela) and gave at par control of 20, 28 and 20 weeds m^{-2} respectively. Percept 10.8 ec (haloxyfop) and calm 15 ec (qizalofop) were found only effective against grassy weeds and gave at par control

with 70 and 75 weeds m^{-2} respectively. Plant height or vine length was affected due to the phytotoxic effect of different herbicides. Early post emergence application of gramoxone 20 ec (paraquat) after the weeds but before the emergence of crop was found as the safest with plant height of 35 cm. Top 33 ec (pendimethalin) and dual gold 960 ec (s-metolachlor) retarded growth and gave at par length of 26 and 30 cm respectively.

Bitter gourd (*memordica charantia*)

Table: effect of herbicides on the weeds count, germination and plant height of bitter gourd

Treatments	**Dose Ml ha^{-1}**	**Germination counts per 4 meter Length**	**Weed counts m^{-2}**	**Difference (%) over control**	**Plant length (cm) 45 das**	**Difference (%) over hw**
T_1: top 33 ec (pendimethalin)	1750	16 ns	22 b	77	32 b	-16
T_2: dual gold 960 ec (s-metolachlor)	1250	14	09 cd	90	29 c	-24
T_3: topmax (pendimethalin+ Metolachlor)	1750	16	15 c	84	31 b	-18
T_4: machete 60 ec (butachlor)	3000	16	25 b	74	32 b	-16
T_5: gramoxone 20 ec (paraquat)	1250	16	12 bc	88	33 b	-13
T_6: percept 10.8 ec (haloxyfop)	750	14	18 b	81	35 a	-08
T_7: calm 15 ec (qizalofop)	625	15	13 c	86	36 a	-05
T_8: weed free (hw)	-	16	06 d	93	38 a	00
T_9: control		15	96 a	00	34 b	-19
Lsd		-	5.9		3.0	

Discussion:

It is evident from the germination counts data per 4 meter length that top 33 ec (pendimethalin) was found as the safest herbicide with 16 plants per 4 meter length which were at par with the control treatment. Dual gold 960 ec (s-metolachlor) gave minimum germination with 14 plants. However, the germination data were found non significant. As regards the weed counts m^{-2} pre-emergence herbicide dual gold 960 ec (s-metolachlor) gave more effective weed control which left only 09 weeds m^{-2} against 96 in control i.e. 90% control against control. As regards the plant hight or length, dual gold 960 ec (s-metolachlor) affected growth and only 29 cm length was recorded against 38 cm in hand weeding. Post emergence grass killer herbicides were found safe

and plant hight in case of percept 10.8 ec (haloxyfop) and calm 15 ec (qizalofop) was found non significant with 35 and 36 cm respectively.

Bottle gourd (*lagenaria siceraria*)

Table: effect of herbicides on the weeds count, germination and plant height of bottle gourd

Treatments	**Dose Ml ha^{-1}**	**Germination counts per 4 meter Length**	**Weed counts m^{-2}**	**Difference (%) over control**	**Plant length (cm) 45 das**	**Difference (%) over hw**
T_1: top 33 ec (pendimethalin)	1750	17 ns	19 b	81	42 ab	-13
T_2: dual gold 960 ec (s-metolachlor)	1250	13	09 c	91	39 bc	-19
T_3: topmax (pendimethalin+ Metolachlor)	1750	15	12 bc	88	41 bc	-15
T_4: machete 60 ec (butachlor)	3000	16	25 b	65	42 ab	-13
T_5: gramoxone 20 ec (paraquat)	1250	16	12 bc	88	43 ab	-10
T_6: percept 10.8 ec (haloxyfop)	750	17	18 b	82	45 a	-06
T_7: calm 15 ec (qizalofop)	625	16	13 bc	87	46 a	-04
T_8: weed free through out		16	05 c	95	48 a	00
T_9: control (weedy check)		17	99 a	00	36 c	-25
Lsd		-	7.9	-	3.0	-

Discussion

It is evident from the germination counts data that top 33 ec (pendimethalin) was found as the safest herbicide with 17 plants m^{-2} which were at par with the control treatment. Dual gold 960 ec (s-metolachlor) gave minimum germination with 13 plants. However, the germination data were found non significant. As regards the weed counts m^{-2} dual gold 960 ec (s-metolachlor) gave more effective weed control which left only 09 weeds m^{-2}. As regards the plant hight or length, dual gold 960 ec (s-metolachlor) affected growth and only 39 cm length was recorded against 48 cm (19% less) in hand weeding. Post emergence grass killer herbicides were found safe and in case of plant hight. Gramoxone 20 ec (paraquat), percept 10.8 ec (haloxyfop) and calm 15 ec (qizalofop) was found non significant with 43, 45 and 46 cm plant height respectively.

SESAME

45. Effect of different sowing dates on the yield of different cultivars of sesame

The experiment was conducted to find out the optimum planting time to get maximum yield in new strains of sesame. The experiment was laid out split plot design with three replication having a plot size of 1.5 m× 5.0 m. Sowing dates were 15th june,25thjune,5th july,15th july,25th july and 5th august,2014. The sesame strains werens-2, ns-22, ns-44, ns-103, th-6 and ts-5(check). Sesame variety ns-2 gave maximum yield (1778 kg ha^{-1}) when it was sown on 15th june, 2014 which was found to be at par withts-3 who gave the seed yield of 1778kg ha^{-1}on the same sowing time. The minimum sesame seed yield was 486 kg ha^{-1} when strain th-6 was sown on 5th july, 2014.

46. Effect of different planting methods and sowing times on the seed yield of sesame

The experiment was conducted to find out the optimum sowing time and suitable sowing method to get maximum yield in sesame. The experiment was laid out in split plot design with three replications having a plot size of 4.50 m×7.0 m. Sowing dates were 15th june, 30th june,15th July ,2015 and sowing method flat, bed and broadcast augmented with ridges. The sesame varieties were th-6, ts-5 used as test material. Sesame variety ts-5 gave maximum yield (793kg ha^{-1}) sown on 15th June by flat method, whereas th-6 gave 751kg ha^{-1} seed yield when it was sown on 30th June by flat method.

47. Weed management in sesame (*sesamum indicum*)

This experiment was conducted on June 10, 2016 with the objective to find out herbicidal solution of weeds in the sesame. Experiment was conducted by using randomized complete block design having three replications. Th-6 was used as test variety and fertilizer was applied @ 100-50-00 NPK kg ha^{-1}. Herbicidal treatments were tested against the weedy check and hand weeding. The following results were met during the first year of study.

Table: effect of herbicides on weeds m^{-2} and yield of sesame (till)

#	**Treatments**	**Dose ha^{-1}**	**Germination counts m^{-2}**	**Weed counts m^{-2}**	**Yield kg ha^{-1}**
1	Top 33 ec pre em ridges (pendimethalin)	1800 ml	15 ns	22 c	480 a
2.	Top 33 ec ppi drill sowing (pendimethalin)	2500 ml	15	18 c	493 a
3.	Dual gold pre em ridges (s-metolachlor)	1200 ml	13	10 d	456 b
4.	Dual gold 960 ec ppi drill	1500 ml	12	03 e	426 b

	(s-metolachlor)				
5.	Machete 60 ec pre emergence on ridges (butachlor)	3000 ml	16	35 b	361 c
6.	Machete 60 ec ppi drill (butachlor)	3000 ml	15	40 b	390 c
7.	Calm 15 ec (qizalofop methyl) post em drill	875 ml	16	14 d	275 d
8.	Percept 10.8 ec post em drill	625 ml	17	17 d	275 d
9.	Weed free throughout		17	03 e	510 a
10.	Control		17	102 a	200 e
Lsd			**-**	**10.5**	**49.05**

Germination counts and weed counts (m^{-2})

It is evident from the germination counts data that there was a non-significant difference among treatments which means no herbicide affected germination significantly. As regards the weed counts m^{-2} that herbicide dual gold 960 ec ppi drill gave as the best weed control which was at par with the hand weeding and both left only 03 weeds m^{-2}. Calm 15 ec (qizalofop methyl) and percept 10.8 ec post emergence application in drill sown were only effective against grassy weeds and could not control broad leaved and sedges and gave at par weeds of 14 and 17 m^{-2} respectively. Top 33 ec pre-emergence applied on ridges, top 33 ec pre plant incorporation in drill sown could not control nutsedge *(cyperus rotundus)* and gave at par weeds of 22 and 18 m^{-2} respectively. Same was the case with machete pre-emergence on ridges and machete 60 ec pre plant incorporation in drill sown which left mutually at par of 35 and 40 weeds m^{-2} respectively.

Seed yield (kg ha^{-1})

As regards the seed yield, out of herbicides, top 33 ec pre-emergence applied on ridges, top 33 ec pre plant incorporation in drill sown gave the maximum seed yield of 480 and 493 kg ha^{-1} which were also at par with weed free season long with seed yield of 510 kg ha^{-1}. Machete pre-emergence on ridges and machete 60 ec pre plant incorporation in drill sown gave lesser yield of 361 and 390 kg ha^{-1}. Poor yield was attributed to the poor weed control. Calm 15 ec and percept 10.8 ec post emergence application in drill sown yielded at par of 275 kg ha^{-1} seed yield. The lowest seed yield 200 kg ha^{-1} was recorded in weedy check treatment.

OILSEED

48. Intercropping of pulses in oilseed crops

Maximum net economic return of (rs. 68256 ha^{-1}) was obtained from linseed + lentil 2:2 intercropping system

Intercropping of linseed + lentil 2:2 at c&p farm

SUGARCANE

49. Intercropping of cereals and pulses with spring planted sugarcane crop

Maximum net return of rs. 281775 kg ha^{-1} with ler of 1.5 was obtained when sugarcane was intercropped with mungbean.

Mungbean intercropped in spring planted sugarcane at C&P farm

From the experiment, it is concluded that mashbean and mungbean can be intercropped in spring planted sugarcane to get maximum economic return and to minimize the cost of production per acre.

Intercropping of mashbean in spring planted sugarcane

50. Screening of herbicides to control weeds in sugarcane

The trial was sown in March, 2016 to screen out new herbicides to control weeds in sugarcane crop. Two new pre-emergence and three new post emergence herbicides i.e. Dafli 80 wdg (atrazine + mesotrione + halosulfuron methyl) @ 1750 g $ha^{-1}$and voltril 63 sc (meso+atrazine+s-metolachlor) @ 2500 ml ha^{-1}(pre-emergence) and maxpro 80 wdg (meso+atrazine+ halo sulfuron) @ 875 g ha^{-1},dafli 80 wdg (meso + atrazine + halo sulfuron) @ 1750 g ha^{-1} and twist 55 sc(atrazine + mesotrione) @ 2500 ml ha^{-1} (post emergence) were tested against their standard herbicides i.e., dual gold 960 ec (s-metolachlor) @ 2500 ml, scope 80 wp (ametryne + atrazine) @ 2500 g ha^{-1} and primextra gold 720 sc (atrazine + s-metolachlor) @ 2000 ml ha^{-1} to control broad leaf weeds, grasses and sedges. Cane variety hsf-240 was used as a test material. The trial was laid out in randomized complete block design having 3 replications with a plot size of 4.50 m × 7.0 m. The following results were recorded:-

Table: effect of herbicides on weeds and cane yield of sugarcane

#	Name of herbicides	Dose Ha^{-1}	Weed density (m^2)						Cane yield* (t ha^{-1})
			Broad leaf weeds	% control	Grasses	% control	sedges	% control	
1	*Dual gold 960e S-metolachlor*	2500 ml	4 c	93.65	7 d	81.08	20 c	83.05	86.65 c
2	*Voltril 63 sc (atrazine + mesotrione + s-metolachlor)*	2500 ml	3c	95.23	7 d	81.08	21 c	82.20	94.65 b
3	*Scope 30 wp (ametryn + atrazine)*	2500 g	3 c	95.23	4 e	88.57	88 b	25.42	86.05 c
4	*Dafli 80 wdg (atrazine + mesotrione + halosulfuron methyl)*	1750 g	1 c	96.87	4 e	88.57	9 f	91.50	98.65 a
5	*Scope 80 wp (ametryn + atrazine)*	2500 g	3 c	95.23	10 c	72.97	94 b	20.34	77.15 e
6	*Maxpro 80wdg (atrazine + mesotrione + halosulfuron methyl)*	875 g	3 c	95.23	8 d	83.78	11 d	90.67	94.65 b
7	*Dafli 80 wdg Atrazine + mesotrione + halosulfuron methyl*	1750 g	3 c	95.23	3 e	91.89	20 c	83.05	94.54 b
8	*Primextra gold 720 sc*	2000 ml	10 b	84.12	32 b	13.51	8 d	93.22	80.33 d

	(atrazine + s-metolachlor)								
9	*Twist 55 sc (atrazine + mesotrione)*	2500 ml	2 c	96.82	7 d	81.08	10 d	91.52	94.65 b
10	Control (weedy check)		63 a	-	37 a	-	118 a	-	65.10 f
Lsd			**2.98**	**-**	**2.46**	**-**	**7.36**	**-**	**0.848**

Weed counts (m^{-2})

It is evident from the table that all the herbicides obviously provided better weed control as compared to weedy check in sugarcane crop. Amongst the pre-emergence herbicides candidate dafli 80 wdg @ 1750 g ha^{-1} provided 96.87%, 88.57% and 91.50 % control of broad leaf weeds, grasses respectively. As for as post-emergence herbicides are concerned candidate herbicide maxpro 80wdg @ 875g ha^{-1} provided 95.23% , 83.78% and 90.67% control of broad leaf weeds, grasses and sedges as compared with standard herbicide scope 80% wp@ 2500 g ha^{-1} which provided 95.23% control of broad leaf weeds and 72.97 % of grasses and 20.34% of sedges, respectively. The lowest weed control was recorded in control treatment (weedy check).

Cane yield (t ha^{-1})

Among pre-emergence herbicides, maximum cane yield (98.65 t ha^{-1}) was produced by dafli 80 wdg @ 1750 g ha^{-1} which was 51.53% higher than control (65.10 t ha^{-1}). Among post emergence candidate herbicides maxpro 80 wdg @ 875 g ha^{-1} produced maximum cane yield (94.65 t ha^{-1}). It was concluded that all the pre and post emergence herbicides significantly increased cane yield over untreated plots (65.10 t ha^{-1}) by controlling weeds in sugarcane crop.

SOYBEAN

51. Enhancing soybean yield by the foliar application of chemicals

A field experiment was conducted at plant physiology research area, agronomic research institute, Faisalabad during the year 2016 to evaluate the influence of different chemicals as foliar sprays viz. Ba (6-benzyl aminopurine) @ 0.08 mgl^{-1} at 30 + 50 days after sowing, solubor @ 750 g ha^{-1} at 30 and 50 das, potassium borate @ 125 g ha^{-1} at 30 + 50 das, potassium citrate @ 125 g ha^{-1} at 30 + 50 das, fertigrain @ 750 ml ha^{-1} at 30 + 50 das, potassium borate @ + potassium citrate each @ 125 g ha^{-1} + fertigrain @ 750 ml ha^{-1} at 30 + 50 das, water spray @

250 l ha^{-1} at 30 + 50 das and control (no spray)) on growth and yield of soybean. The trial was sown on march 20, 2016 in randomized complete block design having a plot size of 2.70 m × 8.0 m, using seed rate 90 kg ha^{-1}. The row to row and plant to plant distance was maintained 60 × 10 cm respectively in all the treatments and crop was fertilized @ 25-60-50 npk kg ha^{-1}. All the growth, yield and yield parameters were significantly affected by the applications of chemicals.

Table: effect of foliar application of chemicals on yield and yields components of soybean

#	Treatment	Number of pods Per plant	% increase in pods per plant	Number of seeds per plant	100-seed weight (g)	Seed yield (kg ha^{-1})
T_1	Ba (6-benzyl aminopurine) @ 0.08 mgl^{-1} at 30 + 50 das	45 cd	12.5	100 de	8.34 d	1080 e
T_2	Solubor @ 750 g ha^{-1} at 30 and 50 das	48 b	20.0	117 b	8.48 b	1305 b
T_3	Potassium borate (k_3bo_3) @ 125 g ha^{-1} at 30 + 50 das	47 bc	17.5	111c	8.40 c	1210 c
T_4	Potassium citrate ($c_6h_5k_3o_7$) @ 125 g ha^{-1} at 30 + 50 das	44.5 cde	11.3	105 d	8.36 cd	1140 d
T_5	Fertigrain @ 750 ml ha^{-1} at 30 + 50 das	43 de	7.5	103 de	8.34 d	1110 de
T_6	Potassium borate (k_3bo_3) @ 125 g ha^{-1} + potassium citrate ($c_6h_5k_3o_7$) @ 125 g ha^{-1} + fertigrain @ 750 ml ha^{-1} at 30 + 50 das	53 a	32.5	127 a	8.68 a	1420 a
T_7	Water spray @ 250 l ha^{-1} at 30 + 50 das	42 ef	5.0	98 e	8.32 d	1065 e
T_8	Control (no spray)	40 f	-	92 f	8.31 d	1005 f
Lsd		**2.65**	**-**	**5.92**	**0.049**	**48.15**

Number of pods per plant

All the chemicals under study significantly affected number of pods per plant. The application of potassium borate + potassium citrate each @ 125 g ha^{-1} + fertigrain @ 750 ml ha^{-1} at 30 and 50 days after sowing produced significantly maximum number of pods per plant (53). On the other hand minimum numbers of pods per plant (40) were recorded where no chemical was sprayed.

Number of seeds per plant

The entire chemicals under study significantly affected number of seeds per plant. The application of potassium borate + potassium citrate each @ 125 g ha^{-1} + fertigrain @ 750 ml ha^{-1} at 30 and 50 days after sowing produced significantly maximum number of seeds per plant (127). Whereas, minimum number of seeds per plant (92) was recorded where no chemical was sprayed.

100-seed weight (g)

100-seed weight is a prime factor in determining yield of crops. 100-seed weight of soybean was significantly affected by various chemicals. The application of potassium borate + potassium citrate each @ 125 g ha^{-1} + fertigrain @ 750 ml ha^{-1} at 30 and 50 days after sowing produced significantly maximum 100-seed weight (8.68 g). On the other hand minimum 100- seed weight (8.31 g) where no chemicals were sprayed.

