ANNUAL DETAILED / PROGRESS REPORT

FOR THE

YEAR

2018-19

AGRONOMIC RESEARCH INSTITUTE
FAISALABAD

ANNUAL DETAILED / PROGRESS REPORT 2018-19

OVERVIEW:

Agronomy, the fountain-head of all the agricultural sciences, plays radical role in food production, food security as well as bridging over the gap in demand and supply of food. Agronomic Research Institute, Faisalabad was established in 1984 with four stations each at Farooqabad, Karor, Khanewal and Bahawalpur to cater for the requirements of different agro-ecological zones of Punjab. The main focus of research in this Institute is to develop comprehensive and adaptable production technologies to improve per unit yield of different field crops and thus to improve 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 remain in plan 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.

Screening of wheat genotypes for heat and drought tolerance and for inducing heat and drought tolerance foliar spray of different osmoprotectans were applied. Potassium and boron was applied for inducing drought tolerance. Different sowing methods were used for better water use efficiency. New wheat strains were screened under Thal irrigated conditions. Cotton planting after full wheat residue incorporation produced higher seed cotton yield (2857 kg ha^{-1}) than burning the wheat residues. Last date of irrigation under Bahawalpur conditions was found 10^{th} of October. Higher seed cotton yield were obtained when crop was planted at 30 cm plant to plant distance. Higher boll retention (73%) and higher seed cotton yield were obtained when potassium and boron were applied @ 110 kg ha^{-1} and 1.5 kg ha^{-1} respectively. Higher Jute fiber yield (3216 kg ha^{-1}) were obtained when N and P was applied @ 75 kg ha^{-1} N and 40 kg ha^{-1} P respectively. Transplantation of 30 days old rice nursery gave maximum paddy yield (4.11 t ha^{-1}) as compared to wattar and dry seeding by using drill and transplanting of 15 days old nursery. Maximum paddy yield 5555 kg/ha and 3333 kg/ha were recorded from plots where nitrogen was applied @ 175 kg/ha in case of transplanted and direct seeded rice respectively. Maximum paddy yield (3445.0 kg ha^{-1}) was obtained when potassium was applied @ 2% K solution with basal dose of K at 50 days after planting. Ridge + furrow transplantation of rice resulted in maximum paddy yield 4900 kg/ha than other planting methods. Maximum paddy yield (3154 kg ha^{-1}) were obtained at 35 kg ha^{-1} seed rate with row spacing of 30 cm. Foliar spray of potassium @ 2% in maize at seedling, jointing and flowering stages increased water use efficiency and grain yield. Heat tolerant hybrids of maize performed better under high thermal regimes. Ten Quinoa lines were screened to introduce new crops under prevailing cropping systems. Potassium, phosphorous and different organic sources were applied in mung bean for increasing radiation use efficiency and to get better crop yield. Lentil cultivars were tested with different plant spacing under Thal irrigated conditions. In spring planted sugarcane, intercropping of sunflower and pulses were tested for better economic return. Different planting patterns were tested in sesame and soyabean while soil and foliar applied B and K increased yield in sunflower. Newly evolved rapeseed strains were tested under Thal irrigated conditions.

Fifteen new herbicides (pre and post emergence) were tested in canola, rice, chickpea, lentil, berseem, cauliflower and peas while 25 old herbicides were tested in wheat and rice to check their bio-efficacy. Zinc enriched has been observed in cucumber (60.95 mg/kg), potato and maize (39.12 mg/kg) by the soil and foliar applied zinc. Studies were conducted on Tulsi regarding irrigation, nutrient management while performance of tulsi were also explored under different ecological zones. Under organic farming, different bio-fertilizers and allelopathic extracts were applied in maize for better crop yield. Preparation and harvesting of vermicompost from earthworms and preparation of on farm compost is in progress. However, results of the research work carried out during 2018-2019 are elaborated briefly as under:

WHEAT

1. Physiological evaluation of wheat genotypes for heat and drought tolerance

The study was conducted to evaluate the performance of ten (10) wheat genotypes witnessed from previous year experiment for drought tolerance under Faisalabad conditions during Rabi 2018-19. The significantly maximum grain yields (6481 kg/ha for normal and 4925 kg/ha for drought stress) were found in G-8 line and comparatively minimum grain yields (3703kg/ha for normal and 2333kg/ha for drought stress) were found in G-2 line. Similarly, the significantly maximum grain yields (6358 kg/ha for ambient temperature and 4867 kg/ha for heat stress) were found in G-8 line and comparatively minimum grain yields (3635 kg/ha for ambient temperature and 2114 kg/ha for heat stress) were found in G-2 line.

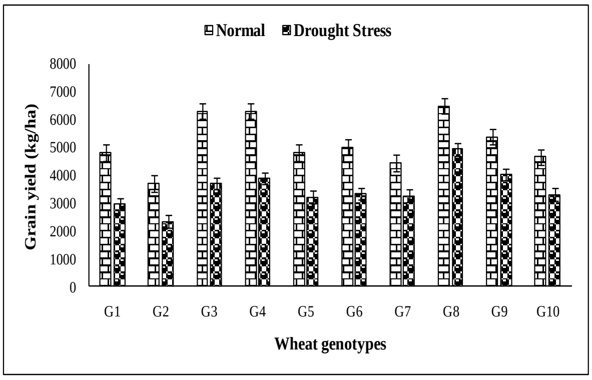


Figure. Maximum Grain yield by G-8 (6481 kg/ha) under normal and drought stress conditions (4925 kg/ha)

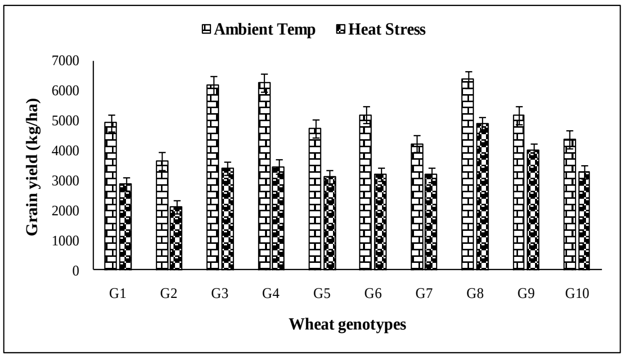


Figure. Maximum Grain yield by G-8 (6358 kg/ha) under ambient temperature and heat stress (4867 kg/ha)

2. Induction of heat and drought tolerance in wheat by the foliar application of osmoprotectants

Osmoprotectants (Magnesium sulphate ($MgSO_4$) @ 2.5%, 5.0%; Potassium orthophosphate (KH_2PO_4) @ 0.1 %, 0.2 %) were foliar sprayed under normal and drought stress conditions for inducing drought tolerance during Rabi 2018-19. The significantly maximum grain yields (3796 kg/ha for normal and 2870 kg/ha for drought stress) were found when Magnesium sulphate ($MgSO_4$) @ 2.5% and Potassium orthophosphate (KH_2PO_4) @ 0.1% were sprayed in combination. Comparatively minimum grain yields (2777 kg/ha for normal and 1111 kg/ha for drought stress) were found under controlled conditions (Table 1a). Similarly, significantly maximum grain yields (3823 kg/ha for ambient temperature and 2981 kg/ha for heat stress) were found when Magnesium sulphate ($MgSO_4$) @ 2.5% and Potassium orthophosphate (KH_2PO_4) @ 0.1 % were sprayed in combination. Comparatively minimum grain yields (2810 kg/ha for ambient temperature and 1315 kg/ha for heat stress) were found under controlled conditions.

Table. Combined spay of $MgSO_4$ @ 2.5% and KH_2PO_4 @ 0.1% in wheat produced grain yield 3796 and 2870 kg/ha under normal and drought conditions, respectively

Osmoprotectants	**Grain Yield (kg/ha)**	
	Drought Stress	**Normal**
Control	**1111**	**2777**
DW @ 250 l/ha	1759	3148
MgSO4 @ 2.5 %	1851	3472
MgSO4 @ 5 %	2037	3241
Potassium Orthophosphate @ 0.1%	1863	3518
Potassium Orthophosphate @ 2%	2592	3603
MgSO4+Pot. Ortho. @2.5+0.1%	**2870**	**3796**

Table. Combined spray of $MgSO_4$ @ 2.5% and KH_2PO_4 @ 0.1% in wheat produced grain yield 3823 and 2981 kg/ha under ambient and heat stress conditions, respectively

Osmoprotectants	**Grain Yield (kg/ha)**	
	Ambient Temp	**Heat Stress**
Control	**2810**	**1315**
DW @ 250 l/ha	3211	1860
MgSO4 @ 2.5 %	3573	1910
MgSO4 @ 5 %	3134	2110
Pot. Ortho. @ 0.1%	3712	2065
Pot. Ortho. @ 0.2 %	3621	2601
MgSO4+Pot.Ortho. @2.5+0.1%	**3823**	**2981**

3. **Alleviation of terminal drought stress in wheat through potassium and boron management**

The study was conducted with objectives to determine comparative efficiency of potassium and boron in drought stressed wheat under Bahawalpur conditions during Rabi season 2018-19. Treatments were comprised of drought stress i.e. irrigation at all critical stages, skipping of one irrigation at initiation of booting, skipping of one irrigation at milking stage. Potassium and boron were applied at sowing time @ 0 kg ha^{-1} K + 0 kg ha^{-1} B, 50 kg ha^{-1} K + 2 kg ha^{-1} B at sowing, 50 kg ha^{-1} K + 3 kg ha^{-1} B, 75 kg ha^{-1} K + 2 kg ha^{-1} B and 75 kg ha^{-1} K + 3 kg ha^{-1} B at sowing. Significantly more and statistically alike grain yield (4301.6 kg ha^{-1}) was recorded with application of 75 kg ha^{-1} K + 2 kg ha^{-1} B at sowing and with 75 kg ha^{-1} K + 3 kg ha^{-1} B at sowing (4382 kg ha^{-1}) compared to other treatments.

Table. Effect of potassium and boron management on grain yield (kg ha^{-1}) of drought stressed wheat

Potassium and boron	Irrigation at all stages	Irrigation skipped at booting	Irrigation skipped at milking	Grain yield (kg ha^{-1})
0 kg ha^{-1} K + 0 kg ha^{-1} B (Control)	3895	3332	3515	3580
Application of 50 kg ha^{-1} K + 2 kg ha^{-1} B at sowing	4291	3565	3876	3911
Application of 50 kg ha^{-1} K + 3 kg ha^{-1} B at sowing	4383	3635	3925	3981
Application of 75 kg ha^{-1} K + 2 kg ha^{-1} B at sowing	4658	3938	4307	4301
Application of 75 kg ha^{-1} K + 3 kg ha^{-1} B at sowing	4692	4055	4398	4382
Grain yield (kg ha^{-1})	4384	3705	4004	

4. **Water use efficiency in wheat by laser grading under different methods of planting**

The study was conducted to improve water use efficiency and productivity of wheat in laser graded field under different methods of planting under Bahawalpur conditions during Rabi season 2018-19. Significantly higher and statistically similar grain yield was observed for "Broadcast of seed & augmented with furrows (Ridging)" (4808.2 kg ha^{-1}) and "Bed planting (90 cm a part beds with three rows)" (4721.2 kg ha^{-1}). While, grain yield was improved by 16% under "Broadcast of seed & augmented with furrows (Ridging)" compared to Rabi drill (Conv.) in flat field.

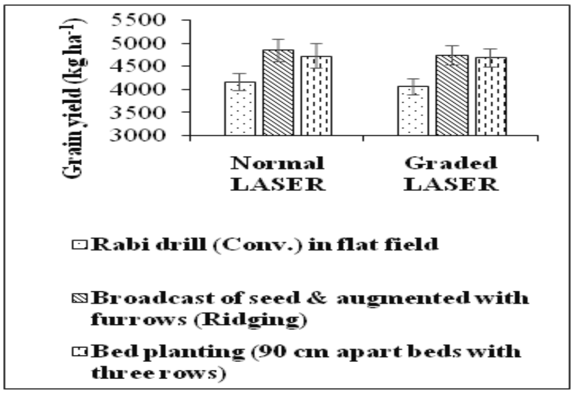


Figure. Effect of laser grading and planting methods on wheat grain yield

5. **Comparison of sowing methods for saving water and improving productivity of wheat**

This study was conducted to find out the best sowing method of wheat that may equally effective in requiring less water for irrigation and giving optimum yield. However, water applied at each treatment has been recorded. Minimum amount of water was required to irrigate field sown with ridge planting technique. Moreover, more grain yield was recorded in ridge as well as bed planting techniques as compared with broadcast (Table 3).

Table. Effect of sowing methods on wheat grain yield

Sowing methods	Grain yield (kg ha^{-1})
Drill sowing	2767
Broadcast	2417
Ridge sowing	3550
Bed sowing	3633

6. **Response of wheat to tillage system and different planting times under arid environment**

The study was conducted to find out the best sowing time and tillage system for wheat under Thal irrigated conditions during Rabi 2018-19. Unaj-2017 was sown with four planting dates from 1st November to 15th December with 15 days interval under three tillage systems i.e. zero tillage, reduced tillage and conventional tillage.

The data presented in revealed that higher grain yield i.e. 3903 kg ha^{-1} was recorded when crop was sown on 1st November and in case of tillage system the conventional tillage system gave maximum grain yield of 3867 kg ha^{-1}. The minimum wheat grain yield of 3256 kg ha^{-1} was received when crop was sown on 3rd week of December while in tillage system the minimum grain yield i.e. 3151 kg ha^{-1} was obtained by zero tillage system.

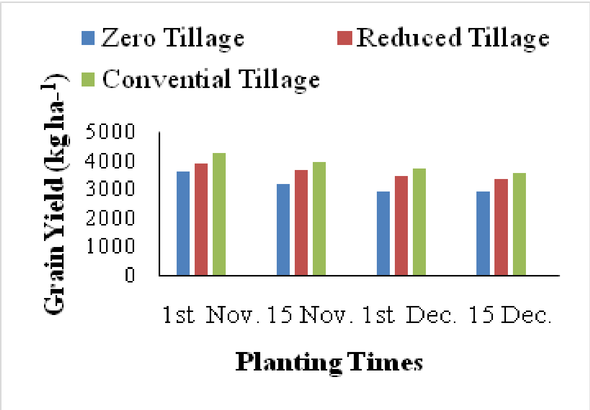


Figure. Effect of different planting times and tillage systems on grain yield (kg/ha) of wheat

7. **Effect of different sowing dates on new wheat genotypes under Thal irrigated conditions**

To find out optimum sowing date of newly evolved wheat varieties under Thal irrigated conditions, the study was conducted during Rabi 2018-19. Wheat strains/varieties i.e. Unaaj 2017, Fakhr-e-Bhakkar-2017, TWS-1334, TWS- 1335, TWS-12165 and Ujala 2016 were sown under six sowing dates with 15 days interval started from 1st of November to 1st of January.

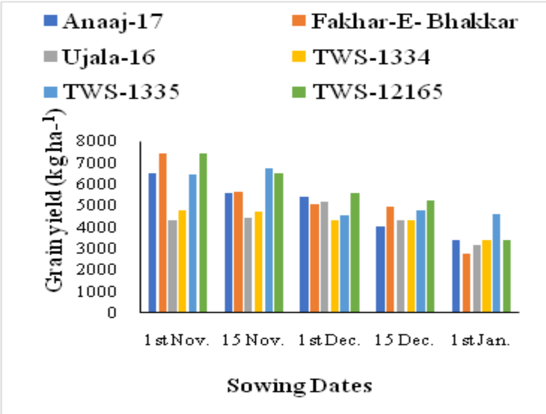


Figure. Effect of different sowing dates on grain yield (kg/ha) of wheat varieties under Thal irrigated conditions

The data presented in depicted that maximum wheat grain yield of 6139 kg ha^{-1} was produced when crop was sown first week of November which was statistically at par with 3rdweek of November i.e. 5590 kg ha-^{1}. The wheat grain yield gradually decreased with delayed planting in month of December and January. Wheat promising line TWS-12165 gave higher grain yield of 5617 kg ha^{-1} which has no significant difference statistically with TWS-1335, Fakhar-Bhakkar and anaaj-17. The lower grain yield 4284 and 4298 kg ha^{-1} was recorded by wheat variety Ujala-16 and TWS-1334 respectively. As for as interaction is concerned Fakhar-e-Bhakkar, TWS-12165 and Anaaj-17 produced higher grain yield when planting was done on first week of November.

8. Re-verification of bio efficacy of herbicides for weed control in wheat

This research was conducted to evaluate different existing herbicides viz; Agritop 40 EC, Allymax 66.7 WG, Axial 050 EC, Topik 15 WP, Sonak 15 WP, Skype 20 EC, Chitta 69 EW, Certain plus 14.5 EC, Buctril super 60 EC, Keychain, Strait 30 EC, Selector 60 EC, Starane-M 50 EC, Harvester 100+ 400 g/L, Laren Max 66.7 WG,Lancelot 45 WG, Ge Chu, Metafin super 28.6 WG against check for their efficacy. The maximum grain yield (3533 kg/ha) was obtained with Axial 50 EC @ 825 ml/ha which is at par with Certain plus 14.5 EC @ 1250 ml/ha for monocot weeds while in case of herbicides used for dicot weeds the highest grain yield (3533 kg/ha) was obtained with Starane-M 50 EC, however minimum grain yield was obtained in control with no herbicide application.

