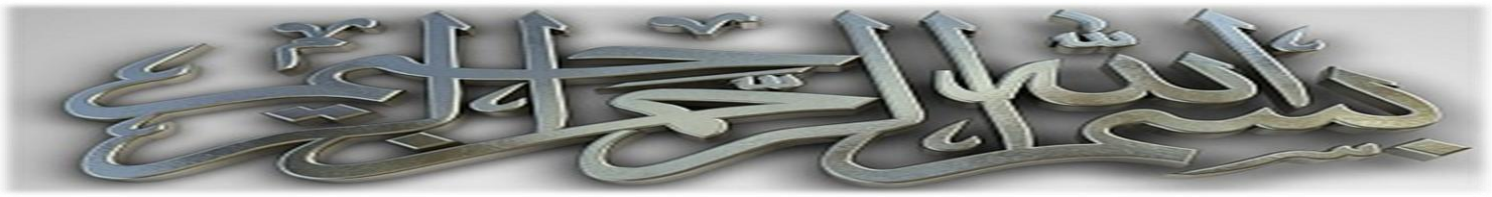

# ANNUAL REPORT 2019-20

# AGRONOMIC RESEARCH INSTITUTE FAISALABAD

**OVERVIEW**

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

Relaying canola in standing cotton proved to be successful at higher seed rates of canola (6 kg $ha^{-1}$). Band placement of fertilizer in bed planted wheat resulted in significant increase in wheat yield. Bio efficacy of different herbicides was evaluated for weed control in rice crop. Council active proved to be the best weedicide, whereas in maize, Connect 48 SL @ 1500 ml ha-1 (post emergence) provided the best weed control. Among different organic sources, combination of farm yard manure (FYM @ 15 t/ha) and sugarcane press mud (7.5 t/ha) resulted in increased turmeric yield. Likewise, FYM @ 3.5 t/ha and poultry waste @ 2.5 t/ha resulted in increased cotton yield in comparison to other organic nutrient sources. Delaying the sowing of mungbean up to 4 weeks of harvesting canola resulted in increased yield of mungbean. Application of potassium and boron resulted in increased boll retention percentage and subsequently increased yield of cotton. Incorporation of wheat residues prior to sowing of cotton resulted in significant increase in cotton yield in comparison to the traditional method of residue burning. Results of different experiments conducted during Kharif 2019 and Rabi 2019-20 are presented and discussed as under.

# WHEAT

## 1. EFFECT OF DIFFERENT SOWING METHODS ON YIELD OF WHEAT IN RICE FIELD

The experiment was conducted at cereals and pulses section to study different sowing methods in wheat. The experiment was laid out in RCBD with three replications. The wheat variety Faisalabad 2008 was sown in plots measuring 29.00 m × 8.7 m using seed @ 125 kg $ha^{-1}$. Yield data recorded is as under:

**Table: Influence of different sowing methods on yield of wheat in rice field**

| Sr. No. | Treatment | Grain Yield (kg $ha^{-1}$) |
|---|---|---|
| **1** | Broadcasting of wheat seed in rice stubbles followed by 1 cultivation & planking | 2615 |
| **2** | Sowing of wheat seed in rice stubbles using happy seeder | 2774 |
| **3** | Sowing of wheat seed in standing rice before harvesting | 2774 |
| **4** | Sowing of wheat seed in rice stubbles using zero tillage drill | 2179 |
| **5** | 2 ploughing with disc harrow+ 1 cultivation+seed broadcasting+1 planking | 1783 |
| **6** | 1 ploughing with disc harrow+urea @ 30 kg/ha+irrigation+ 2 cultivation at wattar condition+seed broadcasting+ planking | 3369 |
| **7** | 1 ploughing with disc harrow+ seed broadcast followed by planking | 2061 |
| **8** | 1 ploughing with disc harrow+urea @ 60 kg/ha+irrigation+ 2 cultivation at wattar condition+seed broadcasting+ planking | 2536 |

The maximum grain yield (3369 kg $ha^{-1}$) was obtained from treatment where 1 ploughing with disc harrow + urea @ 30 kg/ha + irrigation+ 2 cultivation at wattar condition + seed broadcasting+ planking was used while minimum grain yield (1783 kg $ha^{-1}$) was obtained where 2 ploughings with disc harrow+ 1 cultivation + seed broadcasting+1 planking was practiced.

## 2. DETERMINING ADVANCED PLANTING TECHNIQUES WITH CURTAILED SEED RATE IN WHEAT CROP

An experiment was conducted with objective to decrease the use of seed rate by using different sowing methods for wheat crop. The experiment was conducted during Rabi 2019-20 at ARS, BWP. The experiment was laid out under randomized complete block design (RCBD) with split arrangement of treatments and replicated three times. Treatments were comprised of sowing

methods in main plots viz. P1 = Conventional broadcast method; P2 = Bed-furrows method and P3= Line sowing method and seed rates in sub plot viz. S1= 125 kg $ha^{-1}$; S2= 10; S3= 20 kg $ha^{-1}$; S4= 30 kg $ha^{-1}$; S5= 40 kg $ha^{-1}$and S6= 50 kg $ha^{-1}$. Relatively more grain yield was recorded with broadcast sowing (5059 kg $ha^{-1}$) and with seed rate 125 kg $ha^{-1}$ (5222 kg ha-1) compared to other treatments.

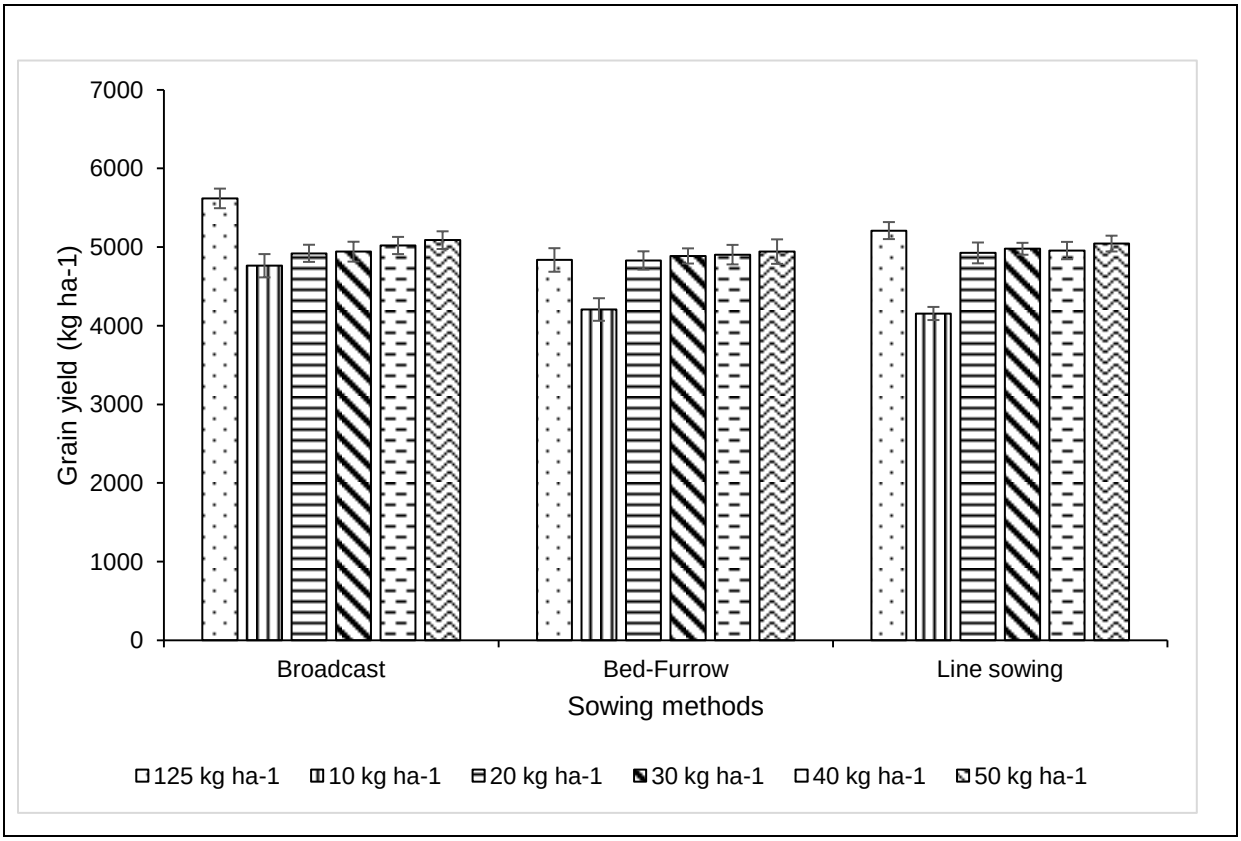


**Figure: Effect of sowing methods and seed rates on grain yield of wheat**

## 3. WATER-SAVING THROUGH REDUCED SEED RATE WITH ORGANIC SEED PRIMING TREATMENT UNDER BED-FURROW WHEAT PRODUCTION

An experiment was conducted with the objective to improve emergence through pre sowing seed treatments and save water by skipping irrigations at different stages of wheat crop under the use of decreased seed rate (4 kg per acre) optimum sowing method (Bed furrow method) selected from experiment-2. The experiment was conducted during Rabi 2019-20 at ARS, BWP. The experiment was laid out under randomized complete block design (RCBD) with split arrangement of treatments and replicated three times. Treatments were comprised of seed treatments in main plots viz. T1 = Control (Dry seed); T2 = Hydro priming; T3= Moringa leaf

extract (MLE30) and irrigation regimes in sub plot viz. I1= Application of irrigation water at tillering (T) + booting (B) + heading (H) + milking (M); I2= Application of irrigation water at tillering (T) + booting (B) + heading (H); I3= Application of irrigation water at tillering (T) + booting (B); I4= Application of irrigation water at tillering (T) + heading (H); I5= Application of irrigation water at tillering (T) + milking (M). Relatively more grain yield was recorded for Moringa leaf extract (MLE30) (3539 kg $ha^{-1}$) and with Application of irrigation water at tillering (T) + booting (B) + heading (H) + milking (M) (4313 kg $ha^{-1}$) compared to other treatments.

**Table: Grain yield of wheat** (kg $ha^{-1}$) **as affected by of treatments and irrigation application at phonological stages**

| **Irrigation regimes/Seed treatments** | **Control (Dry seed)** | **Hydro priming** | **Moringa leaf extract (MLE30)** | **Means of irrigation regimes Grain yield (kg $ha^{-1}$)** |
|---|---|---|---|---|
| **$I_1$= Application of irrigation water at tillering (T) + booting (B) + heading (H) + milking (M)** | 3980 | 4388 | 4571 | 4313 A |
| **$I_2$= Application of irrigation water at tillering (T) + booting (B) + heading (H)** | 3450 | 3870 | 4009 | 3776 B |
| **$I_3$= Application of irrigation water at tillering (T) + booting (B)** | 2338 | 2786 | 3093 | 2739 C |
| **$I_4$= Application of irrigation water at tillering (T) + heading (H)** | 3019 | 3454 | 3602 | 3358 D |
| **$I_5$= Application of irrigation water at tillering (T) + milking (M)** | 2187 | 2287 | 2419 | 2298 E |
| **Means of seed treatments, Grain yield (kg $ha^{-1}$)** | 2995 B | 3357 A | 3539 A | |
| Tukey's HSD for seed treatments= 236.8<br>Tukey's HSD for irrigation regimes= 346.0 | | | | |

## 4. EFFECT OF SOWING DATES AND SEED RATES ON BARLEY YIELD UNDER FAISALABAD CONDITIONS

To evaluate the appropriate sowing time and seed rate of barley under semi-arid conditions of Faisalabad an experiment was laid out in RCBD replicated thrice. It consisted of plot size 2.25 m x 10 m, recommended dose of fertilizer N & P was applied @ 80-57 kg $ha^{-1}$. All P and 1/2 of N were applied as basal dose. While remaining N was supplied with first irrigation. All other agronomic practices were kept uniform. Yield data was recorded and statistically analyzed following standard procedure. The results of the experiment are given below:

**Grain Yield (kg/ha) of barley as influenced by seed rate and sowing dates**

| Seed Rate (kg/ha) | Sowing Dates | | | Mean |
|---|---|---|---|---|
| | 15th November | 30th November | 15th December | |
| **75** | 4593 | 5136 | 4938 | 4889 |
| **100** | 4691 | 5333 | 5284 | 5102 |
| **125** | 4444 | 5037 | 4642 | 4707 |
| **Mean** | 4576 B | 5168 A | 4954 AB | 4899 |
| **LSD at 5% for Sowing Dates= 436.8** | | | | |

It was concluded from the results that sowing of barley on 30th November resulted in maximum grain yield at seed rate of 100 kg/ha whereas minimum grain yield was observed when sown on 15th November using seed rate of 125 kg/ha.

## 5. STUDIES ON FEASIBILITY OF RELAY CROPPING OF CANOLA IN COTTON

This experiment was conducted to explore the feasibility of relay cropping of canola in standing cotton and the optimum seed rate for relay sown canola. Experimental treatments were comprised of conventional sowing, relay sowing with seed rate 5.0 kg $ha^{-1}$, relay sowing with seed rate 6.0 kg $ha^{-1}$, relay sowing with seed rate 7.0 kg $ha^{-1}$. The experiment was sown on 16-10-2019 and was laid out according to randomized complete block design (RCBD) with three replications and net plot size of 10.0 × 7.5 m. Canola variety AARI-Canola was used as test variety in this experiment. Fertilizer was applied as 90-60-50 NPK kg $ha^{-1}$. All agronomic practices (irrigation, weed control and insect pest control) were kept uniform. The crop was

harvested on 30.03.2020. Data regarding yield and yield components were recorded during experiment following standard procedures.

Results of this study showed that relay sowing of canola with seed rate 6 and 7 kg $ha^{-1}$ gave higher yield (1264 and 1269 kg $ha^{-1}$ respectively) as compared with conventional sowing of canola (873 kg $ha^{-1}$). Hence it was concluded that relay sowing of canola with seed rate 6.0 kg $ha^{-1}$ in standing cotton is a feasible approach.

**Table: Effect of relay cropping of canola in standing cotton on canola yield**

| **Treatments** | **Yield (kg $ha^{-1}$)** |
|---|---|
| Conventional sowing | 873 C |
| Relay sowing with seed rate 5.0 kg $ha^{-1}$ | 956 B |
| Relay sowing with seed rate 6.0 kg $ha^{-1}$ | **1264 A** |
| Relay sowing with seed rate 7.0 kg $ha^{-1}$ | **1269 A** |
| LSD value= 29.85 | |

## 6. EVALUATION OF DIFFERENT PLANTING TIME OF WHEAT UNDER LOCAL CONDITIONS

This experiment was conducted to determine the optimum sowing time of wheat in prevailing climatic conditions of Khanewal to address the issue of erratic weather patterns. Wheat was sown on 05.11.2019, 15.11.2019, 25.11.2019, 05.12.2019 and 15.12.2019. Experiment was laid out according to randomized complete block design with three replications and net plot size of 9.0 × 5.0 m. Wheat variety Jauhar-2016 was used as test variety in this experiment. Fertilizer was applied as 120-90-62.5 NPK kg $ha^{-1}$. All agronomic practices (irrigation, weed control and insect pest control) were kept uniform. Experiment was harvested on 23.04.2020. Data regarding yield and yield components were recorded during experiment following standard procedures.

Results of this study showed that high grain yield (4697 kg $ha^{-1}$) of wheat was recorded when wheat was planted on 15.11.2019 however further delay in sowing resulted in significant reduction in grain yield. Hence it might be concluded and recommended that optimum sowing time of wheat is 2$^{nd}$ week of November in Khanewal.

**Table: Effect of sowing time on grain yield of wheat**

| Treatments | Yield (kg $ha^{-1}$) |
|---|---|
| 05.11.2019 | 3773 D |
| 15.11.2019 | **4697 A** |
| 25.11.2019 | 4040 B |
| 05.12.2019 | 3904 C |
| 15.12.2019 | 3383 E |
| LSD value= 34.21 | |

## 7. GRAIN YIELD OF WHEAT UNDER VARIOUS SOWING AND FERTILIZER APPLICATION METHODS

This experiment was conducted to find out best nitrogen application method for each sowing method to have more grain yield. Two factors were studies in this experiment i.e. sowing methods which included drill sowing and bed planting while the other factor was fertilizer application methods that included broadcast, side dressing and band placement. Experiment was sown on 08.11.2020 and was laid out according to split plot design keeping sowing methods in main plots while fertilizer application methods in sub plot. Experiment was replicated three times and net plot size was 6.0 × 1.8 m. Wheat variety Jauhar-2016 was used as test variety in this experiment. Fertilizer was applied as 120-90-62.5 NPK kg $ha^{-1}$ according to treatments. All agronomic practices (irrigation, weed control and insect pest control) were kept uniform. The crop harvested on 23.04.2020. Data regarding yield and yield components were recorded during experiment following standard procedures.

Significant difference in treatments regarding wheat grain yield was observed, maximum grain yield (4872 kg $ha^{-1}$) was recorded when wheat was planted on beds and fertilizer was applied by band placement method as compared with application of fertilizer by broadcast and side dressing methods on the same sowing method. Therefore it was concluded and recommended that wheat should be sown on beds and fertilizer should be applied by band placement method to obtain higher grain yield.

**Table: Grain yield of Wheat as affected by sowing and nitrogen application methods**

| **Treatments** | **Drill planting** | **Bed planting** | **Mean (kg ha$^{-1}$)** |
|---|---|---|---|
| Fertilizer Broadcast | 3928 d | 4268 c | 4098 |
| Fertilizer Side dressing | 4013 d | 4600 b | 4307 |
| Fertilizer Band placement | 4178 c | **4872 a** | 4525 |
| Mean | 4040 | 4580 | |
| LSD value for planting method × fertilizer application method= 44 | | | |

## 8. EFFECT OF HUMIC ACID ON WHEAT YIELD

This experiment was conducted to determine the best application method of humic acid application for wheat. The experimental treatments were comprised of control (no application of humic acid, soil application of 20, 25 kg humic acid ha$^{-1}$, foliar application of 2.0 and 2.5% humic acid solution at tillering stage. Experiment was sown on 11.11.2020 and was laid out according to randomized complete block design (RCBD) having three replications and net plot size was 6.0 × 1.8 m. Wheat variety Jauhar-2016 was used as test variety in this experiment. Fertilizer was applied as 120-90-62.5 NPK kg ha$^{-1}$ according to treatments. All agronomic practices (irrigation, weed control and insect pest control) were kept uniform. The crop was harvested on 23.04.2020. Data regarding yield and yield components were recorded during experiment following standard procedures.

Treatments differed significantly for grain yield of wheat and foliar application of 2.5% humic acid solution at tillering stage resulted in higher grain yield (4184 kg ha$^{-1}$) of wheat as compared with control (2288 kg ha$^{-1}$). Foliar application of humic acid results in improved uptake of macro and micronutrients from soil hence the yield was improved. Therefore, it can be concluded and recommended that wheat crop should be sprayed with 2.5% humic acid solution at tillering stage to obtain higher yield.

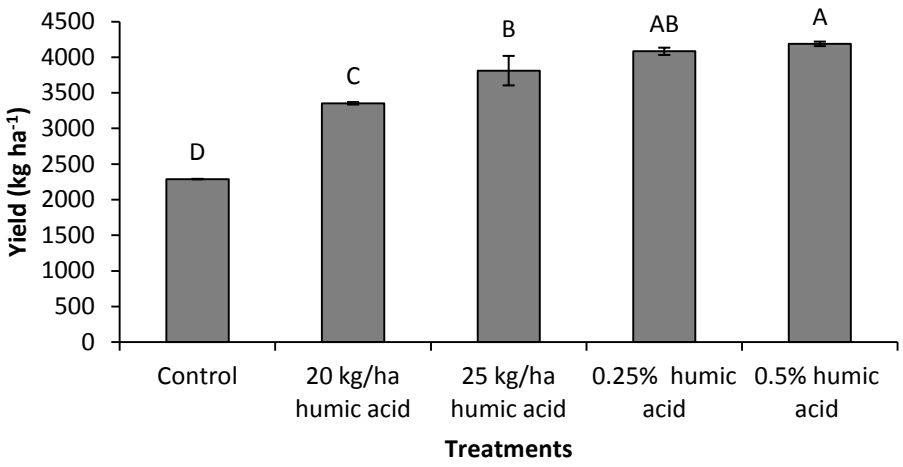


**Figure 10: Effect of humic acid application on grain yield of Wheat**

20 and 25 kg $ha^{-1}$= soil application of humic acid
0.25 and 0.50% are concentrations of humic acid solutions for foliar spray at tillering stage

## 9. EFFECT OF ZINC APPLICATION ON GRAIN YIELD OF WHEAT

This experiment was conducted to evaluate the best technique of zinc application for more productivity in wheat. Experiment was comprised of two factors i.e. wheat varieties; Jauhar-2016, Ghazi-2019 and 2559 and zinc application; control (no application of Zn), soil application of 12 kg Zn $ha^{-1}$, foliar spray of 0.3, 0.4% and 0.5% Zn solution at anthesis and grain filling stages. Experiment was sown on 07.11.2019 and was laid out in field according to randomized complete block design (RCBD) having three replications. Net plot size was 6.0 × 1.8 m. All agronomic practices (irrigation, weed control and insect pest control) were kept uniform. The crop was harvested on 23.04.2020. Data regarding yield and yield components were recorded during experiment following standard procedures.

Significant difference in yield was recorded among various treatments; maximum yield (4884 kg $ha^{-1}$) was recorded where wheat variety V-2559 was foliar sprayed with 0.4% Zn solution at anthesis and grain filling stage (Table 10). However minimum yield (2923 kg $ha^{-1}$) was recorded where no Zn was applied

**Table: Wheat grain yield (kg ha$^{-1}$) as affected by Zn application**

| Treatments | Varieties | | | Mean |
|---|---|---|---|---|
| | Jauhar-2016 | Ghazi-2019 | V-2559 | |
| Control | 2434e | 2401e | 3934cd | 2923 |
| 12 kg Zn ha$^{-1}$ | 3507d | 4467abc | 4584abc | 4186 |
| 0.3% Zn | 3577d | 4051bcd | 4367abc | 3998 |
| 0.4% Zn | 4667ab | 4684ab | **4884a** | 4745 |
| 0.5% Zn | 3584d | 4367abc | 3634d | 3862 |
| Mean | 3554 | 3994 | 4281 | |
| LSD value for varieties×treatments=329 | | | | |

12 kg Zn ha$^{-1}$= dose of Zn for soil application; 0.3, 0.4 and 0.5% Zn are the concentrations of Zn solutions for foliar spray of Zn at anthesis and grain filling stages

## SCREENING OF WHEAT GENOTYPES

### 10. PHYSIOLOGICAL EVALUATION OF WHEAT GENOTYPES FOR HEAT TOLERANCE

The study was conducted to evaluate the performance of ten (10) wheat genotypes witnessed from previous year experiment for heat tolerance under Faisalabad conditions during Rabi 2019-20. The field experiment was laid out in randomized complete block design with split plot arrangement having plot size of 2.0 m × 6.0 m with three replications. Two sowing dates were used i.e. 1$^{st}$ & 3$^{rd}$ week of November. The significantly maximum grain yields for both sowing dates were obtained by genotype 16-C-039 i.e. 6445 kg ha$^{-1}$ and 5120 kg ha$^{-1}$ respectively.