Seed yield (kg ha^{-1})

all the chemicals under discussion affected seed yield of soybean. Significantly maximum seed yield (1420 kg ha^{-1}) was recorded where potassium borate + potassium citrate each @ 125 g ha^{-1} + fertigrain @ 750 ml ha^{-1} at 30 and 50 days after sowing was applied. On the other hand minimum seed yield of (1005 kg ha^{-1}) was recorded in treatment where where no chemicals were sprayed.

GUAR

52. Guar adaptation yield trial

The experiment was sown on 22.06.16 to evaluate the yield performance of advanced lines against existing approved varieties. Five strains 5274, 5290, 5394, 5548 and5509 were tested against two standard br-99 and br-90. The experiment will be laid out in rcbd with three replications having a plot size of 2.7 m × 7.2 m. All agronomic practices and plant protection measures will be kept uniform.

The highest yield was recorded in line 5274 with grain yield of 1160 kg ha^{-1} followed by line 5290 with grain yield of 870 kg ha^{-1}. All other varieties / lines were at par with each other with no any significant difference.

Average yield (kg ha^{-1})				
Varieties	**R_1**	**R_2**	**R_3**	**Mean**
5274	750	718	766	**744**
5290	718	744	750	**737**
5394	686	607	639	**644**

5548	517	480	491	**496**
5509	676	591	634	**634**

MAIZE

53. Screening of herbicides to control weeds in maize

The trial was sown on augast 2016 with the objective to find out new herbicides for effective control of weeds in maize crop. The trial was sown along the 75 cm wide ridges and syngenta-6621 was used as testing variety. It was conducted in randomized complete block design having a plot size of 2.25 m × 8.0 m. One new pre-emergence herbicide formulation i.e. Voltril 63 sc (atrazine + mesotrione + s- metolachlor) was tested against its standard primextra gold 720 sc (atrazine + s-metolachlor). Also two new post emergence herbcides formulations viz. Maxpro 80 wdg (atrazine + mesotrione + halosulfuron methyl) and twist 55 sc(atrazine + mesotrione) were tested against their standard herbicide primextra gold 720 sc(atrazine + s-metolachlor). The following results were recorded during this year of study.

Table: herbicidal effect on weed counts, weed biomass, maize grain yield and cbr

#	Name of herbicides	Dose Ha^{-1}	Weed counts (m^2)	% weed control	Total weed biomass (gm^{-2})	Yield (kg ha^{-1})	Cbr
1	*Primextra gold 720 sc (atrazine + s-metolachlor)*	2000 ml	6 b	93.02	193.67 c	7594 a	1:1.70
2	*Voltril 63 sc (atrazine + mesotrione + s- metolachlor)*	2500 ml	8 b	90.69	198.33 bc	7587 a	1:1.69
3	*Primextra gold 720 sc (atrazine + s-metolachlor)*	1000 ml	09 b	89.53	204.67 bc	7499 a	1:1.67
4	*Maxpro 80 wdg (atrazine + mesotrione + halosulfuron methyl)*	875 g	10 b	88.37	214.33 b	7633 a	1:1.73
5	*Twist 55 sc (atrazine + mesotrione)*	1250 ml	9 b	89.53	212.33 bc	7665 a	1:1.75
6	Control (weedy check)	-	86 a	-	986.67 a	4800 b	1:1.10
Lsd			**6.63**	**-**	**18.98**	**338.75**	-

Weed counts (m^{-2})

The data regarding weed count after 25 days of spray showed that all herbicides, both candidates and standard gave maximum weed control for against all weeds. Minimum weed control was noted in weedy check plot.

Weed biomass (g m^{-2})

Both the pre-emergence and post emergence herbicides i.e. Primextra gold 720 sc (atrazine + s-metolachlor) @ 2000 ml ha^{-1} and voltril 63 sc (atrazine + mesotrione + s- metolachlor) @ 2500 ml ha^{-1} as pre-emergence while maxpro 80 wdg @ 875 g ha^{-1} and twist 55 sc @ 1250 ml ha^{-1} as post emergence produced weed biomass statistically at par to each other. Highest weed biomass (943 g m^{-2}) was recorded in control treatment.

Grain yield (kg ha^{-1})

Both the pre-emergence and post emergence herbicides i.e. Primextra gold 720 sc (atrazine + s-metolachlor) @ 2000 ml ha^{-1} and voltril 63 sc (atrazine + mesotrione + s- metolachlor) @ 2500 ml ha^{-1} as pre-emergence while maxpro 80 wdg @ 875 g ha^{-1} and twist 55 sc @ 1250 ml ha^{-1} as post emergence produced grain yield statistically at par to each other. Highest maize grain yield (7665 kg ha^{-1}) was recorded in treatment where twist 55 sc @ 1250 ml ha^{-1} was sprayed. The lowest grain yield of 4800 kg ha^{-1} was produced in case of control plot.

Cost benefit ratio

As for as cbr is concerned, highest cost benefit ratio (1:1.75) was recorded in post emergence herbicide treatment i.e. Twist 55 sc @ 1250 ml ha^{-1}. On the other hand lowest return was achieved in control treatment (1:1.10).

54. Nutrient enrichment of maize grains by biofortification

The experiment was conducted at research area of plant physiology section, Ayub Agricultural Research Institute, Faisalabad during 2016 to assess the nutrient enrichment of maize by bio- fortification. The treatments comprised of t_1 (control, no spray),t_2 (control, four sprays of water @ 250 l ha^{-1} at 15, 30, 45 & 60 dae),t_3 (one foliar spray of mnm @ 625 ml ha^{-1} dissolved in 250 l of water @15 dae),t_4 (two foliar sprays of mnm @ 625 ml ha^{-1} at 15 & 30 dae),t_5 (two foliar sprays of mnm @ 625 ml ha^{-1} at 15 & 45 dae),t_6 (two foliar sprays of mnm @ 625 ml ha^{-1} at 15 & 60 dae),t_7 (three foliar sprays of mnm @ 625 ml ha^{-1} at 15, 30 & 45 dae),t_8 (three foliar sprays of mnm @ 625 ml ha^{-1} at 30, 45 & 60 dae),t_9 (four foliar sprays of mnm @ 625 ml ha^{-1} at 15, 30, 45 & 60 dae). The experiment was laid out in randomized complete block design with a plot size measuring 4.5 m × 9.0 m. It was replicated thrice and maize variety

pioneer 30y87 was used as test variety. Sowing was done with hand drill using seed @ 25 kg ha^{-1} with row to row distance of 75 cm. Plants were thinned out to maintain plant to plant distance of 25 cm and fertilizers @ 200-100-100 npk kg ha^{-1} was applied at sowing to all the treatments. All other agronomic practices including weed control, irrigation and pest management measures were adopted uniformly. The following results were recorded during course of studies:

Table: effect of micro nutrient mixtures application on different maize parameters

#	Treatments	Chlorophyll content (fv/fm)	Plant height (cm)	Number of grains per cob	100-seed weight (g)	Biological yield (kg ha^{-1})	Grain yield (kg ha^{-1})	Harvest index (%)	Cbr
T_1	Control (no spray)	0.7593	234.00	451.3 h	37.56 i	25305 g	6816 f	22.52 f	1:1.49
T_2	Control (four sprays of water @ 250 l ha^{-1} at 15, 30, 45 & 60 dae	0.7680	232.67	515.6 g	38.07 h	25871 fg	7026 ef	24.19 e	1:1.51
T_3	One foliar spray of micronutrient mixture (mnm)* @ 625 ml ha^{-1} dissolved in 250 l of water @15 dae	0.7763	229.67	540.7 f	38.68 g	26769 ef	7152 de	24.97 de	1:1.62
T_4	Two foliar sprays of mnm @ 625 ml ha^{-1} at 15 & 30 dae	0.7713	233.33	558.7 ef	38.99 f	27514 de	7227 cde	25.27 d	1:1.68
T_5	Two foliar sprays of mnm @ 625 ml ha^{-1} at 15 & 45 dae	0.7747	231.67	569.3 de	39.50 e	28162 cd	7271 cd	25.68 cd	1:1.65
T_6	Two foliar sprays of mnm @ 625 ml Ha^{-1} at 15 & 60 dae	0.7827	235.00	586.0 cd	39.96 d	28780 c	7327 bcd	25.87 cd	1:1.74
T_7	Three foliar	0.7643	234.00	600.3 c	41.06	29066 c	7382	26.47 c	1:1.69

	sprays of mnm @ 625 ml ha^{-1} at 15, 30 & 45 dae				c		bc		
T_8	Three foliar sprays of mnm @ 625 ml ha^{-1} at 30, 45 & 60 dae	0.7600	239.33	623.3 b	42.53 b	30380 b	7496 b	27.76 b	1:1.75
T_9	Four foliar sprays of mnm @ 625 ml ha^{-1} at 15, 30, 45 & 60 dae	0.7843	241.67	651.0 a	44.93 a	31610 a	7947 a	29.35 a	1:1.78
Lsd		**N.s**	**N.s**	**18.11**	**0.101**	**1168**	**212.87**	**0.905**	**-**

Chlorophyll contents (fv/fm)

It is evident from the data presented in table that maximum chlorophyll contents (0.7843) were attained in treatment where four foliar sprays of mnm @ 625 ml ha^{-1} at 15, 30, 45 & 60 dae were applied. The minimum chlorophyll contents (0.7593) were attained in treatment control with no spray.

Plant height (cm)

The maximum plant height (241.67 cm) was achieved in treatment where four sprays of mnm @ 625 ml ha^{-1} at 15, 30, 45 & 60 dae were applied. The minimum plant height (229.67 cm) was achieved in treatment where one foliar sprays of mnm @ 625 ml ha^{-1} at 15 dae were applied.

Grains per cob

The maximum no. Of grains per cob (651) was achieved in treatment with four foliar sprays of mnm @ 625 ml ha^{-1} at 15, 30, 45 & 60 dae followed by three foliar sprays of mnm @ 625 ml ha^{-1} at 30, 45 & 60 dae) was applied. The minimum no. Of grains per cob (451.3) was achieved in control treatment where no spray was applied.

Biological yield (kg ha^{-1})

Significantly the highest biological yield (31610 kg ha^{-1}) was achieved in treatment with four foliar sprays of mnm @ 625 ml ha^{-1} at 15, 30, 45 & 60 dae) followed by (30380) three foliar

sprays of mnm @ 625 ml ha^{-1} at 30, 45 & 60 dae. The minimum biological yield (25305 kg ha^{-1}) was achieved in control treatment where no spray was applied.

Grain yield (kg ha^{-1})

Significantly the highest grain yield (7947 kg ha^{-1}) was achieved in treatment with four foliar sprays of mnm @ 625 ml ha^{-1} at 15, 30, 45 & 60 dae and followed by (7496 kg ha^{-1}) three foliar sprays of mnm @ 625 ml ha^{-1} at 30, 45 & 60 dae). The minimum grain yield (6816 kg ha^{-1}) was achieved in control treatment where no spray was applied.

Harvest index (%)

The highest harvest index (29.35 %) was achieved in treatment with four foliar sprays of mnm @ 625 ml ha^{-1} at 15, 30, 45 & 60 dae. The minimum harvest index (22.52%) was achieved in control treatment where no spray was applied.

Cost benefit ratio (cbr)

The highest cbr (1:1.78) was achieved in treatment with four foliar sprays of mnm @ 625 ml ha^{-1} at 15, 30, 45 & 60 dae. The minimum cbr 1:1.49 was achieved in treatment with four sprays of water @ 250 l ha^{-1} at 15, 30, 45 & 60 dae.

55. Enhancing water use efficiency in maize by the foliar application of chemicals

The experiment was conducted at research area of plant physiology section, Ayub Agricultural Research Institute, Faisalabad during 2016 to assess the water use efficiency of maize by foliar application of naoh, silicon and potassium under normal and moisture stress conditions. The experiment was laid out in randomized complete block design having a plot size of one 3.0 m × 8.0 m. Syngenta-30y86 was used as a test variety. Sowing was done with dibler using seed @ 10 kg ha^{-1} with row to row distance of 75 cm. Plants were thinned out to maintain plant to plant distance of 25 cm and fertilizers @ 200-100-100 npk kg ha^{-1} was applied at sowing to all the treatments. All other agronomic practices including weed control, irrigation and pest management measures were adopted uniformly. The following results were recorded during course of studies:

Table: Effect of different moisture levels and foliar spray on water potential (-mpa)

Foliar spray	Moisture levels	Mean

	M_1 (irrigation at 70% available water)	**M_2 (irrigation at 35% available water)**	
T_1: control	1.45 d	1.73 a	**1.59 a**
T_2: naoh @ 1% solution	1.36 e	1.74 a	**1.55 b**
T_3: si (foliar spray of sodium metasilicate @ 500 ppm	1.23 f	1.52 c	**1.38 c**
T_4: si (foliar spray of sodium metasilicate @ 1000 ppm	1.23 f	1.55 bc	**1.39 c**
T_5: k (foliar spray of solo potash @ 1000 ppm	1.22 f	1.56 b	**1.39 c**
T_6: **foliar spray of solo potash @ 2000 ppm**	1.20 f	**1.54 bc**	**1.37 c**
Mean	**1.28 b**	**1.61 a**	**-**
Lsd for foliar spray: 0.0249, lsd for moisture level: 0.0231, lsd for interaction: 0.0353			

Table: Effect of different moisture levels and foliar spray on maize yield (kg ha^{-1})

Foliar spray	**Moisture levels**		**Mean**
	M_1(irrigation at 70% available water)	**M_2 (irrigation at 35% available water)**	
T_1: control	6890 f	5381 l	**6136 f**
T_2: naoh @ 1% solution	7178 e	5486 k	**6332 e**
T_3: si (foliar spray of sodium metasilicate @ 500 ppm	7485 d	5893 j	**6689 d**
T_4: si (foliar spray of sodium metasilicate @ 1000 ppm	7663 c	6118 i	**6891 c**
T_5: k (foliar spray of solo potash @ 1000 ppm	7983 b	6425 h	**7204 b**
T_6: **foliar spray of solo potash @ 2000 ppm**	8119 a	**6591 g**	**7354 a**
Mean	**7553 a**	**5982 b**	
Lsd for foliar spray: 58.436, lsd for moisture level: 102.98, lsd for interaction: 82.641			

Discussion:

Water potential (-mpa)

Water potential is the potential energy of water per unit volume relative to pure water in reference conditions. Water potential quantifies the tendency of water to move from one area to another due to osmosis, gravity, mechanical pressure, or matrix effects such as capillary action.

Data regarding water potential is presented in table-1 showed that under moisture stress condition maximum water potential (-1.54) was observed in traetment where foliar spray of k @ 2000 ppm was applied, whereas, minimum (-1.74) water potential was recorde in treatment where naoh @ 1% solution was sprayed.

Grain yield (kg ha^{-1})

Significantly the highest grain yield under moisture stress condition (6591 kg ha^{-1}) was achieved in treatment with foliar application of k @ 2000 ppm and followed by application of k @ 1000 ppm (6425 kg ha^{-1}). The minimum grain yield (5311 kg ha^{-1}) under moisture stress condition was recorded in control treatment where no chemical was sprayed. Similar trend was observed for grian yield under normal moisture conditions.

56. Regional adaptability yield trial of different maize hybrid under sheikhupura conditions

To explore the scope of spring maize hybrid cultivation in sheikhupura conditions a trial was laid out in randomized complete block design having 3 replications with a plot size of 7.5 m x 8m. Sowing of trial was completed on 28 of february 2017. Fertilizer @ 250-145-93 npk kg ha^{-1}. Was applied. Seed rate was used @ 25 kg ha^{-1}. The inter row spacing was maintained at 75cm. All other crop management practices were kept uniform. Yield data was recorded (kg ha^{-1}) and is presented in table.

Table.

S. #	hybrids	Yield kg/ha
1	ts-1223	3927
2	ts-11	4096
3	9108	3674
4	P1574	4592
5	P1543	4257
6	Silver queen	3901
7	Silver king	4149
lsd at 5%=		

Statistical analysis of the data showed that there was no statistically significant difference between different lines/ varieties. However, hybrid p1543 gave the highest yield (4592 kg ha^{-1}). While minimum yield (3674 kg ha^{-1}) was produced by the hybrid 9108.

MUNGBEAN

57. Yield response of mungbean to various planting techniques

Maximum grain yield (1125 kg ha^{-1}) was observed in broadcast augmented with furrows with net economic return of rs.68067/-

58. Adoption of zero tillage mungbean in rice wheat cropping system.

To improve farmer income by adjusting a restorative pulse crop in rice wheat cropping system a trial was laid out in split plot replicated thrice. The mungbean variety nm-2011 was used as medium of trial. The fertilizer was applied @ 23-60 np kg ha^{-1}. Treatments were comprised of two factors

Planting method

P1= conventional
P2= zero tillage

Sowing dates

d1= 25th april
d2= 5th may
d3= 15th may

Data on yield and yield related parameters were recorded on the time of harvesting and presented in table.8

Table.

Grain yield kg/ha

	Conventional method	**Zero tillage**	**Average**
25th april	658 b	490 e	**574 b**
5th may	721 a	505 d	**613 a**
15th may	571 c	459 f	**526 c**
Average	**650 a**	**484 b**	

Critical value for comparison of planting method= 29.05

Critical value for comparison of sowing date= 9.86

Critical value for comparison of interaction=30.17

Statistical analysis of the data showed significant differences among sowing methods, sowing times and their interaction.

Conventional sown mungbean on 5th may gave the maximum grain yield (721 kg ha^{-1}) followed by conventional sown mungbean on 25th april which produced the yield of (658 kg ha^{-1})

Lowest yield of (459 kg ha^{-1}) was obtained from plot sown on 15th may by zero tillage.