Table. Re-verification of bio efficacy of herbicides for monocot weeds

Treatment	Grain yield (kg/ha)
Axial 050 EC	3533 a
Certain plus 14.5 EC	3483 a
Topik 15 WP	3366 b
Kauida 60 WP	3167 c
Skype 20 EC	3233 b
Chitta 69 EW	2933 c
Control/weedicheck	2633 d

Table. Re-verification of bio efficacy of herbicides for dicot weeds

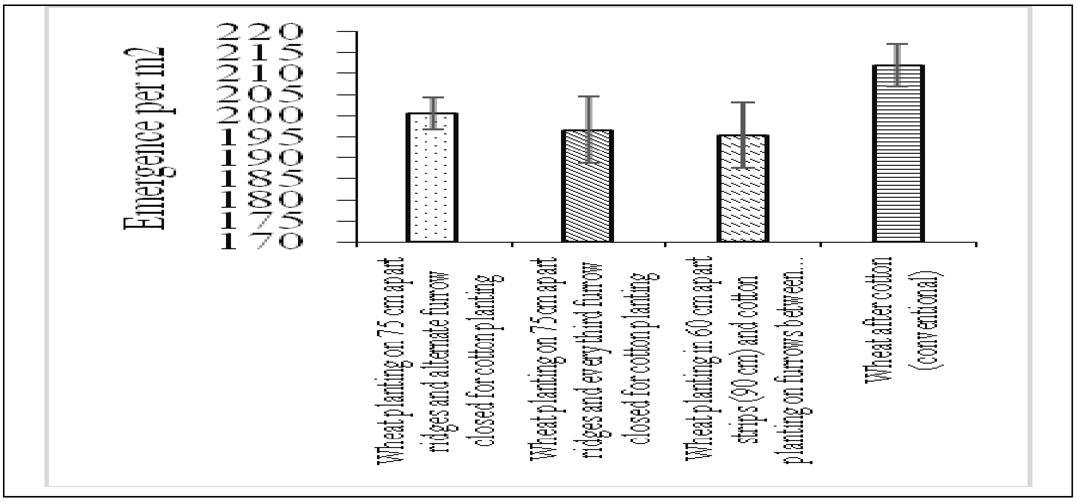
Treatment	Grain yield (kg/ha)
Buctril super 60 EC	3500 a
Selecter 40 EC	3483 a
Starane-M 50EC	3533 a
Broad-X	3450 a
Agritop 40 EC	3233 b
Strait 30 EC	3216 b
Keychain	3483 a
Allymax 66.7 WG	3300 b
Lancelot 45 WG	3333 b
Ge Chu	3333 b
Control/weedicheck	2733 c

9. Water economy in relay cropping of cotton in standing wheat crop

An experiment was conducted with objectives to optimize the sowing method for maximization of water use efficiency. The experiment was conducted at Agronomic Research Station, Bahawalpur during Rabi season 2018-19. The experiment was laid out under Randomized Complete Block Design (RCBD) and replicated three times. Treatments were comprised of T_1= Wheat planting on 75 cm apart ridges and alternate furrow closed for cotton planting; T_2= Wheat planting on 75cm apart ridges and every third furrow closed for cotton planting; T_3= Wheat planting in 60 cm apart strips (90 cm) and cotton planting on furrows between strips and T_4= Wheat after cotton (conventional). Non-significant effect of different relay cropping techniques was recorded for emergence of wheat.

Table. Effect of relay cropping techniques on emergence of wheat (m^{-2})

Treatments	**Emergence per m^2**
T1= Wheat planting on 75 cm apart ridges and alternate furrow closed for cotton planting	200.7
T2= Wheat planting on 75cm apart ridges and every third furrow closed for cotton planting	196.7
T3= Wheat planting in 60 cm apart strips (90 cm) and cotton planting on furrows between strips.	195.3
T4= Wheat after cotton (conventional)	212.0
Tukey’s HSD = Non-significant ($p \leq 0.05$)	



Effect of relay cropping techniques on emergence of wheat (m^{-2})

10. Adaptation of advanced wheat lines to various planting dates under Bahawalpur conditions

An experiment was conducted with objectivesto explore the genetic yield potential and to study the adaptation of various advance lines/varieties under different planting dates.The experiment was conductedat Agronomic Research Station, Bahawalpur during rabi season 2018-19. The experiment was laid out under Randomized Complete Block Design (RCBD) split plot and replicated three times. Treatments were comprised of sowing dates viz. D_1 = 1st November; D_2 = 15th November; D_3 = 1st December and D_4 = 15th December in main plots and V_1 = Johar-16 (Control); V_2 = Gold-16; V_3 = Roshan-17; V_4 = 2511; V_5 = 2557 and V6 = 2559. Non-significant effect of genotypes was recorded for emergence of wheat. While, higher emergence was observed for 1st November and 15th November sowing times compared to other sowing times.

Table. Effect of sowing dates and genotypes on emergence of wheat (m^{-2})

Varieties	**Sowing dates**				**Emergence per m^2**
	1st November	**15th November**	**1st December**	**15th December**	
Johar-16 (Control)	222.7	220.0	204.7	202.0	212.3
Gold-16	222.0	223.0	208.8	195.7	212.3
Roshan-17	225.0	219.0	205.0	191.7	210.2
2511	232.7	224.3	207.7	192.0	214.2
2557	225.3	213.7	211.3	191.0	210.3
2559	221.7	223.7	209.3	188.3	210.8
Emergence per m^2	225.0 A	220.6 A	207.8 AB	193.4 B	
Tukey' HSD for sowing dates = 25.12			Tukey' HSD for genotypes = Non-significant ($p \leq 0.05$)		

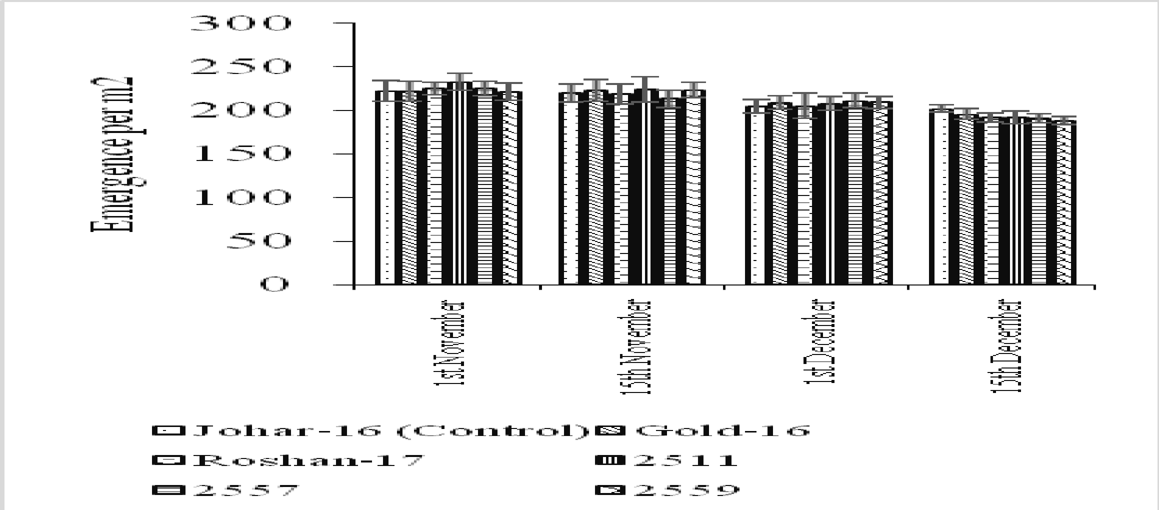


Figure. Effect of sowing dates and genotypes on emergence of wheat (m^{-2})

COTTON

11. Residue management in cotton-wheat cropping system

An experiment was conducted with the objective to the effect of residue on the productivity of cotton crop. The experiment was conducted at Agronomic Research Station, Bahawalpur during Kharif season 2018. Treatments were comprised of T_1= cotton planting after full wheat residue burning; T_2= cotton planting after full wheat residue incorporation; T_3= cotton planting after full wheat residue removed and T_4= cotton planting in full wheat residue left/retained. More seed cotton yield was recorded with cotton planting after full wheat residue incorporation (2857 kg ha^{-1}) compared to other treatments.

Table. Effect of different residue management techniques on seed cotton yield (kg ha^{-1}) of cotton crop

Treatments	**Seed cotton yield (kg ha^{-1})**
T_1 = Cotton planting after full wheat residue burning	2399
T_2 = Cotton planting after full wheat residue incorporation	**2857**
T_3 = Cotton planting after full wheat residue removed	2260
T_4 = Cotton planting after full wheat residue left/retained	2477

12. Determination of last irrigation date in Bt cotton under Bahawalpur conditions

Two sowing dates (15^{th}&30^{th} April) were tested under five irrigation dates (20th September, 1^{st}, 10^{th}, 20^{th} & 30^{th} October) during Kharif 2018 to determine time of last irrigation. Statistically higher seed cotton yield was recorded when crop was sown on 15^{th} April and last Irrigation was applied on 10^{th} of October.

Table. Effect of sowing dates and time of last irrigation application on seed cotton yield (kg ha^{-1}) of cotton crop

Times of last irrigation/ sowing dates	**15th April**	**30th April**
20th September (control)	1907	1706
1^{st} October	2348	1716
10^{th} October	2465	2056

20th October	2450	1950
30th October	2401	1821

13. Mechanical planting of cotton

Cotton crop was planted during Kharif 2018 on 75 cm apart beds with planter; 75 cm apart beds (45cm bed + 30cm furrow) with manual dibbling, on 75cm apart ridges with planter, on 75 cm apart ridges with manual dibbling, on 75 cm wide beds with manual dibbling (check) and drilled in 75 cm spaced rows (check) to sort out the best method. Statistically more (2987 kg ha^{-1}) seed cotton yield was recorded plating cotton on 75 cm wide beds with manual dibbling compared to other treatments.

Table. Effect of planting methods on seed cotton yield (kg ha^{-1}) of cotton crop

Treatments	Seed cotton yield (kg ha^{-1})
Cotton planting on 75 cm apart beds with planter	2520
Cotton planting on 75 cm apart beds (45 cm bed + 30 cm furrow) with manual dibbling	2976
Cotton planting on 75 cm apart ridges with planter	2585
Cotton planting on 75 cm apart ridges with manual dibbling	2902
Cotton planting on 75 cm apart beds with manual dibbling (check)	2987
Flat planting in 75 cm spaced rows by drill (check)	2247

14. Fruit retention behaviour of cotton genotypes under various planting densities

Four cotton varieties (MNH-992, CIM-179, FH-Lalazar and FH-142) were planted at three plant spacing (15, 30 and 45 cm) under Khanewal conditions during Kharif 2018 to study their behavior towards fruit shedding. The cotton variety MNH-992 gave maximum seed cotton yield of 2265 kg ha^{-1} when sown at 30 cm plant to plant distance followed by FH-Lalazar with seed cotton yield of 2237 kg ha^{-1} at similar plant spacing. While minimum was recorded in cotton varieties CIM-179 and FH-142 sown at 45 cm spaced rows.

Table. Effect of planting densities on seed cotton yield (kg/ha) of cotton crop

Varieties	Plant spacing (cm)		
	15	**30**	**45**
MNH-992	1984	2265	2185
CIM-179	2215	1938	1799
FH-Lalazar	2014	2237	2221
FH-142	2188	1939	1820

15. Minimizing fruit shedding in Bt cotton with nutrient management under Faisalabad conditions

The study was conducted during Kharif 2018 to reduce flower shedding in cotton by soil application of potassium and boron. It was observed that maximum (73%) bolls were retained when potassium and boron were applied @ of 110 kg ha^{-1} and 1.5 kg ha^{-1} respectively. Resultantly higher seed cotton yield of 1765 kg ha^{-1} was obtained at this dose.

Table. Effect of potash and boron on boll retaining percentage of cotton crop

Treatments		
B (kg ha^{-1})	K_2O (kg ha^{-1})	
	95	110
	Fruit Retaining %	
1.0	63	69
1.5	66	73
2.0	68	73

Table. Effect of potash and boron levels on seed cotton yield (kg ha^{-1}) of cotton crop

Treatments		
B (kg ha^{-1})	K_2O (kg ha^{-1})	
	95	110
	Seed Cotton Yield	
1.0	1248	1598
1.5	1495	1765
2.0	1471	1748

16. 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, Faisalabad. Thirty four cotton varieties/lines i.e. PC1-PC34 was tested under Thal irrigated conditions. The experiment was sown on 14-05-2018 in RCBD with three replications and Plot size of 3.0 m × 4.5 m with line to line distance 0.75 m. Chemical fertilizer @ 200-115-95 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 on 29-10-2018 and 04-12-2018. The experiment was sown through hand drill and plant to plant distance was maintained after thinning. The results showed that maximum seed cotton yield (3951 kg ha^{-1}) was achieved from PC-20 followed by PC-13 (3827 kg ha^{-1}) and PC-7 (3704 kg ha^{-1}). The Minimum seed cotton yield of 1975 kg ha^{-1} was obtained from variety/line PC-9.

Table: Seed cotton yield of PCCT-1

PROVINCIAL COTTON COORDINATED TRIAL (SET-I)			
Strains	**Yield kgha^{-1}**	**Strains**	**Yield kgha^{-1}**
PC-1	3333 abcde	PC-18	3457 abcde
PC-2	2593 defg	PC-19	3704 abc
PC-3	3457 abcde	PC-20	3951 a
PC-4	2469 efg	PC-21	3086 abcdef
PC-5	3210 abcdef	PC-22	2840 bcdefg
PC-6	3333 abcde	PC-23	3087 abcdef
PC-7	3704 abc	PC-24	3580 abcd
PC-8	2963 abcdefg	PC-25	3333 abcde

PC-9	1975 g	PC-26	3210 abcdef
PC-10	2963. abcdefg	PC-27	3334 abcde
PC-11	3086 abcdef	PC-28	3580 abcd
PC-12	3086 abcdef	PC-29	3704 abc
PC-13	3827 ab	PC-30	2469 efg
PC-14	2593 defg	PC-31	2716 cdefg
PC-15	2593 defg	PC-32	3704 abc
PC-16	2963 abcdefg	PC-33	2222 fg
PC-17	2963 abcdefg	PC-34	2839 bcdefg
	LSD $_{5\%}$	1052.4	

17. Determination of last date of nitrogen application in Bt cotton under varying climatic conditions

An experiment was conducted with the objective to determine time of last nitrogen application in Bt cotton under different sowing dates. The experiment was conducted at Agronomic Research Station, Bahawalpur during kharif season 2018. The experiment was laid out under Randomized Complete Block Design (RCBD) split plot and replicated three times. Treatments were comprised of sowing dates viz. D_1= 15th April and D_2= 30th April in main plots and times of last nitrogen application viz. T_1= 15th August; T_2= 30th August; T_3= 15th September and T_4= 30th September in sub plots. Higher seed cotton yield was recorded with 15th April sowing date (2354.2 kg ha^{-1}) and with last nitrogen application date 15th September (2497.7 kg ha^{-1}) compared to other treatments.

Table. Effect of sowing dates and times of last nitrogen application on seed cotton yield (kg ha^{-1})

Times of last nitrogen/ sowing dates	D_1 = 15th April	D_2 = 30th April	Means of times of last nitrogen
T_1 = 15th August	2036.7	1514.0	1775.3 C
T_2 = 30th August	2344.3	1999.7	2172 B
T_3 = 15th September	2632.0	2363.3	2497.7 A
T_4 = 30th September	2403.7	2175.7	2289.7 AB
Means of sowing dates	2354.2 A	2013.2 B	
Tukey's HSD for sowing dates = 258.25 Tukey's HSD for times of last nitrogen = 248.23			

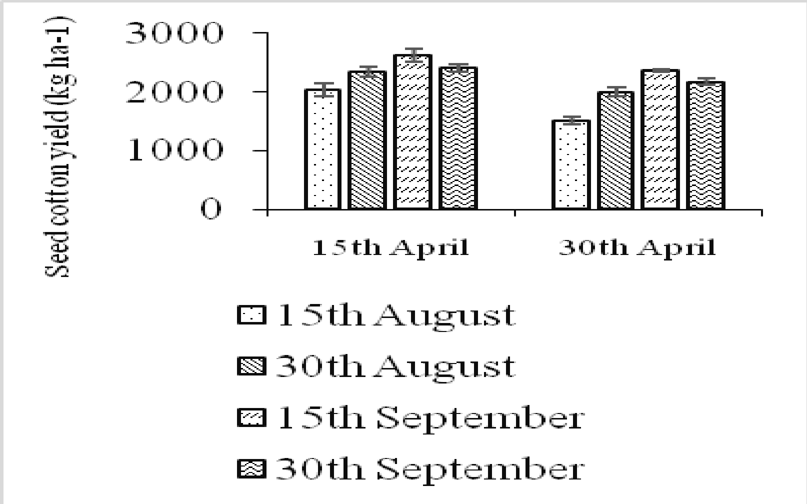


Figure. Effect of sowing dates and times of last nitrogen application on seed cotton yield (kg ha^{-1})

18. Fruit retention behaviour of cotton genotypes under various planting densities

This study was conducted to evaluate the effect of plant spacing and micro-environment on fruit shedding of cotton crop. Results of this study showed that cotton variety MNH-992 gave maximum seed cotton yield of 2265kg ha^{-1} when sown at 30 cm plant to plant distance followed by FH-Lalazar with seed cotton yield of 2237 kg ha^{-1} at similar plant spacing. While minimum was recorded in cotton varieties CIM-179 and FH-142 sown at 45 cm spaced rows.

Table: Seed cotton yield under varying planting densities

Varieties	**Plant spacing (cm)**			**Mean** (kg ha^{-1})
	15	**30**	**45**	
MNH-992	1984cd	2265a	2185b	2145
CIM-179	2215ab	1938d	1799e	1984
FH-Lalazar	2014c	2237ab	2221ab	2157
FH-142	2188b	1939d	1820e	1982
Mean(kg ha^{-1})	2100	2095	2006	
LSD for plant spacing × varieties= 65				

19. Relay cropping of Bt cotton in standing wheat

The area under wheat is reducing which is a threat to our national food security. An experiment was conducted with the objective to adjust the Bt cotton crop in standing wheat as relay crop. The experiment was conducted at Agronomic Research Station, Bahawalpur during kharif season 2018. The experiment was laid out under Randomized Complete Block Design (RCBD) and replicated three times. Treatments were comprised of P_1= wheat planted on ridge and alternate furrow closed for cotton planting on both sides of furrow (Row x Row = 75cm); P_2= wheat planted on ridges and every 3rd furrow closed and cotton planting on both sides of furrow (Paired row of cotton after every 150cm); 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; P_4= Cotton after wheat and P_5= Bt Cotton alone (early). More seed cotton yield was recorded for Bt Cotton alone (early) (3165.3 kg ha^{-1}) compared to other treatments.