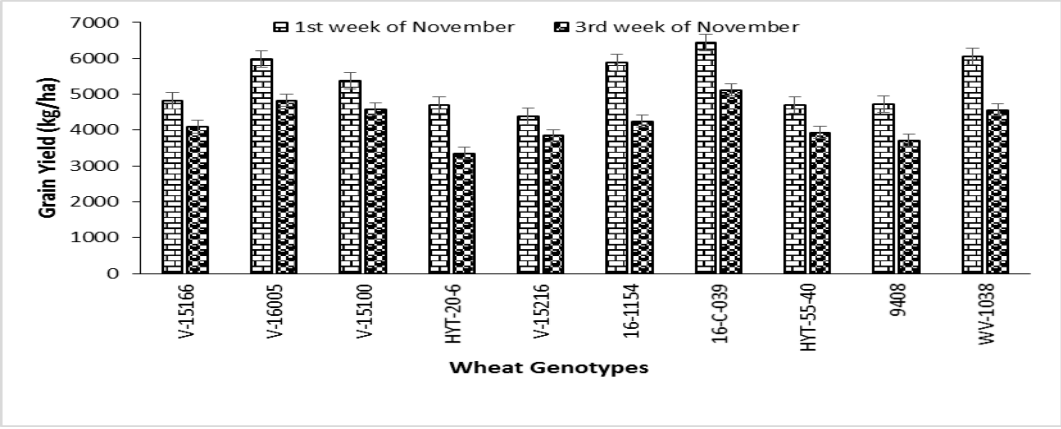


**Figure. Effect of heat stress on wheat grain yield (kg ha$^{-1}$)**

## 11. PHYSIOLOGICAL EVALUATION OF WHEAT GENOTYPES FOR DROUGHT TOLERANCE

The study was conducted to evaluate the performance of ten (10) wheat genotypes witnessed from previous year experiment for heat tolerance under Faisalabad conditions during Rabi 2019-20. The field experiment was laid out in randomized complete block design with split plot arrangement having plot size of 1.8 m × 5.0 m with three replications. Two moisture regimes were used i.e. Normal Moisture and Moisture Stress of -0.4 MPa. Results revealed that significantly maximum grain yields (6581 kg $ha^{-1}$ and 5925 kg $ha^{-1}$) for both moisture regimes, respectively were obtained by genotype HYT-55-40.

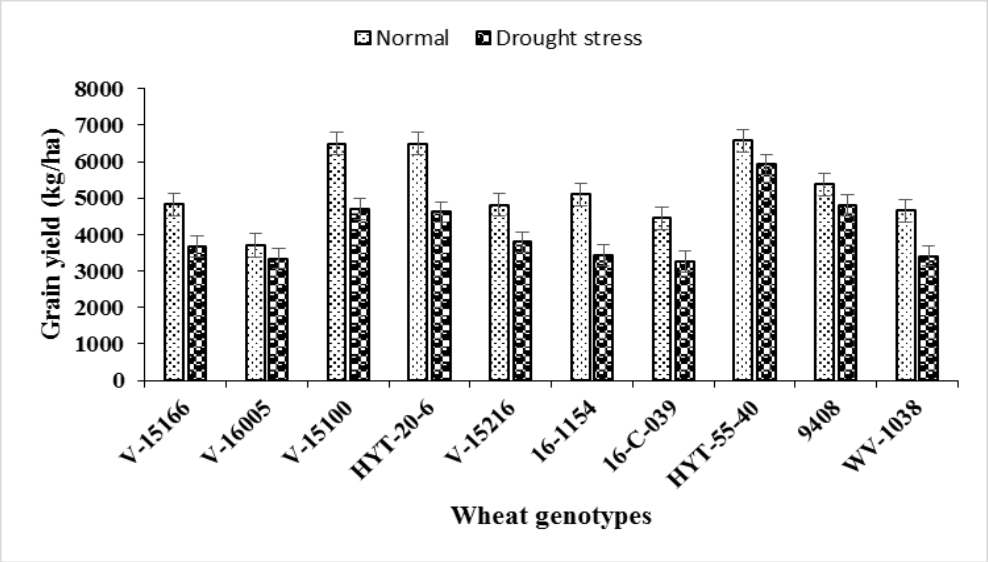


**Figure. Effect of drought stress on wheat grain yield (kg $ha^{-1}$)**

# SCREENING AND EVALUATION OF MEDICINAL PLANTS

## 12. SCREENING AND EVALUATION OF AJWAIN (*TRACHYSPERMUM AMMI*) GERMPLASM

The trial was laid out in RCBD having three replications with plot size of 3.0 m × 14.0 m to screen and evaluate the local ajwain germplasm. Crop was sown on beds (R× R=75 cm). Fertilizer @ 55-55 NP kg $ha^{-1}$ was applied at the time of sowing. All other agronomic practices were kept normal and uniform during the course of study. Results revealed that the maximum seed yield (1432.6 kg $ha^{-1}$) was recorded for genotype 1. The minimum value for seed yield (973.4 kg $ha^{-1}$) was recorded for genotype 5.

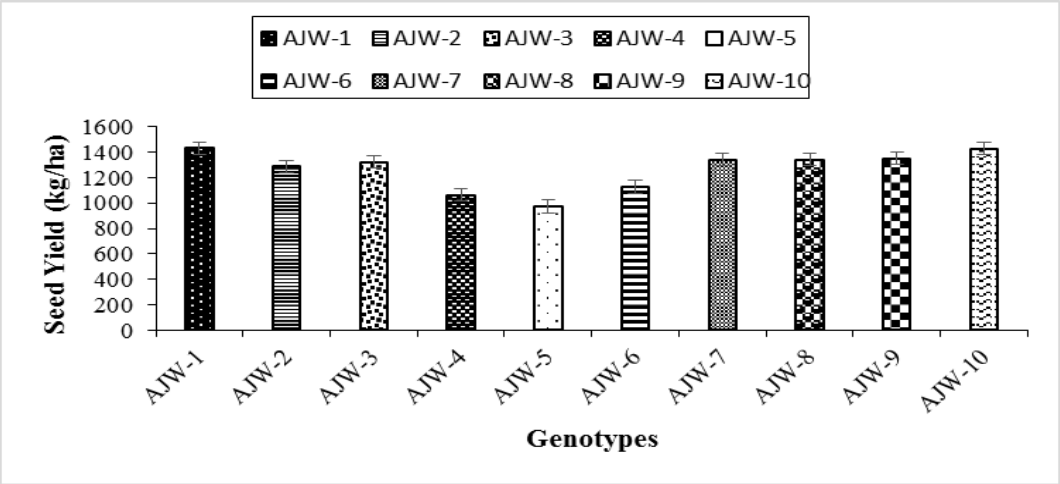


**Figure. Seed yield (kg ha$^{-1}$) of different genotypes of Ajwain**

## 13. SCREENING AND EVALUATION OF ALSI (*LINUM USITATISSIMUM*) GERMPLASM

The experiment was conducted with objective to screen and evaluate the performance of local Alsi germplasm. Treatments were comprised of 10 locally acquired genotypes. Experiment was conducted using randomized complete block design. Treatments were replicated three times. Crop was sown on beds having row to row distance of 75 cm. Uniform agronomic practices were employed for all the treatments. Data were recorded for yield and yield components. Considerable yield differences were observed. Among all genotypes significantly higher seed yield was recorded for genotype LS-01 (2023.6 kg ha$^{-1}$).

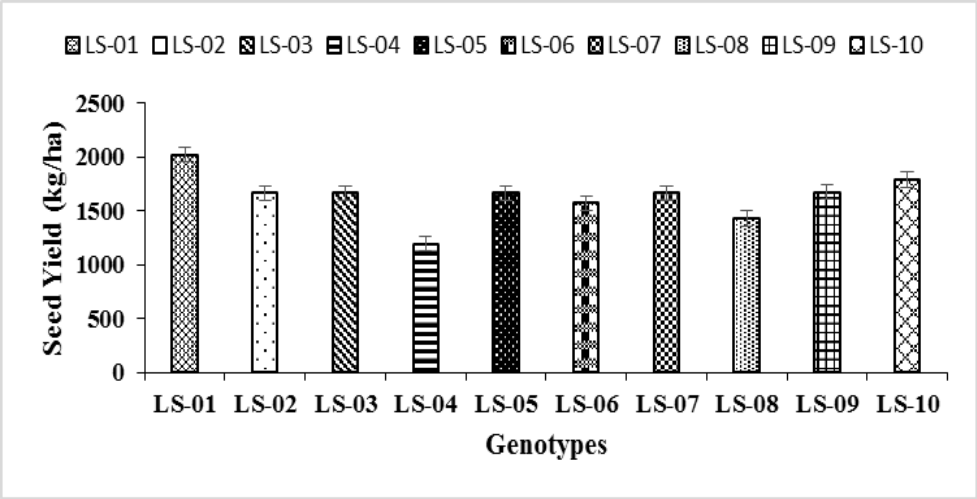


**Figure. Seed yield (kg ha$^{-1}$) of different genotypes of Alsi**

## 14. SCREENING AND EVALUATION OF ISABGOL (*PLANTAGO OVATA*) GERMPLASM

Isbagol is an important medicinal crop. Experiment was conducted with objective to screen and evaluate the performance of local Isabgol germplasm. Treatments were comprised of 10 locally acquired genotypes. Experiment was conducted using randomized complete block design. Treatments were replicated three times. Crop was sown on beds having row to row distance of 75 cm. Uniform agronomic practices were employed for all the treatments. Data were recorded for yield and yield components. Considerable yield differences were observed. Among all genotypes significantly higher seed yield was recorded for genotype ISB-06 (801.6 kg ha$^{-1}$).

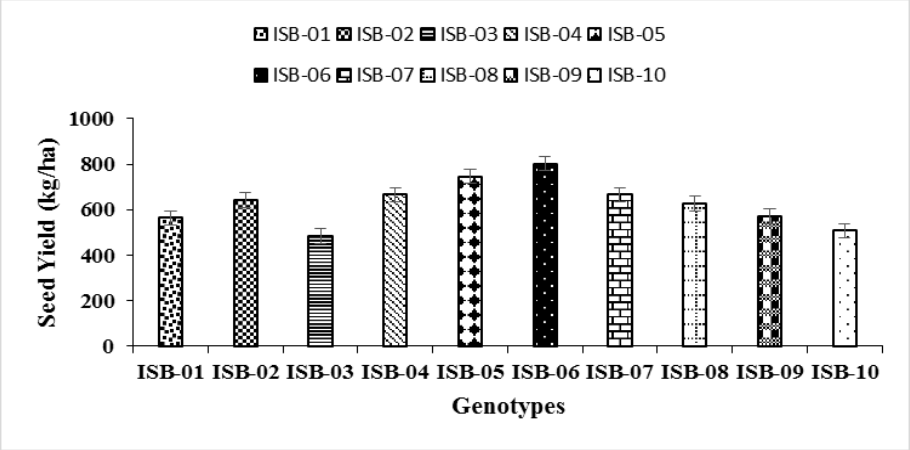


**Figure. Seed yield (kg ha$^{-1}$) of different genotypes of Isbagol**

## 15. SCREENING AND EVALUATION OF FENNEL (*FOENICULUM VULGARE*) GERMPLASM

An experiment was conducted with objective to screen and evaluate the performance of local fennel. Seed was collected from different sources and the treatments were comprised 10 locally acquired genotypes. Experiment was conducted using randomized complete block design having a plot size of 3×14 meter having three replications. Crop was sown on beds having row to row distance of 75 cm. Uniform agronomic practices were applied for all the treatments. Results revealed that all the seed sources yielded equal except Fennel-09 in which attained 05-06% more

height, lodging tendency was more which resulted in reduced 1000 grain weight and ultimate seed yield of 1190 kg $ha^{-1}$.

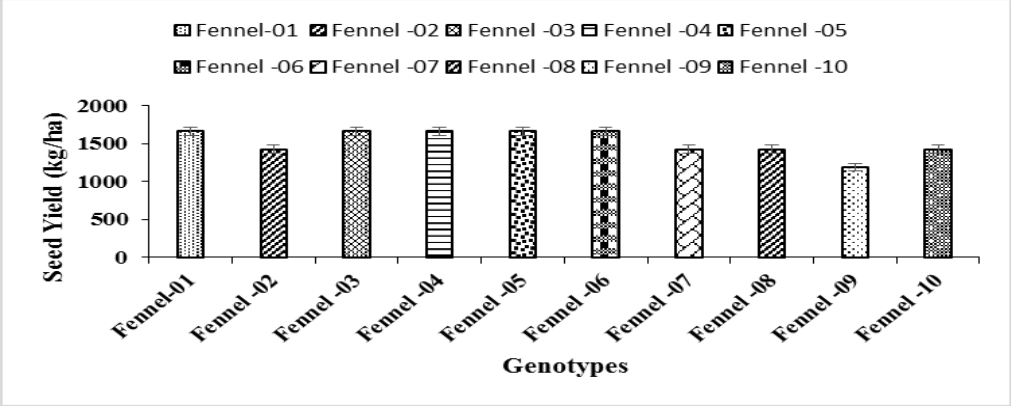


**Figure. Seed yield (kg $ha^{-1}$) of different genotypes of Fennel**


## 16. SCREENING AND EVALUATION OF KALONJI (*NIGELLA SATIVA*) GERMPLASM

Kalonji is an annual flowering plant investigated recently for its potential as a crop in Pakistan. This study was conducted to screen and evaluate the performance of ten Kalonji lines collected from different sources. The experiment was laid out in randomized complete block design with plot size of 3 m × 14.0 m having three replications. Kalonji was sown on beds (R× R=75 cm). Fertilizer @ 55-25 NP kg $ha^{-1}$ was applied at the time of sowing. All other agronomic

practices were kept normal and uniform during the course of study. The significantly maximum seed yield (733 kg $ha^{-1}$) were recorded in PP-K-1 while lowest seed yield (44 kg $ha^{-1}$) were recorded in PP-K-6.

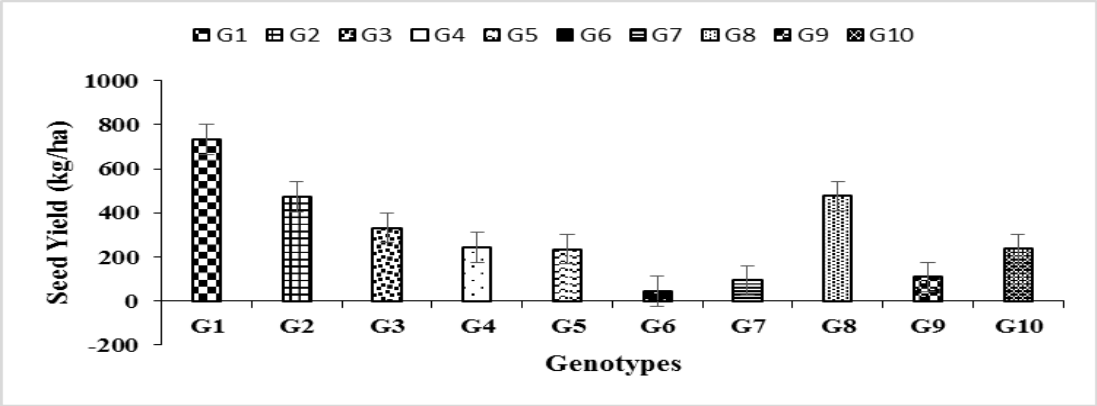


**Figure. Seed yield (kg $ha^{-1}$) of different genotypes of Kalonji**


## 17. EVALUATION AND MULTIPLICATION OF QUINOA (*CHENOPODIUM QUINOA*) GENOTYPES

This study was conducted to evaluate the performance of ten (UAF-6, UAF-9, UAF-11, UAF-15, UAF-17, UAF-24, UAF-51, UAF-81, UAF-82 and UAF-126) Quinoa lines from UAF selection. The experiment was laid out in randomized complete block design with plot size of 1.4 m × 9.0 m having

three replications. The significantly maximum grain yield (2560 kg/ha) was found in UAF-Q-6 line and comparatively minimum grain yield (1060 kg $ha^{-1}$) were recorded in UAF-Q-17.

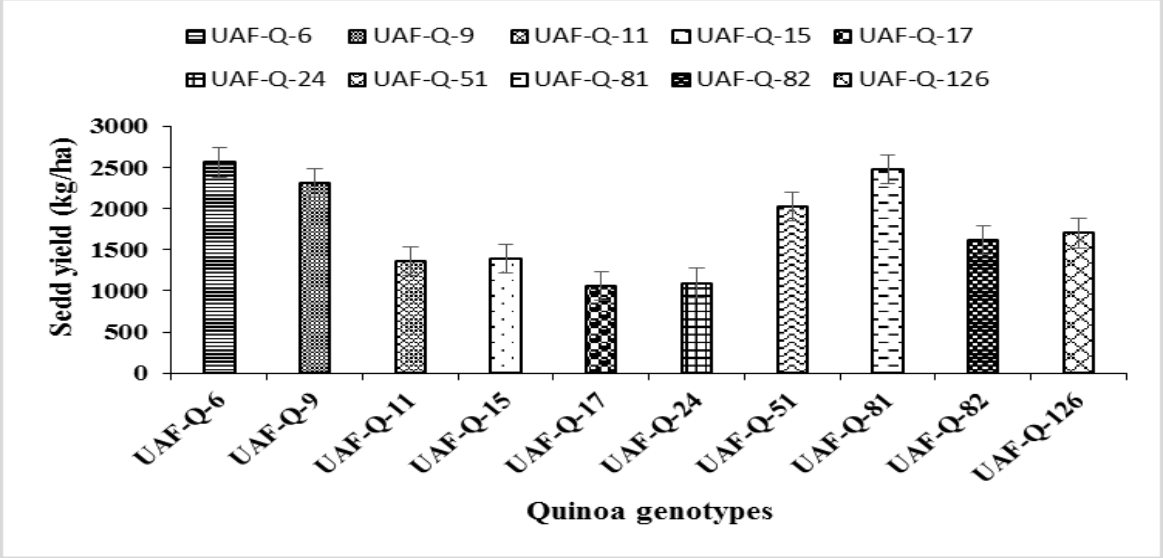


**Figure. Seed yield (kg $ha^{-1}$) of quinoa germplasm**

# HERBICIDES SCREENING

## 18. BIO-EFFICACY/SCREENING OF HERBICIDES FOR RICE (*ORYZA SATIVA* L.)

This trial was conducted with the objective to find out comparative efficacy of weedicides of different sources and formulations on individual weed species in rice crop. Thirteen herbicides formulations viz. Machete 60 EC, Rifit 500 EC, Nictra 50 EC, Total care 14.4 OD, Greensun 10 EC, Daokda 100D, Crop tech 10 EC, Tesco 210 OD, Acetochlore 50 EC, Kelion 50 WG, Council Activ 30 WG, Pyranex 30 WDG and Winsta 30 WP were tested against Control (weedy check). All herbicides gave comparatively better weed control as compared to check and paddy yield was at par for all herbicides used, however, comparatively maximum paddy yield (3900 kg $ha^{-1}$) was obtained with Council active 30 WG and minimum (2867 kg $ha^{-1}$) paddy yield was obtained with weedy check.

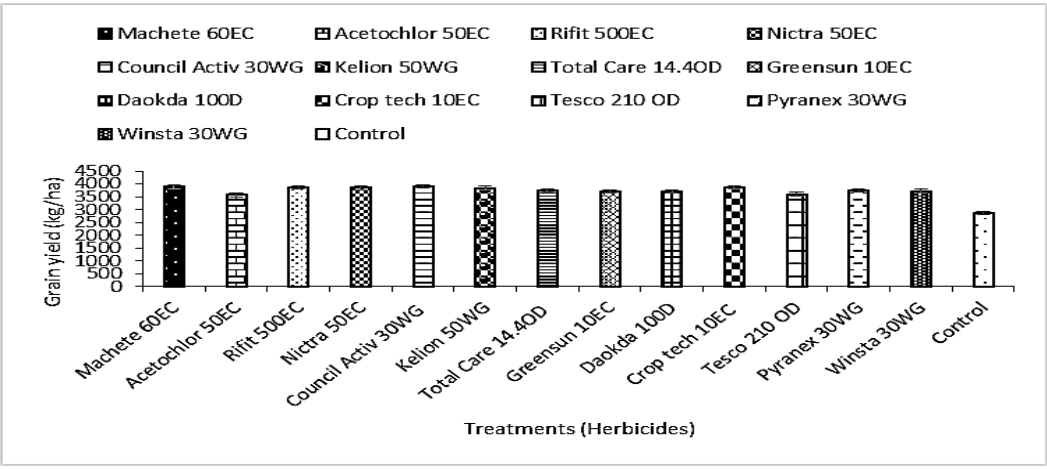


**Figure. Effect of herbicides on paddy yield (kg $ha^{-1}$)**

## 19. TESTING OF NEW HERBICIDES FOR MAIZE (*ZEA MAYS* L.)

Different pre and post emergence herbicide formulations viz. Burton 960 EC, Arch 74 EC, Topmax 96 EC, Preact 96 EC, Stomp 455 g/L CS, Quintal 96 EC, Wintle 960 EC, High guard 960 EC, Voltril 63 SC, Click 72.7 SE, Primextra gold 720 SC, Dual gold 960 EC, Clio combo 33.6 SC, Commict ultra 24 WDG, Halt plus 31 WDG, Landmaster 58 WDG, Rapta gold 53 SC were tested against Control (weedy check). Highest maize grain yield (4700 kg $ha^{-1}$) was recorded in treatment where Connect 48 SL

@ 1500 ml $ha^{-1}$ (post emergence) was sprayed. The lowest grain yield of 2375 kg $ha^{-1}$ was produced in case of weedy check.