A) Rabi 2016-17

WHEAT

59. Effect of different sowing dates on the new wheat genotypes under thalirrigated conditions

Five sowing dates i.e. D1 = 01-11-2016, d2 = 16-11-2016, d3 = 01-12-2016, d4 = 16-12-2016 and d5 = 31-12-2016 were tested against two wheat varieties i.e. V1 = ujala-2016 and galaxy- 2013 under thal irrigated conditions. The layout was split plot design with three replications having main plot size 7.2 m × 8m and sub plot size 3.6 m × 8 m. The results revealed that sowing of wheat on 01-11-2016 yielded maximum grain yield i.e. 4398 kg ha^{-1} followed by sowing of wheat on 16-11-2016 by yielding grains 3936 kg ha^{-1}. Minimum wheat grain yield i.e. 2037 kg ha^{-1} was received when wheat crop was sown on 31-12-2016. Comparison between varieties indicate that galaxy- 2013 yielded maximum wheat grain yield i.e. 3445 kg ha^{-1}. While minimum wheat grains i.e. 3185 were obtained from ujala-2016. As for as interaction is concerned sowing of galaxy- 2013 on 01-11-2016 produced maximum wheat grain yield i.e. 4815 kg ha^{-1} followed by sowing of wheat variety ujala- 2015 on the same date by producing 3981 kg ha^{-1} wheat grains. Minimum wheat grains yield i.e. 2130 and 1944 kg ha^{-1} was received from wheat variety ujala- 2016 and galaxy- 2013 respectively when sown on 31-12-2016.

60. Effect of intercropping of wheat with canola under thal irrigated conditions

This experiment was conduct to find out best suited intercropping between two rabi crops under thal irrigated conditions. Six treatments t1, wheat (alone) in line sowing, t2, wheat (alone) in broadcast sowing, t3 canola (alone) in line sowing, t4 canola (alone) in broadcast sowing t5, two rows of wheat + two rows of canola and t6, four rows of wheat + four rows of canola were sown at ars karor, distt. Layyah, during rabi 2016-17. The layout was rcbd with three replications having plot size 2.7 m × 7 m. The experiment was sown on 15-11-2015 and harvested on 13-05-2016.the all other agronomic practices were kept normal and uniform. The above given results reveal that maximum income (rs. 123693/-) was received from t1 where wheat (alone) was sown in lines followed by t2 which yielded (rs.99876/-) where wheat (alone) was sown in broadcast. The minimum income (rs. 79452/-) was generated from t6 where four rows of wheat + four rows of canola were sown.

61. Effect of conservation and conventional tillage on the productivity of wheat in rice-wheat system

Treatment comparison means revealed that conventional tillage gave maximum grain yield of (4396.7 kg ha^{-1}). However minimum grain yield (3666.7 kg ha^{-1}) was obtained from zero tillage.

62. Yield response of wheat to various planting techniques.

Statistical analysis showed non-significant results. However, broadcast produced maximum grain yield of (4026 kg ha^{-1})and minimum grain yield (3640 kg ha^{-1}) was obtained from zero tillage and (3640 kg ha^{-1}) from drill sowing method.

Flat sowing of wheat by drill after soil preparation at C&P farm

63. Effect of pea intercropping on the wheat yield.

To explore the scope of wheat-pea intercropping to enhance soil fertility and farmers income a trial was laid out in randomized completely block design with three replication. Trial was sown on 17th november 2016. Wheat variety glaxy-2013 and pea variety climax used as testing material. Treatments were as

1. Wheat alone (22.5 cm apart rows)
2. Pea alone (45 cm apart rows)
3. Wheat 1 row +pea 1 row (r×r distance 45 cm)
4. Wheat 2 rows+ pea 2 rows (r×r distance 45 cm)
5. Wheat 3 rows+ pea 1row(r×r distance 45 cm)
6. Wheat 3 rows+ pea 2 rows (r×r distance 45 cm)
7. Wheat 4 rows+ pea 4 rows (r×r distance 45 cm)
8. Wheat 2 rows +pea 4 rows+ wheat 2 rows (r×r distance 45 cm).

Data on wheat grain yield and yield components was recorded and presented in table. 15

table

Treatments	**Fresh pea pods yield (kg ha^{-1})**	**Wheat yield (kg ha^{-1})**
Wheat alone (22.5 cm apart rows)	-	4306 a
Pea alone (45 cm apart rows),	6501 a	-

Wheat 1 row +pea 1 row (r×r distance 45 cm)	3122 c	2528 c
Wheat 2 rows+ pea 2 rows (r×r distance 45 cm)	1172 e	2146 d
Wheat 3 rows+ pea 1row(r×r distance 45 cm)	1834 d	3841 b
Wheat 3 rows+ pea 2 rows (r×r distance 45 cm)	2039 d	1942 e
Wheat 4 rows+ pea 4 rows (r×r distance 45 cm),	3089 c	2039 de
Wheat 2 rows +pea 4 rows+ wheat 2 rows (r×r distance 45 cm).	4194 b	2456 c

Critical value for comparison pea yield=233.81

Critical value for comparison wheat yield =140.13

Statistical analysis of the data showed the significant differences among treatment means. According to the data maximum wheat yield (4306 kg ha^{-1}) was obtained from the treatment (wheat alone 22.5 cm apart rows). While the treatment (pea alone (45 cm apart rows) produced the maximum pea pods yield (6501kg ha^{-1}).

Economic analysis

Table.

Treatments	**Gross income (rs.)**	**Expenses (rs.)**	**Net return (rs.)**
Wheat alone (22.5 cm apart rows)	139945	51030	88915
Pea alone (45 cm apart rows),	130020	37455	92565
Wheat 1 row +pea 1 row (r×r distance 45 cm)	144600	58249	86351
Wheat 2 rows+ pea 2 rows (r×r distance 45 cm)	93185	57115	36070
Wheat 3 rows+ pea 1row(r×r distance 45 cm)	161512	55815	105697
Wheat 3 rows+ pea 2 rows (r×r distance 45 cm)	103895	55819	48076
Wheat 4 rows+ pea 4 rows (r×r distance 45 cm),	128047	58237	69810
Wheat 2 rows +pea 4 rows+ wheat 2 rows (r×r distance 45 cm).	163700	58891	104809

Economic analysis showed the maximum return of (105697 rupee) from the treatment (wheat 3 rows+ pea 1row(r×r distance 45 cm)) while minimum return (36070 rupee) was from the treatment (wheat 2 rows+ pea 2 rows (r×r distance 45 cm)

64. Effect of zinc biofortification on wheat yield and grain quality at various growth stages

Statistical analysis showed non-significant results. However, soil application of $znso_4$ @ 25 kg ha^{-1} at the time of sowing gave maximum (4825.7 kg ha^{-1}) grain yield followed by (4521.3 kg ha^{-1}) grain yield obtained from 0.5% (500g/100l/acre) solution of $znso_4$ applied at heading stage and

minimum grain yield (4286.7 kg ha^{-1}) was obtained from 0.5% (500g/100l/acre) solution of $znso_4$ applied at grain filling stage.

Zinc biofortification on wheat at c&p farm area

65. Yield response of wheat to various application times of phosphorous

Treatment comparison means showed non-significant results however, all p (90 kg ha^{-1}) applied with first irrigation gave maximum grain yield (4226.7 kg ha^{-1}) and minimum grain yield (3883.3 kg ha^{-1}) was obtained when half P at first irrigation and half P applied at the time of sowing.

66. Adaptation of advanced wheat lines to various planting dates under bahawalpur conditions

The trial was conducted at agronomic research station, bahawalpur to explore the genetic yield potential and to evaluate the adaptation of various advance lines/varieties to different planting times for maximum grain yield. The experiment was laid out in split plot arrangement giving more importance to varieties/strains, with three replications having a net plot size of 2.25m x 8m. Fertilizer was applied @ 120-90-60 npk kg ha^{-1}. Experimental treatments and grain yield data recorded is as under.

Table Grain yield of advance wheat lines/varieties in different planting dates under Bwp conditions, 2016-17

Grain yield (kg/ha)							
Treatments	**Varieties**						
	Gold-16	**Jauhar-16**	**V-2511**	**V-2557**	**V-2559**	**V-12304**	**Mean**
D1 (1/11)	5792	6003	6145	6257	6167	6020	**6064** a
D2 (11/11)	5892	6096	6278	6328	6234	6118	**6158** a
D3 (21/11)	5750	5892	6167	6267	6163	5987	**6038** a

D4 (1/12)	4373	4483	4492	4500	4428	4386	**4444** b
D5 (11/12)	3656	3720	3747	3777	3697	3730	**3721** c
D6 (21/12)	3104	3128	3036	3033	2911	3123	**3056** d
Mean	**4761 c**	**4887 b**	**4978 ab**	**5027 a**	**4933 ab**	**4894 b**	4913
Lsd at 5% for sowing dates = 213.48, for var = 110.15, for sd*varieties = 269.82							

Data presented in the above table-7 revealed that the most suitable/optimum time for planting wheat for almost all the wheat varieties/strains included in the experiment, under the agro ecological conditions of bahawalpur was the 1st to 25th november beyond that a linear decrease in the wheat grain yield was observed. As far as the varieties/strains were concerned v2557, v2511 and v2559 were statistically at par with maximum mean grain yields as 5027, 4978 and 4933 kg ha^{-1} respectively. The lowest grain yield 4761 kg ha^{-1} was obtained from wheat variety gold-16.

Thus it is concluded that optimum planting time for wheat is 1st to 25th november under the agro ecological conditions of bahawalpur.

67. Control of weeds in wheat cotton zone

The experiment was conducted at the research area of agronomic research station, bahawalpur to control weeds and to evaluate their effect on growth and yield of wheat. The trial was laid out in RCBD with three replications having a plot size of 3m x 8m. The wheat variety jauhar-16 was sown on 19.11.2016 using a seed rate of 125 kg ha^{-1}. It was fertilized as 120-90-62.5 NPK kg ha^{-1}. All PK & 1/3 N was applied at sowing while remaining 2/3 n was applied at 1st irrigation. The data on weed count and wheat grain yield was recorded, analyzed & presented in the following table.

Table: Yield response of weed management in wheat at ARS, Bahawalpur

Treatments		**Grain yield (kg ha^{-1})**		
		2015-16	**2016-17**	**Mean**
T_1	Axial 1050 ec@ 750 ml / ha	4597 b	4841 bc	4719
T_2	Clodenofop @ 350 g / ha	4540 b	4851 abc	4540
T_3	Buctril super 60ec (bromoxynil + mcpa) @ 750 ml ha^{-1})	4036 c	4660 c	4348
T_4	Harvester @ 1085 ml / ha	3963 c	4666 c	4666
T_5	Harvester @ 1085 ml / ha + clodenofop	5077 a	5054 ab	5066
T_6	Axial 050ec (penoxaden) @ 750 ml ha^{-1} + harvester	4971 a	5103 ab	5037
T_7	Axial1050 ec@ 750 ml / ha + buctril super60ec (bromoxynil + mcpa) @ 750 ml ha^{-1})	5064 a	5174 a	5119

T_8	Control	3015 d	4002 d	3509
	Lsd at 5%	**253.77**	**325.52**	

Table: Control of weeds in wheat in cotton zone at ARS, Bahawalpur during Rabi 2016-17

Treatments		Weed count (m^{-2})			Bio-mass	Grain yield
		Broad leaf	Narrow leaf	Total (#)	(gm^{-2})	(kg/ha)
T1	Axial @ 750 ml/ha	9.60	4.00	13.60	31.1	4841 bc
T2	Clodinofop @ 350 g/ha	10.00	5.00	15.00	37.2	4851 abc
T3	Buctril supper @ 750ml/ha	2.00	28.00	31.00	68.3	4660 c
T4	Harvester @1085 ml/ha	5.10	32.00	37.10	72.0	4666 c
T5	Harvester @1085 ml/ha + clodinofop @ 350 g/ha	5.00	3.00	8.00	20.2	5054 ab
T6	Harvester @1085 ml/ha + axial @ 750 ml/ha	3.30	2.00	5.00	11.3	5103 ab
T7	Axial @ 750 ml/ha + buctril supper @750 ml/ha	3.4	3.00	6.4	16.4	5174 a
T8	Control	18.60	30.00	48.60	107.8	4002 d
						Lsd5%=325.52

Data presented in table-8 showed that on the basis of two years average significantly maximum grain yield 5119 kg $ha^{-1}$was recorded from t_7 where axial @ 750 ml/ha + buctril supper @750 ml/ha was sprayed and it remained statistically at par with t_6 and t_5 producing grain yield of 5037and 5066 kg ha^{-1} respectively. Whereas the lowest grain yield of 3509 kg ha^{-1} was recorded from t_8 (control). Data on weed count weed bio- mass is presented in table 8a.

68. Physiological and yield performance of wheat genotypes under heat stress

The experiment was conducted at farm area of plant physiology section, Ayub Agricultural Research Institute, Faisalabad during 2016-17 to assess the performance of wheat genotypes against heat stress. The trial was laid out in split plot design having three replications and plot size measuring 1.5 m × 6.0 m and using seed @ 125 hg ha^{-1}. Two temperature treatments was kept in main plots whereas, 40 wheat genotypes were randomized in sub plots. For inducing heat stress the crop will be covered by polyethylene plastic sheet during 1st

fortnight of March. Recommended fertilizer dose (115-85-60 NPK kg ha^{-1}) were applied and hand weeding was done to control weeds. The following results were recorded:

Table: effect of heat stress on grain yield of wheat genotypes

Sr #	Genotype	Normal condition	Heat stress (under tunnel)	Percent difference	Yield stability index
1	13338	1514.403	908.642	-40.0	0.60
2	14227	1481.481	1037.037	-30.0	0.70
3	Hyt-08-7	1876.543	1333.333	-28.9	0.71
4	14154	1497.942	908.642	-39.3	0.61
5	Uos-2	1604.938	987.6543	-38.5	0.62
6	12fj01	1456.79	1086.42	-25.4	0.75
7	Hyt-80-34	1308.642	1135.802	-13.2	0.87
8	Hyt-80-44	1497.942	888.8889	-40.7	0.59
9	13b3146	1382.716	740.7407	-46.4	0.54
10	Cgri-pv1	1366.255	770.3704	-43.6	0.56
11	Tws12155	1711.934	1086.42	-36.5	0.63
12	V-13348	1473.251	938.2716	-36.3	0.64
13	14151	1448.56	987.6543	-31.8	0.68
14	Cdri-2	1366.255	1135.802	-16.9	0.83
15	14b1028	1432.099	493.8272	-65.5	0.34
16	13167	1506.173	987.6543	-34.4	0.66
17	13bt017	1382.716	938.2716	-32.1	0.68
18	Nr453	1563.786	938.2716	-40.0	0.60
19	9496	1539.095	691.358	-55.1	0.45
20	11fjs309	1415.638	592.5926	-58.1	0.42
21	14c040	1423.868	938.2716	-34.1	0.66
22	14c036	1646.091	1185.185	-28.0	0.72
23	Uos-1	1440.329	1037.037	-28.0	0.72
24	Fsd-08	1695.473	1037.037	-38.8	0.61
25	14170	1415.638	888.8889	-37.2	0.63
26	14b1030	1572.016	987.6543	-37.2	0.63
27	Nr443	1975.309	888.8889	-55.0	0.45
28	Glaxy	1506.173	1037.037	-31.1	0.69
29	14225	1547.325	987.6543	-36.2	0.64
30	G-2	1662.551	790.1235	-52.5	0.48
31	13bt034	1613.169	691.358	-57.1	0.43
32	Nr487	1399.177	1037.037	-25.9	0.74
33	12fj26	1827.16	1037.037	-43.2	0.57
34	14168	1300.412	987.6543	-24.1	0.76
35	14152	1530.864	938.2716	-38.7	0.61
36	13bt016	1432.099	1185.185	-17.2	0.83
37	Nr457	1596.708	1185.185	-25.8	0.74
38	Tws12464	1669.061	1481.481	-11.2	0.88
39	Cdri-sa	1794.239	1283.951	-28.4	0.72

40	13325	1514.403	1135.802	-25.0	0.75
Mean		1534.73	983.2	-35.94	0.64

Grain yield (kg ha^{-1})

Results revealed that heat stress substantially affected the grain yield (kg acre^{-1}) of all the genotypes as, average over genotypes; heat stress reduced the grain yield by 35.95%. Under normal conditions, maximum grain yield (1975.30 kg acre^{-1}) was recorded by the genotype nr-443 followed by hyt-08-7 with average yield grain yield of 1876.53 kg acre^{-1}. Genotype 14b1028 was the most affected genotype from heat stress as its yield reduced by 65.5% under heat stress conditions compared to normal conditions. Similarly, a 58.1% yield reduction was observed in genotype 11fjs309. On the other hand maximum yield stability index (ysi) (88) was observed in genotype tws12464 which was followed byhyt-80-34 with ysi of 87.

69. Physiological evaluation of wheat varieties/ lines for drought tolerance under field and lab. Conditions

Laboratory studies:

Thirty six genotypes along with a check variety were tested for drought tolerance. Ten seeds of each genotype were sown in petri dishes. After 10 days of germination, the seedlings were shifted to growth chamber. Water stress (-0.4 mpa) was applied using peg8000 solution. Data of root & shoot elongation and coleoptiles length were recorded.

The data presented in table 1.1 showed that root length of most of the genotypes was less under water stress than under normal moisture conditions. Under moisture stress conditions, maximum root length (11.67 cm) was noted in genotype 11061 and was followed by 11160 and 9383 having each root length of 11.50 cm. While under normal moisture, genotype 11098 gave maximum root length (13.07 cm). In case of shoot length, all the genotypes performed better under normal moisture than under water stress conditions. Under moisture stress genotypes 11098, 11032 and 12266 produced higher shoot length of 10.13, 9.39 and 9.20 cm, respectively as compared with check variety (fsd-2008) generating shoot length of 7.39 cm. As regards coleoptiles length, genotypes 11092, 11032 and 12266 performed better by achieving coleoptiles length of 3.77, 3.63 and 3.57 cm, respectively.