Table. Effect of relay cropping techniques on seed cotton yield (kg ha^{-1})

Treatments	Seed cotton yield (kg ha^{-1})
P_1 = Wheat planted on ridge and alternate furrow closed for cotton planting on both sides of furrow (Row × Row = 75 cm)	2602.7 B
P_2 = Wheat planted on ridges and every 3rd furrow closed and cotton planting on both sides of furrow (Paired row of cotton after every 150 cm)	2410.7 BC
P_3 = Wheat planted on flat in 90 cm strips and 60 cm space after each strip for cotton dibbling (double row) (Paired row of cotton after every 150 cm)	2677.0 B
P_4 = Cotton after wheat	2015.7 C
P_5 = Bt cotton alone (early)	3165.3 A
Tukey's HSD	362.68

20. Efficacy of pre and post emergence herbicides in cotton

An experiment was conducted with the objective to find out the most suitable pre and post emergence herbicides for weed control in cotton. The experiment was conducted at Agronomic Research Station, Bahawalpur during kharif season 2018. The experiment was laid out under Randomized Complete Block Design (RCBD) and replicated three times. Treatments were comprised of T_1 = Dual Gold 2 L/ha (Pre-emergence); T_2= Pendimethline 3 L/ha (Pre-emergence); T_3= Acetaclore 1000 ml/ha (Pre-emergence); T_4= Phenoxaprop-p-ethyl) 1250ml/ha (Post-emergence for Grasses); T_5= Clodinofop 450g/ha (Post –emergence for Grasses); T_6= Heloxyfop @ 1250ml/ha (Post –emergence for Grasses) and T_7= Control. Higher seed cotton yield was recorded with 'Dual Gold 2 L/ha (Pre-emergence)" (2510.3 kg ha^{-1}) compared to other treatments.

Table. Effect of pre and post emergence herbicides on seed cotton yield (kg ha^{-1})

Treatment	Seed cotton yield 2017 (kg ha^{-1})
T_1 = Dual gold 2 L/ha (Pre-emergence)	2510.3 A
T_2 = Pendimethalin 3 L/ha (Pre-emergence)	2316.3 AB
T_3 = Acetaclore 1000 mL/ha (Pre-emergence)	2191.3 AB
T_4 = Phenoxaprop-p-ethyl 1250 mL/ha (Post emergence for grasses)	1831.0 CD
T_5 = Clodinofop 450 g/ha (Post emergence for grasses)	1921.7 BC
T_6 = Heloxyfop 1250 mL/ha (Post emergence for grasses)	1809.0 CD
T_7 = Control	1417.7 D
Tukey's HSD	437.72

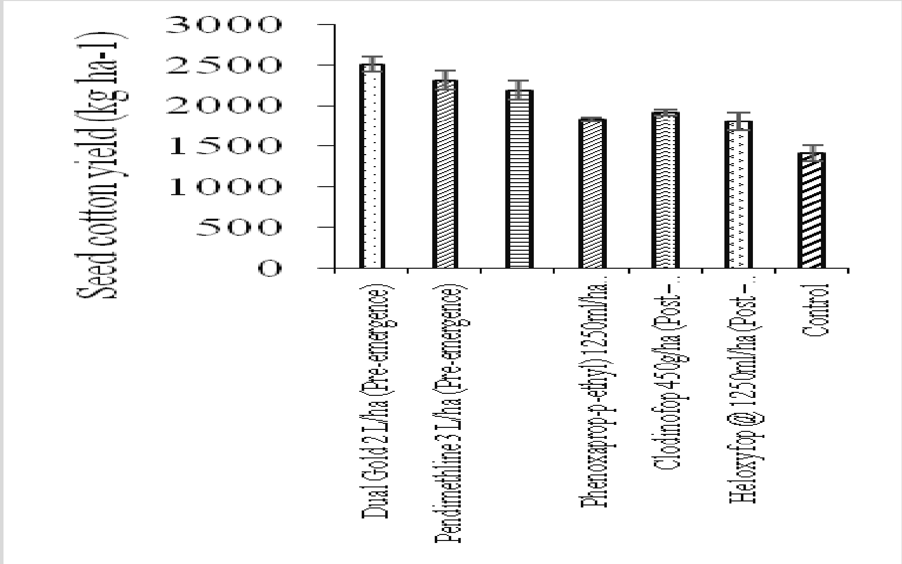


Figure. Effect of pre and post emergence herbicides on seed cotton yield (kg ha^{-1})

21. Growing organic cotton

An experiment was conducted with the objective to find out the most suitable organic inputs and their doses for growing successful organic cotton crop in Bahawalpur. The experiment was conductedat Agronomic Research Station, Bahawalpur during kharif season 2018. The experiment was laid out under Randomized Complete Block Design (RCBD) and replicated three times. Treatments were comprised of T_1= FYM @ 10 t/ha; T_2= Poultry waste @ 10 t/ha; T_3= Press mud @ 10 t/ha; T_4= FYM @ 3.5 t/ha + Poultry waste @ 5 t/ha and T_5= Control. Relatively more seed cotton yield was recorded with “FYM @ 3.5 t/ha + Poultry waste @ 5 t/ha” (2565 kg ha-1) compared to other treatments.

Table. Effect of organic manures on seed cotton yield (kg ha^{-1})

Treatments	**Seed cotton yield (kg ha^{-1})**
T_1 = FYM @ 5 t/ha	2127.3 BC
T_2 = Poultry waste @ 5 t/ha	2202.7 AB
T_3 = Press mud @ 5 t/ha	2150.0 BC
T_4 = FYM @ 3.5 t/ha + Poultry waste @ 2.5 t/ha	2565.0 A
T_5 = Control	1817.3 C
Tukey’s HSD	374.98

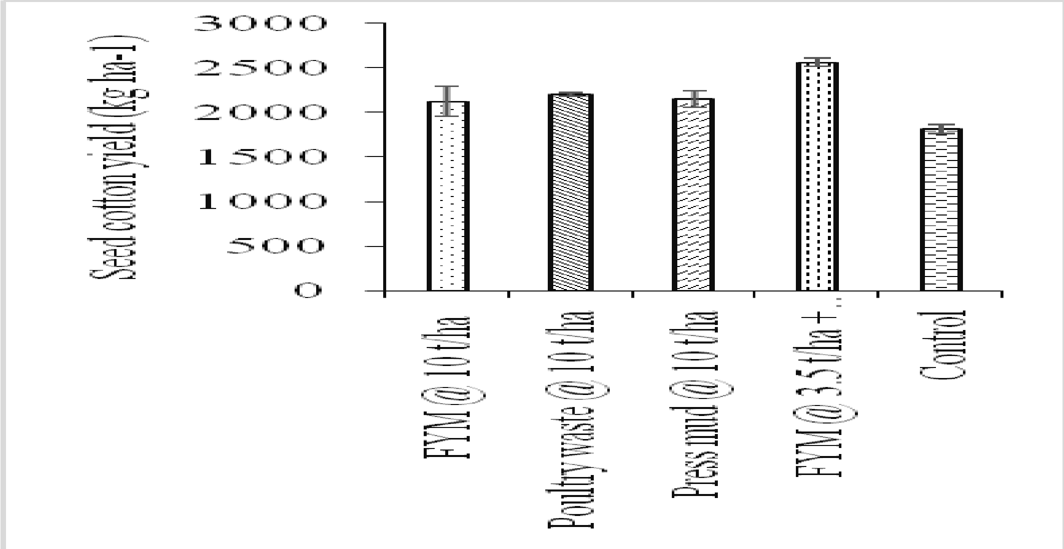


Figure. Effect of organic manures on seed cotton yield (kg ha^{-1})

22. Fruit retention behaviour of cotton genotypes under various planting densities

This study was conducted to evaluate the effect of plant spacing and micro-environment on fruit shedding of cotton crop. Results of this study showed that cotton variety MNH-992 gave maximum seed cotton yield of 2265kg ha^{-1} when sown at 30 cm plant to plant distance followed by FH-Lalazar with seed cotton yield of 2237 kg ha^{-1} at similar plant spacing (Table 1).While minimum was recorded in cotton varieties CIM-179 and FH-142 sown at 45 cm spaced rows.

Table. Seed cotton yield under varying planting densities

Varieties	**Plant spacing (cm)**			**Mean (kg ha^{-1})**
	15	**30**	**45**	
MNH-992	1984cd	2265a	2185b	2145
CIM-179	2215ab	1938d	1799e	1984
FH-Lalazar	2014c	2237ab	2221ab	2157
FH-142	2188b	1939d	1820e	1982
Mean(kg ha^{-1})	2100	2095	2006	
LSD for plant spacing × varieties= 65				

23. 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 under Khanewal conditions. The experiment revealed that the sowing of cotton on 3rd week of March, 1st week of Apriland 3rd week of April gave more seed cotton yield i.e. 2748, 2394 and 2224 kg ha^{-1}respectively (Figure 2). While sowing of cotton at 1st week of May gave seed cotton yield of 2124 Kg ha^{-1}(Figure 2). However further delay in sowing resulted in considerable reduction in seed cotton yield. In conclusion optimum time of sowing of cotton to attain maximum yield is 3rd week of April to 1st week of May under Khanewal conditions. Moreover cotton variety FH-Lalazar performed best than remaining 2 tested varieties under Khanewal conditions.

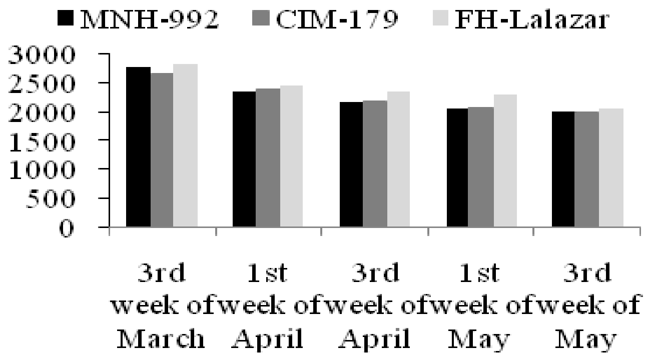


Figure. seed cotton yield as affected by various dates of planting

JUTE

Research on agronomic and breeding aspects of jute crop remained in progress with a goal of sustained supply of raw jute fiber to the industry and higher income to farmers. Nutrient management for higher fiber yield of jute

Different levels (45, 60 and 75 kg/ha) of N and P2O$_5$ (20,30 and 40 kg/ha) were applied to jute to find out the suitable dose. Fiber yield (3304 kg ha^{-1}) was obtained at 75 kg ha^{-1} N and 40 kg ha^{-1} P.

Table. Effect of different nitrogen and phosphorous levels on jute fiber yield (kg ha^{-1})

Fertilizers (Kg/ha^{-1})			
Nitrogen	**P_2O_5**		
	20	**30**	**40**
	Jute Fiber yield (kg ha^{-1})		
45 kg N ha^{-1}	2002	2297	2504
60 kg N ha^{-1}	2717	3205	3182
75 kg N ha^{-1}	3149	3195	3304

BREEDING PROGRAMME OF JUTE

24. Maintenance and evaluation of germplasm

Out of nineteen lines two of *Corchorus capsularis* and seventeen of *Corchorus olitorious* were sown in progeny to row trial. Results suggested that line NWJ-2 of *Corchorus capsularis* gave the higher fiber yield (7.91 g/plant) as shown in Figure 5a and line NTJ-3 of *Corchorus olitorious* gave the maximum fiber yield i.e. 20.80 g/plant.

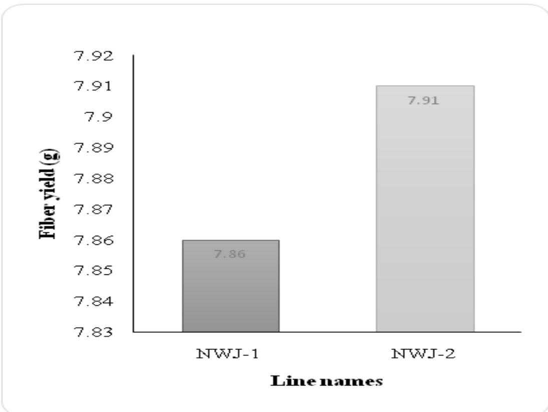


Figure. Fiber yield (g/plant) of two advanced *Corchorus capsularis* lines

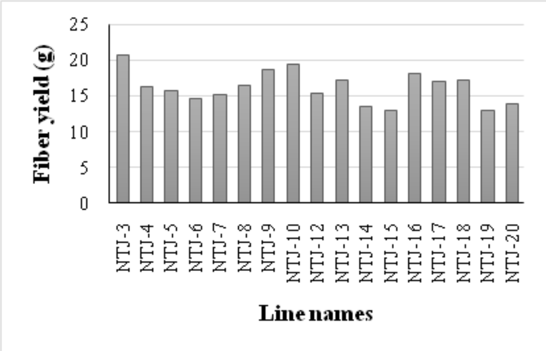


Figure. Advanced line NTJ-3 *Corchorus olitorious* depicting maximum fiber yield (22 g/plant)

25. Study of filial 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. The promising plants were selected from 8 entries in F_4 and 3 entries in F_5 were selected and seed of individual plant was harvested.

RICE

26. Evaluation of different sowing methods in rice for WUE

Four seeding methods of rice viz. Watter seeding (Drill), Dry Seeding (Drill), Transplanting (15 days old nursery) and Transplanting (30 days old nursery) were used under Faisalabad comditions. It was concluded that SRI (15 days old nursery) gave maximum number (295.33) of tillers m^{-2}, maximum numbers of kernels panicle^{-1} (138.33), maximum 1000-kernel weight (22.17 g) and ultimately maximum paddy yield (4313.3 kg ha^{-1}) and it was at par with conventional transplanting (30 days old seedlings) which gave paddy yield of 4113.3 kg ha^{-1}.

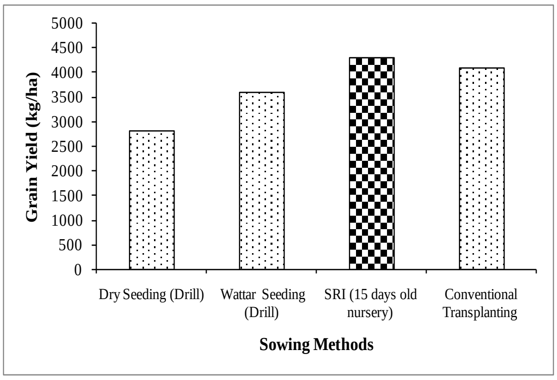


Figure. 15 days old nursery produced 4313 kg/ha paddy yield under SRI system

27. Optimizing nitrogen use for better yield in direct seeded and transplanted fine rice crop through crop simulation modeling

Effect of six levels of nitrogen viz., 0, 70, 105 140, 175,210 kg/ha was studied during 2018 on paddy yield of direct seeded and transplanted (both on 11 July) Noor Basmati keeping P and K at recommended level i.e. 80 and 62 Kg/ha. In case of transplantation, maximum paddy yield 5555 kg/ha was recorded from plots of nitrogen 175 kg/ha against the 4062 kg/ha of paddy yield obtained from the plots which received nitrogen @ 70 kg/ha; however, this yield was at par with that obtained without any additional nitrogen. In case of direct seeding, maximum paddy yield 3333 kg/ha was recorded from plots of nitrogen 175 kg/ha against the 2029 kg/ha of paddy yield obtained from the plots which received no nitrogen.

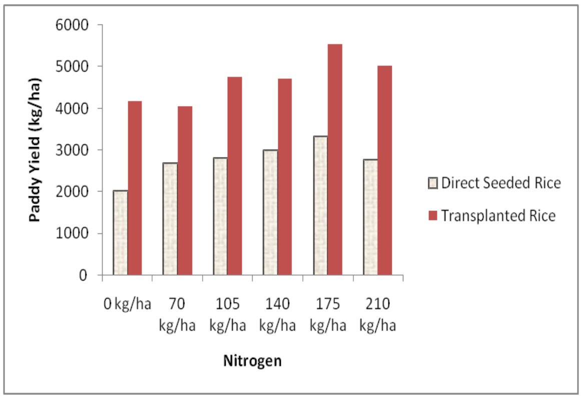


Figure. Effect of different N levels on yield of direct seeded and transplanted fine rice

28. Effect of inorganic, organic and bio fertilizers on yield of rice

Yield response of fine rice to different nutrient doses i.e.organic, inorganic and bio-fertilizers was studies in fine rice**.** Application of 50% synthetic fertilizer + 50 % Farm yard manure resulted in maximum paddy yield of 3852 kg/ha against the minimum yield 3067 kg/ha achieved with the application of 25% synthetic fertilizer + 75% FYM coupled with Azotobacter + Azospirilumbacteria.

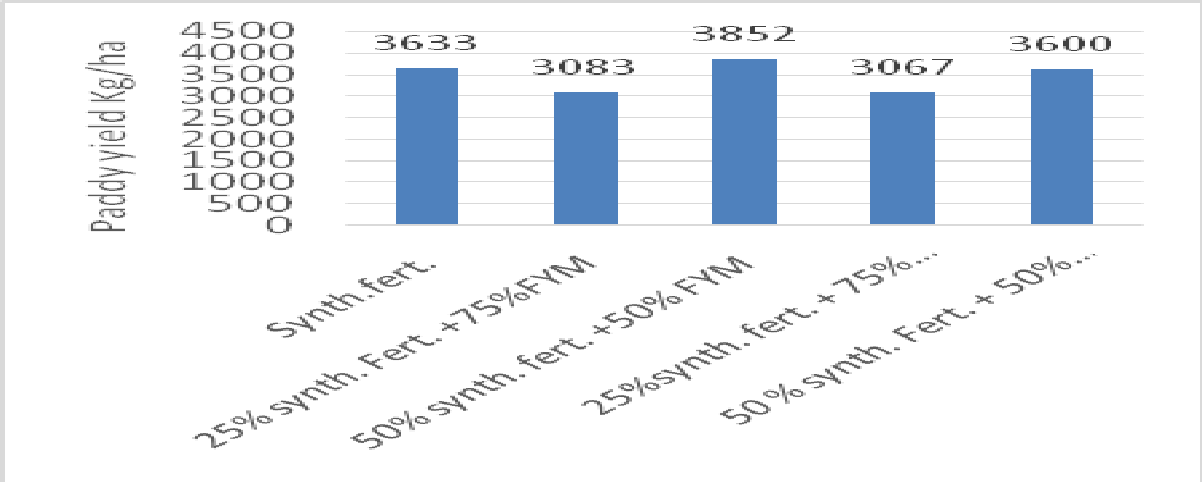


Figure. Yield response of rice to different fertilizer amendments

Figure. Pictorial view of effect of inorganic, organic and bio fertilizers on yield (kg/ha) of rice crop

29. N application in rice using leaf color chart

The study was conducted under Faisalabad conditions during Kharif 2018 for nitrogen management in rice using LCC. There was 3.44 % saving of N without yield compromising of either transplanted or direct seeded fine rice when it was applied using LCC. However, maximum yield (4133 kg/ha) in transplanted rice and 3980 kg/ha in DSR was obtained by applying recommended dose (170-80-62) of NPK which was at par with the yields obtained apply NPK @ 164-80-62 kg/ha using LCC.