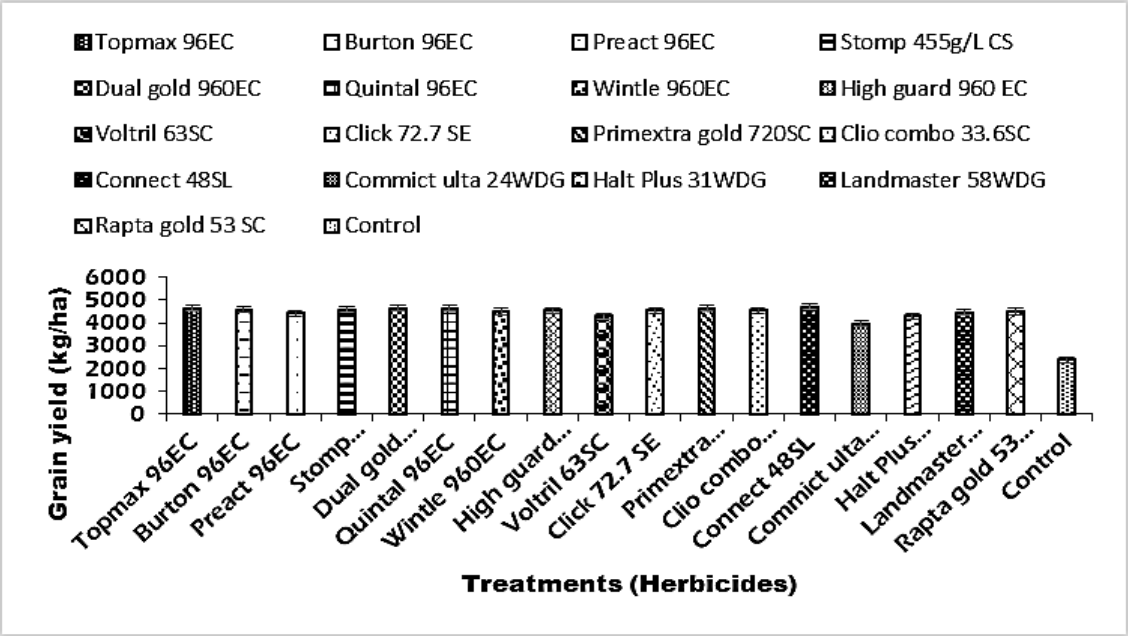


**Figure. Effect of different herbicides on grain yield of maize (kg $ha^{-1}$)**

## 20. SCREENING OF HERBICIDES FOR SUGARCANE (*SACCHARUM OFFICINARUM)*

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, Voltril 63 SC, Twist 55 SC and Connect 48 SC, Keeper 73 WP, Clio combo 33.6 SC, Maxpro 80 WDG, DAfli super 58 WDG, Cane master 50 WP, Fallisto gold 550 SC, Keychain 24 WP were tested. Amongst these herbicides standard Connect 48 SC @ 3000 ml/ha and Maxpro 80 WDG @ 500 g+500 ml+250 g (post emergence) provided 93%, and 92% control of broad leaf weeds and grasses respectively and gave highest cane yield of 83 t/ha. The lowest cane yield of 50 t/ha was obtained with weedy check.

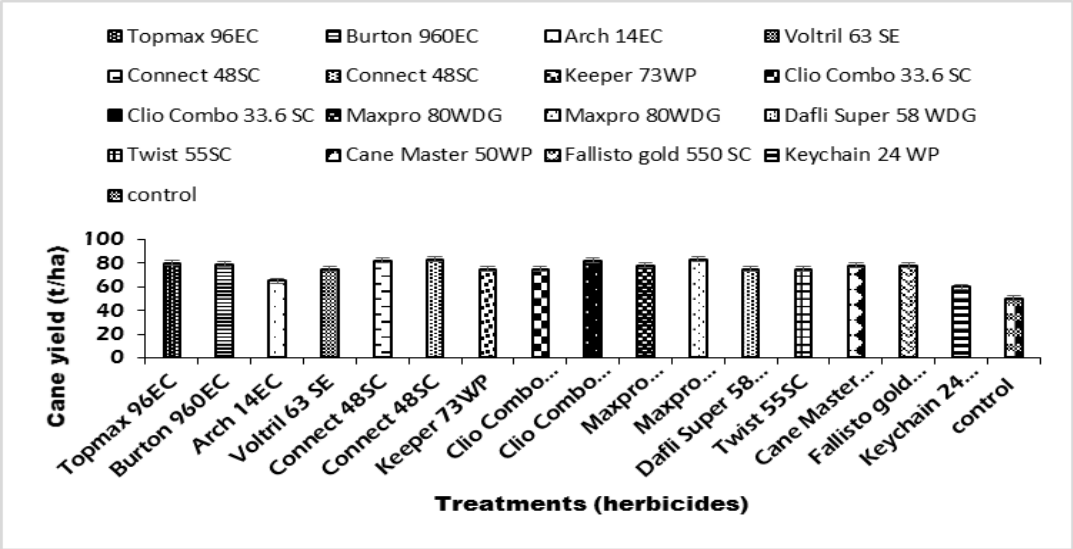


**Figure. Effect of herbicides on cane yield (t/ha)**

## 21. TESTING OF NEW HERBICIDES FOR COTTON (*GOSSYPIUM HIRSUTUM* L.)

This trial was conducted to find out new herbicides for effective weed control in cotton crop. Different herbicide formulations viz: Stomp 455 g/L CS, Panida grande 43.5 EC, Topmax 96 EC, Preact 96 EC (candidate), Dual gold 960 EC, Percept 10.8 EC, High guard 960 EC (candi.), G max light 15 EC and Fusilade 125 EC (candi.) were used against hand weeding and weedy check. Hand weeding gave maximum seed cotton yield of 2683 kg $ha^{-1}$ that was at par with application of Dual gold @ 2000 ml/ha. The minimum seed cotton yield (1067 kg $ha^{-1}$) was observed in control where no herbicides were sprayed.

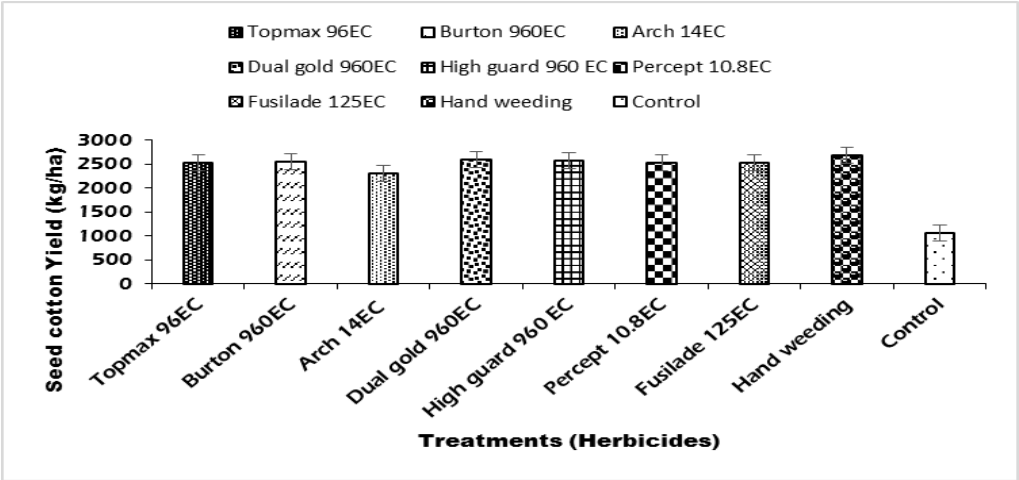


**Figure. Effect of herbicides on seed cotton yield (kg $ha^{-1}$)**

## 22. SCREENING OF NEW HERBICIDES TO CONTROL DICOT WEEDS IN WHEAT (*TRITICUM AESTIVUM*)

This study was conducted under Faisalabad conditions during Rabi 2019-20 to evaluate fourteen herbicides viz; Buctril super 60 EC, Selecter 40 EC, Broxtra 40.8 EC, Starane-M 50EC, Broad-X, Agritop 40 EC, Strait 30 EC, Keychain 24 WP, Allymax 66.7 WG, Lancelot 45 WG, Ge Chu, Judo super 48 EC, Yang sui 50 SC, 2,4-D against weedicheck for chemical weed control in wheat. The experiment was laid out in randomized complete block design with plot size of 2.75 m × 9.0 m having three replications and Punjab-2011 was used as test crop. The results revealed that the maximum weed control percentage was recorded with 2,4-D @ 2000 ml/ha while minimum while highest grain yield (4053 kg $ha^{-1}$) was obtained where Buctril super 60 EC was applied @ 750 ml/ha and minimum yield (3350 kg $ha^{-1}$) was obtained when no herbicide was applied.

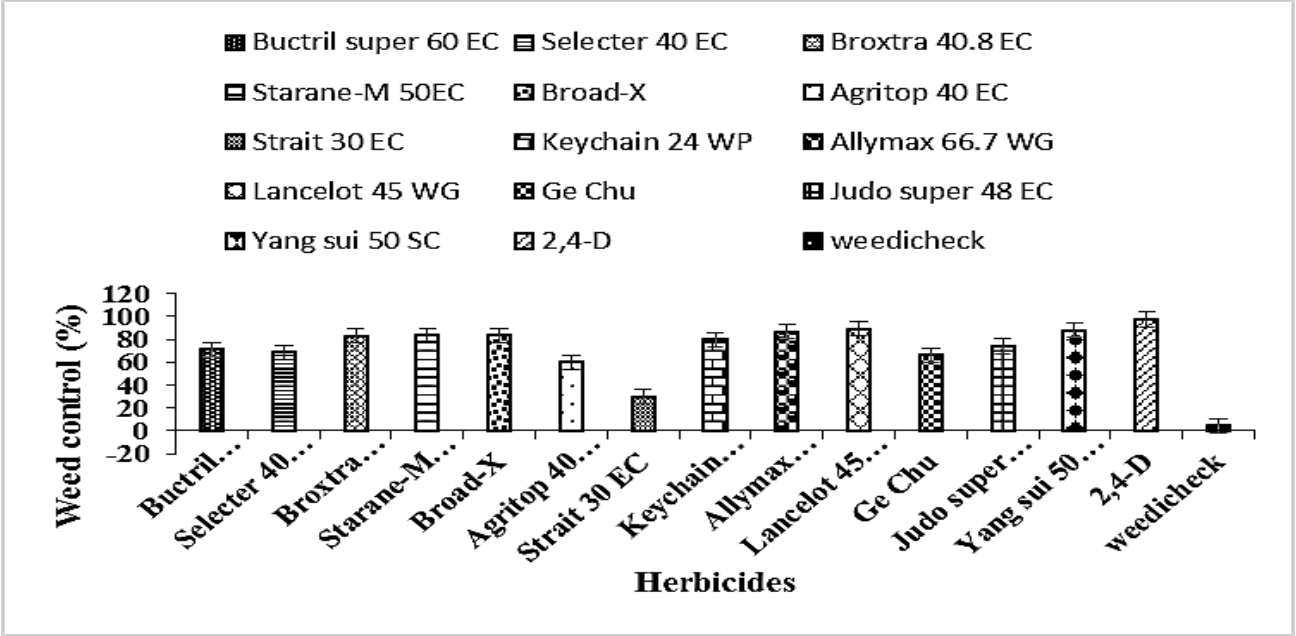


**Figure. Dicot weeds control (%) in wheat**

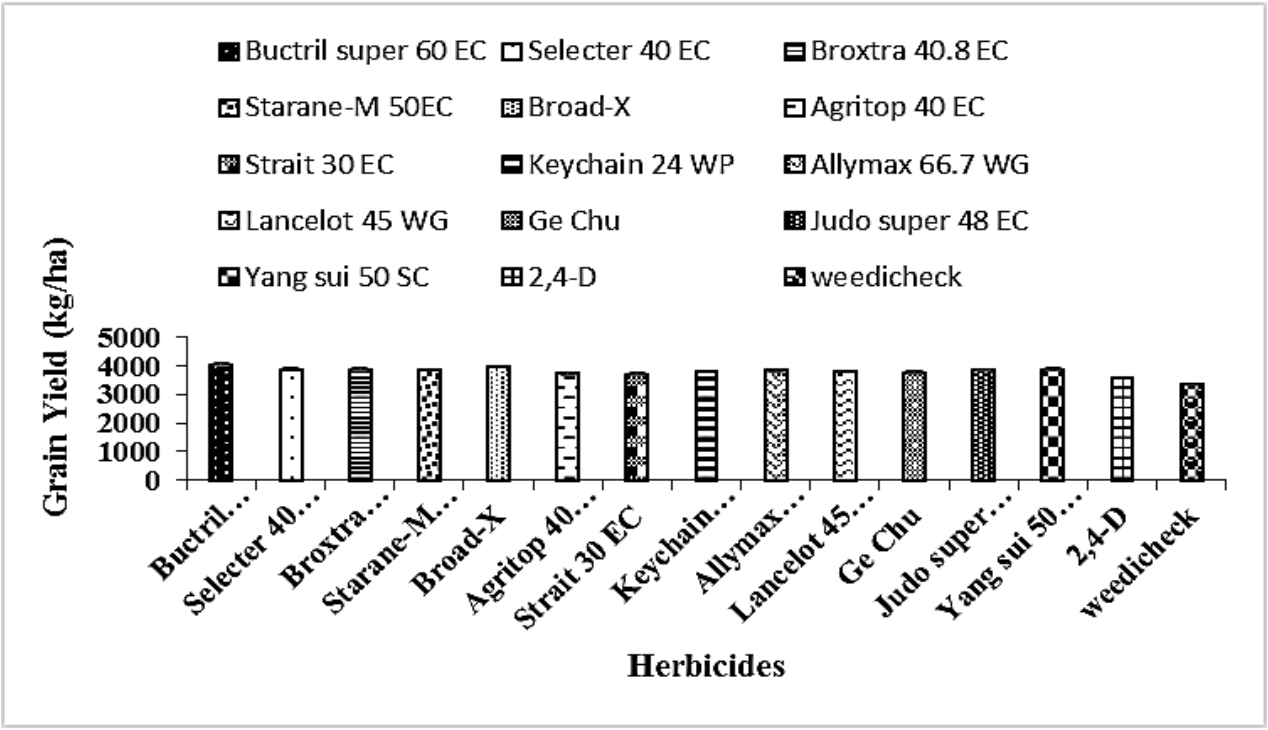


**Figure. Effect of different herbicides on wheat grain yield (kg ha$^{-1}$)**

## 23. SCREENING OF HERBICIDES TO CONTROL MONOCOT WEEDS IN WHEAT (*TRITICUM AESTIVUM*)

This study was conducted under Faisalabad conditions during Rabi 2019-20 to evaluate six herbicides viz; Axial 050 EC, Certain plus 14.5 EC, Topik 15 WP, Skype 20 EC, Puma super 69 EW, Chitta 69 EW against weedicheck for chemical weed control monocot weeds in wheat. The experiment was laid out in randomized complete block design with plot size of 2.75 m × 9.0 m having three replications. The results revealed that the maximum weed control percentage (60.34 %) was recorded with Certain Plus 14.5 EC. The highest grain yield (3783 kg ha$^{-1}$) was obtained where Axial 50 EC was applied @ 330 ml/acre while minimum yield (3316 kg ha$^{-1}$) was obtained when no herbicide was applied.

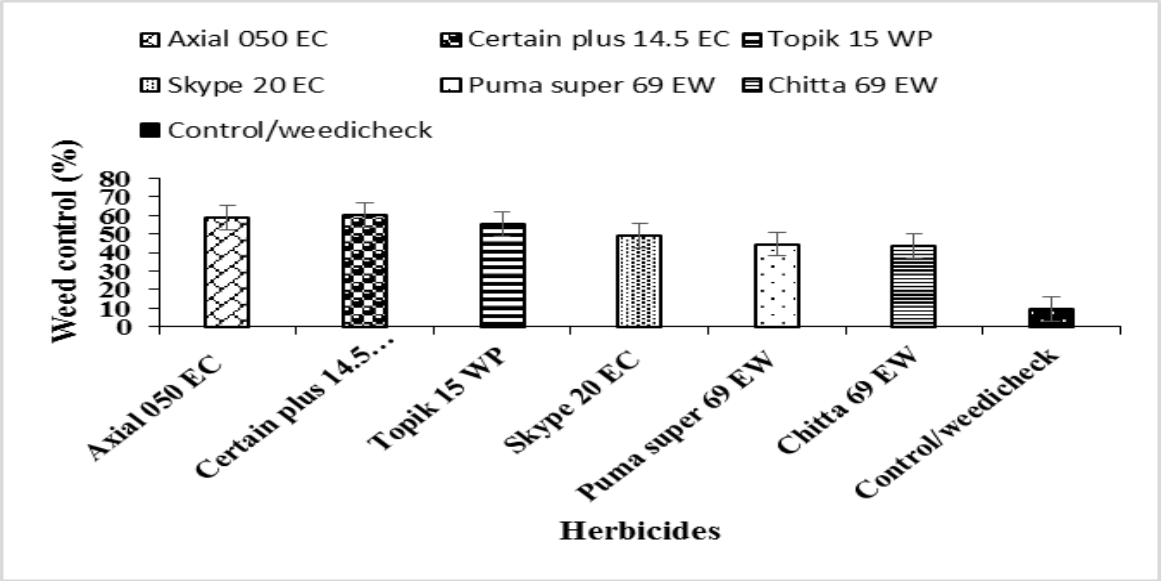


**Figure. Monocot weeds control (%) in wheat**

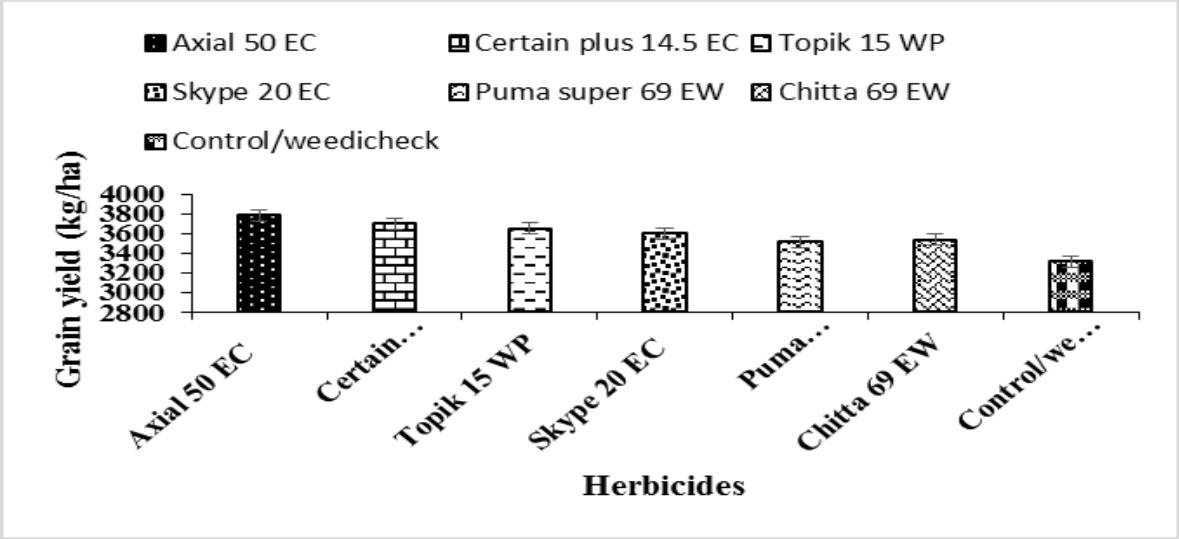


**Figure. Grain yield (kg ha$^{-1}$) of wheat as affected by different herbicides**

## 24. 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 (5907) kg $ha^{-1}$ was obtained from weed free treatment. The treatment Pert plus at 2.25L $ha^{-1}$ post em gave maximum weed control.

**Table. Effect of chemical weed control on weedd density anf yield of okra**

| **Treatments** | **Fruit yield (kg $ha^{-1}$)** | **Weeds ($m^2$)** | **Weed control (%)** |
|---|---|---|---|
| $T_1$ = Pendimethalin at 2.5 L $ha^{-1}$ pre em. | 5015 b | 133 c | 58 |
| $T_2$ = Dual gold at1.80 L ha-1 pre em. | 5175 bc | 121 c | 62 |
| $T_3$ = Pert plus at 2.25 L $ha^{-1}$ pre em. | 5200 b | 105 d | 67 |
| $T_4$ = Percept at 0.875 L $ha^{-1}$ post em. | 4759 d | 227 b | 29 |
| $T_5$ = Calm at 0.625 L $ha^{-1}$ post em. | 4871 cd | 224 b | 30 |
| $T_6$ = Weed free | 5907 a | 0.00 e | 100 |
| $T_7$= Control | 3209 e | 318 a | |
| LSD (0.05) for yield = 209.38<br>LSD (0.05) for weeds = 12.19 | | | |

## 25. 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 2019. 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)” (2503.7 kg $ha^{-1}$) compared to other treatments.

**Table. Effect of weedicides on seed cotton yield for year 2019**

| Treatments | Seed Cotton Yield (kg ha$^{-1}$) |
|---|---|
| | **Means** |
| $T_1$ = Dual gold 2 L/ha (Pre-emergence) | **2504 A** |
| $T_2$ = Pendimethalin 3 L/ha (Pre-emergence) | 2283 AB |
| $T_3$ = Acetaclore 1000 mL/ha (Pre-emergence) | 2158 ABC |
| $T_4$ = Phenoxaprop-p-ethyl 1250 mL/ha (Post emergence for grasses) | 1798 CD |
| $T_5$ = Clodinofop 450 g/ha (Post emergence for grasses) | 1888 BC |
| $T_6$ = Heloxyfop 1250 mL/ha (Post emergence for grasses) | 1776 CD |
| $T_7$ = Control | 1384 D |
| Tukey's HSD | 426.3 |

## 26. IMPROVING THE PRODUCTIVITY OF BRASSICA THROUGH OPTIMIZING SOWING METHODS FOR DIFFERENT GENOTYPES

An experiment was conducted with objective to evaluate the yield potential of Brassica varieties under different methods of planting in comparison with conventional planting. The experiment was conducted during Rabi 2019-20 at ARS, BWP. The experiment was laid out under randomized complete block design (RCBD) with split arrangement of treatments and replicated three times. Treatments were comprised of sowing methods in main plots viz. P1 = Broadcast (conventional) in flat field; P2 = Drill sowing and P3 = Broadcast of seed and augmented with furrows (Ridging) and genotypes in sub plot viz. V1 = Brassica napus; V2 = Brassica juncea. Relatively more seed yield was recorded for Broadcast of seed and augmented with furrows (Ridging) (2498 kg ha-1) and for *Brassica juncea* (2730 kg ha-1) compared to other treatments.

**Table: Effect of sowing methods and genotypes on yield of brassica**

| Genotypes/sowing methods | Broadcast (conventional) in flat field | Drill sowing | Broadcast of seed and augmented with furrows (Ridging) | Means of genotypes, Seed yield (kg ha$^{-1}$) |
|---|---|---|---|---|
| *Brassica napus* | 1895 | 1909 | 1999 | 1934 B |
| *Brassica juncea* | 2544 | 2649 | 2998 | **2730 A** |
| Means of sowing methods, Seed yield (kg ha$^{-1}$) | 2219 B | 2279 AB | **2498 A** | |
| Tukey's HSD for sowing methods = 264.8, Tukey's HSD for genotypes = 261.7 | | | | |

## 27. EFFECT OF DIFFERENT FERTILIZER LEVELS ON GROWTH AND YIELD OF LINSEED (*LINUM USITATISSIMUM*)

To find out the optimum fertilizer rate for new linseed variety Roshni under Farooqabad conditions, an experiment was conducted in Randomized Complete Block Design having three replications with a plot size of 3.0 m ×7.0 m. Trial was sown on 28th of November 2019. Treatments were as under

$F_1$ =80-58-30 NPK kg $ha^{-1}$(Recommended)

$F_2$ =56-41-21 NPK kg $ha^{-1}$

$F_3$ =64-47-24 NPK kg $ha^{-1}$

$F_4$ =72-52-27 NPK kg $ha^{-1}$

$F_5$ =88-64-33 NPK kg $ha^{-1}$

Data on yield were recorded during the course of experiment and presented in kg $ha^{-1}$.

