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OVERVIEW

Rice is second most important food and cash crop of Pakistan. It accounts for 3.1 percent in the value added in agriculture and 0.6 percent of GDP. During the year 2017-18, area cultivated under rice crop in the country has increased by 6.4 percent to 2.89 million hectares compared to 2.72 million hectares of last year. Rice area increased due to higher domestic prices and availability of inputs on subsidized rates, good advisory services and rising demand in International market, which made rice cultivation attractive for growers.

The production of rice reached historically high level of 7.44 million metric tons against the production of 6,849 thousand tonnes and recorded an increase of 8.7 percent over production of last year. Out of 7.44 million metric tons, 3.13 million metric tons were exported earning valuable foreign exchange of US$ 1.49 billion, whereas, last fiscal year in the same period we had exported 2.27 million metric tons of rice amounting to US$.961 million, which shows over all a significant growth of 27% in terms values and 14% in terms of quantity. During the period under review, 332,179 metric tons of basmati rice worth US$ 346 million and about 2.800 million metric tons of non-basmati worth US$ 1148.1 million were exported.

The Punjab is the biggest rice producer province of the country. The area under rice crop was 4.506 million acres which is 5% increase as compared to previous year. Similarly, there was 3.4% increase in basmati area (3.457 million acres). The production of rice is 3.853 million tons during the year 2017-18. Generally, the province of the Punjab contributed 64% area and 50% production to the national rice production.

Three promising fine grain lines were tested in national uniform rice trials during 2017-18 viz., PK BB 8 (early maturing, extra long grain, stiff stem with yield potential 7500 kg/ha), PKBB 15-116 (BLB resistant genes with yield potential of 6000 kg/ha) and PK 8892-4-1-3-1 (high yielding, early maturing, stiff stem, extra-long grain basmati rice with yield potential of 6500 kg/ha),

A. *RICE RESEARCH INSTITUTE, KALA SHAH KAKU*

I. RICE BREEDING

Promising lines with their salient characteristics

❖ ***PKPB 8***

This advance fine grain line has been tested in varietal yield trials during 2015-17 including station, regional and national (NURYT) trials (FIG. 1). It is an early maturing (110 days) line that yielded 4.88 t/ha against 4.40 t/ha (11 % yield advantage) of check variety (PS 2). Average grain length (8.20mm) is better than PS 2 (8.10mm). The cooking quality of this line is very good (17.2mm).

Fig. 1: PKPB 8

❖ ***PKBB 15-116***

This advance Basmati line carries Bacterial leaf blight (BLB) resistant genes (*xa5, Xa7 & Xa21*). It was planted for spot examination at the institute (Fig 2). It has been tested in thirty-two varietal yield trials during 2014-17 including station, regional and national (NURYT) trials. In NURYTs 2016 and 2017. It yielded 3.52 t/ha (20% yield advantage) against 2.93 t/ha of Basmati 515. Its average grain length and cooking quality is at par with Super Basmati.

Fig. 2: PKBB 15-116

❖ ***PK 8892-4-1-3-1***

This advanced basmati line planted for spot examination at the institute (Fig 3) and has been tested in varietal yield trials including station, regional and national (NURYT) trials during 2009-12 and 2016-17. It yielded 3.56 t/ha against 3.18 and 3.34 t/ha of Super Basmati and Basmati 515 respectively which showed 10% and 14% increase over standard check varieties respectively. It is an early maturity, stiff stem, extra-long grain and excellent cooking quality rice variety. Average grain length (7.58mm) is better than Super Basmati (7.42mm) and Basmati 515 (7.50mm). The cooking quality (CGL) of this line was recorded as 15.4mm.

Fig. 3: PK 8892-4-1-3-1

National uniform rice yield trial

In fine grain group, six lines (PKPB8, PKBB15-1, PKBB15-6, PKBB15-116, PK8892-4-1-3-1 and

PK9194-54-1-1-2-2) of RRI, KSK out yielded check variety Basmati 515 (2.68 t/ha) at five locations (Fig. 4).