Lab experiment*:*

Table: effect of different moisture levels and genotypes on root length (cm)

Genotypes	**Normal moisture**	**Moisture stress**	**% decrease**
9082 (nuwyt)	9.17	8.77	4.40

9087	9.00	6.90	23.33
10104	10.83	8.03	25.85
10110	10.50	8.23	21.59
10355	10.00	7.53	24.67
11160	11.97	11.50	3.90
11022 (micro)	12.10	9.33	22.87
11032	10.97	8.33	24.01
11041	9.47	8.17	13.73
11046	10.90	8.43	22.63
11047	11.50	7.67	33.33
11061	11.08	11.67	-5.29
11092	10.83	9.80	9.54
11098	13.07	8.67	33.67
11137	10.40	8.47	18.59
11138	10.47	10.10	3.50
11143	12.93	10.40	19.59
11365	9.90	9.10	8.08
12265	8.80	7.27	17.42
12266	13.03	10.97	15.86
12275	10.37	9.43	9.00
12284	8.07	10.50	-30.17
12304	12.80	8.67	32.29
Fsd-2008	9.23	10.00	-8.30
Tw96010	12.97	10.83	16.45
Tw96018	10.17	7.73	23.93
Tw11510	10.30	10.67	-3.56
Tw11512	11.77	10.87	7.65
Tw11514	11.67	12.83	-10.00
9384	11.07	10.97	0.90
9383	10.00	11.50	-15.00
9110	10.63	8.30	21.94
6377	11.17	9.40	15.82
2095	12.33	9.33	24.32
6422	12.00	8.03	33.06
9346	10.87	6.83	37.12
Mean	**10.90**	**9.31**	**13.80**

Table: E**ffect of different moisture levels and genotypes on shoot length (cm)**

Genotypes	**Normal moisture**	**Moisture stress**	**% decrease**
9082 (nuwyt)	11.33	8.13	28.24
9087	11.27	6.67	40.83

10104	12.17	7.25	40.38
10110	11.67	8.21	29.60
10355	12.83	8.40	34.55
11160	14.43	8.85	38.66
11022 (micro)	11.57	4.35	62.42
11032	12.63	9.39	25.70
11041	13.33	7.39	44.60
11046	12.13	6.48	46.59
11047	12.13	6.08	49.89
11061	11.03	6.00	45.62
11092	11.20	7.01	37.38
11098	10.00	10.13	-1.33
11137	12.80	6.91	46.04
11138	12.50	8.21	34.29
11143	13.53	8.75	35.37
11365	11.90	8.32	30.08
12265	10.80	6.59	39.01
12266	13.67	9.20	32.68
12275	11.17	7.65	31.46
12284	11.83	7.23	38.93
12304	11.47	7.73	32.56
Fsd-2008	13.17	7.39	43.90
Tw96010	12.00	8.88	26.00
Tw96018	11.80	2.93	75.14
Tw11510	11.77	7.97	32.24
Tw11512	12.47	8.61	30.91
Tw11514	13.17	7.68	41.67
9384	10.43	7.39	29.20
9383	11.83	7.87	33.52
9110	8.83	9.15	-3.55
6377	11.33	4.77	57.88
2095	10.63	7.97	25.02
6422	11.23	6.80	39.47
9346	10.60	8.67	18.24
Mean	11.85	7.53	35.92

Table: *E*ffect of different moisture levels and genotypes on coleoptiles length (cm)

Genotypes	**Normal moisture**	**Moisture stress**	**% decrease**
9082 (nuwyt)	2.60	2.83	-8.97
9087	3.07	3.07	0.00
10104	3.00	2.83	5.56

10110	3.33	3.10	7.00
10355	3.43	2.93	14.56
11160	3.90	3.00	23.08
11022 (micro)	3.30	1.90	42.42
11032	3.27	3.63	-11.22
11041	3.27	3.20	2.04
11046	3.60	3.03	15.74
11047	3.50	2.57	26.67
11061	3.43	3.00	12.62
11092	3.17	3.77	-18.95
11098	3.43	3.23	5.83
11137	3.00	3.03	-1.11
11138	3.63	2.87	21.10
11143	2.83	3.33	-17.65
11365	3.70	3.13	15.32
12265	3.40	2.53	25.49
12266	3.70	3.57	3.60
12275	2.97	3.30	-11.24
12284	3.83	2.93	23.48
12304	3.20	2.00	37.50
Fsd-2008	3.63	2.90	20.18
Tw96010	2.73	3.17	-15.85
Tw96018	3.97	2.17	45.38
Tw11510	4.00	3.00	25.00
Tw11512	3.93	3.33	15.25
Tw11514	3.53	3.17	10.38
9384	3.33	3.00	10.00
9383	3.53	3.00	15.09
9110	3.07	3.10	-1.09
6377	3.27	2.37	27.55
2095	3.50	3.00	14.29
6422	3.60	3.47	3.70
9346	3.37	3.03	9.90
Mean	3.39	2.99	10.91

Field trial:

The experiment was laid out in split plot design having three replications and maintaining plot size of 0.45 m × 3.75 m. The sowing was done on 28th november, 2014. Moisture conditions were kept in main plots and genotypes in sub plots. In normal moisture treatment two irrigations were applied at tillering and grain filling stage excluding rauni irrigation; whereas under water

stress conditions only rauni irrigation was applied and after that it was rainfed. Sowing was done with manual drill. Fertilizers were applied @ 160-120-60 npk kg ha^{-1}. Whole the fertilizers were applied at sowing. All the other agronomic practices were kept uniform and data regarding leaf area, photosynthetic efficiency, fertile tillers, grain yield and yield stability index were recorded.

The leaf area was higher under normal moisture than under water stress conditions. The maximum leaf area (56.21 cm^2) under moisture stress was recorded in genotype 12265 and was followed by 9384 and 11137 with leaf areas of 55.99 and 54.97 cm^2, respectively. Under water stress conditions, maximum photosynthetic efficiency (0.823) was measured in genotype 11046 and was followed by 10355 (0.777) and 11365 (0.772).

All the genotypes produced more fertile tillers m^{-2} under normal moisture than that under moisture stress conditions. In water stress conditions, genotype 11365 produced higher fertile tillers (399 m^{-2}) as compared to other genotypes and was followed by 11046 (388 m^{-2}) and 12304 (387 m^{-2}). Higher grain yield was provided by all the genotypes under normal moisture as compared to that in moisture stress. However, under water stress, 11365 produced maximum grain yield (4306 kg ha^{-1}) with yield stability index of 95.28% and was followed by genotypes 9346 (4069 kg ha^{-1}) having yield stability index of 97.86%, genotype 11041 (4059 kg ha^{-1}) with yield stability index of 96.80% and genotype 11032 (4010 kg ha^{-1}) having yield stability index of 82.39%. The overall decrease in grain yield was only 9.34% in water stress conditions (3645 kg ha^{-1}) as compared with that in normal moisture (4027 kg ha^{-1}). The reason could be the excessive rainfall (115.2 mm) from post tillering to maturity stage that had a positive effect on wheat crop under moisture stress conditions.

Field experiment

Table: Effect of different moisture levels and genotypes on leaf area (cm^2)

Genotypes	Normal moisture	Moisture stress	% decrease
9082 (nuwyt)	60.32	54.65	9.39
9087	60.03	54.51	9.21
10104	47.62	43.38	8.89
10110	52.06	48.46	6.91
10355	57.42	52.94	7.80
11160	52.46	40.02	23.71
11022 (micro)	49.35	45.46	7.88
11032	49.56	45.15	8.88
11041	61.85	51.15	17.30
11046	51.08	47.48	7.05
11047	63.40	51.22	19.21

11061	53.37	45.34	15.04
11092	59.94	51.49	14.09
11098	46.82	42.95	8.26
11137	61.94	54.97	11.24
11138	54.82	42.71	22.10
11143	65.31	49.40	24.37
11365	56.95	46.52	18.31
12265	61.09	56.21	7.99
12266	50.31	47.26	6.06
12275	52.88	46.50	12.07
12284	45.45	38.06	16.26
12304	45.49	40.12	11.80
Fsd-2008	52.55	43.44	17.33
Tw96010	52.12	44.45	14.71
Tw96018	41.14	39.79	3.30
Tw11510	44.22	38.12	13.79
Tw11512	43.99	36.15	17.82
Tw11514	53.49	52.34	2.14
9384	58.64	55.99	4.53
9383	52.45	47.57	9.31
9110	57.64	43.96	23.73
6377	60.38	47.73	20.95
2095	53.10	48.87	7.98
6422	59.75	54.00	9.63
9346	46.36	44.81	3.34
Mean	53.76	47.03	12.29

Table: Effect of different moisture levels and genotypes on photosynthetic efficiency

Genotypes	**Normal moisture**	**Moisture stress**	**% decrease**
9082 (nuwyt)	0.787	0.758	3.75
9087	0.746	0.741	0.65
10104	0.788	0.762	3.28
10110	0.784	0.773	1.40
10355	0.781	0.777	0.45
11160	0.788	0.740	6.07
11022 (micro)	0.769	0.750	2.42
11032	0.791	0.749	5.27
11041	0.803	0.743	7.50
11046	0.814	0.823	-1.09
11047	0.811	0.782	3.57
11061	0.775	0.738	4.76

11092	0.804	0.743	7.66
11098	0.774	0.752	2.82
11137	0.793	0.748	5.73
11138	0.801	0.769	3.93
11143	0.781	0.738	5.44
11365	0.794	0.772	2.70
12265	0.791	0.691	12.64
12266	0.784	0.718	8.42
12275	0.765	0.744	2.76
12284	0.764	0.730	4.46
12304	0.775	0.715	7.69
Fsd-2008	0.781	0.697	10.82
Tw96010	0.779	0.744	4.59
Tw96018	0.788	0.748	5.10
Tw11510	0.779	0.737	5.40
Tw11512	0.783	0.699	10.68
Tw11514	0.767	0.741	3.46
9384	0.784	0.694	11.48
9383	0.798	0.747	6.39
9110	0.776	0.712	8.24
6377	0.788	0.747	5.14
2095	0.772	0.746	3.38
6422	0.788	0.730	7.30
9346	0.764	0.750	1.80
Mean	0.784	0.743	5.17

Table: Effect of different moisture levels and genotypes on fertile tillers (m^2)

Genotypes	**Normal moisture**	**Moisture stress**	**% decrease**
9082 (nuwyt)	389	362	6.94
9087	376	340	9.37
10104	358	339	5.49
10110	408	338	17.15
10355	345	343	0.40
11160	366	324	11.44
11022 (micro)	398	320	19.49
11032	389	357	8.29
11041	389	339	12.90
11046	388	388	0.16
11047	411	366	10.96
11061	393	338	13.84
11092	389	363	6.81

11098	372	364	2.21
11137	394	381	3.22
11138	386	366	5.12
11143	337	336	0.34
11365	398	399	-0.10
12265	375	373	0.32
12266	370	357	3.48
12275	358	350	2.27
12284	367	341	6.95
12304	408	387	5.18
Fsd-2008	379	376	0.77
Tw96010	371	351	5.37
Tw96018	346	330	4.53
Tw11510	372	354	4.66
Tw11512	370	364	1.43
Tw11514	368	309	15.88
9384	358	333	6.90
9383	379	330	12.81
9110	365	338	7.55
6377	371	367	0.89
2095	399	330	17.37
6422	367	363	1.18
9346	389	357	8.37
Mean	378	352	6.66

Table: Effect of different moisture levels and genotypes on grain yield (kg ha^{-1})

Genotypes	**Normal moisture**	**Moisture stress**	**Stability index**
9082 (nuwyt)	4405	3970	90.13
9087	4161	3733	89.72
10104	4411	3388	76.80
10110	4020	3398	84.52
10355	4194	3644	86.91
11160	4280	3743	87.45
11022 (micro)	3976	3437	86.44
11032	4867	4010	82.39
11041	4194	4059	96.80
11046	3846	3842	99.90
11047	3955	3457	87.41
11061	3563	3516	98.67
11092	3911	3812	97.47
11098	4476	3852	86.05
11137	4128	3694	89.47

11138	4150	3447	83.06
11143	3802	3477	91.44
11365	4520	4306	95.28
12265	3498	3467	99.10
12266	4263	3773	88.50
12275	3998	3378	84.49
12284	4041	3714	91.89
12304	4020	3733	92.87
Fsd-2008	4128	3891	94.25
Tw96010	3498	3022	86.39
Tw96018	3346	3319	99.17
Tw11510	3324	3131	94.18
Tw11512	3972	3970	99.95
Tw11514	4385	3556	81.09
9384	3955	3931	99.40
9383	3889	3200	82.28
9110	4041	3575	88.47
6377	3449	3398	98.51
2095	4280	3368	78.68
6422	3860	3733	96.72
9346	4158	4069	97.86
Mean	4027	3645	90.79

70. Genetic evaluation of wheat genotypes under salt stress conditions

The trial was sown in earthen pots having completely randomized design. Thirty nine wheat genotypes were tested with salinity levels of 0 and 8 d sm^{-1}. The crop was sown on december, 02-2016. Fertilizer was applied @ 2.5-1.52-0.7 npk g per pot and 6 seeds per pot was sown. Hand weeding will be done to control weeds. The following observations were recorded during the course of studies:

Discussion:

Plant height (cm)

Data regarding plant height is presented in table-1 showed that maximum % decrease (29.9%) in plant height was obtained by genotype hyt-80-44, whereas minimum % decrease (4.4%) was obtained by genotype 13bt017.

Table: effect of various wheat genotypes and salt levels on plant height (cm)

Sr. No.	Genotypes	Salt levels		% decrease
		Normal	Salinity (8 ds m^{-1})	
1.	13338	74.0	70.2	5.4
2.	14227	79.5	65.2	21.9
3.	Hyt-08-7	89.5	79.4	12.7
4.	14154	75.1	61.2	22.7
5.	Uos-2	82.4	71.3	15.6
6.	12fj01	74.6	66.0	13.0
7.	Hyt-80-34	86	68.1	26.3
8.	Hyt-80-44	84.3	64.9	**29.9**
9.	13b3146	66.1	58.7	12.6
10.	Cgri-pv1	79.8	66.2	20.5
11.	Tws12155	85.3	73.4	16.2
12.	V-13348	86.8	70.7	22.8
13.	14151	71.1	65.9	7.9
14.	Cdri-2	79.6	61.9	28.6
15.	14b1028	85.8	74.4	15.3
16.	13167	78.4	66.9	17.2
17.	13bt017	68.6	65.7	**4.4**
18.	Nr453	72.0	63.8	12.9
19.	9496	89.1	78.6	13.4
20.	11fjs309	76.8	62.3	23.3
21.	14c040	80.5	63.2	27.4
22.	14c036	78.7	66.8	17.8
23.	Uos-1	84.1	68.1	23.5
24.	14170	78.7	64.5	22.0
25.	14b1030	77.9	64.2	21.3
26.	Nr443	83.0	71.5	16.1
27.	Glaxy	81.6	69.2	17.9
28.	Nr487	80.7	71.4	13.0
29.	12fj26	83.8	67.6	24.0
30.	14168	75.7	65.1	16.3
31.	13bt016	72.4	62.9	15.1
32.	Nr457	75.4	68.9	9.4
33.	Tws12464	87.8	71.2	23.3
34.	Cdri-sa	77.7	61.2	27.0
35.	12b2511	82.7	65.9	25.5
36.	Tws12245	72.6	58.0	25.2
37.	Nw-1-9-47	74.9	64.5	16.1
38.	14153	77.6	67.9	14.3
39.	Fsd-2008	68.8	59.5	15.6

Chlorophyll fluorescence (fv/fm)

Photosynthesis is particularly reduced when plants are grown under saline conditions, which leads to reduced growth and productivity. Since photosynthesis occupies the central position in providing link between the internal metabolism of plant and the external environment, therefore, any change in external environment will affect photosynthetic ability of a plant in both negative and positive ways. Chlorophyll fluorescence has proved particularly useful in salinity-tolerance screening programs because the effects of salt damage can be detected prior to visible signs of deterioration. Data regarding chlorophyll fluorescence is presented in table-2 showed that maximum % decrease (14.8%) in chlorophyll fluorescence was observed in genotypes 14168, whereas, minimum % decrease (5.9%) in chlorophyll fluorescence was observed in genotype 13bt016.

Effect of various wheat genotypes and salt levels on chlorophyll fluorescence

Sr. No.	**Genotypes**	**Salt levels**		**% decrease**
		Normal	**Salinity (8 ds m^{-1})**	
1.	13338	0.75	0.68	10.3
2.	14227	0.75	0.7	7.1
3.	Hyt-08-7	0.75	0.71	5.6
4.	14154	0.79	0.73	8.2
5.	Uos-2	0.78	0.73	6.8
6.	12fj01	0.79	0.72	9.7
7.	Hyt-80-34	0.71	0.64	10.9
8.	Hyt-80-44	0.77	0.71	8.5
9.	13b3146	0.76	0.69	10.1
10.	Cgri-pv1	0.74	0.68	8.8
11.	Tws12155	0.73	0.68	7.4
12.	V-13348	0.79	0.72	9.7
13.	14151	0.72	0.66	9.1
14.	Cdri-2	0.73	0.64	14.1
15.	14b1028	0.69	0.62	11.3
16.	13167	0.78	0.7	11.4
17.	13bt017	0.78	0.7	11.4
18.	Nr453	0.69	0.61	13.1
19.	9496	0.72	0.64	12.5
20.	11fjs309	0.71	0.65	9.2
21.	14c040	0.68	0.61	11.5
22.	14c036	0.7	0.65	7.7
23.	Uos-1	0.73	0.67	9.0
24.	14170	0.77	0.71	8.5
25.	14b1030	0.72	0.65	10.8
26.	Nr443	0.76	0.69	10.1
27.	Glaxy	0.7	0.63	11.1
28.	Nr487	0.79	0.72	9.7

29.	12fj26	0.71	0.65	9.2
30.	14168	0.70	0.61	**14.8**
31.	13bt016	0.72	0.68	**5.9**
32.	Nr457	0.77	0.7	10.0
33.	Tws12464	0.73	0.62	17.7
34.	Cdri-sa	0.73	0.65	12.3
35.	12b2511	0.74	0.67	10.4
36.	Tws12245	0.73	0.65	12.3
37.	Nw-1-9-47	0.76	0.69	10.1
38.	14153	0.69	0.62	11.3
39.	Fsd-2008	0.69	0.65	6.2

Water potential (-mpa)

Water potential is the potential energy of water per unit volume relative to pure water in reference conditions. Water potential quantifies the tendency of water to move from one area to another due to osmosis, gravity, mechanical pressure, or matrix effects such as capillary action. Data regarding water potential is presented in table-3 showed that maximum % decrease (35.25%) in water potential was observed in genotypes tws12245, whereas, minimum % decrease (5.41%) in water potential was observed in genotype 14b1030.