**Table. Effect of Different Fertilizer Levels on Yield of Linseed**

| Treatments | Yield (kg $ha^{-1}$) |
|---|---|
| F1= 80-58-30 NPK kg/ha (Recommended) | 1863 A |
| F2 = 56-41-21 NPK kg/ha | 1550 C |
| F3 = 64-47-24 NPK kg/ha | 1649 BC |
| F4= 72-52-27 NPK kg/ha | 1784 AB |
| F5= 88-64-33 NPK kg/ha | 1914 A |

LSD value= 148.19

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

The maximum linseed production (1914 kg $ha^{-1}$) was obtained where 8-64-33 NPK kg$ha^{-1}$ were applied and remain at par with plot where 80-58-30 NPK kg$ha^{-1}$ (Recommended)were applied which produced the grain yield of (1863 kg $ha^{-1}$). Whereas the minimum grain yield of (1550 kg $ha^{-1}$) was obtained from the plot where 56-41-21 NPK kg $ha^{-1}$ was applied

## 28. EFFECT OF DIFFERENT SEED RATES ON GROWTH AND YIELD OF LINSEED ( *LINUM USITATISSIMUM*)

To find out the optimum seed rate for new linseed variety Roshni under Farooqabad conditions, a trial was laid out in Randomized Complete Block Design having three replications with a plot size of 3.0 m ×7.0 m. The Trial was sown on 21st of November 2019.

Treatments compared in this trail were as follow.

$SR_1$ =15 kg $ha^{-1}$

$SR_2$ = 20 kg $ha^{-1}$

$SR_3$ = 25 kg $ha^{-1}$

$SR_4$ =30 kg $ha^{-1}$

$SR_5$ = 35 kg $ha^{-1}$

$SR_6$ = 40 kg $ha^{-1}$

Yield data of this trial is presented as follow.

**Table: 10. Effect of Different Seed Rates on Yield of Linseed**

| Treatment | Yield (kg $ha^{-1}$) |
|---|---|
| SR1 = 15 kg/ha | 1537 C |
| SR2 = 20 kg/ha | 1574 C |
| SR3 = 25 kg/ha | 1610 BC |
| SR4 = 30 kg/ha | 1692 ABC |
| SR5= 35 kg/ha | 1753 AB |
| SR6 = 40 kg/ha | 1860 A |

LSD value= 172.00

Statistical analysis of the data showed the significant differences among treatment means. According to the data Maximum linseed yield (1860 kg $ha^{-1}$) was obtained from the treatment where seed rate was 40 kg $ha^{-1}$ was used, while minimum linseed yield 1537 kg $ha^{-1}$ was obtained from the plot where seed rate 15 kg $ha^{-1}$ was used.

## 29. INFLUENCE OF DIFFERENT SOWING DATES ON YIELD OF CANOLA

To find out optimum sowing time for canola under Farooqabad condition a trial was laid out in Randomized Complete Block Design with three replications. Treatments were as under

$D_1$. $10^{th}$ September

$D_2$. $20^{th}$ September

$D_3$. $1^{st}$ October

$D_4$. $10^{th}$ October

$D_5$. $20^{th}$ October

$D_6$. $1^{st}$ November

Data on grain yield of canola are presented as follow

**Table. Influence of Sowing Dates on Yield of Canola**

| Treatments | Yield (kg $ha^{-1}$) |
|---|---|
| D1 = 10th Sep | 2166 A |
| D2 = 20th Sep | 2108 A |
| D3= 1st Oct | 1640 B |
| D4 = 10th Oct | 1432 C |
| D5= 20th Oct | 1315 C |
| D6 = 1st Nov | 962 D |

LSD value= 207.80

Statistical analysis of the data showed the significant difference among treatment means. According to the data maximum Canola yield (2166 kg $ha^{-1}$) was obtained from the plots which was sown on $10^{th}$ of September 2020, while minimum Canola yield 962 kg $ha^{-1}$ was obtained from the plot which was sown on $1^{st}$ of November 2020.

# STUDIES ON BIO-LIQUIDS, CHEMICAL FERTILIZERS AND MOISTURE STRESS

## 30. IMPACT OF INTEGRATED USE OF BIO-LIQUIDS (EARTHWORM WASH) AND CHEMICAL FERTILIZER ON GRAIN YIELD OF MAIZE (*ZEA MAYS* L.)

The experiment was conducted at Research area of Plant Physiology Section, Ayub Agricultural Research Institute, Faisalabad during 2019 to evaluate the performance of maize by the use of organic (earthworm wash) and inorganic sources (chemical fertilizer).

The treatments were comprised of;

**1:** 250:145:90 NPK Kg $ha^{-1}$ + water spray (control)

**2:** 187:110:67 NPK Kg $ha^{-1}$+15% alligator weed bio-liquid

**3:** 187:110:67 NPK Kg $ha^{-1}$+15% alfalfa bio-liquid

**4:** 187:110:67 NPK Kg $ha^{-1}$+15% rice straw bio-liquid

**5:** 187:110:67 NPK Kg $ha^{-1}$ + 7.5% alligator weed bio-liquid + 7.5% alfalfa bio-liquid

**6:** 187:110:67 NPK Kg $ha^{-1}$ + 7.5% alligator weed bio-liquid + 7.5% rice straw bio-liquid

**7:** 187:110:67 NPK Kg $ha^{-1}$ + 7.5% alfalfa bio-liquid + 7.5% rice straw bio-liquid

**8:** 187:110:67 NPK Kg $ha^{-1}$ + 5% alligator weed bio-liquid + 5% alfalfa bio-liquid + 5% rice straw bio-liquid.

The foliar application of bio-liquids was done at 30, 45 and 60 days after sowing. It was concluded that maximum 1000-grain weight (31.13 g) and grain yield (8262.3 kg $ha^{-1}$), was achieved with application of 187:110:67 NPK kg $ha^{-1}$ + 5% alligator weed bio-liquid + 5% alfalfa bio-liquid + 5% rice straw bio-liquid (treatment 8).

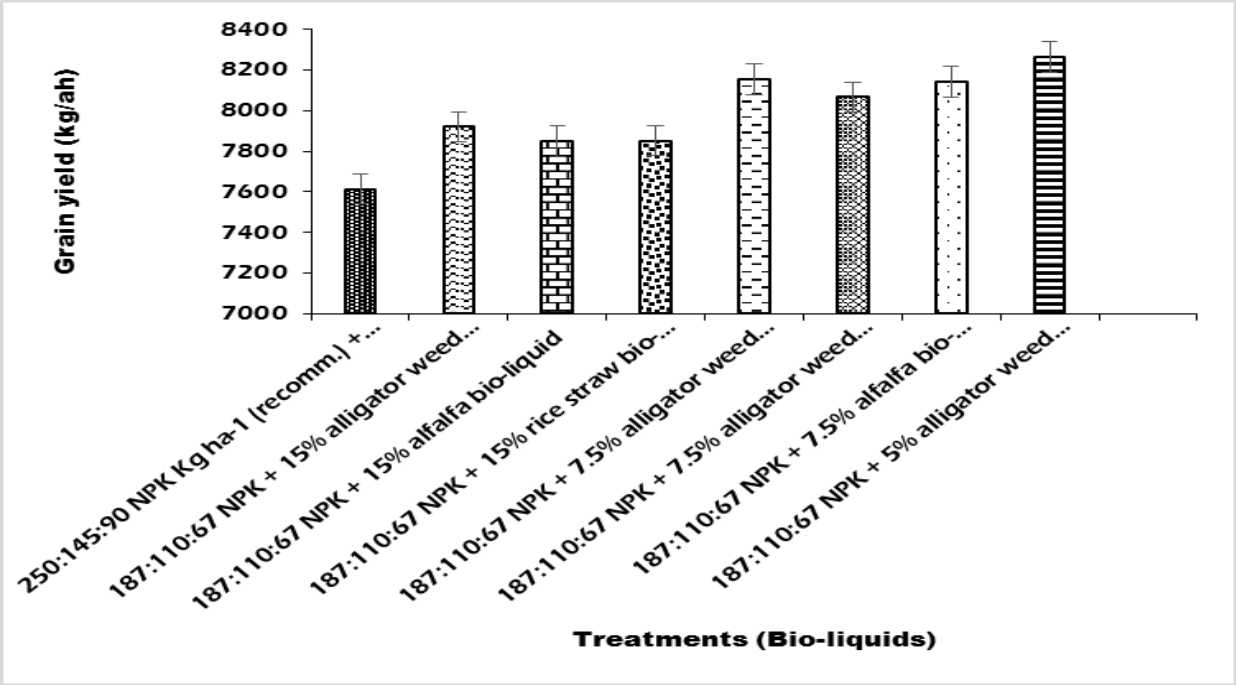


**Figure. Effect of bio-liquids (earthworm wash) and chemical fertilizers on grain yield (kg $ha^{-1}$) of maize**


## 31. IMPACT OF VARIOUS SOURCES OF BIO-LIQUIDS (EARTHWORM WASH) ON ENHANCING DROUGHT TOLERANCE IN MAIZE (*ZEA MAYS* L.)

The experiment was conducted at Research area of Plant Physiology Section, Ayub Agricultural Research Institute, Faisalabad during 2019 to enhance drought tolerance in maize through the foliar application of bio-liquids (earthworm wash). The treatments were as follow.

**A: Field Capacity**

$FC_1$: Field capacity (70%)

$FC_2$: Field capacity (35%)

**B: Foliar spray of bio-liquids**

**1:** Water spray (Control)
**2:** 15% alligator weed bio-liquid
**3:** 15% alfalfa bio-liquid
**4:** 15% rice straw bio-liquid
**5:** 7.5% alligator weed bio-liquid + 7.5% alfalfa bio-liquid
**6:** 7.5% alligator weed bio-liquid + 7.5% rice straw bio-liquid
**7:** 7.5% alfalfa bio-liquid + 7.5% rice straw bio-liquid
**8:** 5% alligator weed bio-liquid + 5% alfalfa bio-liquid + 5% rice straw bio-liquid

The foliar application of bio-liquids was done at 30, 45 and 60 days after sowing. It was concluded that maximum grain yield (8548.7 kg $ha^{-1}$) was achieved in treatment with application of 5% alligator weed bio-liquid + 5% alfalfa bio-liquid + 5% rice straw bio-liquid under normal moisture conditions (70% field capacity), while minimum grain yield (5548.7 kg $ha^{-1}$) was obtained in control under moisture stress conditions (35% FC).

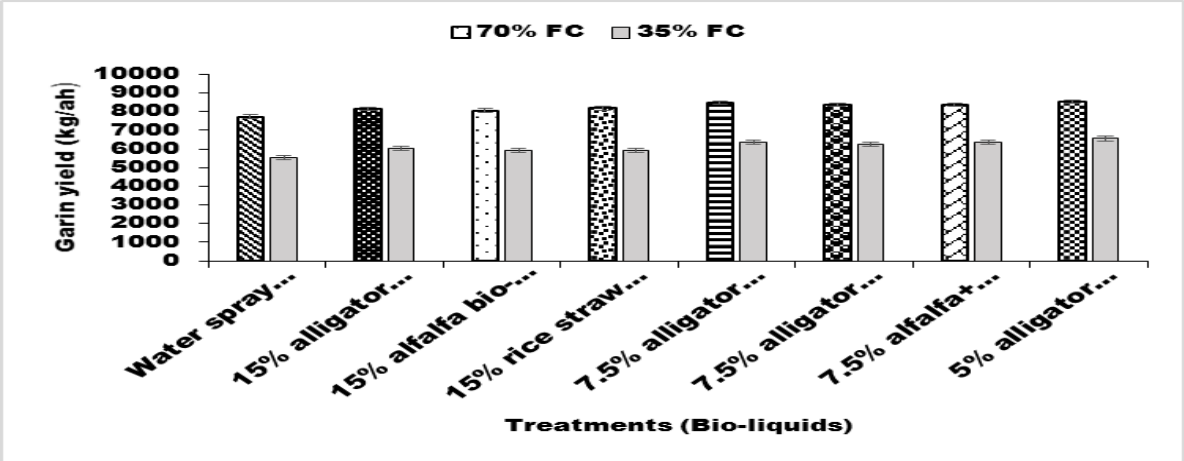


**Figure. Effect of bio-liquids on grain yield of maize (kg $ha^{-1}$) under normal and moisture stress conditions**

# NUTRIENT MANAGEMENT

## 32. NUTRIENT MANAGEMENT STUDIES IN TULSI (*OCIMUM TENUIFLORUM*)

The experiment was conducted at Research area of Plant Physiology Section, Ayub Agricultural Research Institute, Faisalabad during 2019 to find out the optimum fertilizer requirements to obtain the maximum seed yield. The treatments were comprised of;

i) 60-60-00 NPK Kg ha$^{-1}$

ii) 60-60-20 NPK Kg ha$^{-1}$

iii) 60-60-40 NPK Kg ha$^{-1}$

iv) 60-60-60 NPK Kg ha$^{-1}$

It was concluded that maximum raceme/plant (415.4), 1000-grain weight (1.04 g) and grain yield (1047 kg ha$^{-1}$) was achieved when fertilizer was applied @ 60-60-40 kg ha$^{-1}$ NPK, however it is not statistically different from fertilizer application @ 60-60-60 kg ha$^{-1}$ NPK.

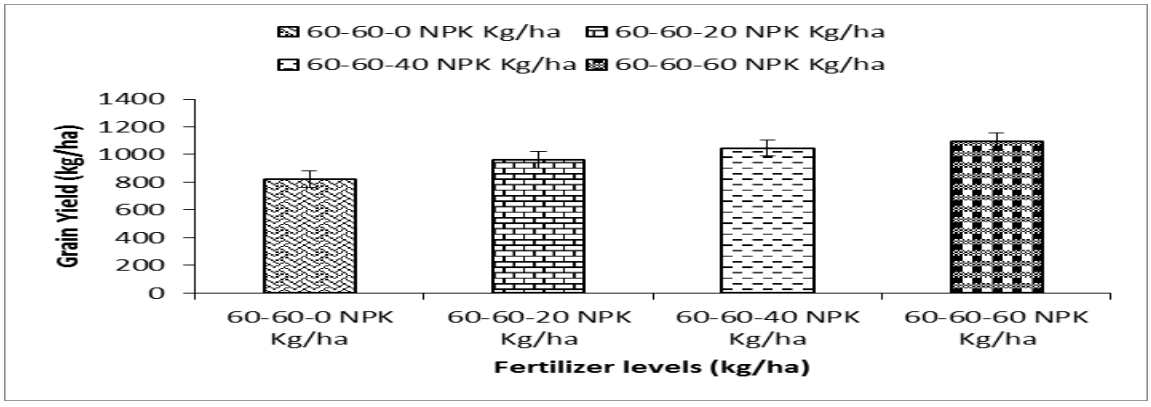


**Figure. Effect of fertilizer levels on grain yield of Tulsi (kg ha$^{-1}$)**

## 33. POTASSIUM USE EFFICIENCY AS INFLUENCED BY PREVAILING TEMPERATURE AND ITS EFFECT ON GROWTH AND YIELD COMPONENTS OF WHEAT

This experiment was planned to determine potassium use efficiency under prevailing temperature and its effects on plant growth and grain yield of wheat. Treatments were

**1.** Control (No potash fertilizer application)

**2.** Recommended dose of potassium (60 kg/ha) at the time of seed bed preparation

**3.** Recommended dose of potassium at the time of seed bed preparation + foliar application of potassium (2% $KNO_3$ solution) at booting stage

**4.** Recommended dose of potassium at the time of seed bed preparation + foliar application of potassium at grain filling stage

**5.** Recommended dose of potassium at the time of seed bed preparation + foliar application of potassium at booting and grain filling stages

**6.** Half dose of recommended potassium at the time of seed bed preparation + half dose at the time of booting stage

**7.** Half dose of potassium at the time of seed bed preparation + half dose at the time of grain filling stage

**8.** One third dose of potassium at the time of seed bed preparation + one third dose at the time of booting stage + one third dose at the time of grain filling stage.

The experiment was laid out in randomized complete block design with plot size of 3 m × 9.0 m having three replications. Fertilizer @ 115-85 NP kg $ha^{-1}$ was applied at the time of sowing. Seed rate was used 125 kg $ha^{-1}$. All other agronomic practices were kept normal and uniform during the course of study. The significantly maximum grain yield (6380 kg $ha^{-1}$) was recorded in treatment number five while minimum grain yield (3144 kg $ha^{-1}$) was recorded for control.

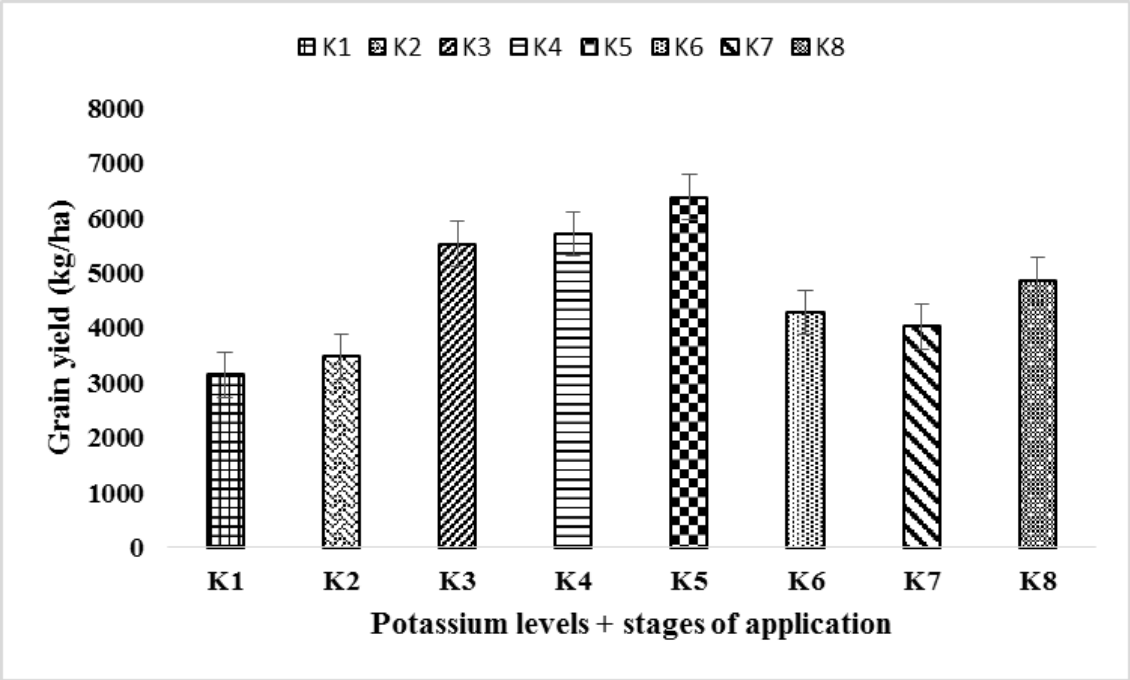


**Figure. Effect of potassium doses and application time on wheat grain yield (kg ha$^{-1}$) under prevailing climatic conditions**

## 34. EFFECT OF MULCHING AND NITROGEN FERTILIZER ON GROWTH AND YIELD OF WHEAT

The trial was conducted to study the interactive effect of mulching and nitrogen fertilizer to improve the productivity of wheat. The trial was laid out in factorial arrangement having three replications. Plots size was 1.8 m × 7.0 m. The mulching was done after germination of wheat crop. Treatments were; $T_1$= Control (No mulch, No fertilizer), $T_2$= No mulch+ 57.5 kg/ha urea, $T_{3=}$ No mulch+ 115 kg/ha urea, $T_4$= Wheat Straw Mulch @ 11.5 t $ha^{-1}$+ No urea, $T_5$= Wheat Straw Mulch @ 11.5 t $ha^{-1}$+ 57.5 kg/ha urea, $T_6$= Wheat Straw Mulch @ 11.5 t $ha^{-1}$+ 115 kg/ha urea, $T_7$= Wheat Straw Mulch @ 5.75 t $ha^{-1}$+ No urea, T8= Wheat Straw Mulch @ 5.75t $ha^{-1}$+ 57.5 kg/ha urea, $T_9$= Wheat Straw Mulch @ 5.75 t $ha^{-1}$+ 115 kg/ha urea. Maximum grain yield (3912 kg ha-$^{1}$) was observed in case of T9 while minimum grain yield (2518 kg ha-$^{1}$) was observed in T1.

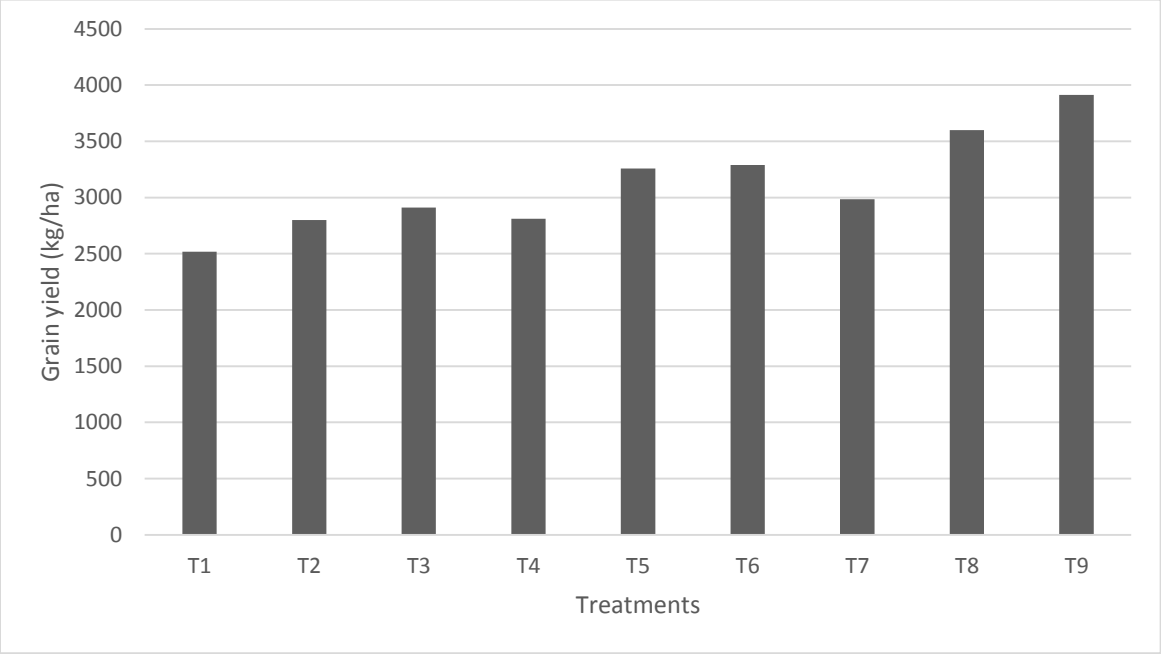


**Figure: Effect of Mulching and Nitrogen Fertilizer on Yield of Wheat (kg $ha^{-1}$)**

## 35. EFFFECT OF SOIL AND FOLIAR APPLICATION OF K AND B ON THE YIELD OF SUNFLOWER

The experiment was conducted to find out the optimum dose and application method for K and B to get maximum yield of sunflower. The experiment was laid out in RCBD with split with three replications having a plot size of 3 m × 6.0 m. The treatments were Control, K @ 62 kg $ha^{-1,}$B @ 5 kg $ha^{-1,}$K @ 62 kg $ha^{-1}$ + K 0.1% (45, 60, 75 DAS), B @ 5 kg $ha^{-1}$ + B 0.1% (45, 60, 75 DAS), K @ 62 kg $ha^{-1}$ + B & K 0.1% (45, 60, 75 DAS), B @ 5 kg $ha^{-1}$ + B & K 0.1% (45, 60, 75 DAS), K 0.1% (45, 60, 75 DAS), B @ 0.1% (45, 60, 75 DAS)were tested. The treatment K 62kg $ha^{-1}$ + B & K 0.1% (45, 60, 75 DAS) gave maximum seed yield (2258) $ha^{-1}$.