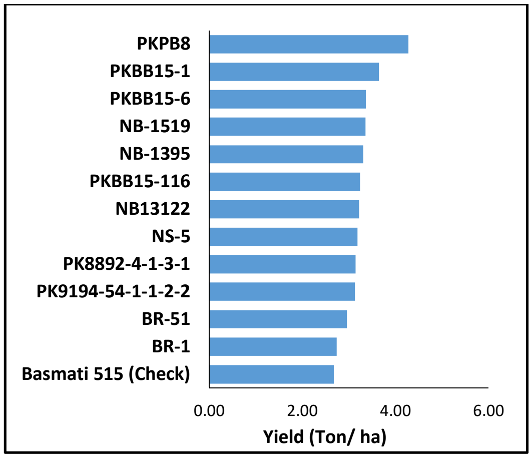

Fig. 4: Mean yield of fine grain lines in NUYRT

Fine grain yield trials

Fifty-eight selected uniform lines along with three check varieties were evaluated in fine grain yield trials (FGYT). Eleven lines performed better (Fig. 5) than check varieties Basmati 515 (3.90 t/ha), PS 2 (4.24 t/ha) and Super Basmati (4.64 t/ha).

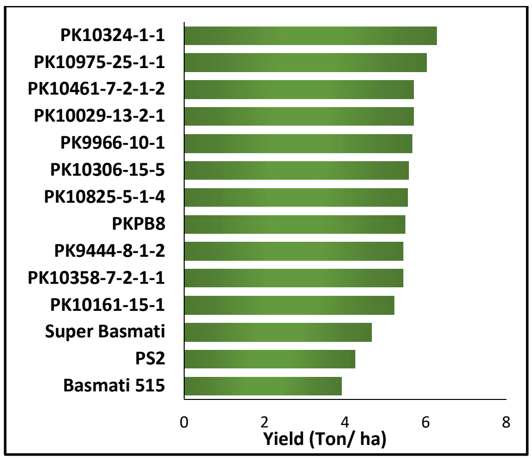

Fig. 5: Mean yield of fine grain promising lines in FGYT

Coarse grain yield trial

Thirty five selected uniform lines along with two check varieties were evaluated in yield trials. Five lines viz., KSK 514 (8.55 t/ha), KSK 515 (8.89t/ha), KSK 517 (8.25 t/ha), KSK 519 (8.55 t/ha) and KSK 489 (9.17 t/ha) out yielded the check varieties viz., KSK 133 (6.94 t/ha) and KSK 434 (7.64 t/ha).

Breeding Studies

Hybridization

For the development of climatic smart rice varieties with biotic (insect pest and diseases), and abiotic stresses (salinity, submergence and drought) tolerant varieties, 250 parental lines were planted in hybridization program. Two hundred and sixty (260) crosses were made and successfully harvested for further evaluation in subsequent generations.

Detail of successful crosses

Breeding objective	No. of crosses
Bacterial leaf blight (BLB)	50
High yielding	40
Flood tolerance	40
Quality	25
Early maturity & Short stature	21
Extra-long grain	13
Salt tolerance	12
Drought	12
Genetic diversity	10
Planthopper	10
Back cross	09
Aroma	08
Plant type	05
Blast	05

BLB resistant basmati varieties/ lines

To combat BLB disease, twenty-four fresh crosses, twenty-eight (28) three-way crosses, eighteen double crosses and ten backcrosses were made. Single panicles from the segregating F_2 generation were selected having single or combination of genes *Xa4, xa5, Xa7, xa13, Xa21*. In F3, 130 progenies of 30 crosses were studied and single panicles from the segregating population were selected. In F_4 generation, 57 progeny lines were studied and

55 single panicle selections were made for further study in subsequent generations. Twenty-three lines were studies in observational plots and 10 lines were selected for yield trials. Disease response of 10 uniform lines and 30 IRBB NILs were studied under natural conditions at three hotspot sites i.e., Hafizabad, Gujranwala and Kala Shah Kaku. Three uniform lines were selected on field performance basis.

DNA Barcoding of Varieties with SSR Markers

DNA Barcoding of 12 approved rice varieties were done by using PCR based DNA markers. Polymorphic markers were identified to distinguish specific genotype from the others. SSR marker RM339 was polymorphic to differentiate PKBB15-116 with band sized 149 bp from Super Basmati with band sized 184. Similarly, RM72 differentiated RRI3 with band sized 177 bp from PS2 with band sized 152 bp (Fig. 6).