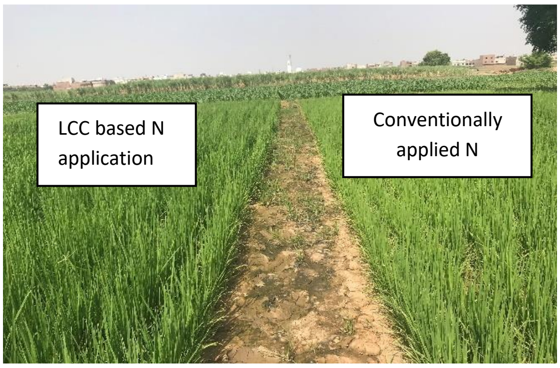


Figure. Pictorial view of comparison of N applied conventionally and by using LCC on rice yield (kg/ha)

30. Comparison of different planting methods in transplanted fine rice

Yield response of Noor Basmati to five planting methods (conventional transplanting, Bed planting, Furrow planting and Ridge planting, Ridge + furrow transplanting was studied under Faisalabad conditions during Kharif 2018. Ridge + furrow transplanting resulted in maximum paddy yield of 4900 kg/ha.

31. Effect of time and application method of potash on growth and yield of fine rice

Six levels of K (K_0, K 62 kg ha^{-1} as basal, K 62 kg ha^{-1} at 30 DAT, ½ K as basal +1/2 at 30 DAT, ½ K as basal +Spray of 2 % K solution at 50 DAT, ½ K as basal +Spray of 2 % K solution at 65 DAT) to find out the best time and method of potash application to reduce lodging, and to improve the yield of fine rice were studied at Farooqabad in Kharif-2018.

Half of the K as Basal dose + Spray of 2% K solution at 50 DAT remained the best with paddy yield of 3445 kg ha^{-1} while minimum paddy yields (2668.0 kg ha^{-1}) was obtained from plots where no potash was applied.

Figure. Pictorial view of time and application method of potash on rice yield (kg/ha^{-1})

32. Chemical weed control in DSR

Various dosed of Pendimethlin, Bispyribic sodium Ethoxysulfuron (Table-7) were tested for weed control in fine rice at Farooqabad during Kharif 2018 Maximum paddy yield (3155kg ha^{-1}**)** was obtained from the plots where Stomp (pendimethlin) @ 2.5 L ha^{-1} as Pre-emergence, Puma super (Fenoxa Pro-P-Ethyle) @ 625 m L ha^{-1} at 25-30 DAS and unstar gold (Ethoxysulfuron) @ 50 g ha^{-1} at 15 DAS were sprayed.

Table. Effect of chemical weed control on yield of direct seeded fine rice

Treatments	**Weeds count m^{-2}**	**Yield kg ha^{-1}**
Pendimethlin (Stomp) @ 2.5 L ha^{-1} as pre emergence.	75	2164
Pendimethlin (Stomp) @ 2.5 L ha^{-1} as pre emergence + 20WP Bispyribic sodium (Clover) @ 200 g ha^{-1} at 25-30 DAS.	42	2987
Pendimethlin (Stomp) @ 2.5 L ha^{-1} as pre emergence + Fenoxaprop-P-Ethyl (Puma super) @ 625 ml ha^{-1} at 15 DAS.	61	2597
Pendimethlin (Stomp) @ 2.5 L ha^{-1} as pre emergence + Ethoxysulfuron (Sunstar Gold) @ 50 g ha^{-1} 25-30 DAS.	36	3044
Pendimethlin (Stomp) @ 2.5 L ha^{-1} as pre emergence + Ethoxysulfuron (Sunstar Gold) @ 50 g ha^{-1} at 15 DAS + Fenoxaprop-P-Ethyl (Puma super) @ 625 ml ha^{-1}) at 25-30 DAS.	10	3155
Bispyribac sodium (Clover 20WP) @ 150 g ha^{-1} at 15 DAS + Fenoxaprop-P-Ethyl (Puma super) @ 750 ml ha^{-1} at 25-30 DAS.	55	2767

Hand weeding (as and when required)	1	3299
Control	182	923

33. Regional adaptability yield trial on coarse rice strains

Rice strain KSK-514 gave maximum paddy yield 6245.3 kg ha^{-1}

While minimum paddy yields (5088.3 kg ha^{-1}) was produced by the line KSK-515.

Table. Paddy yield kg ha^{-1} of different coarse rice strains

Treatments	Yield kg ha^{-1}
KSK-434	5209.7 CD
KSK-486	5412.0 BC
KSK-487	5993.0 A
KSK-489	6164.3 A
KSK-498	5617.3 B
KSK-505	5567.3 B
KSK-514	6245.3 A
KSK-515	5088.3 D
KSK-133	5665.3 B
Kissan Basmati	5387.7 BCD
KSK-118	5453.3 BC
LSD Value	307.26

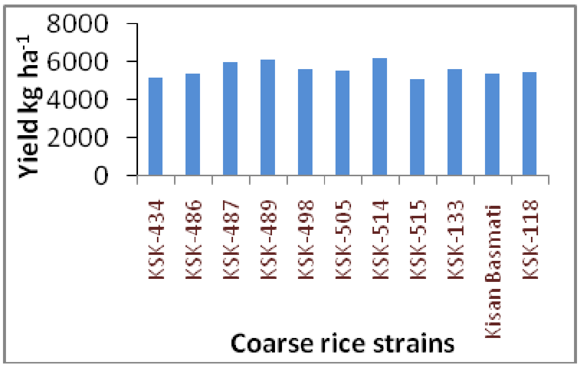


Figure. 1 Paddy yield kg ha^{-1} of different coarse rice strains

34. Regional adaptability yield trial on fine rice strains

Rice strain of fine rice PK 9966-10-1 gave the maximum paddy yield 5013.3 kg ha^{-} While minimum paddy yield (3592.3 kg ha^{-1}) was produced by the line PK 9444-8-1-2

Table. Paddy yield kg ha^{-1} of different fine rice strains

Treatments	Yield kg ha^{-1}
PK PB 15-116	4662.0 B
PK 8892-4-1-3-1	4461.0 C
PK 9444-8-1-2	3592.3 F
PK 9966-10-1	5013.3 A
PK 10029-13-2-1	4032.0 E

PK 10324-1-1	4193.3 D
PK 10683-12-1	4678.0 B
Chenab basmati	4899.0 A
Kissan basmati	4173.3 D
Super basmati	4471.3 C
Pk 111	3672.3 F
LSD Value	124.84

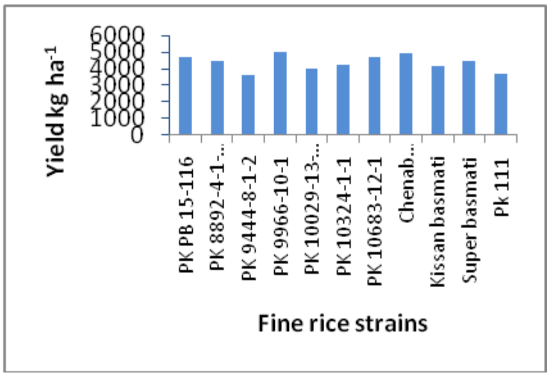


Figure. 2 Paddy yield kg ha^{-1} of different fine rice strains

35. Effect of different fertilizer levels on growth and yield of Chenab basmati under DSR

To standardized fertilizer rate for direct seeded rice culture experiment was conducted at Agronomic Research Station Farooqabad. Experiment consists of following treatments 142-80-62 NPK kg ha^{-1} (Recommended for transplanted rice), 114-64-50 NPK kg ha^{-1}(80 % of recommended for transplanted rice), 128-72-56 NPK kg ha^{-1}(90 % of recommended for transplanted rice), 156-88-68 NPK kg ha^{-1}(110 % of recommended for transplanted rice), 170-96-74 NPK kg ha^{-1} (120 % of recommended for transplanted rice DSR.

Treatments	**Yield kgha^{-1}**
142-80-62 NPK kg ha^{-1}	2978.0 B
114-64-50 NPK kg ha^{-1}	2514.0 C
128-72-56 NPK kg ha^{-1}	2880.8 BC
156-88-68 NPK kg ha^{-1}	3211.0 AB
170-96-74 NPK kg ha^{-1}	3425.8 A
LSD Value	446.60

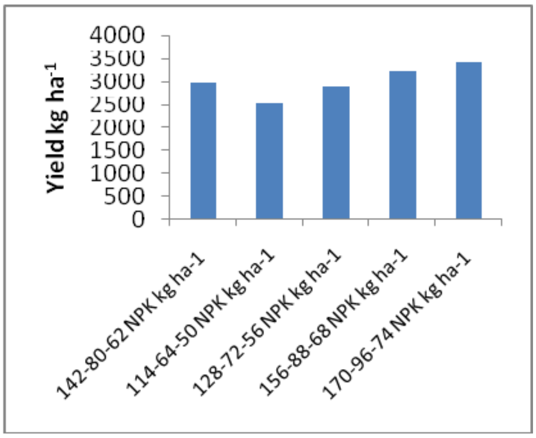


Figure. Effects of Different Fertilizer Levels on Yield Of Chenab Basmati Under DSR.

Pictorial view of Effects of different fertilizer levels on growth and yield of Chenab Basmati under DSR.

36. Effect of microclimate on growth and yield of direct seeded fine rice

To check the impact of artificially created microclimate on growth and yield of fine rice.

Experiment consists of following two factors

1. **Sowing methods**

a) Drill sowing (22.5 cm apart rows) b) Furrow augmented ridge sowing

2. **Irrigation techniques**

a) Continuous standing water from 30 DAS

b) Continuous wetting of land from 30 DAS c) Alternate wetting and drying before wilting from 30 DAS.

According to the data maximum paddy yield (3329.3 kg ha^{-1}) was obtained from the plot which was sown by drill and land was continuously wetted. While minimum paddy yields (2031.3 kg ha^{-1}) was obtained from where rice was sown in furrow augmented ridges and Alternate wetting and drying before wilting from 30 DAS was used.

Table. Effect of Microclimate on Yield of Direct Seeded Fine Rice.

	Drill sowing (22.5 cm apart rows)	**Furrow augmented ridge sowing**	
Continuous standing water from 30 DAS	3293.0 ab	2856.0 bc	**3074.5 A**

Continuous wetting of land from 30 DAS	3329.3 a	2230.0 d	**2779.7 B**
Alternate wetting and drying before wilting from 30 DAS.	2424.3 cd	2031.3 d	**2227.8 C**
	3015.6 A	**2372.4 B**	

LSD value for SM*I=449.58, LSD value for SM = 357.06, LSD value for I= 266.10

Pictorial view of Effect of microclimate on growth and yield of Direct Seeded Fine Rice

37. Effect of time and application method of potash on growth and yield of fine rice

To find out the best time and method of potash application to reduce lodging, and to improve the yield of rice experiment was conducted at Agronomic Research Station Farooqabad. Experiment consists of following treatments k 0, All k as basal (62 kg ha^{-1}), All K at 30 DAT (62 kg ha^{-1}), ½ K as basal +1/2 At 30 DAT, ½ K as basal +Spray of 2 % K solution at 50 DAT., ½ K as basal +Spray of 2 % K solution at 65 DAT.

Table . Effect of time and application method of potash on yield of fine rice

Treatments	**Yield kg ha^{-1}**
k 0	2668.0 C
All k as basal (62 kg ha^{-1})	3114.7 B
All K at 30 DAT (62 kg ha^{-1})	3081.0 B
½ K as basal +1/2 At 30 DAT	3339.0 AB
½ K as basal +Spray of 2 % K solution at 50 DAT	3445.0 A
½ K as basal +Spray of 2 % K solution at 65 DAT.	3114.3 B
LSD Value	272.63

According to the data maximum paddy yield (3445.0 kg ha^{-1}) was obtained from the treatment Half K as Basal+ Spray of 2% K solution at 50 DAT. While minimum paddy yields (2668.0 kg ha^{-1}) was obtained from the control where no potash was applied.

Pictorial view of Effect of time and application method of potash on growth and yield of fine rice

38. Effect of different seed rates and row spacing on growth and yield of chenab basmati under direct seeded rice culture

Experiment consists of following treatments

A. Seed rate a) 20 kg ha^{-1} b) 25 kg ha^{-1} c) 30 kg ha^{-1} d)35 kg ha^{-1}

B. Row spacing a)15 cm b) 22.5 cm c) 30 cm

Table. Effect of different seed rates and row spacing on yield of Chenab basmati under direct seeded rice culture

	20 kg ha^{-1}	25 kg ha^{-1}	30 kg ha^{-1}	35 kg ha^{-1}	
15 cm	2665bc	2625c	2532cd	3048 a	**2718A**
22.5 cm	2691bc	2572cd	2308d	2625c	**2539B**
30 cm	2559cd	2943 ab	2043e	3154 a	**2675A**
	2638B	**2713AB**	**2294C**	**2929A**	

LSD Value for SR*S 305.70, LSD Value for Seed rate 247.46, LSD Value for Plant spacing 110.68

According to the data maximum paddy yield (3154 kg ha^{-1}) was obtained from the treatment where 35 kg ha^{-1} seed rate used and row spacing was kept 30 cm.

Pictorial view of Effect of different seed rates and row spacing on yield of Chenab basmati under direct seeded rice culture

MAIZE

39. Relative performance of spring maize hybrids under terminal heat stress

Seven genotypes [FH-1046, YH-1898, YH-5394, H-5140, YH-5482, Monsanto-9108 (Heat Tolerant) and Maxima (Heat sensitive)] were sown on 1st and 15th March to find the better heat tolerant maize hybrids as adaptation mechanism in changing climate scenario at Faisalabad in 2018. Maize hybrid FH-1046 sown at 1st March gave maximum seed yield-9126 kg ha^{-1}.

Table. Grain yield (kg/ha) of different maize hybrids as effected by terminal heat stress

Hybrids	Grain yield (kg/ha)	
	1st March	15th March
FH-1046	9126	7081.3
YH-1898	8355.7	6148
YH-5394	5985.3	5155.7
YH-5140	3970.3	3822.3
YH-5482	5718.7	4918.3
Monsanto-9108 (Heat Tolerant)	6903.3	6163
Maxima (Heat sensitive)	7111	3600

40. Enhancing water use efficiency in maize by potassium application

The study was conducted with the objective to assess the water use efficiency enhancement in maize by potassium application under Faisalabad conditions during 2018. Two moisture levels i.e. irrigation at 70% and 50% available water under different levels of potassium i.e. control, foliar spray of 1%, 2%, 3%, 4% and 5% K_2SO_4 at seedling, jointing and flowering stages were tested. Maximum seed yield (9207.30 kg ha^{-1}) was achieved in treatment with foliar spray of potassium @ 2.0% under normal moisture condition (Irrigation at 70% available water) while minimum grain yield (7065 kg ha^{-1}) was obtained with foliar spray of potassium @ 5.0% under moisture stress conditions.

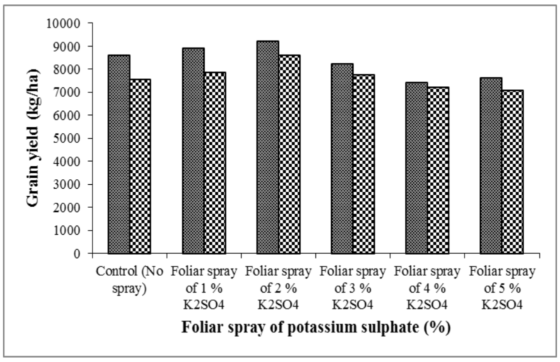


Figure. Effect of different concentrations of potassium sulphate application on grain yield of maize (kg/ha) under normal and water stress conditions

QUINOA

41. Evaluation and multiplication of local quinoa (*Chenopodium quinoa* L.) genotypes

This study was conducted to evaluate the performance of ten (UAF-2, UAF-3, UAF-6, UAF-7, UAF-11, UAF-13 UAF-19, UAF-20, UAF-24 and UAF-27) Quinoa lines from UAF selection. The significantly maximum plant height was recorded in UAF-Q-6 (136.33cm), maximum main panicle length (31cm), no of sub-panicles/plant (27), biological yield (10358 kg/ha) and grain yield (2473.7kg/ha) was found in UAF-Q-6 line and comparatively minimum plant height (92.67cm), main panicle length (18cm), no of sub-panicles/plant (18), biological yield (2055kg/ha) and grain yield (1012kg/ha) were recorded in UAF-Q-24.

Table. Quinoa genotype UAF-Q-6 depicted higher biological (10358 kg/ha) and Grain yield (2473 kg/ha) out of 10 different quinoa genotypes

Varieties	Biological yield (kg/ha)	Grain Yield (kg/ha)
UAF-Q-6	10358	2473
UAF-Q-9	4680	2150
UAF-Q-11	3520	1111
UAF-Q-15	5038	1430
UAF-Q-17	4856	1114
UAF-Q-24	2055	1012
UAF-Q-51	2055	1928
UAF-Q-81	8950	2418
UAF-Q-82	4127	1527
UAF-Q-126	8071 c	1619

PULSES

42. Influence of phosphorous and potash on radiation use efficiency of mungbean

The study was conducted under Faisalabad conditions during Kharif 2018 with the objectives to find the influence of P and K on radiation use efficiency of autumn planted mungbean. Phosphorus was applied @ 0, 57, 68, 80, 45 kg/ha while K2O @ 0, 24, 30, 36, 42 kg/ha was applied. The result depicted significantly greater seed yield 1370 kg/ha by applying fertilizers @ 22-80-30 kg/ha N-P-K compared to seed yield of 882 kg/ha where no P_2O_5 and K_2O were applied.