Table: Effect of various wheat genotypes and salt levels on chlorophyll fluorescence

Water potential

Sr. No.	**Genotypes**	**Salt level**		**% decrease**
		Normal	**Salinity (8 ds m^{-1})**	
1.	13338	1.32	1.52	15.15
2.	14227	1.73	1.92	10.98
3.	Hyt-08-7	1.80	1.92	6.67
4.	14154	1.97	2.05	4.06
5.	Uos-2	2.07	2.35	13.53
6.	12fj01	1.82	1.96	7.69
7.	Hyt-80-34	1.65	1.85	12.12
8.	Hyt-80-44	1.52	1.63	7.24
9.	13b3146	1.47	1.67	13.61
10.	Cgri-pv1	1.82	1.96	7.69
11.	Tws12155	1.47	1.64	11.56
12.	V-13348	1.12	1.32	17.86
13.	14151	1.67	1.86	11.38
14.	Cdri-2	1.35	1.52	12.59
15.	14b1028	1.17	1.47	25.64
16.	13167	1.82	1.96	7.69
17.	13bt017	1.65	1.87	13.33
18.	Nr453	1.22	1.44	18.03

19.	9496	1.62	1.78	9.88
20.	11fjs309	1.18	1.27	7.63
21.	14c040	1.80	1.93	7.22
22.	14c036	1.53	1.73	13.07
23.	Uos-1	1.55	1.82	17.42
24.	14170	1.63	1.82	11.66
25.	14b1030	1.85	1.95	**5.41**
26.	Nr443	1.80	1.94	7.78
27.	Glaxy	1.15	1.32	14.78
28.	Nr487	1.40	1.63	16.43
29.	12fj26	1.72	1.92	11.63
30.	14168	1.15	1.35	17.39
31.	13bt016	1.16	1.31	12.93
32.	Nr457	1.45	1.65	13.79
33.	Tws12464	1.47	1.57	6.80
34.	Cdri-sa	1.65	1.87	13.33
35.	12b2511	1.55	1.77	14.19
36.	Tws12245	1.22	1.65	**35.25**
37.	Nw-1-9-47	1.20	1.37	14.17
38.	14153	1.76	1.89	7.39
39.	Fsd-2008	1.50	1.87	24.67

Grain yield (g pot^{-1})

Data regarding grain yield is presented in table-4 showed that maximum % decrease (42.7%) in grain yield was observed in genotypes tws12245, whereas, minimum % decrease (10.4%) in grain yield was observed in genotype hyt-08-7.

71. Effect of various wheat genotypes and salt levels on chlorophyll fluorescence

Water potential

Sr. No.	**Genotypes**	**Salt level**		**% decrease**
		Normal	**Salinity**	
1.	13338	159	135	15.1
2.	14227	155	131	15.5
3.	Hyt-08-7	164	147	**10.4**
4.	14154	120	97	19.2
5.	Uos-2	118	90	23.7
6.	12fj01	134	96	28.4
7.	Hyt-80-34	131	96	26.7
8.	Hyt-80-44	130	104	20.0
9.	13b3146	128	96	25.0
10.	Cgri-pv1	106	84	20.8
11.	Tws12155	120	94	21.7
12.	V-13348	125	99	20.8
13.	14151	115	82	28.7
14.	Cdri-2	103	87	15.5

15.	14b1028	118	85	28.0
16.	13167	107	68	36.4
17.	13bt017	105	82	21.9
18.	Nr453	102	77	24.5
19.	9496	119	97	18.5
20.	11fjs309	106	82	22.6
21.	14c040	92	62	32.6
22.	14c036	93	66	29.0
23.	Uos-1	126	94	25.4
24.	14170	126	94	25.4
25.	14b1030	133	101	24.1
26.	Nr443	92	68	26.1
27.	Glaxy	129	105	18.6
28.	Nr487	125	96	23.2
29.	12fj26	118	96	18.6
30.	14168	150	90	40.0
31.	13bt016	109	82	24.8
32.	Nr457	116	86	25.9
33.	Tws12464	121	98	19.0
34.	Cdri-sa	110	90	18.2
35.	12b2511	128	96	25.0
36.	Tws12245	110	63	**42.7**
37.	Nw-1-9-47	125	98	21.6
38.	14153	105	87	17.1
39.	Fsd-2008	154	123	20.1

72. Screening of herbicides to control grassy (monocot) weeds in wheat

This experiment was sown on 28 november 2016 with the objective to screen out new herbicides for weed control in wheat. The experiment was laid out in randomized complete block design having three replications. A plot size of 3.0 m × 8.0 m was maintained. Recommended fertilizer dose (115-85-60 npk kg ha^{-1}) were applied and glaxy-2013 was used as test variety. Two new herbicides viz. Axial 050 ec (penoxaden) and skype (clodinafop) were tested against puma super 69 ew (fenoxaprop) and topik (clodinafop). The following results were recorded during this year of study:

table: effect of herbicides on weed counts and grain yield of wheat

#	**Herabicides**	**Dose (ha^{-1})**	**Weeds m^{-2} After sparay**	**Difference**	**Grain yield kg ha^{-1}**
1	Topik 15 wp (clodinafop)	300 g	23 c	56%	3313 a
	Skype 20 ec (clodinafop)	250 ml	25 c	53%	3143 b
2	Puma super 69 ew	1250	30 b	45%	2983 c

	(fenoxaprop)	ml			
5	Axial 050ec (penoxaden)	825 ml	19 d	63%	3433 a
9	Control	-	49 a	-	2183 d
	Lsd	**-**	**3.5**	**-**	**136**

Weed counts (m^{-2})

It is evident from the weed counts data that the candidate herbicides axial 050 ec (penoxaden) @ 825 ml ha^{-1} gave effective weed control against the standard herbicide puma super 69 ew (fenoxaprop) (@ 1250 ml ha^{-1} with 19 and 30 weeds m^{-2}. As regards the other candidate herbicides viz. Skype 20 ec gave 25 weeds which were at par with their standard topik 15 wp (clodinafop) with 23 weeds m^{-2}. All the herbicides gave significantly better weed control than the control in which 49weeds m^{-2} were recorded.

grain yield (kg ha^{-1})

As regards the grain yield of wheat, the candidate herbicide axial 050ec (penoxaden) produced significantly higher grain yield of 34033 kg ha^{-1} as compared to its standar herbicide puma super 69 ew (fenoxaprop) which produced grain yield 2983 kg ha^{-1}. As regards the other candidate herbicides viz. Skype 20 ec which produced significantly lower grain yield of 3143 kg ha^{-1} were as compared to its standard topik 15 wp (clodinafop) with 3313 kg ha^{-1}. All the herbicides gave significantly higher grain yield than control in which 2183 kg ha^{-1} were recorded.

73. Screening of herbicides for the control of dicot weeds in wheat

The trial was sown on november 28, 2016 with the objective to find out new herbicides formulations for the control of broad leaf weeds in wheat. Trial was laid out in randomized complete block design having three replications and a plot size of 3.0 m × 8.0 m. Sowing method was drill sowing having line spacing of 22.5 cm and testing variety was glaxy-2013. Six herbicides viz. Harvester pro 56 ec, jupitor 50 ec, broxtra 40.8 ec, spot light 50 ec, lancelot 45 wg and hussar 100 od were tested against standard herbicides, harvester 50 ec, buctril-super 60 ec, selector 60 ec, starne-m 50 ec and atlantis 3.6 wg . The following results were found during this year of study.

Table: effect of herbicides on broad leaf weeds, weed biomass and grain yield of wheat

#	Herbicides	Status	Dose (ha^{-1})	Weed counts (m^{-2})	% weed control	Grain yield (kg ha^{-1})
1	Harvester 50 ec	Stand.	750 ml	03 c	92%	3117 ab
2	Harvester pro 56 ec	Candi	1000 ml	02 c	94%	3200 a
3	Jupitor 50 ec	Candi	750 ml	02 c	94%	3067 b

4	Buctril-super 60 ec	Stand.	1000 ml	06 b	86%	3030 b
5	Broxtra 40.8 ec	Candi	1250 ml	02 c	94%	3000 b
6	Atlantis 3.6 wg	Stand.	400 g	01 c	97%	3183 a
7	Hussar 100 od	Candi	100 ml	01 c	97%	3100 ab
8	Selector 60 ec	Stand.	1250 ml	07 b	83%	3030 b
9	Spot light 50 ec	Candi	31g	03 c	93%	3100 b
10	Starne-m 50 ec	Stand.	750 ml	03 c	93%	3167 ab
11	Lancelot 45 wg	Candi	800 ml	01 c	97%	3133 ab
12	Control (weedy check)			44 a	-	2167 c
Lsd				**2.05**	**-**	**120**

Weed counts (m^{-2})

It is evident from the weed counts m^{-2} data after 25 days of spray that the candidate herbicides i.e., harvester pro 60 ec, jupitor 50 ec, hussar 100 od and lancelot 45 wg gave statisticaly at par weed control of dicot weeds i.e., 2, 2, 1 and 1 weed counts m^{-2} respectively which is statistically at par to their standard herbicides. The candidate herbicides viz. Broxtra 40.8 ec and spot light 50 ec gave better weed control as compared to their standars buctril-super 60 ec and selector 60 ec. Maximum weed count (44 m^{-2}) was recorded in weedy check plot. All the herbicides both candidate and standard gave weed control more than 80%.

Grain yield (kg ha^{-1})

It is evident from the yield data that all the candidate herbicides i.e., broxtra 40.8 ec, hussar 100 od produced significantly low grain yields respectively as compared to their standard herbicides. All other candidate herbicides produced grain yield statistically at par to their standard herbicides. Maximum grain yield was produced by harvester pro 56 ec (3200 kg ha^{-1}) which is statistically at par to its standard herbicide harvester 50 ec (3117 kg ha-^{1}). On the other hand some standard herbicides like buctril super @ 750 ml ha^{-1} and atlantis 3.6 wg @ 400 g ha^{-1} yielded 3030 and 3183 kg ha^{-1} respectively which were more than their candidate herbicides. Minimum grain yield (2167 kg ha $^{-1}$) was recorded in control plot where no herbicide was applied.

74. Screening of broad spectrum herbicides for the control of weeds in wheat

The trial was sown on december 02, 2016 with the objective to find out new herbicides formulations for the control of grassy and broad leaf weeds in wheat. Trial was laid out in randomized complete block design having three replications and a plot size of 4.5 m × 8.0 m. Sowing method was drill sowing having line spacing of 22.5 cm and testing variety was glaxy-2013. Two new herbicide formulations viz. Afinity ultra 12.4 wp (colodinofop + carfentrazone +

metsulfuron) and zentor super 70 wdg (metribuzin) were tested against their standard herbicides i.e., afinity 3.6 wp (isoproturon + carfentrazone) and sencor 70 wp (metribuzin). The following results were found during this year of study.

Table: effect of herbicides on broad leaf weeds, weed biomass and grain yield of wheat

#	Herbicides	Status	Dose (ha^{-1})	Weed counts (m^{-2})	% weed control	Grain yield ($kg\ ha^{-1}$)
1	Atlantis 3.6 wg (mesosulfuron + iodosulfuron)	Stand.	400 g	5 c	90%	3830 a
2	Affinity 3.6 wg (isoproturon + carfentrazone)	Stand.	2000 g	3 c	93%	3355 c
3	Affinity ultra 12.4 wp (colodinofop + carfentrazone + metsulfuron)	Candi	562 g	4 c	92%	3610 b
4	Sencor 70 wp (metribuzin)	Stand.	250 g	9 b	84%	3375 c
5	Zentor super 70 wdg (metribuzin)	Candi	250 g	9 b	84%	3400 c
6	Control (weedy check)			54 a	-	2677 d
Lsd				**2.09**	**-**	**203**

Weed counts (m^{-2})

It is evident from the weed counts m^{-2} data after 25 days of spray that the candidate herbicides i.e., afinity ultra 12.4 wp and zentor super 70 wdg gave statisticaly at par weed control of grassy and dicot weeds i.e., 4 and 11 weed counts m^{-2} respectively which is statistically at par to their standard herbicides afinity 3.6 wp and sencor 70 wp which results in 3 and 9 weed counts m^{-2} respectively. Maximum weed count (54 m^{-2}) was recorded in weedy check plot. All the herbicides both candidate and standard gave weed control more than 80%.

Grain yield ($kg\ ha^{-1}$)

It is evident from the yield data that both the standard and candidate herbicides produced significantly higher grain yield as compared to control (weedy check). Maximum grain yield 3830 kg ha^{-1} was produced by atlantis 3.6 wg. Significantly minimum grain yield was recorded in weedy check treatment which results in 2677 kg ha^{-1} grain yield.

75. Effect of potassium (k^{+}) fertilizer on agronomic traits of new promising lines of wheat

Experiment was conducted to evaluate the effect of potassium application on agronomic traits of new promising lines of wheat. Two wheat varieties galaxy-2013 and ujala-2016 were sown on 25-11-2016 keeping row to row distance at 22.5 cm. Four different levels of potassium were tested i.e. T_1= 0 kg ha-^{1,} t_2= 62.50 kg ha^{-1}, t_3= 31.25 kg ha^{-1} and t_4= 93.75 using completely randomized design in factorial arrangement having three replications. Nitrogen and phosphorous were applied at 120 and 90 kg ha^{-1} respectively. Plot size was 10 ft. × 20 ft. M. All other agronomic practices were kept uniform.

results of this study revealed that maximum yield was given by variety galaxy-2013 where 62.5 kg potassium (k) ha-1 was applied., while lowest was recorded where 93.75 kg k ha-1 was applied in both varieties as well as in control treatment of ujala-2016. Similar trend was recorded in case of productive tillers however all other recorded parameters were non-significant.

in conclusion the optimum dose of potassium for wheat is 62.5 kg ha-1.

	Plant height			**Productive tillers**			**Spike length (cm)**		
Npk (kg ha^{-1})	Galaxy-2013	Ujala-2016	Mean	Galaxy-2013	Ujala-2016	Mean	Galaxy-2013	Ujala-2016	Mean
120-90-00	100.7	99.0	100.0	542.7b	442.7c	492.7	14.6	13.0	13.8
120-90-62.50	103.0	98.0	100.7	640.7a	567.0b	603.8	14.4	13.3	13.9
120-90-31.25	97.7	101.0	99.3	532.7b	536.7b	534.67	13.3	9.7	11.5
120-90-93.75	100.4	99.0	100.0	427.0c	436.7c	431.8	14.1	12.0	13.0
	100.4	99.56		535.8	495.8		14.11	11.98	
Lsd at 0.05									

	Spikelets per spike			**Yield (kg ha^{-1})**		
Npk (kg ha^{-1})	Galaxy-2013	Ujala-2016	Mean	Galaxy-2013	Ujala-2016	Mean
120-90-00	9.3	8.5	8.9	5428b	4427c	4927
120-90-62.50	9.2	8.6	6.9	6408a	5673b	6040
120-90-31.25	8.6	7.8	8.9	5327b	5367b	5347
120-90-93.75	8.1	7.0	7.6	4270c	4367c	4318
Mean	8.8	8.0		5358	4958	
Lsd at 0.05						

76. Performance of new wheat varieties / strains under khanewal conditions (fsd)

Experiment was conducted to evaluate the performance of different wheat strains under khanewal conditions. Six wheat varieties/ strains i.e. V_1= ujala-2016, v_2= 8068, v_3= 12001, v_4= 11183, v_5= 10110 and v_6= galaxy-2013 were sown on 27-11-2016 keeping row to row distance at 22.5 cm. Experiment was laid out in completely randomized design in factorial arrangement having three replications. Fertilizer was applied at 120-90-62.5 npk kg ha^{-1}. Plot size was 1.8 m × 6 m. All other agronomic practices were kept uniform.

variety galaxy 2013 gave maximum grain yield of 4617 kg ha^{-1} that was statistically at par with variety/ strain ujala-2016, 12001 and 10110 having grain yield of 4420, 4500 and 4437 kg ha-1respectively. However minimum grain yield of 3747 kg ha^{-1} was recorded in wheat strain 8068. In case of productive tillers, maximum tillers were recorded in ujala-2016, 12001, 10110 and galaxy-2013 while minimum were recorded in wheat strain 8068. Whereas all other recorded parameters were non-significant.

in conclusion wheat variety galaxy-2013as well as 10110 and 12001 may be recommended to attain good wheat yield.

Variety	**Plant height (cm)**	**Productive tillers (m^{-2})**	**Spike length (cm)**	**Spikelets per spike**	**Yield (kg ha^{-1})**
Ujala-2016	106.0	447.5a	10.0	17.7	4420.0ab
8068	105.7	379.1b	10.0	18.0	3746.7c
12001	110.3	456.7a	9.7	17.3	4500.0ab
11183	111.3	416.3ab	8.8	15.7	4096.7bc
10110	109.7	450.8a	8.9	16.3	4436.7ab
Galaxy-2013	107.7	467.2a	10.3	18.0	4616.7a
Lsd at 0.05	4.9	54.5	1.6	3.6	502.70

77. Effect of moringa olifera leaf extract (mle) along with synthetic fertilizers on wheat yield under khanewal conditions

Experiment was conducted to evaluate the potential of moringa leaf extracts in reducing the use of synthetic fertilizer and improvement of grain yield of wheat crop. Wheat variety ujala-2016 was sown on 27-11-2016 keeping row to row distance at 22.5 cm. Experiment was comprised of eight treatments viz. T_1= no fertilizer+seed priming with mle, t_2=120-90-60 kg npk ha_{-1}+ seed priming with mle, t_3=90-68-45 kg npk ha_{-1} +seed priming with mle, t_4=60-45-30 kg npk ha^{-1}+seed priming with mle, t_5= no fertilizer+foliar spray of

mle at tillering and booting, t_2=120-90-60 kg npk ha^{-1}+ foliar spray of mle at tillering and booting, t_3=90-68-45 kg npk ha^{-1} + foliar spray of mle at tillering and booting, t_4=60-45-30 kg npk ha^{-1}+ foliar spray of mle at tillering and booting. Experiment was laid out using completely randomized design in factorial arrangement having three replications. Plot size was 3 m × 6 m. All other agronomic practices were kept uniform.