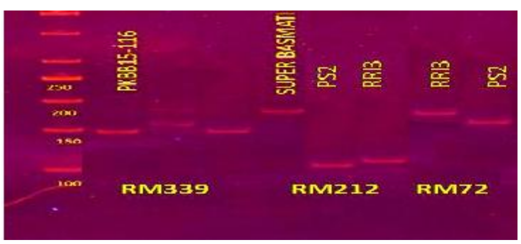

Fig. 6: DNA barcoding of approved varieties using SSR markers

Marker Assisted Breeding

DNA fingerprinting of BLB resistant *Xa4, xa5, Xa7* and *Xa21* genes was done for Marker Assisted Selection (MAS) from breeding material. Molecular screening for presence/ absence of BLB resistant genes in 100 selected genotypes was done (Fig. 7). Twenty seven genotypes carried the single gene and eight genotypes showed the presence of two resistant genes. Similarly, three resistant genes were positively genotyped in two lines and only one genotype carried four pyramided resistant genes.

The presence of BLB resistant gene *Xa21* was confirmed in two advance lines viz. PKBB15-116 and PK 10683-10-1 using pTA248 primers.

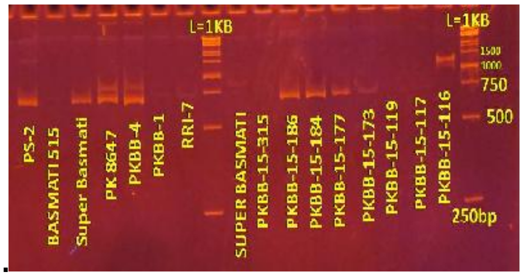

Fig. 7: DNA fingerprinting for BLB resistant genes (*Xa21*) amplified 730 bp (Susceptible) and 1040 bp (Resistant) size fragments

For salinity tolerant gene (*Saltol*) status, 20 rice lines were genotyped. In backcross breeding lines, the transfer of *Saltol* gene was confirmed using AP3206 primer.

Another important abiotic stress tolerant gene *Sub1A* was genotyped in 80 rice lines using *SC3* marker. Fifty advance lines/varieties showed presence of *Sub1A* gene (Fig 8).

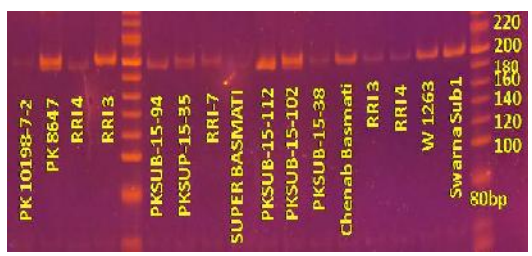

Fig. 8: DNA fingerprinting of submergence resistant genes (*SUB1A*)

The results confirmed the fragrant gene in an important BLB resistant advance line 'PK BB15-116'.

Submergence tolerance screening studies in submergence tank

An experiment was conducted using 115 advance rice genotypes and fourteen local approved varieties to evaluate under submergence/ flooded condition. These genotypes were submerged in pond for a period of 15 days. All the local approved varieties showed zero tolerance Index (TI). However, eight rice lines including Chenab Basmati, OP1-2017-69, OP1-2017-38, OP1-2017-39, OP1-2017-40, OP1-2017-8, OP1-2017-10 and Swarna *sub1* showed tolerant response under flood stress with ≥ 0.9 TI value indicating highest level of submergence tolerance. Ten lines (moderately tolerant) showed TI value from 0.7- 0.9.

Seed Production

Pre basic seed of fine (4126 Kg) and coarse grain varieties (1295 Kg) were produced.

Development of rice hybrids

Fifty two test crosses were studied for the development of hybrid parental lines in hybridization program. (Fig 9)

Fig 9: Hybridization of rice

Nine maintainers and ten restorers were identified. For the development of new CMS lines nine maintainers with desired traits were backcrossed with the recurrent parent. Already 15 identified restorers were studied in the development of different hybrid rice combinations. In Basmati background two new CMS lines (KSK99404 & KSK 8892A) have been developed. In Backcross nursery for the development of new CMS lines, five backcrosses are in BC_5 which are near to development new CMS lines and were studied that all are uniform in morphological traits as well as sterility.