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

| **Treatments** | **Yield kg/ha** |
|---|---|
| Control | 1588 f |
| K 62kg $ha^{-1}$ | 1780 e |
| B 5kg $ha^{-1}$ | 1662 f |
| K 62kg $ha^{-1}$ + K 0.1% (45,60,75 DAS) | 1967 c |
| B 5kg $ha^{-1}$ + B 0.1% (45,60,75 DAS) | 2075 b |
| K 62kg $ha^{-1}$ + B & K 0.1% (45,60,75 DAS) | 2258 a |
| B 5kg $ha^{-1}$ + B & K 0.1% (45,60,75 DAS) | 2101 b |
| K 0.1% (45,60,75 DAS) | 1851 de |
| B 0.1% (45,60,75 DAS) | 1892 cd |
| **LSD (0.05) = 90.68** | |

# ORGANIC FARMING

Following trials were carried out specifically under the umbrella of organic farming:

## 36. IMPACT OF ORGANIC AND BIOFERTILIZER ON MUNG BEAN PRODUCTION

This study was conducted to find out the most suitable combination of organic fertilizers for higher grain production. The trial was laid out in RCBD having three replications. Plots size was 7.0 m × 2.7 m. All organic amendments will be applied two weeks before sowing of crop. All other agronomic practices will be kept uniform. The results revealed that maximum grain yield (2017.8 kg ha-$^{1}$) was obtained when a combination of compost, farm yard manure and co-inoculation was used. The lowest grain yield (1217.5 kg ha-1) was obtained when no manure was applied.

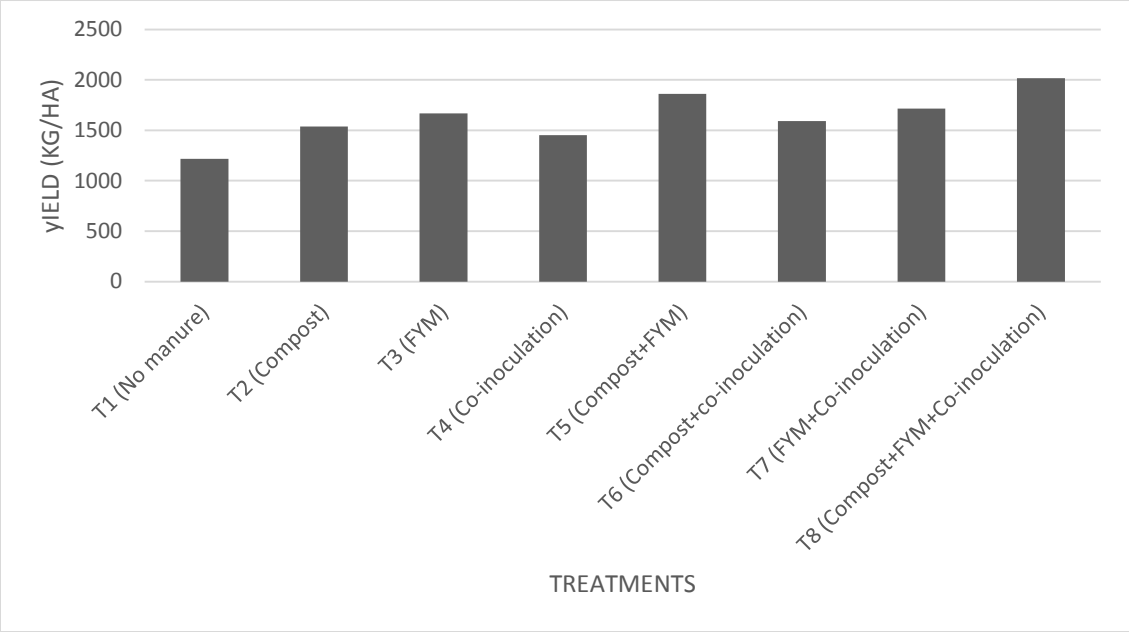


**Figure: Effect of organic manures on mungbean yield (kg ha$^{-1}$)**

## 37. INFLUENCE OF MULCHING OF DIFFERENT CROP RESIDUES ON WEEDS AND YIELD OF WHEAT

The experiment was conducted to evaluate the potential of different crop residue mulches for controlling weed infestation and achieving higher grain productivity during Rabi season 2019-20. The

Randomized Complete Block Design with three replications having net plot size 6.0 m × 1.8 m was used. Wheat variety Galaxy-13 was used. Treatments were; $T_1$= Weedy check, $T_2$= Weed-free, $T_3$ Sorghum mulch @ 8 t ha$^{-1}$, $T_4$= Wheat mulch @ 8 t ha$^{-1}$, $T_5$= Maize mulch @ 8 t ha$^{-1}$, $T_6$= Mung bean mulch @ 8 t ha$^{-1}$. Maximum grain yield (4090 kg ha-$^{1}$) was observed in case of weed free while minimum grain yield (2872 kg ha-$^{1}$) was observed in case of weedy check.

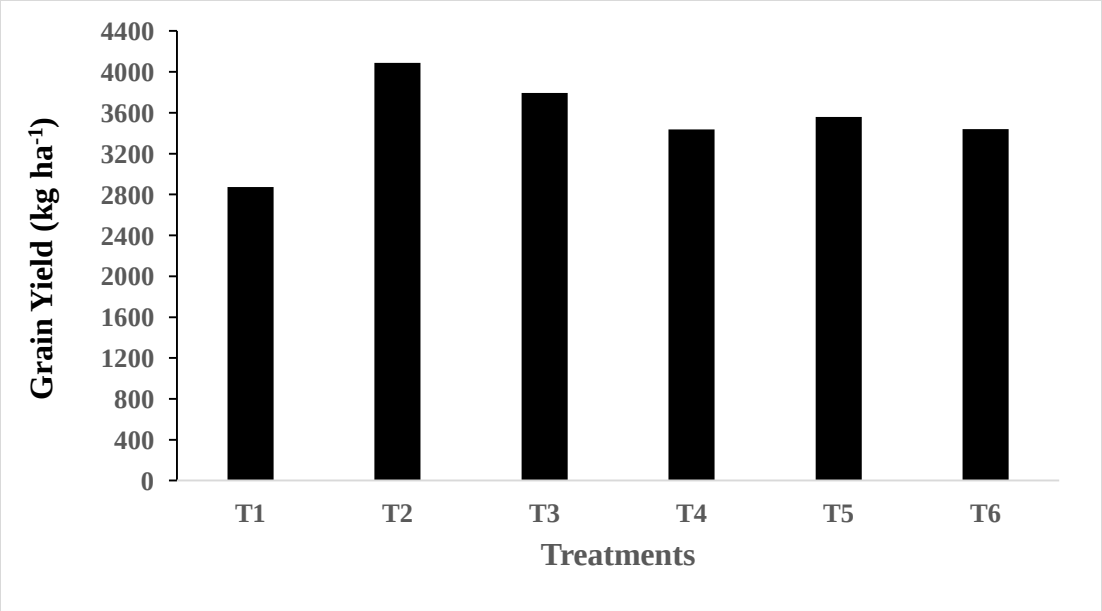


**Figure: Influence of mulches on wheat grain yield (kg ha$^{-1}$); $T_1$= Weedy check, $T_2$= Weed-free, $T_3$ Sorghum mulch @ 8 t ha$^{-1}$, $T_4$= Wheat mulch @ 8 t ha$^{-1}$, $T_5$= Maize mulch @ 8 t ha$^{-1}$, $T_6$= Mung bean mulch @ 8 t ha$^{-1}$**

## 38. INFLUENCE OF DIFFERENT ORGANIC MANURES ON PRODUCTIVITY OF WHEAT

The experiment was conducted to quantify the influence of organic sources in different combinations on wheat productivity during Rabi season 2019-20. The Randomized Complete Block Design with three replications having net plot size 6.0 m × 1.8 m was used. Wheat variety Galaxy-13 was used. Treatments were; $T_1$= Control (no manure), $T_2$= Compost @ 12.77 t ha$^{-1}$, $T_3$= Press mud @ 6.18 t ha$^{-1}$, $T_4$= Vermicompost @ 6.15 t ha$^{-1}$, $T_5$= Compost @ 6.39 t ha$^{-1}$+Press mud @ 3.09 t ha$^{-1}$, $T_6$= Compost @ 6.39 t ha$^{-1}$+Vermicompost @ 3.08 t ha$^{-1}$, $T_7$= Press mud @ 3.09 t ha$^{-1}$+Vermicompost @ 3.08 t ha$^{-}$1, $T_8$= Compost @ 4.26 t ha$^{-1}$+Press mud @ 2.06 t ha$^{-1}$+Vermicompost @ 2.05 t ha$^{-1}$. Maximum grain yield (4552 kg ha-$^{1}$) was observed in case of combined application while minimum grain yield (1718 kg ha-$^{1}$) was observed where no manure was applied.

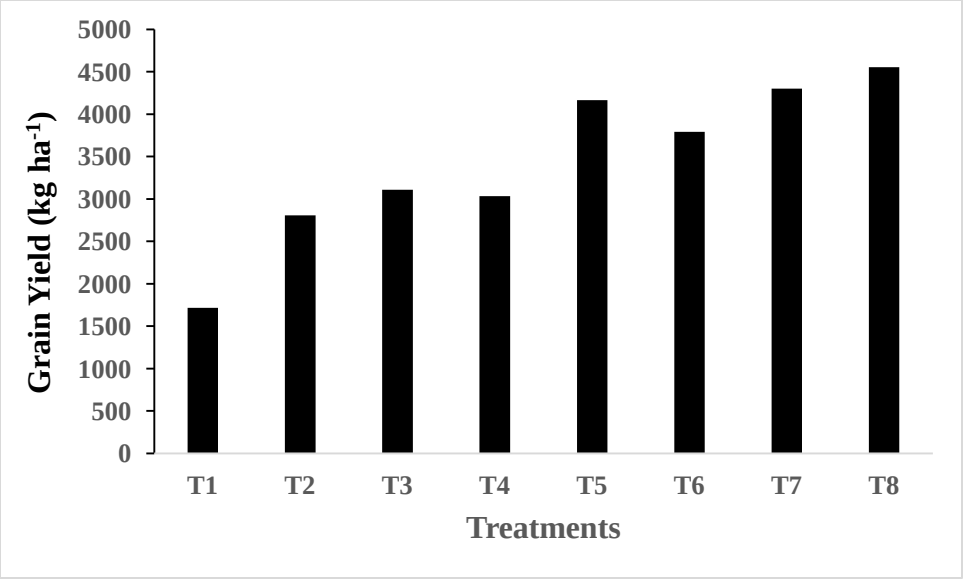


**Figure: Influence of different organic fertilizers on wheat grain yield (kg ha$^{-1}$); $T_1$= Control (no manure), $T_2$= Compost @ 12.77 t ha$^{-1}$, $T_3$= Press mud @ 6.18 t ha$^{-1}$, $T_4$= Vermicompost @ 6.15 t ha$^{-1}$, $T_5$= Compost @ 6.39 t ha$^{-1}$+Press mud @ 3.09 t ha$^{-1}$, $T_6$= Compost @ 6.39 t ha$^{-1}$+Vermicompost @ 3.08 t ha$^{-1}$, $T_7$= Press mud @ 3.09 t ha$^{-1}$+Vermicompost @ 3.08 t ha$^{-}$1, $T_8$= Compost @ 4.26 t ha$^{-1}$+Press mud @ 2.06 t ha$^{-1}$+Vermicompost @ 2.05 t ha$^{-1}$**

## 39. NUTRIENT MANAGEMENT IN MAIZE THROUGH ORGANIC MANURES

The experiment was conducted to quantify the influence of organic sources in different combinations on maize productivity during Kharif season 2019. The Randomized Complete Block Design under factorial arrangement with three replications having net plot size 4.0 m × 2.25 m was used. There were two factors: $F_A$: Varieties ($V_1$= Malka-16; $V_2$= MMRI-Yellow) and $F_B$: Organic fertilizer management ($T_1$= No manure; $T_2$= Farmyard manure (35 t ha$^{-1}$); $T_3$= Poultry manure (6 t ha$^{-1}$); $T_4$= Vermicompost (12 t ha$^{-1}$); $T_5$= Farmyard manure (18 t ha$^{-1}$) + Poultry manure (3 t ha$^{-1}$); $T_6$= Farmyard manure (18 t ha$^{-1}$) + Vermicompost (6 t ha$^{-1}$); $T_7$= Poultry manure (3 t ha$^{-1}$) + Vermicompost (6 t ha$^{-1}$); $T_8$= Farmyard manure (12 t ha$^{-1}$) + Poultry manure (2 t ha$^{-1}$) + Vermicompost (4 t ha$^{-1}$). Highest grain yield was found in case of farm yard manure + poultry manure + vermicompost application, while lowest grain yield was observed where no manure was applied.

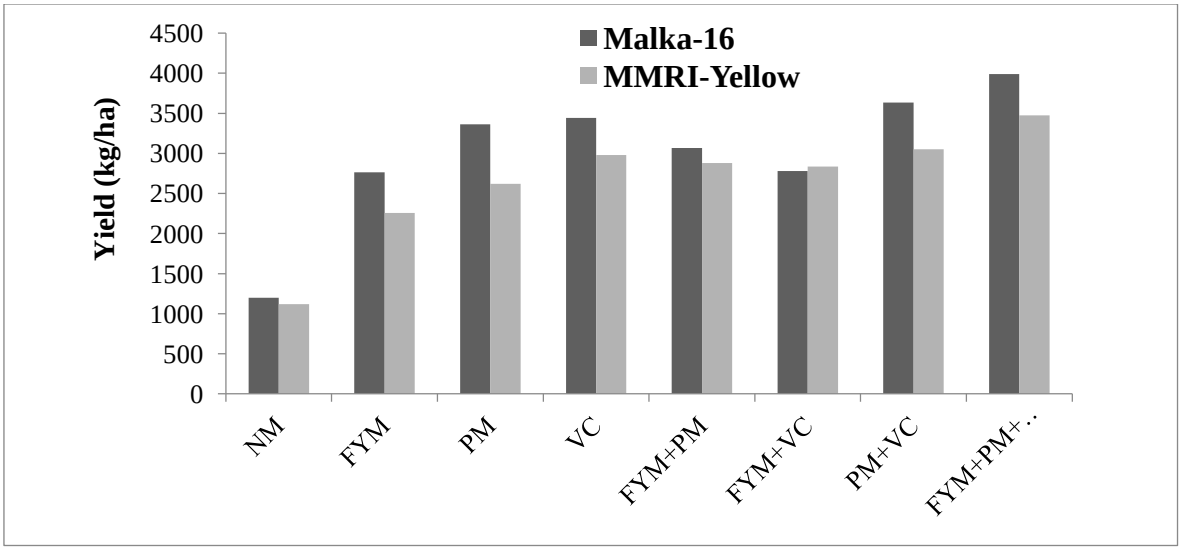


**Figure: Influence of various organic manures on grain yield (kg/ha) in maize;** NM= No manure; FYM= Farm yard manure; PM= Poultry manure; VC= Vermicompost

## 40. 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 $ha^{-1}$, 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 of 8154 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. Influence of different organic nutrient sources on the yield of turmeric**

| **Treatments** | **Yield (kg $ha^{-1}$)** |
|---|---|
| $T_1$ = FYM 15 t $ha^{-1}$ | 5069 d |
| $T_2$ = FYM 20 t $ha^{-1}$ | 6090 c |
| $T_3$ = Sugarcane press mud 7.5 t $ha^{-1}$ | 5704 c |
| $T_4$ = Sugarcane press mud 10 t $ha^{-1}$ | 7033 b |
| $T_5$ = FYM 15 t $ha^{-1}$ + Sugarcane press mud 7.5 t $ha^{-1}$ | 8154 a |
| LSD (0.05)= 622 | |

## 41. 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 conducted at Agronomic Research Station, Bahawalpur during kharif season 2019. 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" (1698.3 kg $ha^{-1}$) compared to other treatments.

**Effect of organic manures on seed cotton yield (2019)**

| **Treatments** | **Seed cotton yield (kg $ha^{-1}$)** |
|---|---|
| $T_1$ = FYM @ 5 t/ha | 1392 BC |
| $T_2$ = Poultry waste @ 5 t/ha | 1427 B |
| $T_3$ = Press mud @ 5 t/ha | 1397 BC |
| $T_4$ = FYM @ 3.5 t/ha + Poultry waste @ 2.5 t/ha | **1698 A** |
| $T_5$ = Control | 1174 C |
| Tukey's HSD | 227.35 |

## VERMICULTURE

The progress in brief is as under:

- The rearing of earth worms and harvesting of vermicompost from red wiggler is going on.
- Six plastic bins are being used for rearing of earthworms
- Four pits were formed for the harvesting of vermicompost from red wiggler.
- 5000 red wiggler worms were shifted from the bins to three pits.
- Production of baby worms is in progress
- Production of 200 kg vermicompost
- Hundred kg vermicompost has been used in organic farming trials.

## PULSES

### 42. INFLUENCE OF CANOLA ON YIELD OF SUBSEQUENTLY SOWN MUNGBEAN

The trial was conducted to evaluate the impact of canola on yield of subsequently sown mungbean at different time intervals. The crop was planted in the field of canola as well as fallow field using standard production packages in plots measuring 6 m x 10 m. Fertilizer NPK @ 22-57-30 kg $ha^{-1}$ was used. The yield data recorded is as under.

**Table. Influence of canola on yield of subsequently sown mungbean**

| Treatment | Yield kg/ha |
|---|---|
| **T1 = Mungbean sown within 7 days after harvesting of canola** | 409.32 C |
| **T2 = Mungbean sown within 14 days after harvesting of canola** | 494.67 B |
| **T3 = Mungbean sown within 21 days after harvesting of canola** | 543.67 B |
| **T4 = Mungbean sown within 28 days after harvesting of canola** | 608.33 A |

### 43. EFFECT OF ZINC APPLICATION ON CHICKPEA YIELD

This experiment was conducted to evaluate the best technique of zinc application for more productivity of chickpea under irrigated conditions of Khanewal. Experiment was comprised of two factors i.e. chickpea varieties; NIAB-16, CH 24/07, CH 104/06 and zinc application; control (no application of zinc), soil application of 6 kg Zn $ha^{-1}$, foliar spray of 0.1, 0.2 and 0.3% Zn solution at early flowering and pod filling stages. Experiment was sown on 16.11.2019 and was sown following randomized complete block design (RCBD) having three replications and net plot size of 4.0 × 2.8. Fertilizer was applied as 22:57:00 NPK kg per hectare. All agronomic practices (irrigation, weed control and insect pest control) were kept uniform. The crop was harvested on 25.04.2020. Data regarding yield and yield components were recorded during experiment following standard procedures.

It was recorded that maximum chickpea yield (9781 kg $ha^{-1}$) was obtained when chickpea plants were sprayed with 0.3% Zn solution at early flowering and pod filling stage while minimum yield (7378 kg $ha^{-1}$) was recorded where no Zn was applied (Table 11). Therefore it might be recommended that chickpea plants should be sprayed with 0.3% Zn solution at flowering and pod filling stage to obtain higher yield.

**Table. Chickpea (kg ha$^{-1}$) yield as affected by Zn application**

| Treatments | Varieties | | | Mean |
|---|---|---|---|---|
| | **NIAB-16** | **CH 24/07** | **CH 1004/06** | |
| Control | 7333 | 7200 | 7600 | 7378 D |
| 6 kg Zn ha$^{-1}$ | 8517 | 8100 | 8100 | 8239 C |
| 0.1% Zn | 8850 | 8767 | 8617 | 8744 BC |
| 0.2% Zn | 9083 | 8783 | 9100 | 8989 B |
| 0.3% Zn | 9893 | 9833 | 9617 | **9781 A** |
| Mean | 8735 | 8537 | 8607 | |
| LSD value=325 | | | | |

**6 kg Zn ha$^{-1}$= dose of soil application of Zn; 0.1, 0.2 and 0.3% Zn are the concentrations of Zn solution for foliar spray at at early flowering and**

## 44. MUNGBEAN ADAPTATION YIELD TRIAL, 2019

This experiment was conducted to find out the best-suited variety/line of Mungbean for Thal irrigated area. Sixteen Mungbean varieties/strains A-P were provided by AZRI Bakhar and were sown on 29-05-2019. The experiment was laid out in RCBD with four replications having plot size 1.2 m x 4.0m. Row spacing was kept 30 cm and chemical fertilizer @ 22 – 57 NP kg ha$^{-1}$ was applied at the time of sowing. The experiment was harvested on 24-08-2019. Four irrigations were applied during the full course of study. At the harvest, following yield data were recorded. The results indicate that the maximum Mungbean seed yield was obtained from Mungbean line TM-1814 i.e. 1317 kg ha$^{-1}$ followed by AZRI-MUNG with Mungbean seed yield of 1190 kg ha$^{-1}$ having statistically at par with each other. The minimum Mung bean grain yield of 375 kg ha$^{-1}$ was obtained from Mung bean line TM-1809.

**Table. Seed Yield (kg ha$^{-1}$) of different mung bean strains**

| Strains | Yield Kg ha$^{-1}$ |
|---|---|
| **TM-1807** | 620 fgh |
| **TM-1806** | 583 ghi |
| **TM-1803** | 569 hi |
| **TM-1802** | 616 gh |
| **AZRI-MUNG-18** | 1190 b |
| **TM-1805** | 1017 c |
| **TM-1822** | 738 def |
| **TM-1809** | 375 j |
| **NM-2016** | 853 d |
| **TM-1810** | 674 fgh |
| **TM-1815** | 700 efg |
| **TM-1816** | 483 ij |
| **TM-1811** | 632 fgh |
| **TM-1814** | 1311 a |
| **TM-1823** | 813 de |
| **TM-1824** | 675 fgh |
| **LSD** | 119.06 |

# COTTON

## 45. PROVINCIAL COTTON CO-ORDINATED TRIAL (PCCT)

This set of trial features permanently in annual program of research with an aim to evaluate yield performance of candidate strains/lines for variety approval. The genotypes were provided by Cotton Research Institute, Multan. Entries were sown in RCBD with three replication having a net plot size of 3 m × 7.5 m. Row × row and plant × plant distance was maintained by 75 cm and 30 cm, respectively. A uniform N-P-K dose of 200-115-95 kg ha$^{-1}$ was applied during whole

growth period. In PCCT (Bt.) 27 genotypes (coded entries) were evaluated for seed cotton yield. Genotype PC-15 (coded entry) gave maximum seed cotton yield of 1069 kg $ha^{-1}$. However lowest seed cotton yield was recorded from PC-17 with seed cotton yield of 693 kg $ha^{-1}$. Perusal of the table will provide a further insight into the results.