Highest grain yield was recorded from the 100% recommended dose (120-90-60) npk where seeds were primed with 30% moringa leaf extracts with grain yield of 5818 kg ha^{-1} , followed by same dose of npk with no primed seeds with grain yield of 5541 kg ha^{-1} . Lowest grain yield was recorded from treatment where no fertilizer was applied in both kind of seeds primed or non-primed.

Hence seed priming with 30% moringa leaf extracts along with recommended dose of npk has potential to boost the yield of wheat crop.

Treatments	**Priming (soaking)**	**30% moring leaf extract**	**Mean**
No Fertilizer	3821f	4852d	4337
100% recommended (120-90-60) npk	5541b	5818a	5679
75% recommended (120-90-60) npk	5214cd	5266c	5240
50% recommended (120-90-60) npk	5082d	5139cd	5110
Mean	4915	5269	
Lsd for interaction at 0.05= 171.8			

78. Performance of wheat varieties / strains under khanewal conditions (bwp.)

Performance of different wheat strains under khanewal conditions. Seven wheat varieties/ strains i.e. V_1= gold-2016, v_2= aas-2011, v_3= 2557, v4= 2511, v_5= 2809 and v_6= johar-2016 and v_7= 2559 were sown on 24-11-2016 keeping row to row distance at 22.5 cm. Experiment was laid out in completely randomized design in factorial arrangement having three replications. Fertilizer was applied at 120-90-62.5 npk kg ha^{-1}. Plot size was 10 ft. × 20 ft. All other agronomic practices were kept uniform.

results of this study showed that maximum yield of 5046 and 5039 kg ha-1 was given by wheat variety/ strain johar-2016 and 2809 respectively. Whereas lowest yield of 4147 kg

ha^{-1} was recorded in aas-2011.in case of plant height maximum was recorded in wheat variety strain 2809, johar-2016 and 2559 while minimum was recorded in gold-2016, aas-2011 and 2511. In case of productive tillers, maximum productive tillers were recorded in johar-2016 and 2809 while lowest were recorded in aas-2011. Similarly maximum spike length and spikelets per spike were recorded in johar-2016 and 2559 while they were minimum in 2511.

in conclusion wheat variety/strain johar-2016 and 2809 has good yield potential under khanewal conditions.

Variety	**Plant height (cm)**	**Productive tillers (m^{-2})**	**Spike length (cm)**	**Spikelets per spike**	**Yield (kg ha^{-1})**
Gold-2016	102.9bc	4927ab	10.6a	10.8a	4767ab
Aas-2011	101.7c	4302c	10.8ab	10.2ab	4147c
2557	108.3ab	4573bc	9.6b	9.5bc	4427bc
2511	100.7c	4780b	8.2c	8.3c	4620b
2809	109.1a	5206a	10.5ab	10.3ab	5039a
Johar-2016	111.9a	5213a	11.1a	11.3a	5046a
2559	109.3a	4861ab	11.3a	11.3a	4707ab
Lsd at 0.05	6.1	421.1	1.4	1.2	401.8

79. Weed management trial on wheat

Experiment was conducted to evaluate the plausible and economical get rid of weeds in wheat crop. Wheat variety ujala-2016 was sown on 25-11-2016 keeping row to row distance at 22.5 cm. Treatments used were as: t_1=topik (clodinofop), t_2= axial (penoxadon) t_3= atlantis (mesosulfuran + iodosulfuran), t_4= sulfan (sulfosulphoran), t_5= buctral super (bromoxinal + mcpa) + axial (penoxadon), t_6=axial+buctral super, t_7= topik (clodinofop) + buctral super, t_8=control. Experiment was laid out in completely randomized design in factorial arrangement having three replications. Fertilizer was applied at 120-90-62.5 npk kg ha^{-1}. Plot size was 10 ft. × 20 ft.. All other agronomic practices were kept uniform.

sulfosulfuran produced highest grain yield of 4913 kg ha^{-1}, followed by topik with grain yield of 4565 kg ha^{-1}. All other herbicides and their combination treatments also produced better yield than control.

Treatments	Yield (kg ha^{-1})	Weed plant density (m^{-2}) 30 days after spray		
		Narrow Leaf	Broad Leaf	Total
Topik	4565 ab	2	8	10
Axial	4033 bc	12	14	26
Atlantis	4198 bc	6	4	10
Sulfosulfuron	4931 a	4	3	7
Buctral super	4400 abc	5	3	8
Axial+buctral super	3831 cd	4	5	9
Topic+buctral	3776 cd	4	2	6
Control	3263 d	17	19	36
Lsd at 0.05	568			

80. Nitrogen uptake and crop yield of wheat as affected by organic and inorganic n-fertilizers

Experiment was conducted to evaluate the potential of organic sources of n in reducing the dose of inorganic n fertilizer. Wheat variety ujala-2016 was sown on 25-11-2016 keeping row to row distance at 22.5 cm. Experiment was comprised of ten treatments viz. T_1= control (120-90-62.5npk kg ha^{-1}), t_2= poultry manure (8 t ha^{-1}), t_3= farm yard manure (10 t ha^{-1}), t_4= slurry (10 t ha^{-1}), t_5= nitrogen (n) 30 kg ha^{-1}+ poultry manure 6 t ha^{-1}), t_6= nitrogen (n) 30 kg ha^{-1}+ farm yard manure 8 t ha^{-1}, t_7= nitrogen (n) 30 kg ha^{-1}+ slurry 8 t ha^{-1}, t_8= nitrogen (n) 60 kg ha^{-1}+ poultry manure 3 t ha^{-1}, t_9= nitrogen (n) 60 kg ha^{-1}+ farm yard manure 4 t ha^{-1}, t_{10}= nitrogen (n) 60 kg ha^{-1}+ slurry 4 t ha^{-1}. Experiment was laid out in completely randomized design in factorial arrangement having three replications. Plot size was 10 ft. × 20 ft.. All other agronomic practices were kept uniform.

the treatment urea @ 60 kg ha^{-1}+ poultry manure @ 3 tons ha^{-1} gave highest grain yield of 6352 kg ha^{-1}, followed by urea @ 60 kg ha^{-1}+ farmyard manure @ 4 tons ha^{-1} with grain yield 5809 kg ha^{-1}. While the lowest grain yields of 3311 kg ha^{-1} was recorded from poultry manure @ 8 t ha^{-1}.

Treatments	Plant height (cm)	Productive tillers (m^{-2})	Spike length (cm)	Spikelets per spike	Yield (kg ha^{-1})
Control (120-90-62.5 npk kg ha^{-1})	92.7	458.3	7.6	17.0	5583.3 c

Poultry manure (8 t ha^{-1})	100.1	230.0	7.0	16.2	3311.0 i
Farm yard manure (10 t ha^{-1})	159.3	408.3	7.6	15.8	5088.3 e
Slurry (10 t ha^{-1})	98.5	331.7	7.3	15.9	4317.7 h
Urea 30 kg ha^{-1}+ poultry manure 6 t ha^{-1})	101.7	453.3	7.5	16.9	5536.0 d
Urea 30 kg ha^{-1}+ farm yard manure 8 t ha^{-1}	100.40	446.7	7.5	16.6	5589.0 c
Urea 30 kg ha^{-1}+ slurry 8 t ha^{-1}	98.3	383.3	7.9	17.0	4838.7 f
Urea 60 kg ha^{-1}+ poultry manure @ 3 t	97.1	535.0	8.2	17.3	6352.0 a
Urea 60 kg ha^{-1}+ farm yard manure 4 t ha^{-1}	98.3	480.0	8.1	16.8	5809.0 b
Urea 60 kg ha^{-1}+ slurry 4 t ha^{-1}	98.6	406.7	7.9	17.5	4418.7 g
Lsd at 0.05	55.6	174.5	0.7	1.6	10.2

81. Economical cropping system under khanewal conditions

This study was conducted to evaluate the suitable cropping system that can provide maximum income per year. Seven different cropping systems were evaluated i.e. T_1= cotton-wheat-cotton-wheat-cotton–wheat, t_2=cotton/wheat-cotton/wheat-cotton/wheat (relay), t_3=rice-wheat-rice-wheat-rice-wheat, t_4=cotton-fallow-cotton-wheat-cotton-fallow, t_5=cotton/berseem-cotton/wheat-cotton-fallow, t_6= cotton/raya-cotton/wheat-cotton/raya (relay) and t_7= mung-wheat-cotton -wheat-mung-wheat. Treatments were sown at 18-11-2016. Wheat variety ujala-2016 and raya variety khanpur raya were used in this experiment. Fertilizer was applied at 120-90-62.5 npk kg ha-1. All other agronomic practices were kept uniform.

Treatment t_3 (rice + wheat) gave maximum economic benefit with rs. 153525 followed by treatments t_5 and t_6 (cotton + berseem and cotton + raya) with rs. 102655 and 124642 respectively. While treatment t_7 (mung + wheat) gave lowest economic benefit of rs. 63080.

Cropping system	**Yield kg / ha**
T1=cotton – wheat – **cotton –wheat**-cotton-wheat	4550
T2=cotton/wheat – **cotton/wheat**- cotton/wheat (relay)	3850
T3=rice-wheat-**rice-wheat**-rice-wheat	4450
T4=cotton- fallow-**cotton-wheat**-cotton-fallow	3400
T5=cotton/berseem-**cotton/wheat**-cotton/berseem (relay)	3500

T6=cotton/raya-**cotton/wheat**-cotton/raya (relay)	20995
T7=mung-wheat-**cotton -wheat**-mung-wheat	3700

	Economical cropping system under khanewal conditions one year 2014-15				
	Treatment	**Total income (rs)/ ha^{-1}**	**Total expenditure (rs)**	**Net income (rs)**	**Cost Benefit ratio (bcr)**
T1	**Cotton + wheat**	295387	195400	99987	1:1.50
T2	**Cotton +wheat**	317572	196850	120722	1:1.61
T3	**Rice+wheat**	372125	218600	153525	1:1.70
T4	**Cotton+wheat**	298357	196250	102107	1:1.52
T5	**Cotton +berseem**	251285	148630	102655	1:1.69
T6	**Cotton+raya**	305042	180400	124642	1:1.69
T7	**Mung-wheat**	173380	110300	63080	1:1.57
	Rate/40 kg = cotton 3200, wheat 1300, mung 2250, raya 2200 Berseem 1000/kanal				

82. Different sowing methods of wheat under khanewal conditions

Experiment was conducted to evaluate the best sowing method for wheat under khanewal conditions. Wheat variety ujala-2016 was sown on 24-11-2016 by using three sowing methods i.e. T_1= line sowing at 22.5 cm, t_2= line sowing at 15 cm and t_3= broadcast. Experiment was laid out in completely randomized design in factorial arrangement having three replications. Plot size was 10 ft. × 20 ft.. All other agronomic practices were kept uniform.

Line sowing at 22.5 cm distance gave the maximum grain yield of 4400 kg ha^{-1}, followed by line sowing at 15 cm distance and broad cast method with grain yield of 4096 and 3800 kg ha^{-1} respectively. Similar trend was observed in case of other two recorded parameters i.e. Productive tillers and spike length.

In conclusion the rows of wheat should be spaced 22.5 cm to attain the maximum yield.

Treatments	**Plant height (cm)**	**Productive tillers (m^{-2})**	**Spike length (cm)**	**Spikelets per spike**	**Yield (kg ha^{-1})**
Line sowing at 22.5 cm distance	100.4	448.0 a	17.0 a	7.9	4400.0 a
Line sowing at 15	94.8	418.7 b	15.8 ab	7.6	4096.7 ab

cm distance					
Broad cast method	101.3	384.0 c	14.7 b	7.4	3800.0 b
Lsd at 0.05	6.1	21.5	1.2	0.8	416.23

1) Comparison of different organic and inorganic sources for nutrient management in wheat.

To find out the best source for nutrient management to get more production and economic benefit a trial was laid out in randomized completely block design with three replication. Trial was sown on 28th november and wheat variety glaxy-2013 was used as testing material. Treatments were as

1. Recommend chemical fertilizer (150-100-50 npk kg ha^{-1}),
2. Natural farming without organic/chemical fertilizer
3. Poultry manure only as source of organic matter (25 t ha^{-1}),
4. Farm yard manure only as source of organic matter (25 t ha^{-1})
5. Poultry manure + half dose of npk
6. Farm yard manure + half dose of npk
7. Poultry manure + full dose of npk
8. Farm yard manure + full dose of npk.

Data on wheat grain yield and yield components was recorded and presented in table.

table

Treatments	**Wheat yield (kg ha^{-1})**
Recommended chemical fertilizer (150-100-50 npk kg ha^{-1})	3707 bc
Natural farming without organic/chemical fertilizer	1347 e
Poultry manure only as source of organic matter (25 t ha^{-1})	2533 d
Farm yard manure only as source of organic matter (25 t ha^{-1})	2333 d
Poultry manure + half dose of npk	3716 bc
Farm yard manure + half dose of npk	3410 c
Poultry manure+ full dose of npk	4294 a
Farm yard manure + full dose of npk.	4095 ab

Critical value for comparison = 514.66

Statistical analysis of the data showed the significant differences among treatment means. According to the data maximum wheat yield (4294 kg ha^{-1}) was obtained from the treatment poultry manure+ full dose of npk. While the treatment natural farming without organic/chemical fertilizer produce the minimum wheat yield of 1347 kg ha^{-1}

Economic analysis

Table.

Treatments	Gross income (rs.)	Expenses (rs.)	Net return (rs.)
Recommended chemical fertilizer (150-100-50 npk kg ha^{-1})	120477	50037	70440
Natural farming without organic/chemical fertilizer	43777	27892	15885
Poultry manure only as source of organic matter (25 t ha^{-1})	82322	36892	45430
Farm yard manure only as source of organic matter (25 t ha^{-1})	75822	35642	40180
Poultry manure + half dose of npk	120770	46912	73858
Farm yard manure + half dose of npk	110825	45662	65163
Poultry manure+ full dose of npk	139555	56287	83268
Farm yard manure + full dose of npk.	133087	55037	78050

Economic analysis showed the maximum return of (83268 rupee) from the treatment (poultry manure+ full dose of npk.) While minimum return was from the treatment natural farming without organic/chemical fertilizer (15885 rupee).

83. Yield performance of promising wheat strains under rice-wheat cropping system.

To find out the best line/strain of wheat for rice-wheat cropping system. A trial was laid out in randomized complete block design having 3 replications with a plot size of 1.8m x 5m. Sowing of trial was completed on 8th of november 2016. Fertilizer @ 150-100-50 npk kg ha^{-1}. Was applied. Seed rate was used @ 125 kg ha^{-1}. The inter row spacing was maintained at 22.5cm. All other crop management practices were kept uniform. Yield data was recorded (kg ha^{-1}) and is presented in table.

table.

S. #	Variety/strains	Yield kg/ha
	12304	3205 e
	11098	3011 f
	12120	3934 d
	12001	4216 b
	13016	3999 c
	13372	4686 a
	Glaxy-2013	4245 b
lsd at 5%=38.202		

Statistical analysis of the data showed significant differences among strains/lines.

Wheat strain 13372 gave the maximum grain yield (4686 kg ha^{-1}) followed by glaxy-2013 which produced the yield of (4245 kg ha^{-1})

Lowest wheat yield of (3011 kg ha^{-1}) was obtained from plots where line-11098 was sown.

DRY PEAS

84. Micro yield trial dry peas

The research trial was carried out in collaboration with pulses research institute; faisalabad to find out best suited variety/line of dry peas for thal irrigated area under rain-fed conditions. The crop was matured only with soaking irrigation. No other irrigation except soaking was applied during whole growth period. Twelve peas entries were sown at agronomic research station, karor in rcbd with three replications having plot size 1.20 m × 4.00 m.the higher grain yield (360kg ha^{-1}) was produced by line number 06 which have statistically no difference with line number 01, 02, 04, 05 07, and 10.

MASHBEAN

85. Yield response of mashbean to various planting techniques

Maximum grain yield (1107 kg ha^{-1}) was observed in broadcast following deep cultivation with net economic return of rs. 96867/- and minimum grain yield **(**1033 kg ha^{-1}) was obtained in broadcast sowing method with net economic return of rs. 90004/-.

86. Comparative study of different methods of planting oat (javi) fodder under bahawalpur conditions.

The study was conducted at agronomic research station, bahawalpur to explore the most suitable method of planting oat fodder to see the yield enhancement, possibility of early sowing of bt-cotton and water economy. The trial was laid out in rcbd with four replications having a net plot size of 6.75m x 7m. The local oat variety was planted on 25.11.2016 using seed @ 90kg/ha. Fertilizer was applied @ 110-60-0 npk kg ha^{-1}. Treatments and grain yield data are presented in the following table.

Table: Oat (javi) fodder yield under different methods of planting in bahawalpur conditions

Planting method		**Fodder yield (tons ha^{-1})**		
		2015-16	**2016-17**	**Mean**
P_1	Broadcast (conv.) In flat field	37.0 b	50.5 b	43.7
P_2	Broadcast of seed & augmented with furrows (ridging)	40.8 a	60.1 a	50.4
P_3	Bed planting (90 cm apart beds with two rows)	39.5 ab	56.1 ab	47.8

P_4	Bed planting (90 cm apart beds with three rows)	40.6 a	59.4 a	50.0
Lsd at 5% for treatment		**2.766**	**5.8057**	

From the fodder yield data presented in the table 9, it was evaluated on the basis of two years average that among various methods of planting *oat fodder,* (p_2) broadcast of seed & augmented with furrows gave mean maximum fodder yield of 50.4 t ha^{-1} followed by (p_4) bed planting (50.0 t ha^{-1}). The lowest mean fodder yield of 437.00 t ha^{-1} was recorded by broadcast method of planting in flat field.