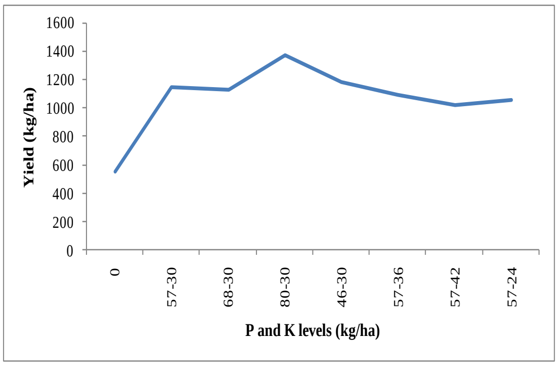


Figure. Influence of Phosphorous and Potash on yield of mungbean

43. Effect of organic amendments and phosphorous solubilizing bacteria on yield of mungbean

The study was conducted under Faisalabad conditions during Rabi 2017-18 with the objectives to examine the effectiveness of Phosphorus Solubilizing Bacteria (PSB) having phosphatase activity in combination with organic amendment. Application of FYM @ 2.4 t/ha coupled with PSB to mungbean crop resulted in higher yields of 1091 kg/ha against the mungbean yield 877 kg/ha obtained by application of FYM @ 2.4 t/ha.

Table. Effect of different organic, inorganic and biological fertilizers on grain yield of mungbean

Treatment	Grain Yield (kg/ha)
Synthetic Fertilizer @ 23-57-30 NPK kg/ha (Recommended)	910
Farm yard manure @ 2.4 t/ha	877
Sugarcane Pressmud @5 t/ha	842
Farm yard manure @ 2.4 t/ha+PSB	1091
Sugarcane Pressmud@5 t/ha+PSB	887

44. Optimizing plant spacing for different lentil cultivars under Thal irrigated conditions

The study was conducted under Thal conditions during Rabi 2018-19 with the objectives to optimize plant density for different lentil cultivars. Three Plant spacing (10 cm, 18 cm & 25 cm), and three cultivars (Chakwal Masoor, NIAB Masoor 2002 and Punjab Masoor 2009) were used in this study. The data given in below Table 14 showed significant effect on grain yield of lentil in respect of plant spacing and varieties as well as interaction. Chakwal Masoor produced higher grain yield of 451 kg ha^{-1} followed by NIAB Masoor 2002 when sown on 18 cm plant spacing. The minimum grain yield of 206kg ha^{-1} was given by Punjab Masoor 2009 when sown on 10 cm plant spacing. As far as interaction is concerned Chakwal Masoor produced maximum grain yield of 451 kg ha^{-1} and minimum 206 kg ha^{-1} by Punjab Masoor 2009.

Table. Effect of different plant spacing on grain yield (kg ha^{-1}) for different lentil cultivars under Thal irrigated conditions

Varieties/	Plant Spacing			
	10 cm	**18 cm**	**25 cm**	**Mean**
Chakwal Masoor	377	451	393	292
NIAB Masoor 2002	295	399	359	377
Punjab Masoor 2009	206	281	283	345
Mean	407	351	257	

45. Mungbean adaptation yield trial

The trial was conducted to find out best suited strains/varieties of mungbean for thal irrigated area, in collaboration with AZRI & NIAB Research Institute, Faisalabad and Bhakkar. Sixteen mungbean strains were tested at Agronomic Research Station Karor, during Kharif, 2018. The layout was Randomized Complete Block Design with three replications having net plot size 1.2 m × 4 m. The row and plant spacing were kept 30 cm and 10 cm respectively. A uniform N-P-K dose of 22-57-00 kg ha^{-1} was applied at the time of sowing. The data presented in figure # 3 showed that maximum grain yield (1251 kg ha^{-1}) was obtained from NM-2016, followed by TM-1426(1153 kg ha^{-1}). The minimum mung grain yield was obtained from TM-1608(406 kg/ha)

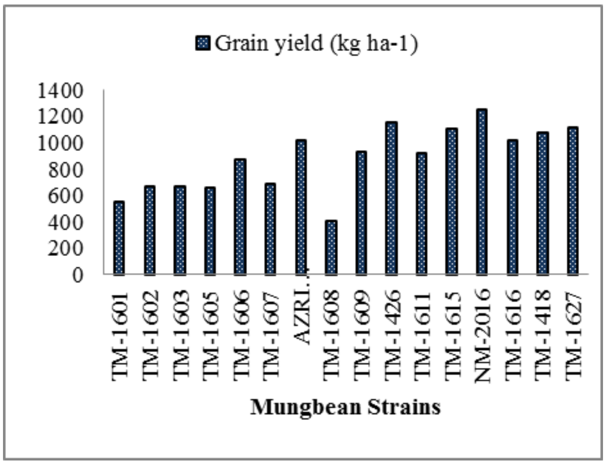


Figure. Mungbean adaptation yield trial

INTERCROPPING

46. Intercropping of sunflower in spring planted sugarcane

In an experiment intercropping of sunflower was experienced in sugarcane planted in 75 cm, 120 cm and 150 cm apart trenches during spring season. Net return of Rs. 92581 and 41461 /acre was depicted by the sugarcane crop sown alone at 120 cm and 75 cm apart trenches. Whereas the intercropping one row of sunflower on the top of 75 cm apart trenches gave net return Rs. 34374/acre and intercropping two rows of sunflower on the top of 120 cm apart trenches gave net return Rs. 39716/acre. Sugarcane planting alone in 150 cm apart trenches or intercropping two rows of sunflower on the top of 150 cm apart trenches depicted a loss of Rs. 25319 and Rs. 28748; respectively. This suggested minimum profitability of sunflower intercropping in spring planted sugarcane.

Figure Sunflower sown on top of 75 cm apart trenches intercropped with sugarcane

Economic Analysis					
Treatments	**Yield Maund/Acre**		**Value (Rs.) Sugar Cane + Sunflower**	**Total Cost (Rs)**	**Net Profit/ Loss (Rs.)**
	Sugar Cane	**Sunflower**			
Sugarcane alone in 75 cm apart trenches	**1079**	**0**	**194220**	**152759**	**41461**
Sugarcane alone in 120 cm apart trenches	**1363**	**0**	**245340**	**152759**	**92581**
Sugarcane alone in 150 cm apart trenches	**708**	**0**	**127440**	**152759**	**-25319**
Sugarcane in 75 cm apart trenches + 1 row of sunflower on ridges	**1034**	**12.65**	**212772**	**178398**	**34374**
Sugarcane in 120 cm apart trenches + 2 rows of sunflower on ridges	**1039**	**14.45**	**218114**	**178398**	**39716**
Sugarcane in 150 cm apart trenches + 2 rows of sunflower on ridges	**708**	**10.43**	**149650**	**178398**	**-28748**

47. Intercropping of pulses with spring planted sugarcane

Intercropping of 3 rows of mungbean on each bed in spring planted sugarcane planted in 120 cm a part trenches resulted in higher return of 87232 Rs. / acre as against the intercropping of 3 rows of mashbean in spring planted sugarcane which resulted in a net return of 63472 Rs. / acre.

Economic analysis							
Treatments	**Cane yield (kg ha^{-1})**	**Intercrop yield (kg ha^{-1})**	**Cane income (Rs.ha^{-1})**	**Intercrop income (Rs.ha^{-1})**	**Total income (Rs.)**	**Total cost (Rs.)**	**Net Return (Rs.)**
Sugarcane alone	88680	0	383098	0	383098	196862	186236
Mung alone	0	1091	0	103645	103645	38050	65595
Mash alone	0	1178	0	135470	135470	38150	97320

Sugarcane + mung	96822	611	418271	58045	476316	233650	242666
Sugarcane + mash	82122	464	354767	53360	408127	233100	175027

Figure Mungbean intercropped with sugarcane in 120 cm apart trenches

48. Ecological efficiency of cotton and mungbean intercropping system at different plant population densities under arid climate

This experiment was carried out to identify the advantages of Cotton/Mung intercropping over solitary cropping through agronomic interactions under arid irrigated conditions. The experiment comprised 5 treatments;T1:solecotton,T2:sole mungbean, T3:75cm space single row of cotton with mungbean at low population densities (cotton:1,77,77& ungbbean:53333), T4: 75cm space single of cotton with mungbean at medium population densities (cotton:26666 & mungbbean:71111), T5: 75cm space single of cotton with mungbean at high population densities(cotton:35555 & mungbbean:1,06,666).The study was conducted in RCBD with 3 replications and plot size of 6.0m x 4.5m.The result revealed that the treatment sole cotton & sole mungbean gave maximum seed cotton yield and mungbean grain yield i.e. 3026 and 1964 kg/ha due to its better LER (1).

Table Yield (Cotton & Mungbean) and cost benefit ration as affected by different plant population densities under arid climate

Intercropping Techniques	**Yield(kgha^{-1})**		**Cost Benefit Ratio**
	Cotton	**Mungbean**	
Sole Cotton	3026 a		1.91:1
Sole Mung bean		1964 a	2.64:1
75 cm space single row of Cotton with Mung bean at low population density	2345 b	1553 b	2.11:1
75 cm space single row of Cotton with Mung	2459 b	1631 ab	2.20:1

bean with medium population density			
75 cm space single row of Cotton with Mung bean at high population density	2468 b	1633 ab	2.30:1
LSD 5%.	297.8	400.8	

49. Impact of sugarcane press mud on growth & yield of lentil

The study was aimed to find out the yield response of lentil to different doses of sugarcane Press Mud @ 5 tons ha^{-1}, 10 tons ha^{-1}, 15 tons ha^{-1} and 20 tons ha^{-1}. Recommended dose of fertilizer was kept as control. Application of press mud @ 10 tons ha^{-1} in lentil resulted in higher yields of 1150 kg/ha against the yield of synthetic fertilizer (1012 kg/ha) which were applied @ 23-57-62 NPK kg/ha.

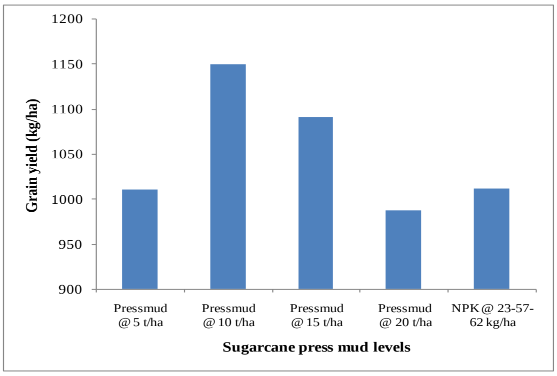


Figure. Effect of different sugarcane press mud levels on growth and yield of lentil

50. Effect of organic amendments and phosphorous solubilizing bacteria on growth and yield of chickpea

An experiment was conducted to examine the effectiveness of Phosphorus Solubilizing Bacteria (PSB) having phosphatase activity in combination with farm yard manure to improve Phosphorus availability for better yield of chickpea. Application of FYM @ 2.4 t/ha coupled with Phosphorous solubilizing bacteria resulted in higher yields of 2222 kg/ha than synthetic fertilizer @ 23-57-62 NPK kg/ha which produced chickpea yield i.e. 1704 kg/ha.

Table. Effect of organic amendments and phosphorous solubilizing bacteria on yield of chickpea

Treatments	Yield (kg/ha)
NPK @ 23:57:62 kg/ha (Recommended)	1704
PSB + Recommended Fertilizer	1778
Farm Yard Manure @ 2.4 t ha-1	2074
PSB + FYM @ 2.4 t/ha	2222
FYM @ 2.4 t/ha + P and K using SSP and MOP.	1926

OILSEEDS

51. Effect of different planting methods and sowing time on the yield of sesame

The experiment was conducted to find out the optimum sowing time and plating method the get maximum yield of sesame. The experiment was laid out in RCBD with split with three replications having a plot size of 4.5 m × 7.0 m. The sowing time were 15th of June,01st of July,15th of July and sowing method were , Flat sowing (R×R = 45 cm),Broadcast augmented with bed planting (90 cm), Bed sowing (Line sowing of two rows on one bed = 90 cm), Broadcast augmented with furrow (60 cm). The maximum seed yield (1259) kg ha^{-1}was obtained from 01st of July. The method of swing Broadcast augmented with furrow (60 cm) gave maximum yield.

Table. **Effect of different planting methods and sowing time on the yield of sesame.**

Methods of Sowing	**Sowing Dates**			**Means**
	D1	**D2**	**D3**	
M1	833 e	889 de	794 f	839 c
M2	888 de	963 c	867 e	906 b
M3	961 c	926 cd	944 cd	939 b
M4	1294 a	1259 a	1111 b	1217 a
Mean	994 b	1009 a	928 c	

LSD (0.05) for sowing dates = 50.05

LSD (0.05) for sowing methods = 42.03

LSD (0.05) for interaction = 60.03

52. Effect of planting patterns and plant spacing on the yield of soybean

The experiment was conducted under Faisalabad conditions to find out the optimum rows pacing and seed placement pattern to get maximum yield of soybean. The planting patterns were seed placement in parallel lines, seed placement in alternate to adjacent row and plant spacing were 5, 10 and 20 cm. The Seed placement in alternate to adjacent row with 10 cm gave maximum yield (2555 kg ha^{-1}).

Table. Effect of planting patterns and plant spacings on the yield of soybean

Planting pattern	**Plant spacing**			
	05 cm	**10 cm**	**20 cm**	**Means**
Seed placement in parallel lines	1666	2083	1555	1766
Seed placement in alternate to adjacent rows	1778	2555	1738	2022
Mean	1722	2319	1646	

53. Effect of different levels of NPK on the yield of soybean

The experiment was conducted to determine the optimum levels of NPK to get maximum yield of soybean. The experiment was laid out in RCBD with three replications having a plot size of 2.7 m × 7.0 m. The treatments 40-30-31, 80-57-62, 96-87-92, 80-57-0 NPK kgha-1were tested. The treatment 96-87-92 NPK kgha^{-1}was gave maximum yield (1599 kg ha^{-1}).

Table effect of different levels of NPK on the yield of soybean

Treatments= N:P:K (Kg ha^{-1})	**Yield (Kg ha^{-1})**
T_1= 40:30:31	1200 C
T_2= 80:57:62	1325 B
T_3= 96:87:92	1599 A
T_4= 80:57:0	1379 B
LSD (0.05)	80

54. Effect of soil and foliar application of K and B on the yield of sunflower

The experiment was conducted under Faisalabad conditions to find out the optimum dose and application method of K and B to get maximum yield in sunflower. The treatments consisted of control (No K and B), K @ 62 kg ha-1, B @ 5kg ha^{-1}, K @ 62 kg ha^{-1} + K 0.1% foliar (45, 60, 75 DAS), B 5kg ha^{-1} + B 0.1% foliar (45, 60, 75 DAS), K 62 kg ha^{-1} + B and K 0.1% foliar (45, 60, 75 DAS), B 5 kg ha^{-1} + B and K 0.1% foliar (45,60,75 DAS), K 0.1% foliar (45, 60, 75 DAS), B 0.1% foliar (45,60,75 DAS). Maximum seed yield (2976) ha^{-1} was obtained by applying K @ 62 kg ha^{-1} + B and K 0.1%; sprayed 45, 60, 75 DAS.

Table. Effect of soil and foliar application of K and B on the yield of sunflower

Treatments	**Yield kg/ha**
$T_{1=}$ Control	2045
$T_{2=}$ K 62kg ha^{-1}	2575
$T_{3=}$ B 5kg ha^{-1}	2107
$T_{4=}$ K 62kg ha^{-1} + K 0.1% (45,60,75 DAS)	2881
$T_{5=}$ B 5kg ha^{-1} + B 0.1% (45,60,75 DAS)	2371
$T_{6=}$ K 62kg ha^{-1} + B & K 0.1% (45,60,75 DAS)	2976
$T_{7=}$ B 5kg ha^{-1} + B & K 0.1% (45,60,75 DAS)	2721
$T_{8=}$ K 0.1% (45,60,75 DAS)	2431
$T_{9=}$B 0.1% (45,60,75 DAS)	2295
LSD (0.05) = 339	

55. Yield potential trial on raya varieties under different methods of planting

An experiment was conducted with objectives to evaluate the yield potential of *Raya* varieties under different methods of planting in comparison with conventional planting. The experiment was conductedat Agronomic Research Station, Bahawalpur during rabi season 2018-19. The experiment was laid out under Randomized Complete Block Design (RCBD) with split plot arrangement and replicated three times. Treatments were comprised of P_1 = Broadcast (conventional) in flat field; P_2 =Drill sowing and P_3 =Broadcast of seed and augmented with furrows (Ridging) in main plots and V_1 = Super raya and V_2 = Khanpurraya in sub plots.

Non-significant effect of different sowing methods and genotypes was recorded for emergence of raya.