**Seed cotton yield (PCCT Bt.) during the year 2019**

| **Coded entry** | **Seed cotton yield (kg $ha^{-1}$)** | **Coded entry** | **Seed cotton yield (kg $ha^{-1}$)** |
|---|---|---|---|
| **PC-1** | 1038 AB | **PC-18** | 789 ABC |
| **PC-2** | 991 ABC | **PC-19** | 810 ABC |
| **PC-3** | 846 ABC | **PC-20** | 775 ABC |
| **PC-4** | 871 ABC | **PC-21** | 906 ABC |
| **PC-5** | 853 ABC | **PC-22** | 856 ABC |
| **PC-6** | 856 ABC | **PC-23** | 898 ABC |
| **PC-7** | 910 ABC | **PC-24** | 921 ABC |
| **PC-8** | 859 ABC | **PC-25** | 818 ABC |
| **PC-9** | 864 ABC | **PC-26** | 823 ABC |
| **PC-10** | 755 BC | **PC-27** | 819 ABC |
| **PC-11** | 881 ABC | | |
| **PC-12** | 971 ABC | | |
| **PC-13** | 952 ABC | | |
| **PC-14** | 805 ABC | | |
| **PC-15** | 1069 A | | |
| **PC-16** | 939 ABC | | |
| **PC-17** | 693 C | | |
| **$LSD_{0.05}$: 299.51** | | | |

## 46. MINIMIZING SQUARE/FLOWER SHEDDING IN BT. COTTON WITH NUTRIENT MANAGEMENT

Experiment was conducted to assess the effect of boron and potassium fertilizer on crop productivity and flower retention in cotton. The objective was to reduce square/flower shedding in cotton by soil application of potassium and boron. Treatments consists of three levels of boron (1.0, 1.5, 2.0 kg $ha^{-1}$) and two levels of potassium fertilizer (95, 110 kg $ha^{-1}$). The trial was laid out in RCBD having three replications. Plots size was 3.0 m × 7.5 m with 75 cm row spacing and

30 cm plant spacing. NPK @ 200-115-95 kg $ha^{-1}$ was applied to cotton. All $P_2O_5$, K and 1/3$^{rd}$ N was applied at sowing and remaining N at squaring and flowering stages in two equal splits. Results revealed that maximum seed cotton yield (1868 kg $ha^{-1}$) was obtained when 110 kg $K_2O$ $ha^{-1}$ was applied with 1.5 kg B $ha^{-1}$. However maximum boll retaining percentage (76%) was observed when 110 kg $K_2O$ $ha^{-1}$ was applied with 1.5 kg B $ha^{-1}$ which was at par (76%) with 110 kg $K_2O$ $ha^{-1}$ along 2.0 kg B $ha^{-1}$.

## 47. DETERMINATION OF LAST IRRIGATION DATE IN BT COTTON UNDER VARYING CLIMATIC CONDITIONS

An experiment was conducted with the objective to determine time of last irrigation in Bt cotton under different sowing dates. The experiment was conducted at Agronomic Research Station, Bahawalpur during kharif season 2019. 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 irrigation in sub plots viz. $T_1$ = Irrigation on 20th September (control); $T_2$= Irrigation on 1st October; $T_3$= Irrigation on 10th October; $T_4$= Irrigation on 20th October and $T_5$= Irrigation on 30th October. Higher seed cotton yield (2218.3 kg $ha^{-1}$) was recorded with 15$^{th}$ April sowing date and with last Irrigation on 10th October (2163.5 kg $ha^{-1}$) compared to other treatments (Table 1).

**Table 1: Effect of sowing dates and times of last irrigation application on seed cotton yield for year 2019**

| Times of last irrigation/ sowing dates | $D_1$ = 15$^{th}$ April | $D_2$ = 30$^{th}$ April | Means of times of last irrigation Seed cotton yield (kg $ha^{-1}$) |
|---|---|---|---|
| $T_1$ = Irrigation on 20$^{th}$ September (control) | 1830 | 1609 | 1719 C |
| $T_2$ = Irrigation on 1$^{st}$ October | 2243 | 1616 | 1929 BC |
| $T_3$ = Irrigation on 10$^{th}$ October | 2363 | 1964 | **2163 A** |
| $T_4$ = Irrigation on 20$^{th}$ October | 2349 | 1856 | 2103 AB |
| $T_5$ = Irrigation on 30$^{th}$ October | 2305 | 1729 | 2017 AB |
| Means of sowing dates, Seed cotton yield (kg $ha^{-1}$) | **2218 A** | 1755 B | |
| Tukey's HSD for sowing dates = 226.5<br>Tukey's HSD for times of last irrigation = 211.5 | | | |

## 48. 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 2019. 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 15$^{th}$ April sowing date (2305.4 kg ha$^{-1}$) and with last nitrogen application date 15th September (2431.0 kg ha$^{-1}$) compared to other treatments.

**Table. Effect of sowing dates and times of last nitrogen application on seed cotton yield for year 2019**

| Times of last nitrogen/ sowing dates | $D_1$ = 15$^{th}$ April | $D_2$ = 30$^{th}$ April | Means of times of last nitrogen Seed cotton yield (kg ha$^{-1}$) |
|---|---|---|---|
| $T_1$ = 15$^{th}$ August | 1988 | 1479 | 1734 C |
| $T_2$ = 30$^{th}$ August | 2298 | 1933 | 2115 B |
| $T_3$ = 15$^{th}$ September | 2565 | 2297 | **2431 A** |
| $T_4$ = 30$^{th}$ September | 2370 | 2142 | 2256 AB |
| Means of sowing dates, Seed cotton yield (kg ha$^{-1}$) | **2305 A** | 1963 B | |
| Tukey's HSD for sowing dates = 197.6<br>Tukey's HSD for times of last nitrogen = 256.3 | | | |

## 49. PHENOLOGY OF DIFFERENT COTTON GENOTYPES UNDER DIFFERENT PLANTING DATES IN COTTON-WHEAT CROPPING SYSTEM

An experiment was conducted with the objective to study the flowering and boll setting behavior and their contribution towards yield under different climatic conditions. The experiment was conducted at Agronomic Research Station, Bahawalpur during kharif season 2019. The experiment was laid out under Randomized Complete Block Design (RCBD) split plot and replicated three times. Treatments were comprised of sowing dates in main plots viz. $S_1$= 15$^{th}$ April; $S_{2=}$ 1$^{st}$ May, and $S_3$= 15$^{th}$ May and $S_4$= 30$^{th}$ May varieties in sub plots viz. $V_1$= BS-15; $V_2$= BH-223; $V_3$= MNH-1020; $V_4$= MNH-1026; $V_5$= VH-327. More seed cotton yield was

recorded under sowing date "15th April" (2755.1 kg ha$^{-1}$) and with variety "BS-15" (2557 kg ha$^{-1}$) compared to other treatments.

**Table. Effect of sowing dates and genotypes on seed cotton yield for year 2019**

| Varieties | Sowing dates | | | | Seed cotton yield (kg ha$^{-1}$) |
|---|---|---|---|---|---|
| | 15$^{th}$ April | 1$^{st}$ May | 15$^{th}$ May | 30$^{th}$ May | |
| BS-15 | 2881 | 2873 | 2547 | 1929 | **2557 A** |
| BH-223 | 2683 | 2410 | 2081 | 1540 | 2179 BC |
| MNH-1020 | 2758 | 2559 | 2215 | 1740 | 2318 AB |
| MNH-1026 | 2891 | 2731 | 2407 | 1840 | 2467 A |
| VH-327 | 2562 | 2314 | 1969 | 1425 | 2067 C |
| Seed cotton yield (kg ha$^{-1}$) | **2755 A** | 2577 A | 2244 B | 1694 B | |
| Tukey' HSD for sowing dates = 266.4 | | | Tukey' HSD for genotypes = 638.4 | | |

## 50. 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 2019. The experiment was laid out under Randomized Complete Block Design (RCBD) and replicated four times. 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" (2747.8 kg ha$^{-1}$) compared to other treatments.

**Table. Effect of residue management practices on seed cotton yield for year 2019**

| **Treatments** | **Seed cotton yield (kg ha$^{-1}$)** |
|---|---|
| $T_1$ = Cotton planting after full wheat residue burning | 2365 AB |
| $T_2$ = Cotton planting after full wheat residue incorporation | **2748 A** |
| $T_3$ = Cotton planting after full wheat residue removed | 2195 B |
| $T_4$ = Cotton planting after full wheat residue left/retained | 2432 AB |
| Tukey's HSD = 475.8 | |

## 51. 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 2019. 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) (2267.7 kg $ha^{-1}$) compared to other treatments (Table 8).

**Table 8: Effect of different relay cropping techniques on seed cotton yield for year 2019**

| **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) | 2103 AB |
| $P_2$ = 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) | 1916 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) | 2146 AB |
| $P_4$ = Cotton after wheat | 1755 C |
| $P_5$ = Bt cotton alone (early) | **2268 A** |
| Tukey's HSD = 337.7 | |

## 52. MECHANICAL PLANTING OF COTTON

An experiment was conducted with the objective to study the effect of residue on the productivity of cotton crop. The experiment was conducted at Agronomic Research Station, Bahawalpur during kharif season 2019. The experiment was laid out under Randomized Complete Block Design (RCBD) and replicated three times. Treatments were comprised of$P_1$= Cotton plating on 75 cm apart beds with planter; $P_2$= Cotton plating on 75 cm apart beds (45cm bed + 30cm furrow) with manual dibbling; $P_3$= Cotton planting on 75cm apart ridges with planter; $P_4$= Cotton planting on 75 cm apart ridges with manual dibbling; $P_5$= Cotton plating on 75 cm wide beds with manual dibbling (check) and $P_6$= Flat planting in 75 cm spaced rows by

drill (check). More seed cotton yield was recorded with "Cotton plating on 75 cm wide beds with manual dibbling (check)" (2916.3 kg ha-1) compared to other treatments (Table 9).

**Table. Effect of planting methods on seed cotton yield for year 2019**

| Treatments | Seed cotton yield (kg ha$^{-1}$) |
|---|---|
| $P_1$ = Cotton planting on 75 cm apart beds with planter | 2456 AB |
| $P_2$ = Cotton planting on 75 cm apart beds (45 cm bed + 30 cm furrow) with manual dibbling | **2914 A** |
| $P_3$ = Cotton planting on 75 cm apart ridges with planter | 2529 AB |
| $P_4$ = Cotton planting on 75 cm apart ridges with manual dibbling | 2834 A |
| $P_5$ = Cotton planting on 75 cm apart beds with manual dibbling (check) | **2916 A** |
| $P_6$ = Flat planting in 75 cm spaced rows by drill (check) | 2182 B |
| Tukey's HSD = 530.0 | |

## 53. EXPLORING ECONOMIC OPTIMAL NITROGEN APPLICATION AND ITS EXCESSIVE USE IN COTTON THROUGH MODELING APPROACH

This study was conducted to determine the economical optimum dose and to quantify losses of nitrogen (N) in cotton crop through empirical modeling approach. Experimental treatments were comprised of seven levels of nitrogen i.e. 0, 75, 100, 125, 150, 175 and 200 kg N ha$^{-1}$. Experiment was sown on 23.05.2019 following randomized complete block design (RCBD) with three replications and net plot size of 9.0 × 4.5 m. Cotton variety of VH-327 was used as test variety. Nitrogen fertilizer was applied according to treatments while PK fertilizer was applied as 75-95 PK kg ha$^{-1}$ respectively at time of sowing. All agronomic practices (irrigation, weed control and insect pest control) were kept uniform. The crop was harvested on 18.10.2019. Data regarding yield and yield components were recorded during experiment following standard procedures. An equation was developed to regress the values of yield with an increase of each unit of N through quadratic relationships.

Results of this experiment revealed that seed cotton yield increased by increasing level of nitrogen from 0 to 200 N kg ha$^{-1}$, however further increase in N doses could not result in add up to seed cotton yield.

Therefore, it might be concluded that the N levels applied beyond 200 N kg ha$^{-1}$ were excessive and contributed to loss of nitrogen (Figure 1). The empirical relationship between seed cotton yield and nitrogen application showed significant ($R^2$=0.81) relationship. Same trend was recorded in case of benefit cost ratio of the treatments. Most economical dose of N was 200 kg

ha$^{-1}$ while further increase in the level of N fertilizer was analyzed as uneconomical use of N in cotton in Khanewal conditions.

In conclusion, the optimum level of N for cotton is 200 kg N ha$^{-1}$ that not only gave higher seed cotton yield but also have higher benefit cost ratio.

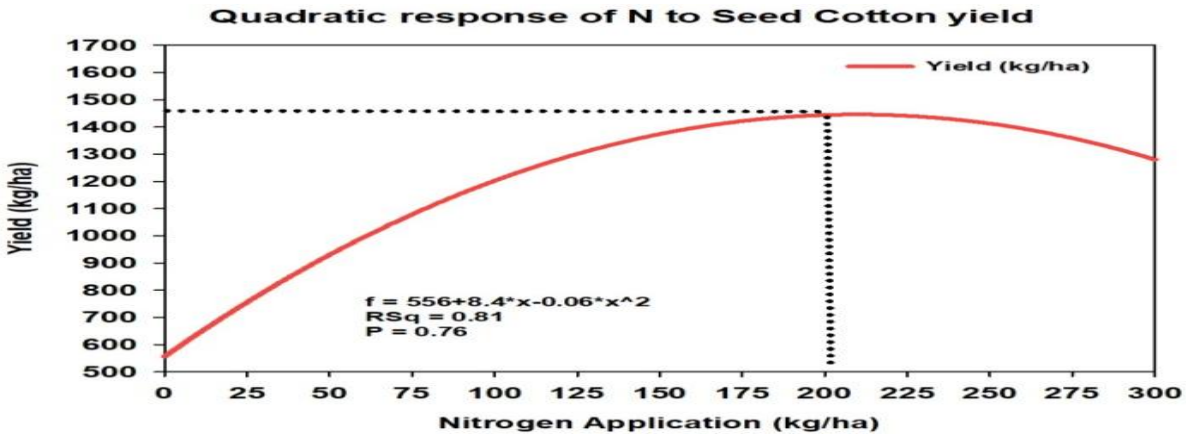


**Figure. Empirical relationship between yield and nitrogen application**

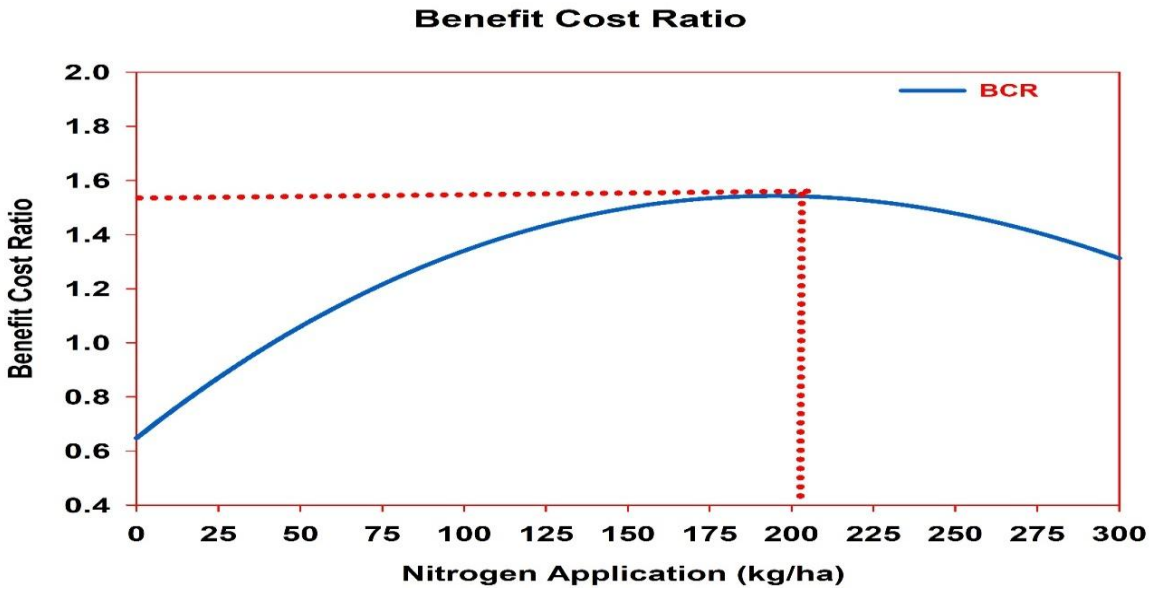


**Figure. Benefit Cost Ratio (BCR) of N application in Cotton**

## 54. EFFECT OF MULCHING ON SEED COTTON YIELD AND SALT ACCUMULATION IN SOIL

This study was conducted to appraise the effect of mulching on accumulation of salt in soil and seed cotton yield under high climate index. Experimental treatments were comprised of five different mulching treatments *viz;* control (conventional), plastic mulching, wheat straw

mulching, organic matter (FYM) mulching and organic matter (FYM) + wheat straw mulching. Mulch of FYM and wheat straw was applied @ 20 and 15 Mg $ha^{-1}$, respectively on top of bed at the time of sowing. Experiment was sown on 23.05.2019 following randomized complete block design (RCBD) with three replications having net plot size of 9.0 × 4.5 m. Cotton variety of VH-327 was used as test variety. Fertilizer was applied as 200-75-95 NPK kg $ha^{-1}$. All agronomic practices (irrigation, weed control and insect pest control) were kept uniform. Cotton crop was harvested on 18.10.2019. Pre-sowing and post harvesting soil samples were analyzed for EC and pH. Data regarding salt accumulation, yield and yield components were recorded during experiment following standard procedures.

Results of this study showed that treatments did not significantly affected the pH of soil, however the application of FYM mulching resulted in less EC value of soil that showed the less salt contents accumulation in the soil (Figure 4). Likewise this treatment also gave higher seed cotton yield (2071 kg $ha^{-1}$) as compared with control (1136 kg $ha^{-1}$). The application of FYM also responded well to benefit cost ratio (1.71:1) which is higher as compared with benefit cost ratio of control (1.05:1).

In conclusion, mulching with FYM reduce salt accumulation in soil and enhance seed cotton yield particularly in problem soils. Hence this practice is recommended for problem soils.

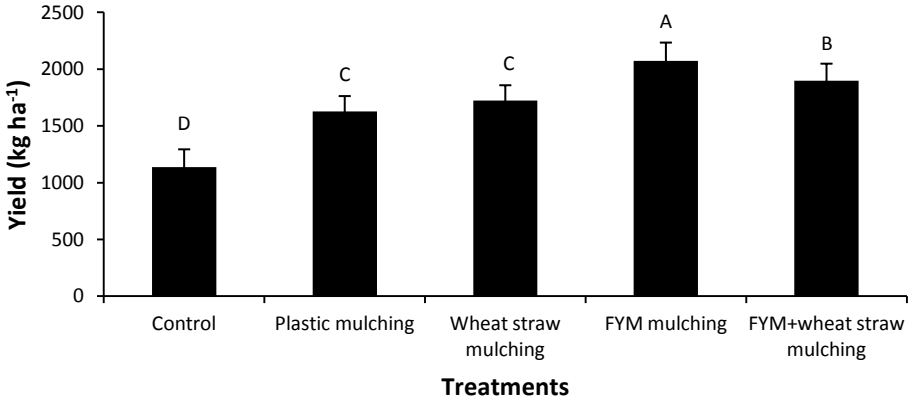


**Figure. Seed cotton yield affected by various mulching treatments**

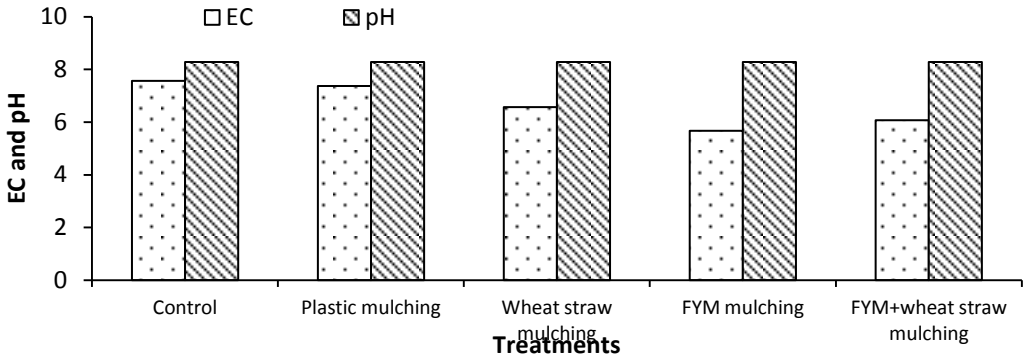


**Figure. EC and pH of experimental soil affected by various mulching treatments**

**Table. Economic analysis of various mulching treatments**

| Treatments | Cost of production (Rs./ ha) | Gross income (Rs./ ha) | BCR |
|---|---|---|---|
| **Control** | 94396 | 99400 | 1.05:1 |
| **Plastic mulching** | 152792 | 142275 | 0.93:1 |
| **Wheat straw mulching** | 194519 | 150792 | 0.78:1 |
| **FYM mulching** | 105746 | 181213 | **1.71**:1 |
| **FYM+ Wheat straw mulching** | 197769 | 166104 | 0.84:1 |

## 55. EVALUATION OF NEW BED PLANTING TECHNIQUE FOR WATER SAVING IN COTTON

This study was conducted to evaluate new technique of cotton planting in comparison with conventional methods for water saving and final productivity of the technology. Experimental treatments were comprised of three bed planting techniques *viz;* conventional bed and furrow planting (75 cm bed top and 75 cm furrow), new bed planting technique (105 cm bed top+ 45 cm furrow) and new bed planting technique in standing wheat crop (105 cm bed top+ 45 cm furrow). In standing wheat, cotton was sown on 09.04.2019 while in conventional bed planting and new bed planting treatments. Cotton was sown on 21-05-2019. Experiment was laid out in field according to randomized complete block design (RCBD) with four replications having net plot size of 9.0 × 6.0 m. Cotton variety MNH-1026 was used as test variety. Fertilizer was applied as 200-75-95 NPK kg $ha^{-1}$. All agronomic practices (irrigation, weed control and

insect pest control) were kept uniform. Cotton crop was harvested on 18.10.2019. Data regarding, measurement of irrigation water on each irrigation, yield and yield components were recorded during experiment following standard procedures.