Budget position / summary for the year 2016-17.

	Pay of officers	**Pay of staff**	**Regular allowances**	**Other allowances**	**Total contingency**	**G. Total.**
	(a01101)	**(a011051)**	**(a012-1)**	**(a012-71-99)**	**(a03 to a013)**	
Allocation for 2016-17	30,52,000	27,00,000	37,17,000	75,000	15,75,000	**1,11,19,000**
Expenditure	27,63,000	27,18,000	32,42,000	75.000	15,30,000	**1,03,28000**
Balance	2,88,0000	18,000	4,75,000	0	45,000	**7,91,000**

MUSTARD

87. Micro yield trial of

This trial was conducted with an objective to screen out best suited variety/line of mustard for thal irrigated area. The field study was conducted in collaboration with oilseeds research institute, faisalabad. Thirteen mustard varieties/ strains were sown at agronomic research station karor, during rabi, 2016-17 in randomized complete block design. The experiment having plot size 1.8 m × 6 m was spaced 45 in rows. The fertilizer (n-p-k) at the rate of 90-85-60 kg ha^{-1} was used at the time of sowing. The experiment was sown with hand drill and 15 cm plant to plant distance was maintained after thinning.it was concluded that the strain brj-1304 gave maximum seed yield of 2224 kg ha^{-1} followed by kj-238 that produced grain yield of 1599 kg ha^{-1}. The minimum seed yield 1038 kg ha^{-1} was received from super raya which indicated that all the strains produced more yield than check variety.

88. Varietal effect on the yield of mustard (b.juncea)

The experiment was conducted to find out the most suitable variety for mustard. The experiment was laid out in RCBD with three replications having plot size 6.0 m x 1.8 m. Row

and plant spacing were maintained as 45cm and 15 cm respectively. Thirteen varieties/strains of mustard were tested. The crop was sown on 21-10-2015 and fertilizer was applied @ 75-75 kg ha^{-1} np. The seed yield data reveals non-significant difference among the varieties.

CANOLA

89. Effect of different sowing dates on the yield of different varieties

The experiment was conducted to find out the optimum sowing time to get maximum yield in new strains of canola. The experiment was laid out in split plot design with three replications having a plot size of 2.7 m×6.0 m. Row and plant spacing were maintained as 45 cm and 15 cm, respectively. Sowing dates were in main plot and varieties in sub plot. Sowing dates were 15thseptember, 1st october, 15th october, 1stnovember and 15thnovember 2015. The canola varietiesaari- canola and zbj-08051 were used as test material. Aari- canola gave maximum yield (1518 kg ha^{-1}). Whereas as the maximum yield 2067 kg ha^{-1} was obtained when sowing was done on 15thsepmbeter, 2015 which was found to be statistically at par with 1964 kg ha^{-1} when sowing was done on 1st october,2015 .

RAPE SEED

90. Micro yield trial of rapeseed

The trial was conducted with a view to find out best suited strains of rapeseed for thal irrigated area, in collaboration with oilseeds research institute, faisalabad. Seven rapeseed strains along with two check varieties i.e. Faisal canola and rohisarson were sown at agronomic research station karor, during rabi, 2016-17. The layout was randomized complete block design with three replications having net plot size 1.8 m × 6 m. The row and plant spacing were kept 45 cm and 15 cm respectively. A uniform n-p-k dose of 90-85-60 kg ha^{-1} was applied at the time of sowing during whole growth period. The experiment was sown through hand drill and plant to plant distance was maintained after thinning. Maximum yield (2173 kg ha^{-1}) was obtained from strain rbn-13017, which was statistically at par with rbn-13029 (2092 kg ha^{-1}).

91. Varietal effect on the yield of rape seed (b. napus)

The experiment was conducted to find out the most suitable variety for rapeseed. The experiment was laid out in rcbd with three replications having plot size 6 m x 1.8 m. Row and plant spacing were maintained as 45cm and 15 cm respectively. Seven varieties/strains of rape seed were tested. The crop was sown on 21-10-2015 and fertilizer was applied @ 75-75 kgha^{-1} np. The seed yield data reveals non-significant difference among the varieties.

BRASSICA

92. Effect of varieties on the yield of zaid kharif brassica

The experiment was conducted to find out the most suitable variety for zaidkharif brassica. The experiment was laid out in rcbd with three replications having plot size 6.0 m x 1.8 m. Row and plant spacing were maintained as 45cm and 15 cm respectively. Eleven entries of zaidkharif brassica were tested. The crop was sown on 18-9-2015and fertilizer was applied @ 75-75kg ha^{-1} np. The seed yield data reveals highly significant difference among the varieties. Variety f produced maximum seed yield of 2840kg ha^{-1}. The minimum seed yield 1080 kg ha^{-1} was obtained from variety toria.

93. Effect of differnet levels of np fertilizer on the yield of brassica (zbj-08051)

The experiment was conducted to find out the most suitable combination of n and p to get maximum yield of brassica juncea (canola type). The experiment was laid out in rcbd with split plot arrangements havingthree replications and plot size of 1.6 m x 6.0 m.the trial was sown on 16-10-2015 with row and plant spacing 40 cm and 15 cm respectively. The levels of phosphorus and nitrogen used were 0,60,75,90 and 0,60,75,90,105 kg ha^{-1} respectively. The maximum seed yield (2291 kg ha^{-1}) was recorded from the treatment where n was applied @ 105kg ha^{-1}whereas maximum seed yield 2335 kg ha^{-1} where p was applied @ 75 kg ha^{-1}.

POTATO

94. Effect of different planting dates on the tuber yield of potato

The experiment was conducted to find out the optimum sowing time of different strains of potato. The experiment was laid out in split plot design with three replications having a plot size of 1.4 m × 4.0 m. Row and plant spacing were maintained as 70 cm and 20 cm, respectively. Planting dates were in main plot and varieties in sub plot. The sowing dates were 5th october, 15th october, 25th october, 5th november and 15th november, 2015 and potato strains were fd69-1, pri-red and fd51-5. At 5th october, the maximum tuber yield28.9 tons ha^{-1} was recorded from pri-red which was found to be at par with fd69-1 and with the same variety which produced 28.3 tons $ha^{-1}$when sown on 15th october, and 5th october respectively .the minimum tuber yield 14.9kg $ha^{-1}$was recorded from fd69-1 which was sown on 15th november.

fig: variety/strain pri-red when sown on 15th october

95. Effect of different levels of fertlizer on the tuber yield of potato.

The experiment was conducted to find out the optimum fertilizer dose to get maximum yield of potato. The experiment was laid out in rcbd with three replications having a plot size of 7.0 m × 1.4 m. Row and plant spacing were maintained as 70 cm and 20 cm, respectively. Planting was done on 29th october, 2015. The npk level used were 0-150-125,150-150-125,250-150-225,350-150-125,300-0-125,300-75-125,300-125-155,300-175-125 and300-225-125. The maximum tuber yield 39.8 tons ha^{-1} was recorded from the treatment where npk were used at the rate300-225-125 kg ha^{-1}.the minimum tuber yield 19.6tons $ha^{-1}$was recorded where npk were used at the rate 0-150-125kg ha^{-1}.

Fig: dr.faqir hussain anjum & dr. Babar hussain taking observation of fertilizer trial of potato

CHICKPEA

96. Chickpea cooperative yield trial (kabuli)

The trial was conducted in collaboration with nuclear institute of agriculture and biology, faisalabad to select best suited strains of chickpea under thal irrigated area. Eighteen chickpea were sown in randomized complete block design with three replications having plot size 1.2 m × 4 m at agronomic research station, karor – layyah. The experiment was sown with hand drill by maintaining 30, 10 cm row and plant spacing.maximum grain yield of 2865 kg ha^{-1} was received from line no. 05 followed by line no. 09 which produced grain yield 2840 kg ha^{-1}, while minimum chickpea grain yield (1363 kg ha^{-1}) was produced by line 03.

97. Chickpea cooperative yield trial (desi)

The trial was conducted in collaboration with pulses research institute, faisalabad, to screen out best suited variety/line for thal irrigated area. Twenty chickpea strains were sown at agronomic research station, karor – layyah. The layout was rcbd with three replications having plot size 1.2 m × 4 m. The experiment was sown with hand drill by maintaining 30, 10 cm row and plant spacing.the results showed that maximum grain yield of 2782 kg ha^{-1} was received from line no. 16 which has statistically no significant difference with line no. 13 and 12 by producing grain yield of 2754 and 2695 kg ha^{-1} respectively.

98. Performance of chickpea with garlic intercropping

Maximum gross income (rs. 213588 ha^{-1}) was obtained from garlic 2 rows on top at r x r 30 cm + 1 row on each side of the 120 cm apart beds.

99. Effect of different levels of np on the yield of garlic

The experiment was conducted to find out the optimum fertilizer dose to get maximum yield of garlic. The experiment was laid out in rcbd with split plot arrangementalong with three replications having a plot size of 5.0 m × 1.4 m. Row and plant spacing were maintained as 20 cm and 10 cm, respectively. Varieties/ strains were in main plot while fertilizer in sub plots. Variety gulabi (standard)and vrig-1 and fertilizer level of np,120-60,120-85,140-60,140-85,160-60,160-85 were used. Planting was done on 15th october, 2015. The maximum garlic bulb yield8.48 tons ha^{-1} was recorded from the treatment where np were used at the rate 160-60 kg ha^{-1}.the minimum tuber yield 7.07 tons ha^{-1} was recorded where np were used at the rate 120-60 kg ha^{-1}as regard of varieties gulabi (standard) gave maximum bulb yield 9.81 t ha^{-1} where the candidate line vrig-1 produced 5.80 t ha^{-1} bulb yield.

100. Integrated weed management in garlic (a*llium sativum*)

This trial was sown on october 25, 2016 with the objective to find out such a solution of weed problem that would reduce the number of hand weeding by adding a single application of pre or post emergence herbicides like stomp (pendimethalin) @ 2500 ml ha^{-1}, dual gold (s-metolachlor) 2000 ml ha^{-1}, hadaf (oxyfluorfen) @ ml ha^{-1}, calm (qizalofop) @ 625 ml ha^{-1}, oxygen (oxyfluorfen) @ 625 ml ha^{-1} and axifin + calm each @ 625 ml ha^{-1}. Each treatment was also followed by a single hand weeding 45 days after sowing of garlic. The trial was conducted through randomized complete block design having three replications with a plot size of 3.0 m × 2.0 m. The following treatments were followed:

Table: effect of herbicides on weeds, population, plant height, stem girth and bulb yield of garlic

#	Treatments	Weeds count (m^{-2}) (30 das)	Stem girth (cm) (120 das)	Dry bulb q ha^{-1} (15 dah)
1	Stomp 455 g/l cs @ 2500 ml ha^{-1} pre-emergence +1 hand weeding 45 das	56 b	2.0 a	53.45 a
2	Dual gold 960 ec @ 2000 ml ha^{-1} pre-emergence +1 hand weeding 45 das	12 d	1.5 b	45.12 b
3	Hadaf 24 ec @ 750 ml ha^{-1} pre-emergence +1 hand weeding 45 das	59 b	2.0 a	52.08 a
4	Oxygen 24 ew @ 750 ml ha^{-1} post emergence +1 hand weeding 45 das	53 b	1.8 a	49.30 b
5	Calm 15 ec @ 625 ml ha^{-1} post emergence +1 hand weeding 45 das	52 b	*1.8 a*	*47.90 b*
6	Axifin 24 ec @ 625 ml ha^{-1} + calm 15 ec @ 625 ml ha^{-1} post emergence +1 hand weeding 45 das	30 c	*1.7 a*	*52.75 a*
7	Hand weeding thrice	02 e	*2.0 a*	*55.55 a*
8	Control	109 a	1.2 b	1.92 c
	Lsd	**12.5**	**0.31**	**4.5**

Discussion

Weed counts m^{-2}:

It is evident from the weed counts m^{-2} data that out of herbicides dual gold 960 ec @ 2000 ml ha^{-1} (pre-emergence) +1 hand weeding 45 das gave as the most effective weed control with only 12 weeds m^{-2}. Stomp 455 g/l cs @ ec @ 2500 ml ha^{-1}, hadaf 24 ec @ 750 ml ha^{-1}, oxygen 24 ew @

ml ha^{-1} (post emergence) and calm 15 ec @ 625 ml ha^{-1} (post emergence) could not control *cyperus rotundus* (deela) and gave at par 56 , 59, 53 and 52 weeds m^{-2}. All the herbicides were found better than control which gave 109 weeds m^{-2}. All the weeds were removed with a hand weeding from all the treatments almost 45 days after sowing.

Phytotoxic effects of dual gold 960 ec @ 2000 ml ha^{-1}were observed and measured from the comparative stem girth of garlic. Inspite of better weed control, the bulb yield was found significantly lower than the safer herbicides like stomp 455 g/l cs @ 2500 ml ha^{-1}, hadaf 24 ec @ 750 ml $ha^{-1}$and calm 15 ec @ 625 ml ha^{-1}. Dual gold 960 ec @ 2000 ml ha^{-1} also affected stem girth. Maximum stem girth of 2.0 cm was recorded each in stomp 455 g/l cs @ 2500 ml $ha^{-1}$and hand weeding thrice. It was followed by hadaf 24 ec @ 750 ml ha^{-1}, oxygen 24 ew @ ml ha^{-1}, calm 15 ec @ 625 ml ha^{-1} and axifin 24 ec @+ 625 ml ha^{-1} + calm 15 ec @ 625 ml $ha^{-1}$with at par stem girth of 2.0, 1.8, 1.8 and 1.7 cm respectively.

Dry bulb yield:

As regards the dry bulb yield which was collected one month after harvesting, stomp 455 g/l cs @ 2500 ml ha^{-1} yielded maximum of 53.45 q ha^{-1} which was attributed to the safer germination and better stem girth. It was followed by hadaf 24 ec @ 750 ml ha^{-1} with 52.08 q ha^{-1} which were found at par to stomp 455 g/l cs. Dual gold 960 ec @ 2000 ml ha^{-1} showed phytotoxic effects on the germination, stem girth. Inspite of better weed control, its bulb yield of 45.12 q ha^{-1} was found at par with oxygen 24 ew @ 750 ml ha^{-1} and calm 15 ec @ 625 ml ha^{-1} (post emergence) + 1 hand weeding 45 das which gave 45.12 and 49.30 q ha^{-1} respectively. Highest bulb yield was obtained in case of three hand weedings which yielded 55.55 q ha^{-1}. Control treatment was badly hit by weeds and the minimum yield of only 1.92 q ha^{-1} was recorded. It was concluded that application any of the mentioned pre or post emergence herbicides plus one hand weeding gave more economic yield of garlic

LENTIL

101. Performance of lentil with garlic intercropping

Maximum gross income (rs. 123142 ha^{-1}) was obtained from lentil alone at r x r 30 cm (6 rows) conventional method.

102. Yield response of lentil to various planting techniques

Maximum grain yield (914.3 kg ha^{-1}) was observed in broadcast augmented with furrow followed by bed sowing (803 kg ha^{-1}) and minimum grain yield (358.7 kg ha^{-1}) was observed in zero tillage method.

Broadcast augmented with furrows in lentil at c&p farm

ONION

103. Chemical weed control in onion

The experiment was conducted to find out the most suitable herbicide to control weeds in onion. The experiment was laid out in rcbd with three replications having a plot size of 5.0 m ×2.10m.row and plant spacing were maintained as 35cm and 10 cm respectively. The treatments were pendimethalin330 e @ 3.750 lit/ha pre-emergence, pendimethalin 330 e @ 3.750 lit/ha pre-emergence + one hoeing 45 dat, dual gold 960 e (standard) @ 2.0 lit/ha pre-emergence, dual gold 960 e (standard) @ 2.0 lit/ha pre-emergence + one hoeing 45 dat. Axifin (oxygen) @ 0.750 l ha^{-1}pre-emergence, axifin (oxygen) @ 0.750 l ha^{-1}pre-emergence+ one hoeing 45 dat ,axifin (oxygen) @ 1.0 l ha^{-1}post-emergence, axifin (oxygen) @ 1.0 l ha^{-1}post-emergence + one hoeing 45 dat, , weed free (3 – 4 hand weeding) and control.the maximum numbers of weeds 542.0 m^{-2} were found in control. The maximum bulb yield 9.93 ton/ha was recorded from the pendimethalin 330 e @ 3.750 lit/ha pre-emergence + one hoeing 45 dat which was found to be at par with the treatment weed free which produced 9.23 t ha^{-1} bulb yield. The minimum bulb yield of 4.60ton ha^{-1} was recorded from axifin (oxygen) @ 1.0 l ha^{-1}post-emergence.

Fig: weed control treatment where pendimethalin 330 e @ 3.750 lit/ha pre-emergence was applied.