Table. Effect of sowing methods on emergence of raya (m^{-2})

Genotypes	Planting methods			Emergence per m^2
	Broadcast (conventional) in flat field	Drill sowing	Broadcast of seed and augmented with furrows (Ridging)	
Super raya	133.7	133.3	130.7	132.6
Khanpurraya	141	123.0	124.3	129.4
Emergence per m^2	137.3	128.2	127.5	
Tukey' HSD for sowing dates = Non-significant ($p \leq 0.05$) Tukey' HSD for genotypes = Non-significant ($p \leq 0.05$)				

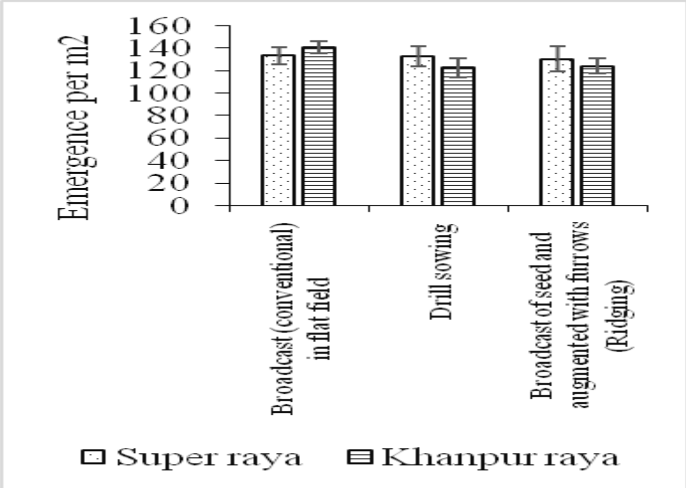


Figure. Effect of sowing methods on emergence of raya (m^{-2})

HERBICIDES

56. Weed management in canola

This study was conducted under Faisalabad conditions during Rabi 2018-19 to evaluate eleven herbicides viz; Stomp 455 g/L CS, Dual gold 960 EC, Topmax 96 EC, Pert 50 SC, G Max lite 15 EC, Axial 050 EC and Pret 50 SC+G Max lite for chemical weed control in canola. Maximum grain yield (2767 kg/ha) was obtained with manual control which is at par with dual gold 960 EC applied @ 2000 ml/ha while minimum yield (1983 kg/ha) was obtained with Pret 50 SC (post emergence) applied @ 1000ml/ha.

Table. Effect of weeds control through application of different pre and post emergence herbicides on canola grain yield (kg/ha)

Treatments	Grain yield (kg/ha)
Stomp 455 g/l CS	2383 b
Stomp 455 g/l CS	2150 bc
Dual gold 960 EC	2600 a
Dual gold 960 EC	2733 a
Topmax 96 EC	2317 b
Topmax 96 EC	2467 b
Pert 50 SC	1983 c
Pert 50 SC	2117 bc
G Max lite 15 EC	2350 b
Axial 050 EC	2350 b
Pert50 SC + G Max lite	2467 b
Manual/mechanical control	2767 a
Control/weedicheck	1767 d

57. Re-verification of bio efficacy of herbicides for weed control in wheat

This research was conducted to evaluate fifteen different existing herbicides viz; Atlantis 3.6 WG, Findus 3.6 WG, Ferarray 16 EC, Axial 050 EC, Topik 15 WP, Sonak 15 WP, Skype 20 EC, Certain plus 14.5 EC, Buctril super 60 EC, Selector 60 EC, Starane-M 50

EC, Bromoxynil +MCPA 40 EC, Harvester 100+ 400 g/L, Laren Max 66.7 WG, Metafin super 28.6 WG against check for their efficacy. The maximum grain yield (3533 kg/ha) was obtained with Axial 50 EC @ 825 ml/ha which is at par with Certain plus 14.5 EC @ 1250 ml/ha for monocot weeds while in case of herbicides used for dicot weeds the highest grain yield (3533 kg/ha) was obtained with Starane-M 50 EC, however minimum grain yield was obtained in control with no herbicide application.

Table. Re-verification of bio efficacy of monocot herbicides on grain yield of wheat crop

Treatment	Grain yield (kg/ha)
Axial 050 EC	3533
Certain plus 14.5 EC	3483
Topik 15 WP	3366
Kauida 60 WP	3167
Skype 20 EC	3233
Chitta 69 EW	2933
Control/weedicheck	2633

Table. Re-verification of bio efficacy of dicot herbicides on grain yield of wheat crop

Treatment	Grain yield (kg/ha)
Buctril super 60 EC	3500
Selecter 40 EC	3483
Starane-M 50EC	3533
Broad-X	3450
Agritop 40 EC	3233
Strait 30 EC	3216
Keychain	3483
Allymax 66.7 WG	3300
Lancelot 45 WG	3333
Ge Chu	3333
Control/weedicheck	2733

58. Weed management in *Egyptian clover* (berseem)

This research was conducted under Faisalabad conditions during Rabi 2018-19 to evaluate three herbicides viz; Stomp 455 g/L CS, FTN 90 WP and Axial 050 EC for their weed control efficacy in berseem. Maximum fodder yield of 149 t/ha was obtained with Stomp 455 g/l CS @ 3750 ml/ha while minimum green fodder yield (123 t/ha) was obtained where no herbicide was applied.

Table. **Comparative efficiency of different pre and post emeregence herbicides on berseem fodder yield**

Herbicides	Fodder yield (t/ha)
Stomp 455 g/l CS	149
Stomp 455 g/l CS	149
Round up 540 g/l SL	149
Stomp 455 g/l CS	146

Stomp 455 g/l CS	147
FTN 90 WP 15 DAS	142
FTN 90 WP 21 DAS	145
FTN 90 WP 28 DAS	150
Control/weedicheck	123

59. Weed management in gram/chickpea

The study was carried under Faisalabad conditions during Rabi 2018-19 to evaluate herbicides viz; Stomp 455 g/L CS, Dual gold 960 EC, Topmax 96 EC, G Max lite 15 EC and Axial 050 EC for chemical weed control in gram/chickpea and lentil. The highest grain yield (1472 kg/ha) of gram was obtained with mechanical control and minimum grain yield (972 kg/ha) in control. In case of lentil highest grain yield (1079 kg/ha) was obtained with mechanical control while minimum yield (260 kg/ha) was obtained where no herbicide was applied.

Table. Grain yield (kg/ha) of chickpea as affected by spray of different pre and post emegence herbicides to reduce weeds crop competition

Herbicides	Grain yield (kg/ha)
Stomp 455 g/l CS	1434
Stomp 455 g/l CS	1462
Dual gold 960 EC	1342
Dual gold 960 EC	1392
Topmax 96 EC	1378
Topmax 96 EC	1434
G Max lite 15 EC	1302
Axial 050 EC	1302
Manual/mechanical control	1472
Control/weedicheck	972

60. Weed management in lentil

This experiment was conducted to evaluate eight herbicides viz; Stomp 455 g/L CS, Dual gold 960 EC, Topmax 96 EC, G Max lite 15 EC and Axial 050 EC for chemical weed control against mechanical/manual control in lentil. The experiment was laid out in randomized complete block design with plot size of 3.0 m × 5.0 m having three replications. In case of lentil highest grain yield (1079 kg/ha) was obtained with mechanical control while minimum yield (260 kg/ha) was obtained where no herbicide was applied.

Table. Effect of several pre and post emergence herbicides to control weeds and enhance grain yield (kg/ha) of lentil

Herbicides	Grain yield (kg/ha)
Stomp 455 g/l CS	962 a
Stomp 455 g/l CS	1026 a
Dual gold 960 EC	931 ab
Dual gold 960 EC	999 a
Topmax 96 EC	888 b

Topmax 96 EC	952 a
G Max lite 15 EC	793 b
Axial 050 EC	793 b
Manual/mechanical control	1079 a
Control/weedicheck	260 c

61. Testing of new herbicides for cotton

This trial was conducted to find out new herbicides for effective weed control in cotton crop. The pre- emergence application ofherbicide candidates Burton 960 EC @ 1500 mL ha^{-1} and Dual gold 960 EC @ 2000 ml ha-1 gave maximum and statisticallyat par seed cotton yield of 1.15 t ha^{-1}. The minimum seed cotton yield (0.67 t ha^{-1}) was observed in control where no herbicides were sprayed.

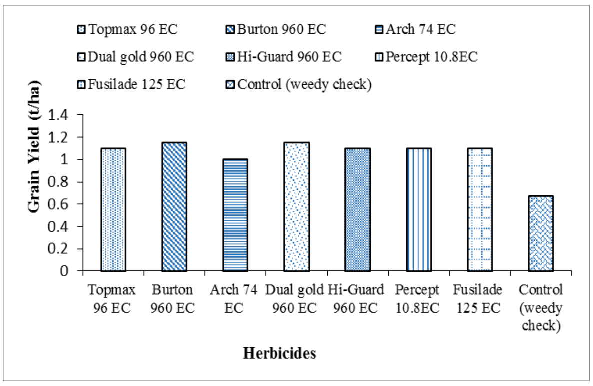


Figure. Effect of herbicides on seed cotton yield (t/ha)

62. Screening of New Herbicides for Sugarcane

The experiment was conducted to find the efficacy of new herbicides to control weeds (grasses, broad leaf weeds and sedges) in sugarcane crop. New pre-emergence and post emergence herbicides i.e., Topmax 96 EC, Burton 960 EC, Arch 74 EC, Primextra gold 720 SC, Voltril 63 SC, Twist 55 SC and Connect 48 SC were tested. Amongst the pre-emergence herbicides standard Topmax 96 EC @ 250 ml ha-1 provided 92%, and 93% control of broad leaf weeds and grasses respectively. However, in case of sedges Burton 960 EC (88%) performed better. As for as post-emergence herbicides are concerned performance of candidate herbicide Connect 48 SCprovided 93%, 89% and 90% control of broad leaf weeds, grasses and sedges, respectively. Over all, herbicide Topmax 96 ECproved better to control weeds and to increase cane yield of sugarcane over check.

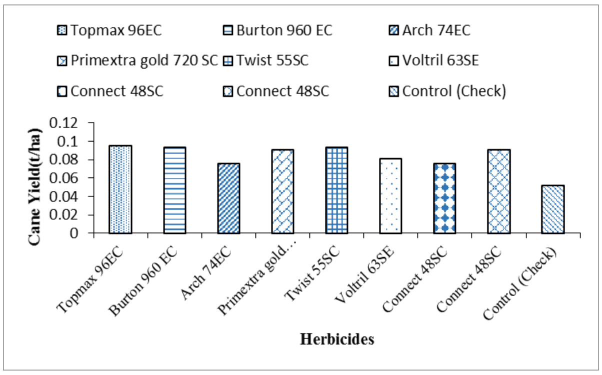


Figure. Effect of herbicides on cane yield (t/ha)

63. Testing of New Herbicides for Maize

Nine pre and post emergence herbicides formulations viz. Burton 960 EC, Arch 74 EC, Topmax 96 EC, Voltril 63 SC, Primextra gold 720 SC, High guard 960 EC, Dual gold 960 EC, Fallisto gold 55 SC and Connect 48 SLwere tested against Control (weedy check). Highest maize grain yield (3.90t ha^{-1}) was recorded in treatment where Primextra gold 720 SC @ 2000 mL ha^{-1} was sprayed. The lowest grain yield of 2.25 t ha^{-1} was produced in case of weedy check. Thecandidate herbicides did not show any phytotoxicity in maize.

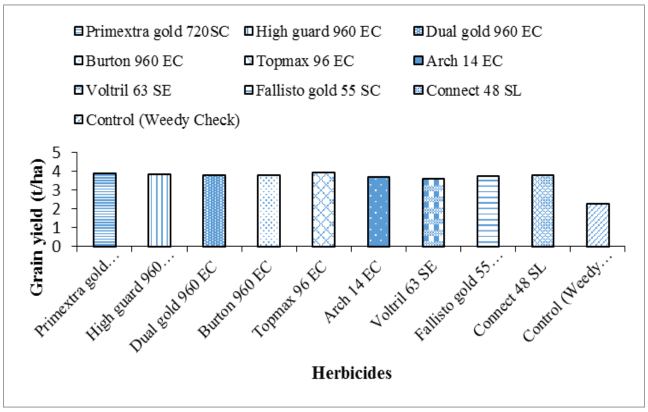


Figure. Effect of different herbicides on grain yield of maize (t/ha)

64. Screening of new herbicides for rice

This trial was conducted with the objective to screen out new herbicides for weed control in rice crop. Twelve herbicides(old + new) formulations viz. Machete 60 EC,Caster 50 EC,Client 90 EC, Acetore 50 EC, Kelion 50 WG, Council Activ 30 WG, Pyranex 30 WDG, Nictra 50 EC, Rifit 50 EC, Apirofort 55.08 SC, Winsta 30 WP, and Zebra 10 SC were tested against Control (weedy check). New herbicides gave comparatively better weed control and paddy yield was at par howevermaximum paddy yield (4.05 t ha^{-1}) was obtained with council active 30 WG and minimum (2.10 tha^{-1}) paddy yield was obtained with weedy check.

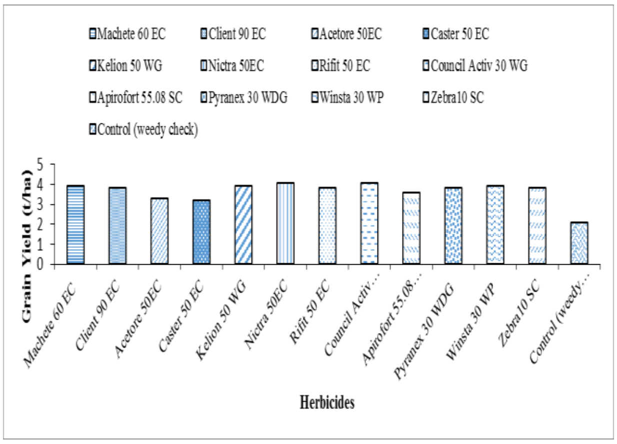


Figure. Effect of herbicides on paddy yield (t/ha)

65. Weed management in okra

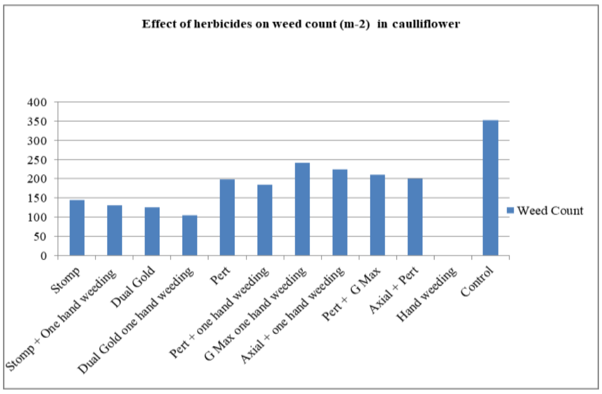
The experiment was conducted to find out the most suitable herbicide for weed control. The experiment was laid out in RCBD with three replications having a plot size of 2.1 m × 7.0 m. Row and plant spacing were maintained as 70 cm and 15 cm, respectively. The treatments were Pendimethalin at 2.5 L ha^{-1} pre em.Dual gold at 1.80 L ha-1 pre em. Pert plus at 2.25 L ha^{-1} pre em. Percept at 0.875 L ha^{-1} post em. Calm at 0.625 L ha^{-1} post em.Weed free,Control was tested. The maximum fruit yield (4921) kg ha^{-1} was obtained from weed free treatment. The treatment Percept at 0.875L ha^{-1} post em was gave maximum weed control.

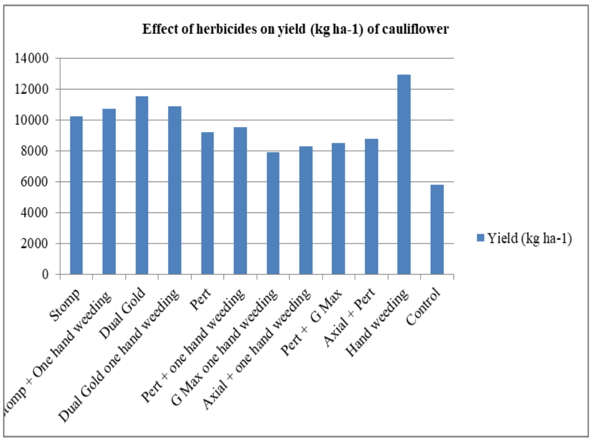
Table Effect of herbicides on fruit yield (kg/ha)

Treatments	**Fruit yield (kg ha^{-1})**	**Weeds (m^2)**	**Weed control (%)**
T_1 = Pendimethalin at 2.5 L ha^{-1} pre em.	4232 b	140 cd	62
T2 = Dual gold at1.80 L ha-1 pre em.	4127 b	154 c	57
T_3 = Pert plus at 2.25 L ha^{-1} pre em.	4338 b	132 d	64
T_4 = Percept at 0.875 L ha^{-1} post em.	3571 c	268 b	27
T_5 = Calm at 0.625 L ha^{-1} post em.	3518 c	259 b	29
T_6 = Weed free	4921 a	0.00 e	100
T_7= Control	2201 d	368 a	
LSD (0.05) for yield = 304.65 LSD (0.05) for weeds = 15.17			

66. Weed management in cauliflower

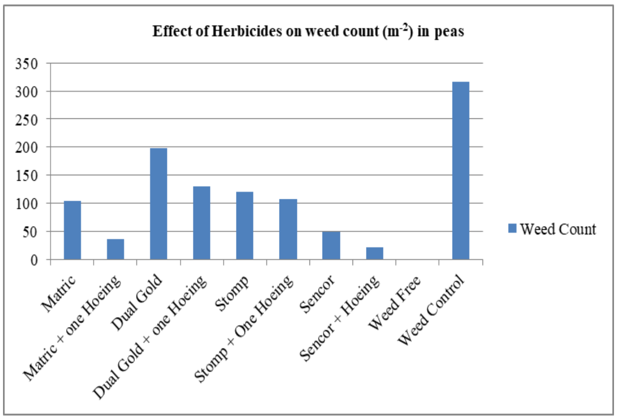
The experiment was conducted to investigate the most practicable package of weed management in cauliflower. The experiment was laid out in RCBD with three replications having a plot size of 3.0 m × 5.0 m. The treatments Stomp 455 g/l CS 2000 ml/ha Pre emergence plus one hand weeding, Stomp 455 g/l CS 2500 ml/ha Pre emergence plus one hand weeding, Dual gold 960 EC1500 ml/ha Pre emergence plus one hand weeding, Dual gold 960 EC 2000 ml/ha Pre emergence plus one hand weeding, Pert 750 ml/ha Post emergence for BL weeds plus one hand weeding, Pert 1000 ml/ha Post emergence for BL weeds plus one hand weeding, G Max lite 15 EC 650 ml/ha Post emergence for grassy weeds plus one hand weeding, Axial 050 **EC** 825 ml/ha Post emergence for grassy weeds plus one hand, Pert+ G Max lite 800 ml/ha +650 ml/ha Post emergence for BL weeds and grasses complex, Axial 050 EC+ Pert 800 ml/ha +825 ml/ha Post emergence for BL weeds and grasses complex, 3-4 Hand weeding, Control. The weed free treatment gave maximum cauliflower yield (16273) kgha^{-1}.The treatment Stomp 455 g/l CS 2500 ml/ha Pre emergence plus one hand weeding gave maximum weed control.