Results of this study showed that higher seed cotton yield (2246 kg $ha^{-1}$) was obtained by planting cotton through new bed planting technique as relay crop in standing wheat as well as alone crop (Table 2). Likewise less amount of water was required to irrigate the field sown by new bed planting technique as compared to conventional bed planting technique. Moreover sowing of wheat by using new bed planting technique also resulted in higher water use efficiency.

In conclusion planting of cotton as relay crop through new bed planting technique gave 47% higher seed cotton yield than conventional sowing of cotton. Moreover, water use efficiency of this technique was also 50% higher than conventional bed-furrow planting of cotton.

**Table. Seed cotton yield as affected by new bed planting techniques**

| **Sowing technique** | **Seed cotton yield (kg $ha^{-1}$)** | |
|---|---|---|
| | **2018** | **2019** |
| Conventional bed and furrow | 1600 C | 1183 C |
| New bed planting technique | 2133 B | 1590 B |
| New bed planting technique in standing wheat | 2667 A | 2246 A |
| LSD value = 91.64 | **245.30** | **41.64** |

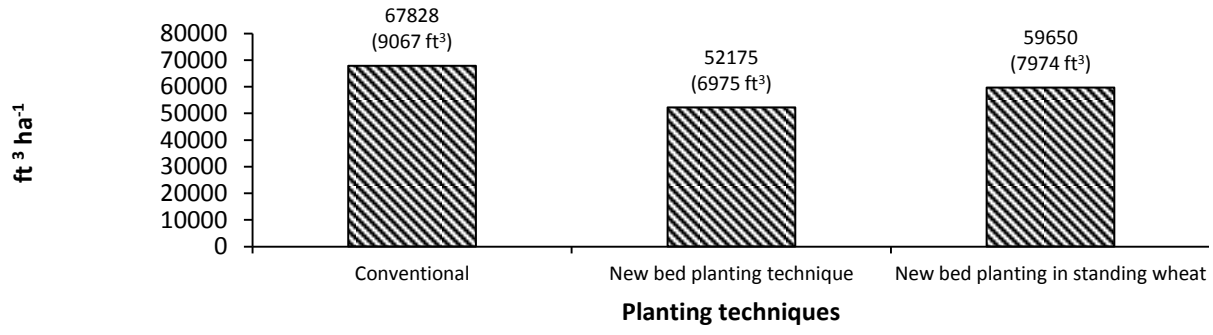


**Figure. Total amount of water applied to cotton crop in various planting techniques**

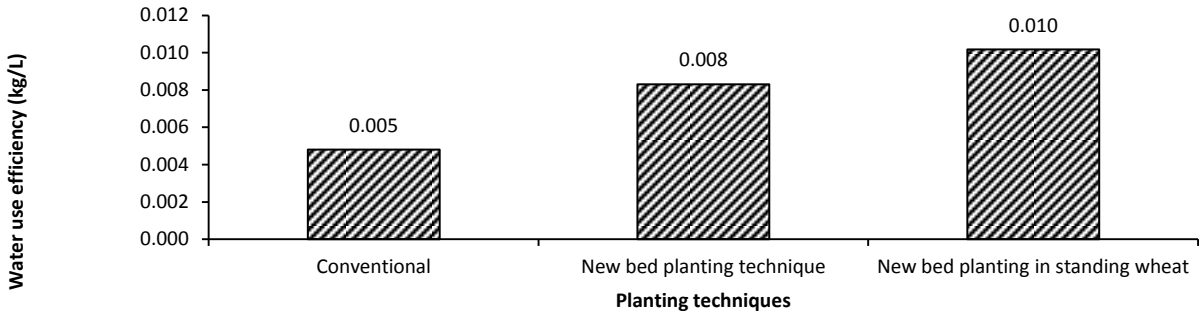


**Figure 6: Water use efficiency of planting techniques of cotton**

## 56. WHEAT RESIDUE MANAGEMENT IN COTTON-WHEAT CROPPING SYSTEM

This study was conducted to manage residues of wheat and improve yield of cotton. Experimental treatments were comprised of four techniques of wheat residue management that were wheat residues removed completely ($T_1$), wheat residues incorporated ($T_2$), wheat residues burnt ($T_3$), and wheat residues remained in field ($T_4$). This experiment was sown on 23.05.2019 according to randomized complete block design (RCBD) with three replications having net plot size of 15.0 × 9.0 m. IUB-2013 was used as test variety of cotton in this experiment. Fertilizer was applied @ 200-75-95 NPK kg $ha^{-1}$. However, an additional basal dose of 57 kg nitrogen per hectare at the time of wheat residue incorporation was applied for decomposition of residues. All agronomic practices (irrigation, weed control and insect pest control) were kept uniform. The crop was harvested at maturity on 18.10.2019. Data regarding yield and yield components were recorded during experiment following standard procedures.

It can be depicted from the results that the treatment where crop wheat crop residues were incorporated in field resulted in higher seed cotton yield (2752 kg $ha^{-1}$) as compared to other treatments. Therefore, it is concluded that wheat crop residues should be incorporated in field to enhance the yield of subsequent cotton crop by applying the additional dose of N.

**Table. Seed cotton yield as affected by various wheat residue management techniques**

| Wheat residues management techniques | Seed cotton yield (kg ha$^{-1}$) | |
|---|---|---|
| | **2018** | **2019** |
| $T_1$= Wheat residues removed completely | 2288 | 2612 B |
| $T_2$= Wheat residue incorporated | 2300 | 2752 A |
| $T_3$= Wheat residue burnt | 2296 | 2518 B |
| $T_4$= Wheat residue remain in field | 2314 | 2480 C |
| LSD value = 36.84 | | |

## 57. EVALUATING TIME OF LAST IRRIGATION FOR BT- COTTON UNDER KHANEWAL CONDITION

This study was conducted to determine optimum time to stop the irrigation for cotton crop under Khanewal condition. The treatments were comprised of five cut off dates of irrigation 15th September, 25$^{th}$ September, 5$^{th}$ October, 15$^{th}$ October and 25$^{th}$ October. This experiment was sown on 21.05.2019 and was laid out in field condition according to randomized complete block design (RCBD) with three replications having net plot size of 8.0 × 6.0 m. IUB-2013 was used as test variety of cotton in this experiment. Irrigation was applied according to treatments. Fertilizer was applied @ 200-75-95 NPK kg ha$^{-1}$. All agronomic practices (weed control and insect pest control) were kept uniform. The crop was harvested on 18.10.2019. Data regarding yield and yield components were recorded during experiment following standard procedures.

Results of this study highlighted that application of irrigation after 5$^{th}$ October did not influence on yield improvement significantly. So, it is better to stop applying irrigation to cotton crop after 5$^{th}$ of October to save water without any negative effect on yield.

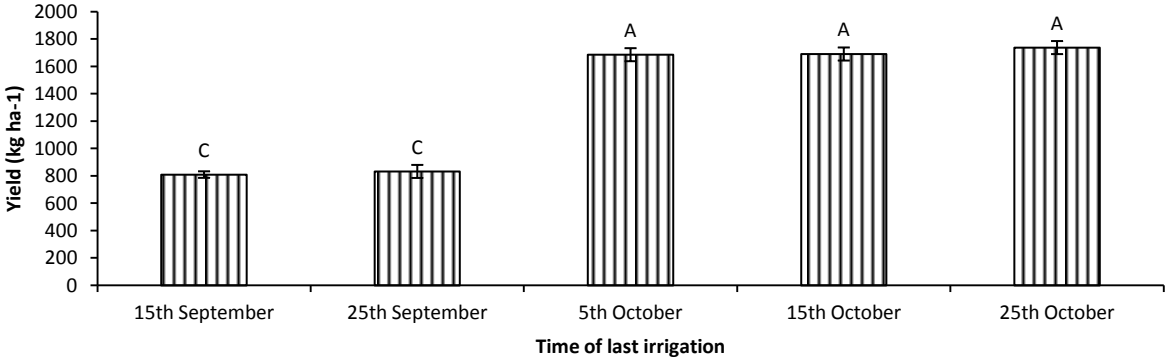


**Figure 7: Seed cotton yield as affected by time of last irrigation**

## 58. EVALUATING TIME OF LAST DOSE OF NITROGEN FERTILIZER APPLICATION FOR BT-COTTON UNDER KHANEWAL CONDITION

This study was conducted to determine optimum time to stop the fertilizer application for cotton crop in Khanewal condition. The treatments were comprised of 15$^{th}$ August, 30$^{th}$ August, 15$^{th}$ September and 30$^{th}$ September. This experiment was sown on 25.05.2019. Experiment was laid out according to randomized complete block design (RCBD) with three replications having net plot size of 9.0 × 8.0 m. MNH-1026 was used as test variety of cotton in this experiment. Nitrogen fertilizer was applied as per treatments. Fertilizer was applied @ 200:75-95 NPK kg ha$^{-1}$. All agronomic practices (irrigation, weed control and insect pest control) were kept uniform. The crop was harvested on 18.10.2019. Data regarding yield and yield components were recorded during the season of experiment following standard procedures.

Result of this study showed that application of nitrogen fertilizer to cotton crop should be completed up to 15$^{th}$ of September because applying fertilizer beyond this did not contribute in the yield improvement.

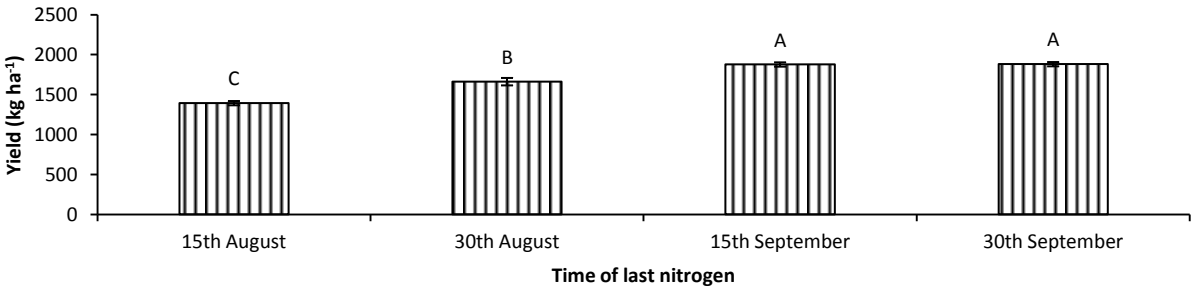


**Figure 8: Seed cotton yield as affected by Time of last dose of Nitrogen application**

## 59. ADAPTATION OF NEW BT-COTTON VARIETIES/STRAINS UNDER DIFFERENT PLANTING TIMES

This study was conducted to find out the adaptability and best suitable sowing time of new Bt. varieties / strains of cotton for yield potential under Khanewal conditions. The treatments were comprised of four sowing dates 15$^{th}$ March, 1$^{st}$ April, 15$^{th}$ April, 1$^{st}$ May, 15$^{th}$ May and three cotton varieties MNH-992, CIM-179 and FH-Lalazar. Experiment was laid out in field according to split plot design in factorial arrangement with three replications having net plot size of 15.0 × 6.0 m. Sowing dates were kept in main plots while varieties were kept in sub plots.

Fertilizer was applied @ 200-75-95 NPK kg $ha^{-1}$. All agronomic practices (irrigation, weed control and insect pest control) were kept uniform. The crop was harvested on 18.10.2019. Data regarding yield and yield components were recorded during the course of experiment following standard procedures.

Maximum seed cotton yield (2833 kg $ha^{-1}$) was recorded when cotton variety MNH-992 was sown at 1st April, however delay in sowing of cotton resulted in less yield. The minimum seed cotton yield (778 kg $ha^{-1}$) was recorded when cotton was sown on 15th May. Therefore it is recommended that best time of sowing of cotton in 1st week of April in Khanewal.

**Table. Seed cotton yield under varying planting dates**

| **Treatments/Sowing dates** | **MNH-992** | **CIM-179** | **FH-Lalazar** | **Mean (kg $ha^{-1}$)** |
|---|---|---|---|---|
| 15th March | 2500 ab | 1500 def | 2000 bcd | 2000 |
| 1st April | **2833 a** | 2000 bcd | 1833 cde | 2222 |
| 15th April | 2167 bc | 1167 fg | 2000 bcd | 1778 |
| 1st May | 1333 ef | 1833 cde | 2000 b-e | 1722 |
| 15th May | 667 g | 1000 fg | 667 g | 778 |
| **Mean** | 1900 | 1500 | 1700 | |
| LSD for sowing dates × varieties= 689.50 | | | | |

## 60. PROVINCIAL COORDINATED COTTON TRIAL (PCCT) FOR YIELD PERFORMANCE UNDER KHANEWAL CONDITION

This study was conducted to evaluate the performance of different varieties / strains of cotton under Khanewal conditions for yield performance. Experimental treatments were comprised of twenty five Bt. cotton lines and two non-Bt. cotton lines. The cotton crop was sown on 18-05-2019. Experiment was laid out according to randomized complete block design (RCBD) with three replications and net plot size of 6.0 × 3.0 m. Fertilizer was applied @ 200-75-95 NPK kg $ha^{-1}$. All agronomic practices (irrigation, weed control and insect pest control)

were kept uniform. The crop was harvested on 18.10.2019. Data regarding yield and yield components were recorded during experiment following standard procedures.

It was recorded in the results that V4 and V18 lines gave highest seed cotton yield (2519 and 2537 kg $ha^{-1}$ respectively). Whereas minimum seed cotton yield (1396 kg $ha^{-1}$) was recorded in cotton line V23.

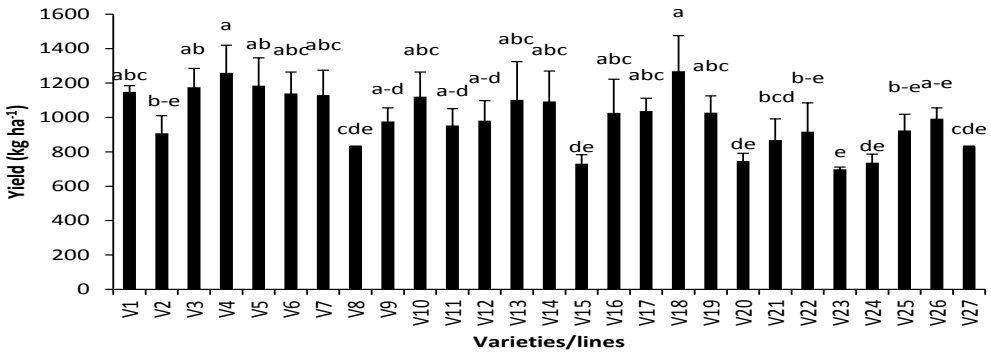


**Figure. Seed cotton yield of various cotton lines/cultivars in agro climatic conditions of Khanewal**

# JUTE

## 61. NUTRIENT MANAGEMENT FOR HIGHER FIBER YIELD OF JUTE

The objective of this study was to find out the appropriate nitrogen and phosphorus doses for jute to get higher fiber yield. For this purpose three levels of nitrogen (45, 60, 75 kg $ha^{-1}$) with three levels of phosphorus (20, 30, 40 kg $ha^{-1}$) were evaluated. Treatments were laid out in factorial design having three replication with net plot size of 1.8 m × 7.0 m. Row to row and plant to plant distance was maintained to be 30 cm and 10 cm, respectively. Perusal of table suggest that interactive effect of N × P was not significant. However both N and P effect the jute fiber yield significantly. Jute fiber yield increased as fertilizer level increased and significantly higher yield was obtained at 40 kg $ha^{-1}$ P and 75 kg $ha^{-1}$ N which was also similar to the 30 kg $ha^{-1}$ P and 60 kg $ha^{-1}$ N, respectively.

**Table. Jute Fiber yield (kg $ha^{-1}$) under the influence of different levels of N & P**

| Treatments | 20 kg $P_2O_5$ $ha^{-1}$ | 30 kg $P_2O_5$ $ha^{-1}$ | 40 kg $P_2O_5$ $ha^{-1}$ | Mean |
|---|---|---|---|---|
| **45 kg N $ha^{-1}$** | 2387 | 2435 | 2529 | 2450 b |

| | | | | |
|---|---|---|---|---|
| **60 kg N ha$^{-1}$** | 2895 | 3243 | 3513 | 3217 a |
| **75 kg N ha$^{-1}$** | 3286 | 3386 | 3522 | 3398 a |
| **Mean** | 2856 b | 3021 ab | 3188 a | |
| $LSD_{0.05}$= Nitrogen= 299,$P_2O_5$= 299,Nitrogen × $P_2O_5$ = NS | | | | |

# BREEDING PROGRAMME OF JUTE

## 62. MAINTENANCE AND EVALUATION OF JUTE GERMPLASM

The objective was to maintain the genetic purity of jute crop for desired morpho-agronomic traits to select breeding materials for further crop improvement. Nineteen jute lines from which two lines were of *C. capsularis* and seventeen lines were of *C. olitorious* were sown in progeny to row trial. Plots size was 0.9 m × 5.0 m with 30 cm row spacing and 10 cm plant spacing. Nitrogen and Phosphorus was applied @ 60 and 30 kg ha$^{-1}$. All phosphorus was applied as basal dose while nitrogen was applied in two equal splits at sowing and 30 days after sowing. Results suggested that line NWJ-2 of *C. capsularis* gave the higher fiber yield i.e. 13 g/plant and line NTJ-6 of *C. olitorious* gave the maximum fiber yield (16 g/plant). Perusal of the table gives further insight about the performance of jute germplasm at Faisalabad conditions.

**Table. Average Plant height (m), stem girth (cm) and fiber yield (g) of *C. capsularis***

| Line # | Plant Height(m) | Stem Diameter(cm) | Fiber Yield (g) |
|---|---|---|---|
| 1 | 2.79 | 1.98 | 8.5 |
| 2 | 2.99 | 2.12 | 13.0 |

**Table. Average Plant height (m), stem girth (cm) and fiber yield (g) of *C. olitorious***

| Line # | Plant Height(m) | Stem Diameter(cm) | Fiber Yield (g) |
|---|---|---|---|
| 1 | 3.38 | 2.65 | 11.0 |
| 2 | 3.76 | 2.74 | 12.5 |
| 3 | 3.63 | 2.41 | 11.5 |
| 4 | 3.98 | 2.78 | 13.0 |
| 5 | 3.84 | 2.61 | 12.0 |
| 6 | 4.12 | 2.98 | 16.0 |
| 7 | 3.69 | 2.77 | 12.0 |
| 8 | 3.58 | 2.53 | 11.0 |
| 9 | 3.08 | 2.19 | 7.5 |
| 10 | 3.30 | 2.46 | 12.0 |
| 11 | 3.18 | 2.37 | 11.0 |
| 12 | 3.20 | 2.48 | 11.5 |
| 13 | 3.00 | 2.21 | 10.0 |
| 14 | 3.11 | 2.28 | 10.5 |
| 15 | 3.09 | 2.17 | 9.0 |
| 16 | 3.34 | 2.47 | 11.5 |
| 17 | 3.26 | 2.23 | 9.5 |

## 63. STUDY OF FILIAL GENERATION OF JUTE (*C. OLITORIUS*)

This study was 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. Plots size was 0.9 m × 3.0 m with 30 cm row spacing and 10 cm plant spacing. Nitrogen and Phosphorus were applied

@ 60 and 30 kg $ha^{-1}$. All phosphorus was applied as basal dose while nitrogen was applied in two equal splits at sowing and 30 days after sowing. There are 5 entries in $F_5$ and 3 entries in $F_6$. Single plant to row was sown from each entry and superior row was selected from an individual plant.

# RICE

## 64. RESPONSE OF DIRECT SEEDED FINE RICE TO GROWING DEGREE DAYS AT VARIOUS PLANT DENSITIES

The experiment was designed with the aim to optimize the paddy yield of fine rice by coinciding plant densities and crop growth duration. The experiment was laid out in split plot design with three replications and crop was sown with dibbler. The plot size was 3.45 m × 10 m. The crop was fertilized @ 170-80-62 NPK kg/ha. All PK and 1/3$^{rd}$ N was applied as basal dose while the remaining 2/3$^{rd}$ N was applied in 2 splits during July and August. All other agronomic practices were kept uniform.

| **Paddy Yield (kg/ha)** | | | | |
|---|---|---|---|---|
| **Sowing Dates** | **Row Spacing (cm)** | | | **Mean** |
| | **23 cm** | **15 cm** | **11 cm** | |
| **SD-1 (15-05-2019)** | 2485 g | 2659 f | 2633 f | **2593 C** |
| **SD-2 (01-06-2019)** | 3279 e | 3761 c | 3543 d | **3528 B** |
| **SD-3 (15-06-2019)** | 3898 c | 4711 a | 4587 b | **4399 A** |
| **SD-4 (30-06-2019)** | 2012 i | 2175 h | 2327 g | **2172 D** |
| **SD-5 (15-07-2019)** | 811 j | 843 j | 850 j | **835 E** |
| **Mean** | 2497 c | 2830 a | 2788 b | |
| **Tukey's HSD Value at 0.05 P: Row Spacing:14 Sowing dates: 131** | | | | |

The results concluded that maximum paddy yield was observed when rice was sown on 15.06.2019 at 15 cm row spacing in DSR while minimum yield was observed when sown on 15.07.2019. Late sowing drastically reduced paddy yield in direct seeded fine rice.

## 65. EFFECT OF ALFALFA ON THE YIELD OF SUBSEQUENTLY TRANSPLANTED FINE RICE

The study was conducted to check the sustainability of soil to produce higher paddy yield of fine rice after alfalfa in a series of years. The experiment was laid out in RCBD and replicated thrice. Alfalfa was sown in plots measuring 3 m x 10 m during second week of Oct. using seed @ 20 kg/ha in 45 cm apart rows using single row hand drill. Rice crop was transplanted during fourth week of June in plots which had one year of alfalfa, respectively. The crop was fertilized @ 170-80-62 NPK kg/ha. All other agronomic practices were kept uniform. The yield data after one year of alfalfa is as under:

| **Treatments** | **Yield kg/ha** |
|---|---|
| Conventionally sown transplanted rice (Control) | 2317 |
| Rice transplantation after one year of alfalfa crop | 2534 |

It was concluded that rice sown after one year of alfalfa resulted in 9.36 % higher paddy yield over conventionally transplanted rice.

## 66. RELAY CROPPING OF BERSEEM IN STANDING RICE

The trial was designed to optimize berseem fodder yield by sowing in standing rice. The experiment was laid out in RCBD with three replications. The Berseem advance line FSBSJB-64 was sown in plots measuring 5.5 m×8 m. All crop husbandry practices were kept uniform and adopted as per standards. Yield Data was recorded following standard procedure. The results are given in the table.

**Table: FODDER YIELD OF BERSEEM SOWN IN STANDING RICE DURING 2019-20**

| **Sr. No.** | **SEED RATE ( kg/ha)** | **FODDER YIELD (kg/ha)** |
|---|---|---|
| **1** | **Seed @ 20 kg/ha broadcasted in standing rice** | **86728 B** |
| **2** | **Seed @ 25 kg/ha broadcasted in standing rice** | **86721 B** |
| **3** | **Seed @ 30 kg/ha broadcasted in standing rice** | **87468 B** |
| **4** | **Seed @ 35 kg/ha broadcasted in standing rice** | **97961 A** |
| **5** | **Seed @ 40 kg/ha broadcasted in standing rice** | **99021 A** |
| **6** | **Seed @ 45 kg/ha broadcasted in standing rice** | **98034 A** |
| | **LSD @ 5%** | **1102.9** |

The results concluded that 40 kg/ha seed rate of berseem resulted in maximum fodder yield when sown in standing rice which is also statistically at par with seed rate of 35kg/ha and 45 kg/ha which indicates that increase in seed rate increase forage yield.