Fig: control (where no weed control measure was adopted)

104. Integrated weed management in onion (a*llium cepa*)

This trial was sown on february 6, 2017 with the objective to find out weeds solution in onion crop. The herbicides namely stomp (pendimethalin) @ 2500 ml ha^{-1}, dual gold (s-metolachlor) 2000 ml ha^{-1}, hadaf (oxyfluorfen) @ 750 ml ha^{-1}, calm (qizalofop) @ 625 ml ha^{-1}, oxygen (oxyfluorfen) @ 625 ml ha^{-1}, axifin + calm each @ 625 ml ha^{-1} each. Every treatment was also followed by a single hand weeding 45 days after transplanting. The trial was conducted through randomized complete block design having four replications with a plot size of 1.5 m × 4.0 m. Plant to plant distance of 8 cm was maintained on both sides of 75 cm ridges. The following results were obtained during the year of study:

Table: effect of herbicides on weeds, plant population and bulb yield of onion

#	Treatments	Weeds m^{-2} (30 das)	Population counts m^{-2} (45 das)	Onion yield q ha^{-1} (146 das)
1	Stomp 455 g/l cs @ 2500 ml ha^{-1} (pre-emergence) +1 h and weeding 45 das	04 d	20 ns	107 a
2	Dual gold 960 ec @ 2000 ml ha^{-1} (pre-emergence) +1 h and weeding 45 das	04 d	19	88 c
3	Hadaf 24 ec @ 750 ml ha^{-1} (pre-emergence) +1 h and weeding 45 das	7 c	20	99 a
4	Oxygen 24 ew @ 750 ml ha^{-1} (post emergence) +1 h and weeding 45 das	8 c	20	84 c
5	Calm 15 ec @ 625 ml ha^{-1} (post emergence) +1 h and weeding 45 das	13 b	*20*	*73 d*
6	Axifin 24 ec @ 625 ml ha^{-1} + calm 15 ec @ 625 ml ha^{-1} post emergence +1 hand weeding 45 das	11 b	*21*	*99 b*
7	Hand weeding thrice	03 d	*20*	*107 a*
8	Control	28 a	01	05 e
Lsd		**2.5**	**-**	**7.6**

Discussion:

It is evident from the weed counts m^{-2} data that maximum weed control was given by hand weeding thrice with only 03 weed which was followed by dual gold 960 ec @ 2000 ml ha^{-1} (pre-emergence) and stomp 455 g/l cs @ 2500 ml ha^{-1} (pre-emergence) + 1 hand weeding 45 das each with 04 weeds m. Slight phytotoxic effect of dual gold was observed on the growth and development of onion. Hadaf 24 ec @ 750 ml ha^{-1} (pre-emergence) +1 hand weeding 45 das and oxygen 24 ew @ 750 ml ha^{-1} (post emergence) +1 hand weeding 45 das gave 07 and 08 weeds which were statistically at par with each other. A slight phytotoxic effect of oxygen (post emergence) was also observed. Inspite of equal weed control dual gold with stomp and oxygen with hadaf, a slight yield depression was recorded. Axifin 24 ec @ + 2000 ml ha^{-1} (pre-emergence) + calm 15 ec @ 625 ml ha^{-1} (post emergence) + 1 hand weeding 45 das left 11 weeds which was followed by calm 15 ec @ 625 ml ha^{-1} (post emergence) + 1 hand weeding 45 das with 13 weeds. Calm 15 ec @ 625 ml ha^{-1} only controled grassy weeds, no effect on broad leaved, sedges and gave 13 weeds. Hadaf 24 ec @ 750 ml ha^{-1} (pre-emergence) and oxygen 24 ew @ 750 ml ha^{-1} (post emergence) + 1 hand weeding 45 das had no effect on perennial weeds like deela and lehli.

As regards the plant population data, these were found non-significant. It means that no herbicide could reduce plant population. As regards the bulb yield, maximum bulb yield was recorded in case of stomp 455 g/l cs @ 2500 ml ha^{-1} (pre-emergence) + 1 hand weeding 45 das and treatment

of hand weeding thrice in which dry bulb yield of 107 q ha^{-1} were achieved in each case. Dual gold 960 ec @ 2000 ml ha^{-1} (pre-emergence) + 1 hand weeding 45 das and oxygen 24 ew @ 750 ml ha^{-1} (post emergence) + 1 hand weeding 45 das yielded 88 and 84 q ha^{-1}.

KALONJI

105. Irrigation management in kalonji (*nigella sativa*)

The trial was sown on october 12, 2016 with the objective to find out the most critical stages for irrigation application to kalonji to harvest the maximum seed yield. The trial was laid out in randomized complete block design having three replications with net plot size of 3.0 m × 8.0 m. Kalonji was planted on ridges (r × r = 60 cm) maintaining 30 cm plant spacing using seed rate @ 7.50 kg ha^{-1}. Fertilizer @ 50-25 np kg ha^{-1} was applied at the time of sowing. The following eight irrigation treatments were applied at different growth stages of crop i.e., irrigation at sowing + 15 das + 30 das + flowering + pod formation + seed formation , irrigation at sowing + 15 das + flowering + pod formation + seed formation , irrigation at sowing + 30 das + flowering + pod formation + seed formation, irrigation at sowing + 15 das + flowering + seed formation, irrigation at sowing + 30 das+ flowering + seed formation, irrigation at sowing + 30 das + pod formation + seed formation, irrigation at sowing + 30 das + pod formation and irrigation at sowing + flowering + seed formation. All other agronomic practical were kept normal and uniform during the course of study. The data on yield and yield components were recorded and selected to statistical analyzed.

Table: Effect of irrigation at various growth stages on the yield and yield components of kalonji (nigella sativa)

Treatments	No. Of capsules^{-1}	No. Of seeds capsules^{-1}	1000-seed weight (g)	Seed yield (kg ha^{-1})
T_1: irrigation at sowing + 15 das + 30 das + flowering + pod formation + seed formation	97.50 a	108.63 a	2.67 a	990 a
T_2: irrigation at sowing + 15 das + flowering + pod formation + seed formation	95.00 b	108.22 b	2.59 b	944 b
T_3: irrigation at sowing + 30 das + flowering + pod formation + seed formation	89.49 d	105.73 d	2.51 c	837 d
T_4: irrigation at sowing + 15 das + flowering + seed formation	92.95 c	106.45 c	2.45 d	890 c
T_5: irrigation at sowing + 30 das+ flowering + seed formation	87.40 e	103.59 e	2.43 de	802 e
T_6: irrigation at sowing + 30 das + pod formation + seed formation	83.58 f	102.53 f	2.40 e	768 f

T_7: irrigation at sowing + 30 das + pod formation	78.04 g	101.98 g	2.21 g	663 h
T_8: irrigation at sowing + flowering + seed formation	76.27 h	101.46 h	2.33 f	730 g
Lsd	**0.534**	**0.194**	**0.0419**	**19.18**

No. Of capsules plant^{-1}

No. Of capsules plant^{-1} is a vital yield causative factor in kalonji. The data on capsules plant^{-1} (table-1) shows that irrigation at sowing +15 das+ flowering + pod formation + seed formation produced highest number of capsules plant ^{1} (97.50). On the other hand the lowest numbers of capsules plant^{-1} (76.27) were recorded when irrigation was applied only at sowing + flowering + seed formation stage. All the other irrigation treatments were intermediate to both these treatments.

No. Of seeds capsules^{-1}

This is also an important yield contributing factor. The results (table-1) revealed that seeds capsule^{-1} was affected significantly by irrigation treatments. Considerably highest number of seeds capsule^{-1} (108.63) were formed where irrigations were applied at sowing +15 das +30 das + flowering + pod formation and at seed formation stages. The minimum numbers of seeds capsule^{-1} (101.46) were produced when irrigations were applied only at sowing +30 das + pod formation stages only. All the other irrigation treatments remained intermediate to both there treatments.

1000-seed weight (g)

1000-seed weight is also an important yield contributing parameter. The data on 1000-seed weight (table-1) revealed that when irrigations were applied at sowing +15 das +30 das + flowering + pod formation and at seed formation stages produced seeds with significantly highest (2.67 g) 1000-seed weight. On the other hand lowest 1000-seed weight (2.21 g) was recorded when irrigation was applied at sowing + 30 das + pod formation stages only.

Seed yield (kg ha^{-1})

The final seed yield of a crop is an expression of the combined effect of all the yield components. The data on yield kg ha^{-1} (table-1) showed that all the irrigation treatments affected significantly the seed yield. Significantly highest seed yield 990 kg ha^{-1} was produced where irrigation were applied at sowing time + 15 das +30 das + flowering +pod formation and seed formation stages. This significantly higher yield is attributed to significantly higher number of capsule plant^{-1}, no. Of seeds capsule^{-1} and 1000-seed weight in this treatment. This also revealed

that in order to harvest the highest potential of kalonji irrigation has to be applied at the stages according to stages mentioned in this treatment. On the other hand lowest seed yield 663 kg ha^{-1} was obtained where irrigation were applied only at sowing + 30 das and pod formation stages.

Economic analysis

Treatments	Fixed cost (rs.)	Variable cost (rs.)	Total cost (rs.)	Gross income (rs.)	Net income (rs.)	Cbr
T_1: irrigation at sowing + 15 das + 30 das + flowering + pod formation + seed formation	33500	7000	40500	99000	58500	1:2.44
T_2: irrigation at sowing + 15 das + flowering + pod formation + seed formation	33500	5800	39300	94400	55100	1:2.40
T_3: irrigation at sowing + 30 das + flowering + pod formation + seed formation	33500	5800	39300	83700	44400	1:2.13
T_4: irrigation at sowing + 15 das + flowering + seed formation	33500	4600	38100	89000	50900	1:2.34
T_5: irrigation at sowing + 30 das+ flowering + seed formation	33500	4600	38100	80200	42100	1: 2.10
T_6: irrigation at sowing + 30 das + pod formation + seed formation	33500	4600	38100	76800	38700	1: 2.02
T_7: irrigation at sowing + 30 das + pod formation	33500	3400	36900	66300	29400	1: 1.80
T_8: irrigation at sowing + flowering + seed formation	33500	3400	36900	73000	36100	1: 1.98

106. Enhancing kalonji (n*igella sativa*) yield by the foliar application of bio-chemicals

The trial was sown on october 12, 2016 with the objective to evaluate the influence of different chemicals as foliar sprays viz. Ba (6-benzyl aminopurine) @ 0.08 mgl^{-1} at 30 + 50 days after sowing, solubor @ 750 g ha^{-1} at 30 and 50 das, potassium borate @ 125 g ha^{-1} at 30 + 50 das, potassium citrate @ 125 g ha^{-1} at 30 + 50 das, fertigrain @ 750 ml ha^{-1} at 30 + 50 das, isabion @ 500 ml ha^{-1} at 30 + 50 das, potassium borate @ + potassium citrate each @ 125 g ha^{-1} + fertigrain @ 750 ml ha^{-1} at 30 + 50 das, potassium borate @ + potassium citrate each @ 125 g ha^{-1} + fertigrain @ 750 ml ha^{-1} + + high zinc (cmm) @ 625 g ha^{-1} at 30 + 50 das, water spray @ 250 l ha^{-1} at 30 + 50 das and control (no spray) on growth and yield of kalonji. The trial was laid

out in randomized complete block design having three replications with net plot size of 3.0 m × 8.0 m. Kalonji was planted on ridges (r×r=60 cm) maintaining 30 cm plant spacing using seed rate @ 7.50 kg ha^{-1}. Fertilizer @ 50-25 np kg ha^{-1} was applied at the time of sowing. All other agronomic practical were kept normal and uniform during the course of study. The data on yield and yield components were recorded and selected to statistical analyzed.

Table: effect of foliar application of chemicals on yield and yields components of kalonji

Treatments	**No. Of capsules^{-1}**	**No. Of seeds capsules^{-1}**	**1000-seed weight (g)**	**Seed yield (kg ha^{-1})**
T_1: ba (6-benzyl aminopurine) @ 0.08 mgl^{-1} at 30 + 50 das	84.87 c	94.46 bc	2.15 e	821 c
T_2: solubor @ 750 g ha^{-1} at 30 and 50 das	86.94 bc	95.50 bc	2.23 cd	841 c
T_3: potassium borate @ 125 g ha^{-1} at 30 + 50 das	87.98 abc	97.57 b	2.25 bc	849 c
T_4: potassium citrate @ 125 g ha^{-1} at 30 + 50 das	84.35 c	93.45 bcd	2.19 de	830 c
T_5: fertigrain @ 750 ml ha^{-1} at 30 + 50 das	83.84 c	92.04 cd	2.27 bc	856 bc
T_6: isabion @ 500 ml ha^{-1} at 30 + 50 das	83.15 c	89.27 d	2.25 bc	845 c
T_7: potassium borate @ 125 g ha^{-1} + potassium citrate @ 125 g ha^{-1} + fertigrain @ 750 ml ha^{-1} at 30 + 50 das	91.08 ab	103.80 a	2.30 ab	887 b
T_8: t_7 + high zinc (cmm) @ 625 g ha^{-1} at 30 + 50 das	93.15 a	106.91 a	2.34 a	948 a
T_9: water spray @ 250 l ha^{-1} at 30 + 50 das	77.63 d	83.04 e	2.09 f	738 d
T_{10}: control (no spray)	62.28 e	72.66 f	1.93 g	678 e
Lsd	**5.29**	**4.64**	**0.050**	**36.05**

No. Of capsules plant^{-1}

No. Of capsules plant^{-1} is a crucial yield contributing aspect in kalonji. The data on capsules plant^{-1} showed that application of potassium borate @ 125 g ha^{-1} + potassium citrate @ 125 g ha^{-1} + fertigrain @ 750 ml ha^{-1} + high zinc (cmm) @ 625 g ha^{-1} at 30 + 50 das produced maximum number of capsules plant ^{1} (93.15) which was followed by the application of

potassium borate @ 125 g ha^{-1} + potassium citrate @ 125 g ha^{-1} + fertigrain @ 750 ml ha^{-1} at 30 + 50 das (91.08). Both the treatments were statistically at par to each other. On the other hand the lowest numbers of capsules $plant^{-1}$ (62.28) were recorded in control (no spray) treatment.

No. Of seeds $capsules^{-1}$

This is also a vital yield causative factor. The results revealed that seeds $capsule^{-1}$ was affected significantly by foliar application of chemicals. Considerably highest number of seeds $capsule^{-1}$ (106.91) were formed where potassium borate @ 125 g ha^{-1} + potassium citrate @ 125 g ha^{-1} + fertigrain @ 750 ml ha^{-1} + high zinc (cmm) @ 625 g ha^{-1} at 30 + 50 das was applied. The minimum numbers of seeds $capsule^{-1}$ (72.66) were produced when no chemical was sprayed (control). All the other foliar spray treatments remained intermediate to both these treatments.

1000-seed weight (g)

The data on 1000-seed weight revealed that when potassium borate @ 125 g ha^{-1} + potassium citrate @ 125 g ha^{-1} + fertigrain @ 750 ml ha^{-1} + high zinc (cmm) @ 625 g ha^{-1} at 30 + 50 das was sprayed produced seeds with significantly highest (2.34 g) 1000-seed weight. On the other hand lowest 1000-seed weight (1.93 g) was recorded in control treatment where no chemical was applied.

Seed yield (kg ha^{-1})

The final seed yield of a crop is an expression of the combined effect of all the yield components. The data on yield kg ha^{-1} showed that application of all the chemicals affected significantly the seed yield. Significantly highest seed yield 948 kg ha^{-1} was produced where potassium borate @ 125 g ha^{-1} + potassium citrate @ 125 g ha^{-1} + fertigrain @ 750 ml ha^{-1} + high zinc (cmm) @ 625 g ha^{-1} at 30 + 50 das was sprayed. This significantly higher yield is attributed to significantly higher number of capsule $plant^{-1}$, no. Of seeds $capsule^{-1}$ and 1000-seed weight in this treatment. On the other hand lowest seed yield 678 kg ha^{-1} was obtained where no chemical was applied.

LINSEED

107. Chemical weed control in linseed

The experiment was conducted to find out the most suitable herbicide to control weeds in linseed. The experiment was laid out in rcbd with three replications having a plot size of 6.0 m ×

1.8 m. Row spacing was maintained as 30 cm. The treatments were pendimethalin 330 e @ 2.50 lit/ha pre-plant incorporation, pendimethalin 330 e @ 2.50 lit/ha pre-emergence, dual gold 960 e @ 2.0l ha^{-1} pre-plant incorporation, dual gold 960 e @ 2.0l ha^{-1} pre-emergence, topic @ 0.250 $kgha^{-1}$ post-emergence (40-50 das), weed free (3 – 4 hand weeding) and control. The maximum numbers of weeds 212.0 m^{-2} were found in control. The maximum seed yield 941 kg ha^{-1} was recorded from the weed free treatment while the treatments while maximum seed yield805 kg ha^{-1} was obtained from pendimethalin 330 e @ 2.50 lit/ha pre-plant incorporation. The minimum seed yield of 718 kg ha^{-1} was obtained from the control treatment.

108. Effect of irrigation schedule on growth and yield of linseed (*linum usitatissimum*)

To study the effect of different irrigation schedule on linseed yield an experiment was conducted in randomized completely block having three replications with a plot size of 4.5 m × 8 m. Trial was sown on 8th of november and linseed variety chandni was used as testing material. Treatments were as

1. One irrigation before branching (30 days after sowing)
2. One irrigation before flowering (50 days after sowing)
3. One irrigation before capsule formation (70 days after sowing)
4. Two irrigations before branching and flowering (30 & 50 das)
5. Two irrigations before branching and capsule formation (30 & 70 das)
6. Two irrigations before flowering and capsule formation (50 & 70 das)
7. Three irrigations before branching, flowering and capsule formation (30,50 & 70 das Data on yield and yield components were recorded during the course of experiment and presented in kg ha^{-1} in table.

Table.

Treatments	**yield (kg $ha.^{-1}$)**
One irrigation before branching (30 days after sowing)	605 e
One irrigation before flowering (50 days after sowing)	630 de
One irrigation before capsule formation (70 days after sowing)	679 d
Two irrigations before branching and flowering (30 & 50 das)	777 c
Two irrigations before branching and capsule formation (30 & 70 das)	854 b
Two irrigations before flowering and capsule formation (50 & 70 das)	1007 a
Three irrigations before branching, flowering and capsule formation (30,50 & 70 das)	1042 a

critical value for comparison = 60.83

Statistical analysis of the data showed significant difference among treatment means.

The maximum linseed production (1042 kg ha^{-1}) was obtained where three irrigations

before branching, flowering and capsule formation (30, 50 & 70 das) were applied and remain at par with plot where two irrigations before flowering and capsule formation (50 & 70 das) were applied which produced the grain yield of (1007 kg ha^{-1}).

while the minimum grain yield of (605 kg ha^{-1}) was obtained from the plot where one irrigation was applied before branching (30 days after sowing)

Table. Meteorological data

Month	**Rainfall (mm)**	**Mean temperature (^{o}c)**	
		Maximum	**Minimum**
Nov	0	30.1	13.3
Dec	0	22.2	8.3
Jan	34.8	18.7	7.4
Feb	3.5	24.6	10.7
March	6.5	28.00	15.7
April	16.2	37.9	22.4