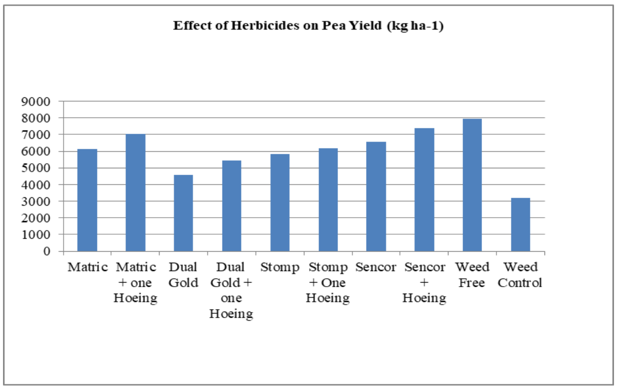




67. Weed management in peas

The experiment was conducted to find out the best and suitable herbicide for controlling the weeds in peas. The experiment was laid out in RCBD with three replications having a plot size of 1.8 m × 5.0 m.The treatments Matric 25 ZC 1.250**L ha**$^{-1}$ Pre- em, Matric25 ZC 1.250**L ha**$^{-1}$ Pre- em + one hoeing &earthingup 45 DAS, Dual Gold 960 EC 2.00**L ha**$^{-1}$ Pre- em, Dual Gold 960 EC2.00**L ha**$^{-1}$Pre- em, + one hoeing &earthing up 45 DAS 2.00 Pendimethalin 330 E 3.75**L ha**$^{-1}$ Pre- em, Pendimethalin 330 E 3.75**L ha**$^{-1}$+ one hoeing &earthing up 45 DAS, Sencor 70 WP 310 g**ha**$^{-1}$ Pre- em, Sencor 70 WPWP 310 g**ha**$^{-1}$ Pre- em,+ one hoeing &earthing up 45 DAS 310 g , Weed Free(3-4 hand weeding &earthing up 45 DAS), Control .The weed free treatment gave maximum peas yield (9533) kgha^{-1}Dual Gold 960 EC 2.00**L ha**$^{-1}$ Pre- emergence gave maximum weed control.





68. Determination of comparative efficacy of broad leaf weedicides in wheat

An experiment was conducted with objectivesto sort out the better broad leaf weedicide for weeds control in wheat crop.The experiment was conductedat Agronomic Research Station, Bahawalpur during rabi season 2018-19. The experiment was laid out under Randomized Complete Block Design (RCBD) and replicated three times. Treatments were comprised of T_1= Control; T_2= Buctril Supper 60EC (Bomoxynil+MCPA) @ 750 ml ha^{-1}; T_3=Bomoxynil +MCPA 40EC @ 1250 ml ha^{-1}; T_4= Starane-M 50EC (Fluroxypyr +MCPA) @ 750 ml ha^{-1}; T_5= Harvester100+400g/L (Fluroxypyr +MCPA) @ 1000 ml ha^{-1}; T_6= Laren Max 66.7 WG (Metsulfuron + Tribenuron) @20 g ha^{-1}; T_7= Selector 60EC (Bomoxynil +MCPA) @ 750 ml ha^{-1} and T_8= Metafin Supper 28.6 WG (Metsulfuron + Tribenuron) @20 g ha^{-1} + @20 g ha^{-1}. Non-significant effect of different weedicides was observed for emergence of wheat.

Table. Effect of different weedicides on emergence of wheat (m^{-2})

Treatments	Emergence per m^2
T1= Control	192.3
T_2= Buctril Supper 60EC (Bomoxynil +MCPA) @ 750 ml ha^{-1}	200.0
T_3=Bomoxynil +MCPA 40EC @ 1250 ml ha^{-1}	195.3
T_4= Starane-M 50EC (Fluroxypyr +MCPA) @ 750 ml ha^{-1}	200.0
T_5= Harvester100+400g/L (Fluroxypyr +MCPA) @ 1000 ml ha^{-1}	198.3
T_6= Laren Max 66.7 WG (Metsulfuron + Tribenuron) @20 g ha^{-1}	195.3
T_7= Selector 60EC (Bomoxynil +MCPA) @ 750 ml ha^{-1}	206.7
T_8= Metafin Supper 28.6 WG (Metsulfuron + Tribenuron) @20 g ha^{-1} + @20 g ha^{-1}	20.6.0
Tukey HSD = Non-significant (p≤0.05)	

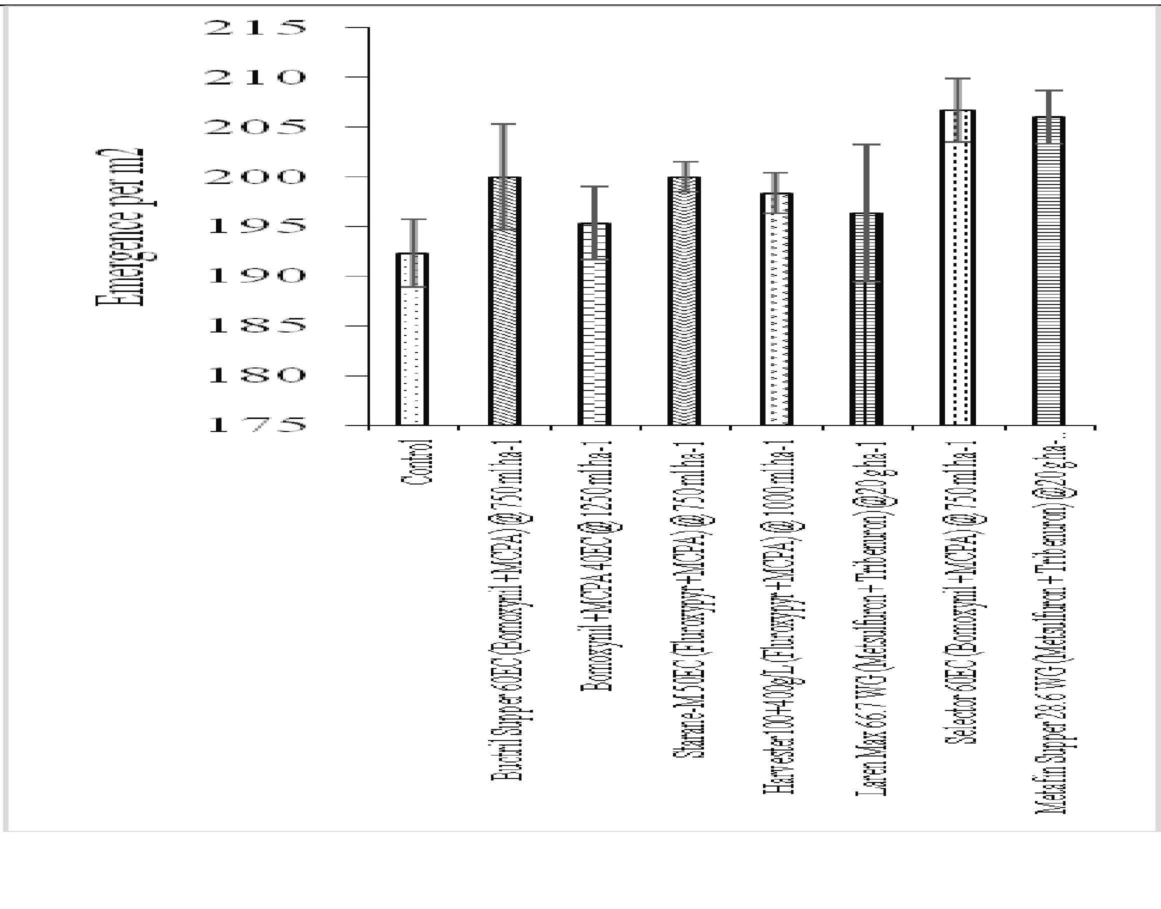


Figure. Effect of different weedicides on emergence of wheat (m^{-2})

69. Integrated weed management in wheat

An experiment was conducted with objectives to sort out the better integrated weed management strategy for weeds control in wheat crop. The experiment was conductedat Agronomic Research Station, Bahawalpur during rabi season 2018-19. The experiment was laid out under Randomized Complete Block Design (RCBD) and replicated three times. Treatments were comprised of T_1 = Control; T_2= Atlantis3.6WG (Mesosulfuron) @ 400 g ha^{-1}; T_3= Ferarry 16 EC (Fenoxaprop + Metribuzin) @ 750 ml ha^{-1} and T_4= Findus 3.6. WG (Mesosulfuron + Iodosulfuron) @ 400 g ha^{-1}. Non-significant effect of different integrated weed management techniques was observed for emergence of wheat (Table 12) (Figure 12).

Table. Effect of different integrated weeds management techniques on emergence of wheat (m^{-2})

Treatments	Emergence per m^2
T_1 = Control	194.0
T_2= Atlantis3.6WG (Mesosulfuron) @ 400 g ha^{-1}	202.3
T_3= Ferarry 16 EC (Fenoxaprop + Metribuzin) @ 750 ml ha^{-1}	200.7
T_4= Findus 3.6. WG (Mesosulfuron + Iodosulfuron) @ 400 g ha^{-1}	206.00
Tukey HSD = Non-significant ($p \leq 0.05$)	

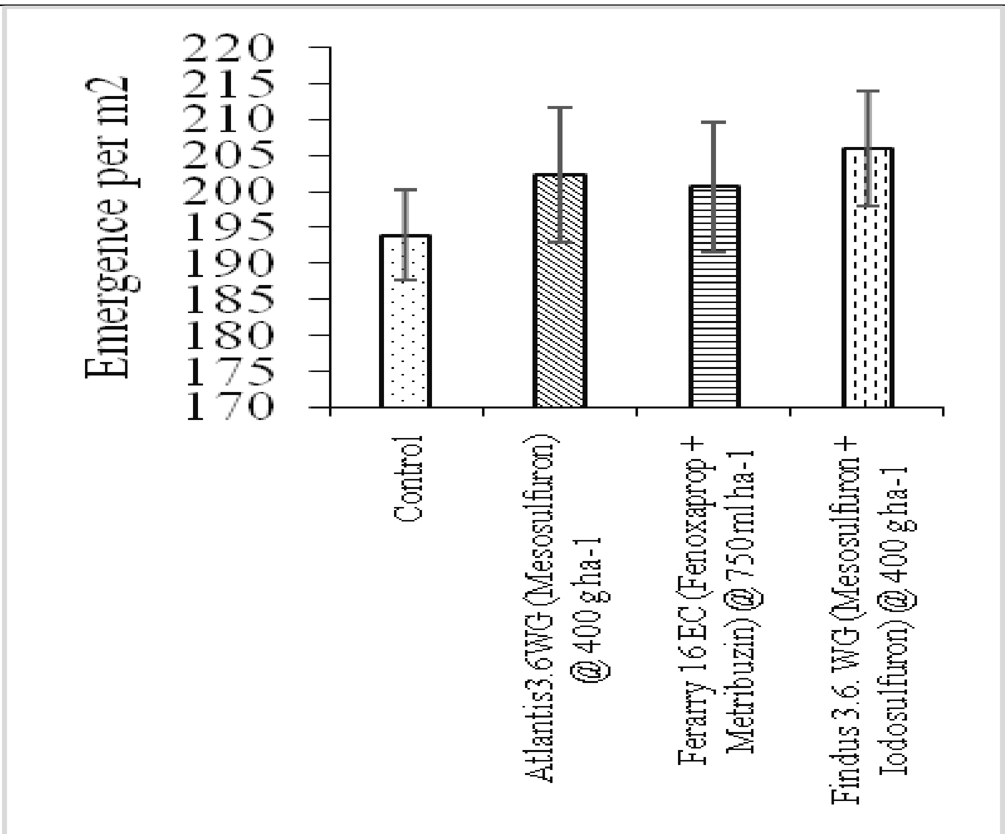


Figure. Effect of different integrated weeds management techniques on emergence of wheat (m^{-2})

70. Determination of comparative efficacy of narrow leaf weedicides in wheat

An experiment was conducted with objectivesto sort out the better narrow leaf weedicide for weeds control in wheat crop. The experiment was conductedat Agronomic Research Station, Bahawalpur during rabi season 2018-19. The experiment was laid out under Randomized Complete Block Design (RCBD) and replicated three times. Treatments were comprised of T_1= Control; T_2= Axial 050EC (Penoxaden) @ 825 ml ha^{-1}; T_3= Topik 15WP (Clodinafop propargyl) @300 g ha^{-1}; T_4= Sonak 15WP (Clodinafop propargyl) @300 g ha^{-1}; T5= Skype 20EC (Clodinafop propargyl) @250 ml ha^{-1} and T_6= Certain plus 14.5 EC (Clodinafop + Fenoxaprop + Tralkoxydim) @ 1250 ml ha^{-1}. Non-significant effect of different narrow leaf weedicides was observed for emergence of wheat.

Table. Effect of different weedicides on emergence of wheat (m^{-2})

Treatments	Emergence per m^2
T_1= Control	194.0
T_2= Axial 050EC (Penoxaden) @ 825 ml ha^{-1}	203.3
T_3= Topik 15WP (Clodinafop propargyl) @300 g ha^{-1}	200.0
T_4= Sonak 15WP (Clodinafop propargyl) @300 g ha^{-1}	206.7
T_5= Skype 20EC (Clodinafop propargyl) @250 ml ha^{-1}	202.0
T_6= Certain plus 14.5 EC (Clodinafop + Fenoxaprop + Tralkoxydim) @ 1250 ml ha^{-1}	206.0
Tukey's HSD = Non-significant ($p \leq 0.05$)	

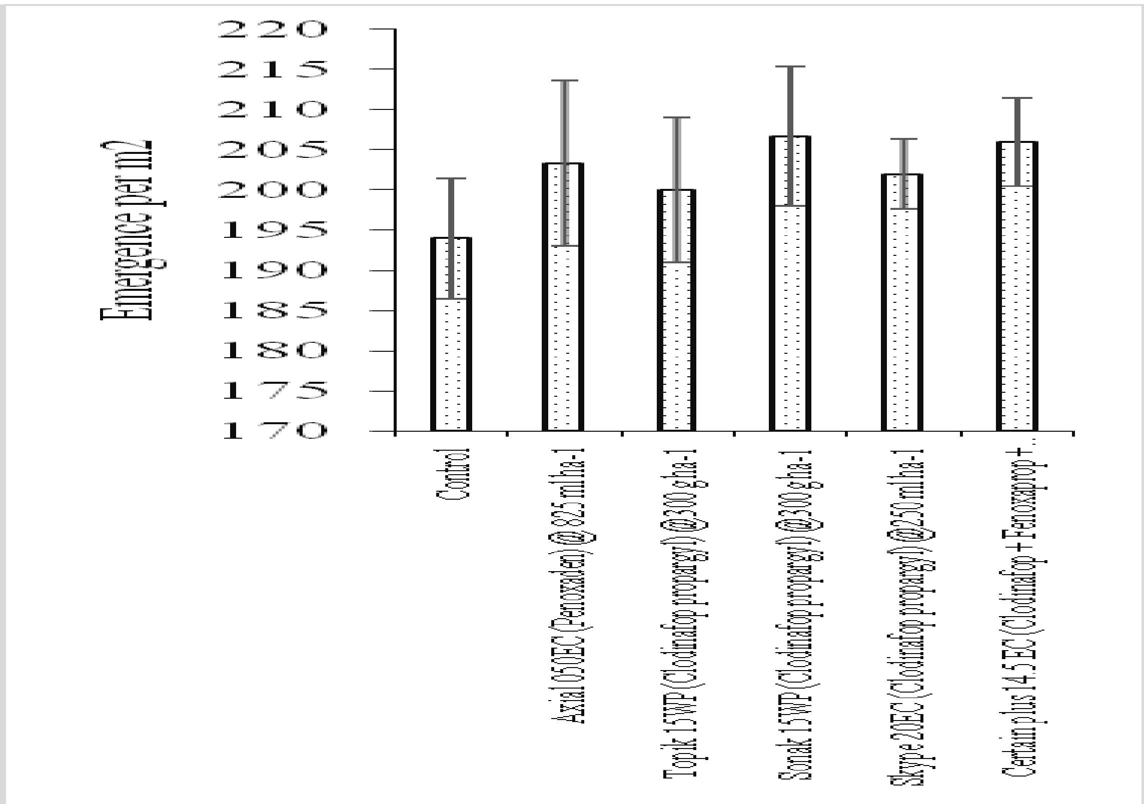


Figure. Effect of different weedicides on emergence of wheat (m^{-2})

MEDICINAL PLANTS

71. Multilocational yield performance of tulsi (*Ocimum tenuiflorum* L.)

The trial was conducted at Faisalabad, Karor, Khanewal, Farooqabad and Dhakkar for their comparison to see maximum yield potential of tulsi under different agro-ecological zones of Punjab. The highest grain yield (999.87 kg ha^{-1}) was achieved at Faisalabad while the minimum grain yield (867.87 kg ha^{-1}) was obtained at Pakpattan.

72. Irrigation management studies in tulsi (*Ocimum tenuiflorum*)

The experiment was conducted under Faisalabad conditions to assess the optimum water requirements of tulsi. The treatments were; Irrigation at 70% available water, Irrigation at 60% available water, Irrigation at 50% available water and Irrigation at 40% available water. Maximum raceme/plant (510.33), 1000-grain weight (1.267 g) and grain yield (1143 kg ha^{-1}) was achieved when irrigation was applied at 60% available water.

73. Nutrient management studies in tulsi (*Ocimum tenuiflorum*)

The experiment was conducted under Faisalabad conditions to find out the optimum fertilizer requirements of tulsi. The treatments were NPK @ 60-60-0, 60-60-20, 60-60-40 [1] and 60-60-60 Kg ha^{-1}. Maximum raceme/plant (410), 1000-grain weight (0.96 g) and grain yield (1018 kg ha^{-1}) was achieved when fertilizer NPK was applied @ 60-60-40 kg ha^{-1}.