### 67. PERFORMANCE EVALUATION OF COARSE RICE STRAINS

An experiment was conducted to test the yield potential of promising coded lines of coarse rice varieties/lines provided by the Director, Rice Research Institute, Kala Shah Kaku. The trial was laid out in Randomized Complete Block Design having 3 replications. Rice nursery was transplanted on 22$^{nd}$ of July 2019. All agronomic practices and plant protection measures were kept uniform for all the treatments. Data on paddy yield were recorded at maturity are presented as follow..

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

| **Treatments** | **Yield (kg ha$^{-1}$)** |
|---|---|
| KSK-133 | 6333 |
| KSK-486 | 5600 |
| KSK-487 | 6466 |
| KSK-489 | 5466 |
| KSK-498 | 5666 |
| KSK-505 | 4933 |
| KSK-514 | 5666 |
| KSK-515 | 5533 |
| LSD Value | NS |

Statistical analysis of the data showed that there was statistically no significant difference among different lines/ varieties. However Rice strain KSK-487 gave maximum paddy yield 6466 kg ha$^{1}$. While minimum paddy yield (4933 kg ha$^{-1}$) was produced by the line KSK-505.

### 68. 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

1. 142-80-62 NPK kg ha$^{-1}$ (Recommended for transplanted rice)
2. 114-64-50 NPK kg ha$^{-1}$(80 % of recommended for transplanted rice)
3. 128-72-56 NPK kg ha$^{-1}$(90 % of recommended for transplanted rice)
4. 156-88-68 NPK kg ha$^{-1}$(110 % of recommended for transplanted rice)

5. 170-96-74 NPK kg $ha^{-1}$ (120 % of recommended for transplanted rice

Data on paddy yield were recorded and presented as follow.

**Table. Effect of different fertilizer levels on yield of Chenab Basmati under DSR**

| Treatments | Yield (kgha$^{-1}$) |
|---|---|
| 142-80-62 NPK kg ha$^{-1}$ | 3268 b |
| 114-64-50 NPK kg ha$^{-1}$ | 2788 c |
| 128-72-56 NPK kg ha$^{-1}$ | 3163 bc |
| 156-88-68 NPK kg ha$^{-1}$ | 3500 ab |
| 170-96-74 NPK kg ha$^{-1}$ | 3715 a |
| LSD Value | 410.45 |

Statistical analysis of the data showed the significant differences among the treatment means. According to the data maximum paddy yield (3715 kg ha$^{-1}$) was obtained from the treatment where 170-96-74 NPK kg ha$^{-1}$ (120 % of recommended for transplanted rice) was applied. While minimum paddy yields (2788 kg ha$^{-1}$) was obtained from plots where 114-64-50 NPK kg ha$^{-1}$ (80 % of recommended for transplanted rice), fertilizer was applied

## 69. 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 a trial was laid out in Split Plot Design having three replications. Treatments were comprised of two factors

**A. Sowing methods**

1. Drill sowing (22.5 cm apart rows)
2. Furrow augmented ridge sowing

**B. Irrigation techniques**

1. Continuous standing water from 30 DAS
2. Continuous wetting of land from 30 DAS
3. Alternate wetting and drying before wilting from 30 DAS

Data on paddy yield and yield components was recorded and presented in table.4

**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** | 3567 a | 3187 ab | **3377 A** |
| **Continuous wetting of land from 30 DAS** | 3600 a | 2600 c | **3100 B** |
| **Alternate wetting and drying before wilting from 30 DAS.** | 2767 bc | 2383 c | **2575 C** |
| | **3311 A** | **2723 B** | |

**LSD value for SM*I=524.97, LSD value for SM2 = 477.86, LSD value for I= 234.28**

Statistical analysis of the data showed the significant differences among the treatment means. According to the data maximum paddy yield (3600 kg $ha^{-1}$) was obtained from the plot which was sown by drill and land was continuously wetted. While minimum paddy yields (2383 kg $ha^{-1}$) was obtained from plots where rice was sown in furrow augmented ridges and alternate wetting and drying before wilting from 30 DAS was used.

## 70. EFFECT OF DIFFERENT SEED RATES AND ROW SPACING ON GROWTH AND YIELD OF CHENAB BASMATI UNDER DIRECT SEEDED RICE CULTURE

To standardize the seed rate and row spacing for direct seeded fine rice a trial was laid out in Split Plot Design with three replications. The trial was sown with hand drill on 14th of June 2019. Experiment comprised of following treatments

**A. Seed rate**

1. 20 kg $ha^{-1}$
2. 25 kg $ha^{-1}$
3. 30 kg $ha^{-1}$
4. 35 kg $ha^{-1}$

**B. Row spacing**

1. 15 cm
2. 22.5 cm
3. 30 cm

Data on paddy yield and yield related parameters were recorded on the time of harvesting and presented as follow.

**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** | 2733 de | 2850 cd | 3073 bc | 3247 ab | **2976 A** |
| **22.5 cm** | 2503 ef | 2817 cd | 2837 cd | 2957 cd | **2778 B** |
| **30 cm** | 2240 f | 2737 de | 2750 de | 3350 a | **2769 B** |
| | **2492 C** | **2801 B** | **2887 B** | **3184 A** | |

**LSD Value for SR*S 275.32, LSD Value for Seed rate 167.42, LSD Value for Plant spacing 134.33**

Statistical analysis of the data showed the significant differences among the treatment means. According to the data maximum paddy yield (3350 kg $ha^{-1}$) was obtained from the treatment where 35 kg $ha^{-1}$ seed rate used and row spacing was kept 30 cm. While minimum paddy yield (2240 kg $ha^{-1}$) was obtained from the treatment where 20 kg $ha^{-1}$ seed rate used and row spacing was kept 30 cm.

## 71. CHEMICAL WEED CONTROL IN DIRECT SEEDED RICE

To find out the more suited weedicide to control weeds in direct seeded rice a trial was laid out in Randomized Complete Block Design having 3 replications. Trial was sown on 4th of July 2019 by using hand drill. Rice variety Kissan Basmati was used as testing material. Treatments were as

1. ***Stomp*** (pendimethlin) FMC @ 2.5 L $ha^{-1}$ as pre emergence.
2. ***Machete*** 60 EC FMC(butachlor) @ 2.0 lit $ha^{-1}$ Pre em
3. **Acetore** 50 EC Ali Akbar group (acetochlor) @ 250 ml $ha^{-1}$ Pre em
4. ***Council activ*** 30WG Bayer Pakistan(Ethoxysulfuron+ triafamon)@187 g $ha^{-1}$Pre em
5. ***Kelion*** 50WGJaffar(Orthosulfamuron) @200 g $ha^{-}$ Pre em
6. ***Clover*** 20WP (bispyribic sodium) @ 200 g $ha^{-1}$ post em at25-30 DAS.
7. ***Winsta 30*** **WP** FMC-united (Bispyribac Sodium +bensulfuron) 250g $ha^{-1}$ post em at 25-30 DAS ***Dowang*** 14.5 OD Tara group (bispyribic sodium + cyhalofop) @ 1250 ml $ha^{-1}$post em within 25-30 DAS

   **Bisco Super** 10 OD Saiban group (Fenoxaprop + penoxulam) @ 1250 ml $ha^{-1}$post em within 25-30 DAS
8. **Green Sun** Kanzo AG@ 1750 ml $ha^{-1}$ post em within 25-30 DAS
9. Hand weeding (Control)

Data on weed density and yield of direct seeded rice are presented as follow.

**Table. Effect of weed control on yield of direct seeded rice**

| **Treatments** | **Weeds $m^{-2}$** | **Yield $kgha^{-1}$** |
|---|---|---|
| **Stomp** (pendimethlin) FMC @ 2.5 L $ha^{-1}$ as pre emergence. | 106 C | 1567 E |
| **Machete** 60 EC FMC(butachlor) @ 2.0 lit $ha^{-1}$ Pre em | 60 F | 2627BC |

| | | |
|---|---|---|
| **Acetore** 50 EC Ali Akbar group (acetochlor) @ 250 ml $ha^{-1}$ Pre em | 74 E | 2433 C |
| **Council activ** 30WG Bayer Pakistan(Ethoxysulfuron+ triafamon)@187 g $ha^{-1}$Pre em | 121 B | 1400 E |
| **Kelion** 50WGJaffar(Orthosulfamuron) @200 g $ha^{-}$ Pre em | 120 B | 1467 E |
| **Clover** 20WP (bispyribic sodium) @ 200 g $ha^{-1}$ post em at25-30 DAS. | 101 C | 1733DE |
| **Winsta 30 WP** FMC-united (Bispyribac Sodium +bensulfuron) 250g $ha^{-1}$ post em at 25-30 DAS. | 86 D | 2033 D |
| **Dowang** 14.5 OD Tara group (bispyribic sodium + cyhalofop) @ 1250 ml $ha^{-1}$post em within 25-30 DAS | 75 DE | 2453 C |
| **Bisco Super** 10 OD Saiban group (Fenoxaprop + penoxulam) @ 1250 ml $ha^{-1}$post em within 25-30 DAS | 35 G | 2970AB |
| **Green Sun** Kanzo AG@ 1750 ml $ha^{-1}$ post em within 25-30 DAS | 45 G | 2830 B |
| Hand weeding | 1 H | 3243 A |
| Control | 238 A | 723 F |
| LSD at 5 % | 11.04 | 344.50 |

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

According to the data maximum paddy yield (2970 kg $ha^{-1}$**)** after hand weeding **(**3243 kg $ha^{-1}$) was obtained from the plots where Bisco Super (Fenoxaprop + penoxulam) @ 1250 ml $ha^{-1}$ as Post emergence was sprayed. While minimum paddy yield (723 kg $ha^{-1}$) was obtained from the control (No control of weeds).

## 72. CHEMICAL WEED CONTROL IN TRANSPLANTED FINE RICE

To find out the best Weedicide to control weeds in transplanted fine rice a trial was laid out by using RCBD having three replications. Treatments were as under

1. ***Machete*** 60 EC FMC(butachlor) @ 2.0 lit $ha^{-1}$ Pre em 3-5 DAT.
2. **Acetore** 50 EC Ali Akbar group (acetochlor) @ 250 ml $ha^{-1}$ Pre em 3-5 DAT.
3. ***Council activ*** 30WG Bayer Pakistan(Ethoxysulfuron+ triafamon)@187 g $ha^{-1}$Pre em 3-5 DAT.
4. ***Kelion*** 50WGJaffar(Orthosulfamuron) @200 g $ha^{-}$ Pre em 3-5DAT..
5. ***Clover*** 20WP (bispyribic sodium) @ 200 g $ha^{-1}$ post em at18-25 DAT.
6. ***Winsta 30*** **WP** FMC-united(Bispyribac Sodium +bensulfuron) 250g $ha^{-1}$ postem at 18-25 DAT.
7. ***Dowang*** 14.5 OD Tara group (bispyribic sodium + cyhalofop) @ 1250 ml $ha^{-1}$post emwithin 10-15
8. **Bisco Super** 10 OD Saiban group (Fenoxaprop + penoxulam) @ 1250 ml $ha^{-1}$post em within 25-30 DAS
9. **Green Sun** Kanzo AG@ 1750 ml $ha^{-1}$ post e within 25-30 DAS
10. Hand weeding

11. Control

The rice nursery was transplanted on 26th of July 2019. All the other agronomic practices were kept uniform for all the treatments.

Data on weed density and yield of direct seeded rice are presented as follow.

**Table. Effect of weed control on yield of transplanted fine rice**

| **Treatments** | **Weeds count $m^{-2}$** | **Yield kg $ha^{-1}$** |
|---|---|---|
| **Machete** 60 EC FMC(butachlor) @ 2.0 lit $ha^{-1}$ Pre em 3-5 DAT. | 14 B | 2280 E |
| **Acetore** 50 EC Ali Akbar group (acetochlor) @ 250 ml $ha^{-1}$ Pre em 3-5 DAT. | 13 B | 2437 DE |
| **Council activ** 30WG Bayer Pakistan(Ethoxysulfuron+ triafamon)@187 g $ha^{-1}$Pre em 3-5 DAT. | 9 CDE | 2963 BC |
| **Kelion** 50WGJaffar(Orthosulfamuron) @200 g $ha^{-}$ Pre em 3-5DAT.. | 12 BC | 2533 DE |
| **Clover** 20WP (bispyribic sodium) @ 200 g $ha^{-1}$ post em at18-25 DAT. | 8 DE | 3070 B |
| **Winsta 30 WP** FMC-united(Bispyribac Sodium +bensulfuron)250g $ha^{-1}$ postem at 18-25 DAT. | 11 BCD | 2650 CD |
| **Dowang** 14.5 OD Tara group (bispyribic sodium + cyhalofop) @ 1250 ml $ha^{-1}$post emwithin 10-15 DAT | 7 E | 3183 AB |
| **Bisco Super** 10 OD Saiban group (Fenoxaprop + penoxulam) @ 1250 ml $ha^{-1}$post em within 10-15 DAT | 6 E | 3253 AB |
| **Green Sun** Kanzo AG@ 1750 ml $ha^{-1}$ post em within 10-15 DAT | 6 E | 3253 AB |
| Hand weeding | 1 F | 3557 A |
| Control | 22 A | 1767 F |
| LSD at 5% | 4.15 | 346.04 |

According to data maximum paddy yield (3253 kg $ha^{-1}$) after hand weeding (3557 kg $ha^{-1}$) respectively was obtained from the plots where Green Sun Kanzo AG@ 1750 ml $ha^{-1}$ post em within 10-15 DAT and Dowang 14.5 OD Tara group (bispyribic sodium + cyhalofop) @ 1250 ml $ha^{-1}$post emwithin 10-15 DAT and Bisco Super 10 OD Saiban group (Fenoxaprop + penoxulam) @ 1250 ml $ha^{-1}$post em within 10-15 DAT were sprayed. Lowest yield of (1767kg.$ha^{-1}$) was obtained from control (Where no chemical was sprayed).

**METEOROLOGICAL DATA**

The meteorological data recorded from January 2019 – June 2020 are presented as follow.

| Month | Temperature Max ($^{o}$C) | Temperature Min ($^{o}$C) | Rainfall (mm) | Wind Velocity (km/h) (8am) | Wind Velocity (km/h) (5pm) |
|---|---|---|---|---|---|
| **2019** | | | | | |
| January | 19.3 | 5.7 | 18.4 | 0.6 | 1.2 |
| February | 20.5 | 8.0 | 56.8 | 0.8/8 | 1.8/22 |
| March | 26.1 | 12.7 | 39.6 | 1.0/14 | 2.7/27 |
| April | 35.2 | 20.1 | 33.6 | 1.8/22 | 2.0/25 |
| May | 38.7 | 23.0 | 31.6 | 2.1/26 | 2.4/27 |
| June | 41.4 | 26.3 | 29.3 | 2.7/26 | 3.0/28 |
| July | 37.0 | 26.7 | 144.6 | 2.5/27 | 3.2/27 |
| August | 37.2 | 26.9 | 84.0 | 1.7/24 | 1.7/23 |
| September | 36.9 | 26.4 | 48.1 | 2.5/27 | 1.9/22 |
| October | 32.9 | 18.9 | 22.4 | 1.1/15 | 1.1/13 |
| November | 26.3 | 12.8 | 3.0 | 0.8/10 | 1.1/11 |
| December | 17.0 | 6.0 | 7.0 | 1.0/11 | 1.0/10 |
| **2020** | | | | | |
| January | 17.3 | 5.5 | 50.8 | 0.5/8 | 1.6/16 |
| February | 23.8 | 8.7 | 24.8 | 0.5/5 | 2.3/23 |
| March | 24.5 | 13.9 | 135.0 | 1.8/21 | 2.5/28 |
| April | 33.1 | 18.8 | 20.4 | 1.7/22 | 1.9/25 |
| May | 37.5 | 23.1 | 19.9 | 1.9/24 | 2.0/25 |
| June | 39.0 | 25.8 | 69.8 | 2.4/28 | 3.4/26 |

## 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. Vermicomposting is a component of organic farming. Rearing (Figure 32) and harvesting of vermicompost for soil fertility improvement in organic farming program is in progress.

**Figure. Rearing of earthworms and vermicomposting**

## ON FARM COMPOST FORMATION

On farm compost formation has been started at Fiber Crops Section at Faisalabad.

**Figure. On farm compost formation at Faisalabad**

## ON-GOING PROJECTS

**1. PARB PROJECT-904 "**Nutrition enhancement of crops, fruits, vegetables and their products under climate change scenario"
**2. ADP Project** on "Research and promotion of medicinal plants in Punjab"

**RESEARCH PULICATIONS**

1. Xue Feng Zong, Jun Lv, Muhammad Shahid, Shakeel Ahmad Anjum, Na-Jia Li, Xiu-Juan He, Yu Xu, Xiao Wu, San-Gen Wang. 2019. Biomass accumulation, photosynthetic pigments, osmotic adjustments and antioxidant activities of *Leymus chinensis* in response to BA, BR and GA. Planta Daninha. 37: 1-9. **(IF 0.544)**
2. Muhammad Farrukh Saleem, **Muhammad Shahid**, Abdul Shakoor, Shakeel Ahmad Anjum, Amna Saleem and Muhammad Ashfaq Wahid. 2019. Removal of early fruit branches regulations in endotoxins delays senescence and improves boll opening and yield in Bt cotton genotypes. South African Journal of Botany. 121 (2): 510-518. **(IF: 1.442)**
3. **Muhammad Shahid**, Muhammad Farrukh Saleem, Amna Saleem, Muhammad Aown Sammar Raza, Muhammad Kashif, Abdul Shakoor and Muhammad Sarwar. 2019. Exogenous potassium instigated biochemical regulations confer terminal heat tolerance in wheat. Journal of Soil Science and Plant Nutrition. 19: 137-147. **(IF: 2.116)**
4. Zong Zuefeng, Dong Yufeng, **Muhammad Shahid**, Shakeel Ahmad Anjum, Abdul Shakoor, Lv Jun, Li Najia, He Xiujuan, Xu Yu, Wu Xiao and Wang Sangen. 2019. Improving growth and physiochemical attributes of *Leymus chinensis* through exogenous brassinolide, urea and potassium dihydrogen phosphate in arid grassland. Agrociencia. 53: 99-114. **(IF 0.270)**
5. Shakeel Ahmad Anjum, Nadeem Akbar, Umair Ashraf, Imran Khan, Abdul Shakoor, Muhammad Ishfaq, Muhammad Sajid Hanif, **Muhammad Shahid** and Muhammad Shareef. 2019. Interactive effect of rice production systems and tillage systems in rice-wheat cropping systems. Pakistan Journal of Science. 71 (1): 21-27. **(HEC Recognized)**
6. Najia Ali, **Muhammad Shahid**, Xuefeng Zong, Jun Lv, Daibin Wang, Amna Saleem, Shakeel Ahmad Anjum and Sangen Wang. 2019. Exogenously applied 5 aminolevulinic acid mediated physiochemical regulations ameliorate weak light stress in tobacco seedlings. Bangladesh Journal of Botany. 48 (2): 353-358. **(IF 0.214)**
7. Muhammad Tariq Saeed, Muhammad Ashfaq Wahid, Muhammad Farrukh Saleem, **Muhammad Shahid**, Tariq Aziz and Muhammad Waqas Ali. 2019. Improving

phosphorous uptake efficiency and quality of maize through optimization of basal application. Maydica. 64 (1): 1-7. **(IF: 0.231)**

8. Muhammad Farrukh Saleem, Muhammad Asif Kamal, **Muhammad Shahid**, Amna Saleem, Amir Shakeel and Shakeel Ahmad Anjum. 2019. Exogenous selenium instigated physiochemical transformations impart terminal heat tolerance in Bt cotton. Journal of Soil Science and Plant Nutrition. /doi.org/10.1007/s42729-019-00139-3. **(IF: 2.116)**
9. **Muhammad Shahid,** Muhammad Farrukh Saleem, Amna Saleem, Muhammad Sarwar, Haroon Zaman Khan and Abdul Shakoor. 2020.Foliar potassium induced regulations in glycine betaine and malondialdehyde were associated with grain yield of heat-stressed bread wheat (*Triticum aestivum* L.). Journal of Soil Science and Plant Nutrition. /doi.org/10.1007/s42729-020-00250-w. **(IF: 2.156)**
10. Muhammad Farrukh Saleem, Muhammad Asif Kamal, **Muhammad Shahid**, Muhammad Awais, Amna Saleem, Muhammad Aown Sammar Raza and Bao-Luo Ma. 2020. Studying the foliar selenium-modulated dynamics in phenology and quality of terminal heat-stressed cotton (*Gossypium hirsutum* L.) in association with yield. Plant Biosystems. //doi.org/10.1080/11263504.2020.1779835. **(IF: 1.787).**
11. **Ullah, A**., A. Ahmad, T. Khaliq, J. Akhtar and G. Hoogenboom. **2019**. Path analysis approach to assess the compensatory impact of yield attributes on pearl millet grain yield in semi-arid and arid areas of Punjab, Pakistan. **Journal of Animal and Plant Sciences**. 29(3): 746-753.

**BOOKS CHAPTERS**

**Ullah, A.,** I. Ahmad, H.U. Rehman, U. Saeed, A. Ahmad, A. Mehmood and G. Hoogenboom. 2019. Climate smart interventions of small-holder farming systems. In: Climate smart agriculture.

**Ahmad, I.,** A. Ullah, M.H. Rahman, B. Ahmad, S.A. Wajid, A. Ahmad and S. Ahmad. 2019. Climate change impacts and adaptations strategies for agronomic crops. In: Climate smart agriculture.

## MISCELLANEOUS ACTIVITIES

1. 242 seed samples of different crops and vegetables were tested for germination under ISO-17025 certified Seed testing Laboratory
2. Data recording on physiological parameters like photosynthetic efficiency, leaf area, stomatal conductance, transpiration rate, water potential and osmotic potential of different agronomic and vegetable crops
3. Identification of weeds and their control
4. Testing and screening of total 42 herbicides (14 for Kharif and 28 for Rabi crops) for their effectiveness to control weeds
5. Recording and dissemination of meteorological data at Faisalabad for facilitation of students and researchers
6. Two trainings and ten seminars were attended by the scientists of plant physiology section
7. Advisory services for farmers regarding production technologies of major field crops, alternative crops and medicinal plants
8. Facilitation of four Ph.D. students and five B.Sc. students in Agriculture regarding internship and supervision of research work
9. Maintenance of weed bank and herbal garden for demonstration to visitors especially students from different institutes of Punjab
10. Availability/sale of total 6782 stevia plants and 280 gram stevia seed to the farmers for multiplication in Punjab
11. Publication of 43 Urdu articles during 2019-20

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