BIOFORTIFICATION - NUTRIENT ENHANCEMENT

74. Bio-fortification of cucumber with zinc by soil & foliar application of (Zn SO_4)

The study was conducted under Faisalabad conditions to find out the optimum levels of zinc (soil and foliar application) for enhancing nutritional value (bio-available Zn) in cucumber. Treatments comprising of control (No Zn); three treatments of soil application of $ZnSO_4$ @ 10, 20, 30 kg ha^{-1} along with four foliar application of 0.1% Zn (45, 55, 65, 75 DAS) The maximum Zn contents (60.95 ppm) were recorded where four foliar application of 0.1% Zn @ 45,55,65,75 DAS along with 30 kg ha^{-1} of soil application.

Table. Nutrient enhancement in cucumber through soil and foliar application of Zn

Treatments = (Zn SO4) kg ha^{-1}	**Yield (kg ha^{-1})**	**Zn uptake (ppm)**
Control	14780	20.10
10 + 0.1% spray (45,55,65,75 DAS)	16013	42.00
20 + 0.1% spray (45,55,65,75 DAS)	16416	51.05
30 + 0.1% spray (45,55,65,75 DAS)	17125	60.95
0.1% spray (45,55,65,75 DAS)	16101	38.17

75. Bio-fortification of potato with zinc by soil & foliar application of ($ZnSO_4$)

The study was conducted under Faisalabad conditions to find out the optimum levels of zinc (soil and foliar application) for enhancing nutritional value (bio-available Zn) in potato. The treatments were comprised of control (No Zn), 10 kg ha^{-1} (Zn SO4) + 0.1% spray of (Zn SO4) 45,55,65,75 DAS, 20 kg ha^{-1} Zn SO4) + 0.1% spray (45,55,65,75 DAS), 30 kg ha^{-1} (Zn SO4) + 0.1% spray (45,55,65,75 DAS) and 0.1% spray of (Zn SO4) (45, 55, 65, 75

DAS) .The treatment 30 kg ha^{-1} (Zn SO4) + 0.1% spray (45,55,65,75 DAS) gave maximum potato yield (21226) kg ha^{-1}.

76. Bio-fortification of Maize by zinc application

The experiment was conducted under Faisalabad conditions during 2018 to assess the zinc enrichment in maize by bio-fortification. The treatments consisted of Control (No Zn), soil application of Zinc sulphate @ 15 kg ha^{-1}, Foliar spray of Zinc sulphate @ 1.0% at 5th leaf, tasseling and grain formation stages and Foliar spray of Zinc sulphate @ 2.0% at 5th leaf, tasseling and grain formation stages. Maximum 1000-grain weight (344.0 g), higher biological yield (33777 kg ha^{-1}), grain yield (8.23 t ha^{-1}) and Bio-available Zinc (39.12 mg/kg) was achieved in treatment with Foliar spray of Zinc sulphate @ 2.0% at 5th leaf, tasseling and grain formation stages.

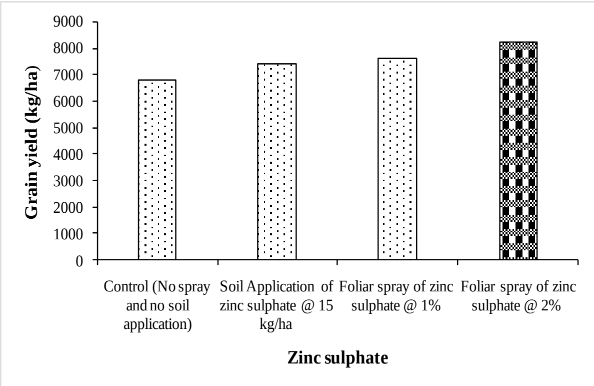


Figure. Effect of soil and foliar applied zinc on maize grain yield (kg ha^{-1})

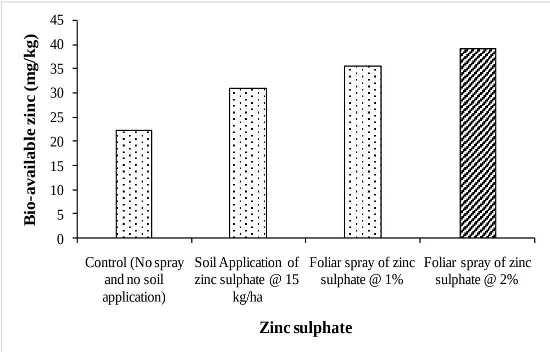


Figure. Effect of soil and foliar applied zinc on bio-available grain zinc contents (g)

ORGANIC FARMING

77. Effect of different organic sources of nutrients on turmeric yield

The experiment was conducted to find out the most suitable type and level of organic manures for organic production of garlic. The experiment was laid out in RCBD with three replications having a plot size of 2.1x m × 7.0 m· Row and plant spacing were maintained as 70 cm and 30 cm, respectively. The organic manure used were FYM 15t ha^{-1}, FYM 20t ha^{-1}, $^{-1}$, Sugarcane press mud 5t ha^{-1}, Sugarcane press mud 10t ha^{-1}·FYM 15t ha^{-1}, Sugarcane press mud 7.5t ha^{-1}.The maximum Turmeric yield of15675 kg ha^{-1} was recorded from the treatment where the combination of the FYM 15t ha^{-1}, Sugarcane press mud 7.5t ha^{-1} was applied.

Table Effect of different organic sources on turmeric yield

Treatments	**Yield (kg ha^{-1})**
T1 = FYM 15 t ha^{-1}	11508 c
T2 = FYM 20 t ha^{-1}	11905 bc
T3 = Sugarcane press mud 7.5 t ha^{-1}	12798 b
T4 = Sugarcane press mud 10 t ha^{-1}	14980 a
T5 = FYM 15 t ha^{-1} + Sugarcane press mud 7.5 t ha^{-1}	15675 a
LSD (0.05)= 1190.3	

78. Nutrient management in maize through organic manures

Different organic manures alone and in combination were tested on maize varieties- **Malka-16 & MMRI-Yellow**. The results revealed that maximum grain yield (2587 kg ha^{-1}) was obtained when a combination of farm yard manure, poultry manure and vermicompost was used. However statistically similar grain yield (2452 kg ha-1) was obtained when farm yard manure and poultry manure was applied in combination. The lowest grain yield (1061 kg ha-1) was obtained when no manure was applied. Among the varieties Malka-16 performed better.

Table. Influence of different organic manures on maize grain yield (kg ha^{-1})

Treatments	**Maize varieties**	
	Malka-16	**MMRI-Yellow**
No Manure	1191	930
Farm Yard Manure (35 t ha^{-1})	1705	1727
Poultry Manure (6 t ha^{-1})	2377	1777
Vermicompos t (12 t ha^{-1})	1600	1558
Farm Yard Manure (18 t ha^{-1}) + Poultry Manure (3 t ha^{-1})	2385	2518
Farm Yard Manure (18 t ha^{-1})+ Vermicompos t (6 t ha^{-1})	2016	1869
Poultry Manure (3 t ha^{-1}) + Vermicompost (6 t ha^{-1})	2146	2148
Farm Yard Manure (12 t ha^{-1}) + Poultry Manure (2 t ha^{-1}) + Vermicompost (4 t ha^{-1})	2608	2566

79. Organic approach for weed management in maize

The objective of this study was to evaluate the potential of different allelopathic plant extracts for controlling weed infestation and achieving higher grain yield in maize. In this study different approaches for weed management were practiced on two different varieties of maize. Among these approaches, combinations of sorghum water extract, sunflower water extract and brassica water extract control the maximum weeds hence gave the maximum grain yield of 1838 kg ha^{-1}. However weedy check, sunflower water extract alone and brassica water extract alone gave the minimum weed control ultimately the lower grain yield. Among the varieties Malka-16 performed better against weeds.

Table. Influence of different extract application on maize grain yield (kg ha^{-1})

Treatments	Malka-16	MMRI-Yellow	Mean
Weedy Check	1582	1471	**1527**
Sorghum Water Extract	1659	1588	**1624**
Sunflower Water Extract	1601	1491	**1546**
Brassica Water Extract	1598	1500	**1549**
Sorghum Water Extract + Sunflower Water Extract	1777	1840	**1808**
Sorghum Water Extract + Brassica Water Extract	1733	1616	**1674**
Sunflower Water Extract + Brassica Water Extract	1770	1736	**1753**
Sorghum Water Extract + Sunflower Water Extract + Brassica Water Extract	1901	1775	**1838**
Mean	**1702**	**1627**	

80. Influence of Different Organic Sources and Their Combinations on Yield and Yield Components of Wheat *(Triticumaestivum)*

The experiment was conducted to quantify the influence of organic sources in different combinations on wheat productivity during Rabi season 2018-19. In this study different organic manures alone and in combination were tested to check their effect on wheat yield and its components. Maximum plant height (107.4 cm) was observed in case of vermicompost application while minimum plant height (102.5 cm) was observed where no manure was applied.

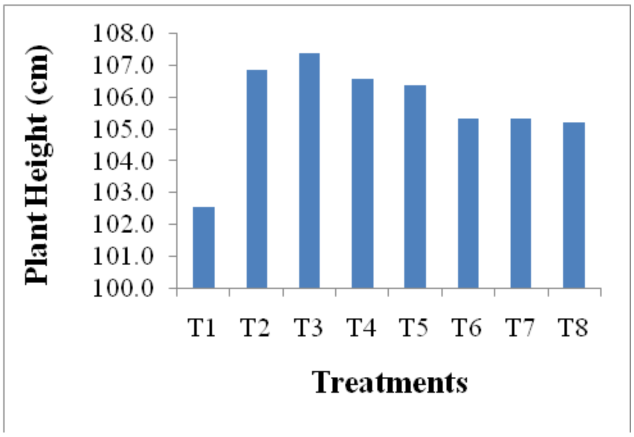


Figure: Influence of different organic fertilizers on wheat plant height (cm)

T_1= Control (no manure), T_2= Press mud @ 10 t ha^{-1}, T_3= Vermicompost @ 10 t ha^{-1}, T_4= Farm yard manure @ 10 t ha^{-1}, T_5= Press mud @ 5 t ha^{-1}+Vermicompost @ 5 t ha^{-1}, T_6= Press mud @ 5 t ha^{-1}+Farm yard manure @ 5 t ha^{-1}, T_7= Vermicompost @ 5 t ha^{-1} + Farm yard manure @ 5 t ha^{-}1, T_8= Press mud @ 3.3 t ha^{-1}+Vermicompost @ 3.3 t ha^{-1} +Farm yard manure @ 3.3 t ha^{-1}

FODDER

81. Oat fodder yield enhancement under different methods of planting

An experiment was conducted with objectives to see the yield enhancement due to vigorous growth, under different methods of planting in comparison with conventional planting and to facilitate early sowing of Bt-Cotton. The experiment was conductedat Agronomic Research Station, Bahawalpur during rabi season 2018-19. The experiment was laid out under Randomized Complete Block Design (RCBD) and replicated four times. Treatments were comprised of T_1= Broadcast (Conv.) in flat field
T_2= Broadcast of seed & augmented with furrows (Ridging); T_3= Bed planting (90 cm apart beds with two rows) and T_4= Bed planting (90 cm apart beds with three rows). Non-significant effect of different sowing methods was recorded for emergence of oat.

Table. Effect of sowing methods on emergence of oat (m^{-2})

Treatments	Emergence per m^2
T1= Broadcast (Conv.) in flat field	247.0
T2= Broadcast of seed & augmented with furrows (Ridging)	245.0
T3= Bed planting (90 cm apart beds with two rows)	247.8
T4= Bed planting (90 cm apart beds with three rows)	234.0
Tukey's HSD = Non-significant (p≤0.05)	

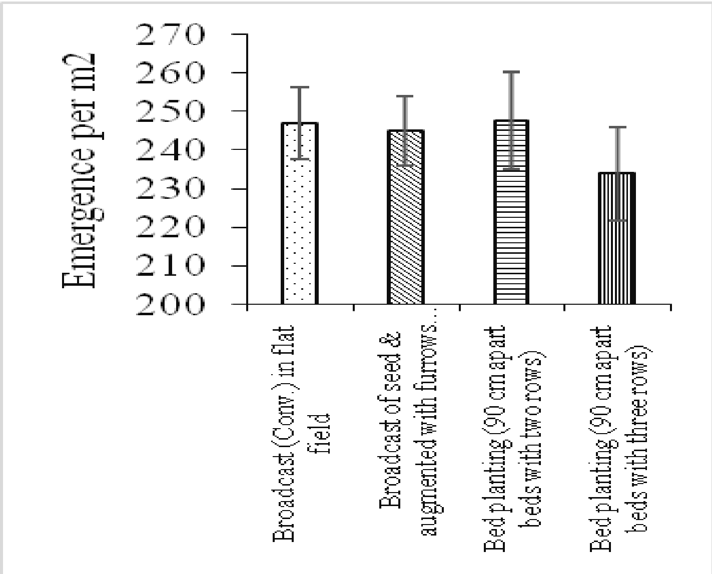


Figure. Effect of sowing methods on emergence of oat (m^{-2})

82. Zonal guar yield trial

This study was conducted to find out best suited varieties/lines of Guar for sandy loam soil of Thal irrigated area for their grain yield and adaptability. The trial was conducted in association with Guar Botanist, Bahawalpur. Six guar varieties/lines i.e. BR-17, S-6161, S-5885, S-5823, S-6260 and S-6384 were sown on 11-06-2017 in RCBD with three replications and Plot size of 1.8 m × 6 m with line to line distance 0.45 m. Chemical fertilizer @ 30-60-60 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 experiment was sown through hand drill and plant to plant distance was maintained after thinning. The data presented in figure # 4 showed that maximum grain yield 1323 kg/ha was obtained from guar strain S-6384 followed by S-5823 which gave 1232 kg/ha. The minimum grain yield was received from S-6260 which gave 682 kg/ha.

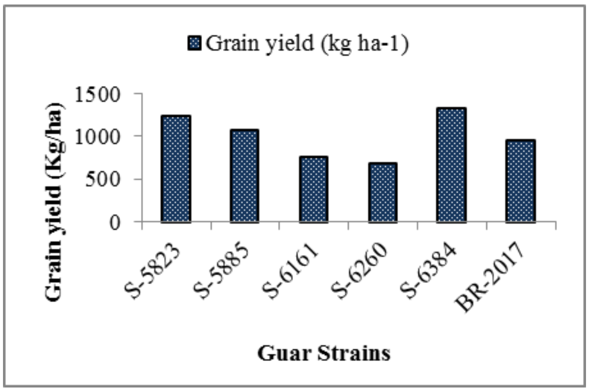


Figure. Zonal guar yield trial under Irrigated conditions

83. Weed management in maize fodder

An experiment was conducted with the objective to find out the most suitable pre and post emergence herbicide for weed control in maize fodder. The experiment was conductedat Agronomic Research Station, Bahawalpur during kharif season 2018. The experiment was laid out under Randomized Complete Block Design (RCBD) and replicated three times. Treatments were comprised of T_1= Atrazine + Mesotrione @ 1250mlL/ha (Post-emergence); T_2= Primextra gold @ 1000 ml/ha (Post-emergence); T_3= Pendimethline 3 L/ha (Pre-emergence); T_4= Atrazine @ 1250mlL/ha (Post-emergence) and T_5= Control. Relatively more green fodder yield was recorded with "Atrazine + Mesotrione @ 1250mlL/ha (Post-emergence)" (26354 kg ha^{-1}) compared to other treatments (Table 5) (Figure 5).

Table. Effect of weedicides on green fodder yield of maize (kg ha^{-1})

Treatments	Green fodder yield (kg ha^{-1})
T_1 = Atrazine + Mestrione 1250 mL/ha (Post emergence)	262542 A
T_2= Primextra gold 1000 mL/ha (Post emergence)	23590 AB
T_3 = Pendimethalin 3 L/ha (Pre-emergence)	20154 B
T_4 = Atrazine 1250 mL/ha (Post emergence)	24570 A
T_5 = Control	12595 C
Tukey's HSD	3731.7

VERMICOMPOSTING

84. Rearing of earthworms for vermicomposting

The objective of this study is to develop procedure for rearing of earthworms and harvesting of vermicompost for soil fertility improvement under Faisalabad conditions (Figure 16). Vermicomposting is a component of organic farming. Rearing and harvesting of vermicompost for soil fertility improvement in organic farming program is in progress.

Figure. Pictorial view of rearing of earthworms and vermicomposting

On farm compost formation

On farm compost formation has been started at Fiber Crops Section at Faisalabad (Figure 17)

Figure. Pictorial view of on farm compost formation at Faisalabad

ON-GOING PROJECTS

1. PARB PROJECT-288

Development of Sorghum-Sudan Grass Hybrids for Better Forage Yield and Quality under normal and Drought Stress

2. PARB PROJECT-904

Nutrition enhancement of crops, fruits, vegetables and their products under climate change scenario.

3. PARB Project No-272

Improving Nitrogen Use Efficiency in Agriculture using Urease Enzyme Inhibitors

4. ADP

Accreditation of Seed Testing Laboratory under ISO-17025

SEED PRODUCTION

#	Name of Crop/ Variety	Seed production (kg)
1	Mungbean / AZRI-2006	340
2	Jwaar Y.S.S 98	1350
3	Bajra Y.B.S 98	4950
4	Til T.S.5	1260
5	Maize M.M.R.I Yellow	14428
6	Rice Basmati Super	1658
7	Rice Chenab Basmati	5355
8	Rice Punjab Basmati	5270
9	Rice Kisan Basmati	2125
10	PK 1121	952

RESEARCH PUBLICATIONS

1. Imtiaz Hussain, Akhter Ali, Ansaar Ahmad, **Hafiz Muhammad Nasrullah.** 2018. Impact of ridge-furrow planting in Pakistan: Empirical evidence from farmer field. International Journal of Agronomy.
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MISCELLANEOUS ACTIVITIES

- Urdu/English articles = 25
- Radio talks = 35
- Seminars attended /delivered = 19
- Internee supervised = 30
- Class visits = 04
- Capacity building = 12
- Farmer days conducted = 2
- Case presented for varietal approval = 3
- Production of Stevai Plants = 10000
- Seed germination tested = 259
- Measuring physiological parameters of field crops = 500

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