In hybrid rice seed multiplication of parental lines of identified hybrids 36 Kg seed of IR75596A and 48 Kg seed of CMS line IR58025A were multiplied for their maintenance and as well as hybrid rice seed production (Fig 10).

Fig. 10: Seed Multiplication on Small scale

In hybrid rice seed production, 34 kilograms of local test hybrid KSK 111H and ten kilogram of KSK 118H were produced for testing in NUYRT (Fig 11).

Fig. 11: Hybrid seed production

Total of 13 local test hybrids (Non Basmati and Basmati) were tested in non-replicated yield trials at the institute (Fig. 12). Four different hybrids i.e., KSK 140H (6.00 t/ha), KSK 142H (5.6 t/ha), KSK 131H (4.50 t/ha) and KSK 141H (4.5 t/ha) out yielded the check variety Basmati

385 (4.20 t/ha) and one hybrid KSK 143H (4.30 t/ha), out yielded hybrid check KSK 133 (4.00 t/ha).

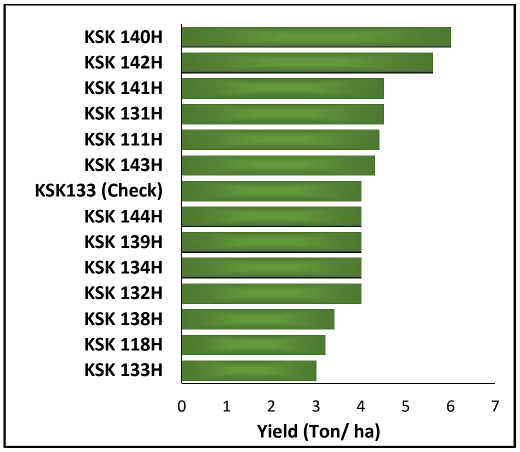

Fig. 12: Yield comparison of local test hybrids

II. AGRONOMY

Effect of different post-emergence herbicides on percent weed control and grain yield of basmati rice

The experiment was conducted to explore the weedicide for effective control of weeds especially for three noxious weeds i.e., *Leptochloa chinensis* (Kallar Grass), *Eragrostis japonica* (Bansi grass) and *Dactyloctenium aegyptium* (Madhana Grass) in dry-seeded rice DSR (Fig. 13).

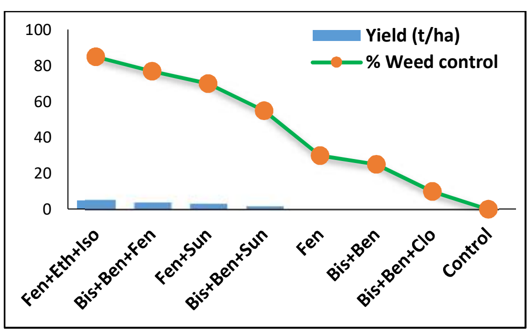

Fig. 13: Effect of different post-emergence herbicides on percent weed control and grain yield of basmati rice

Among all the treatments, the excellent weed control (85%) was achieved by Fen+Eth+Iso (Fenoxaprop-p-ethyl + Ethoxyxulfuron + Isoxadifen-ethyl) with highest yield (5.13) followed by Bis+Ben+Fen (bispyribac sodium + bensulfuron + Fenoxaprop-p-ethyl) applied plots (77%) with 3.74 t/ ha yield.

Screening of Pre-Emergence Herbicides to Control Weeds in Transplanted Rice

The experiment was conducted to find out the most effective pre-emergence herbicides for control of weeds in transplanted rice. Pre-emergence herbicides viz: Triafamone 10%+ Ethoxy sulfurone methyl 20% and Orthoxysulfomuron were applied with shaker bottle after four days of transplanting.

Fig. 14: Herbicide application and crop 30 days after herbicide application

Among all the treatments (Table 1), the maximum weed control (80%) was achieved in the plots (Fig. 14) where Triafamone + Ethoxysulfurone methyl was applied with highest paddy yield (3.5 t/ha). The lowest weed control and paddy yield (1.7 t/ha) was observed in the plots where no herbicide was applied. However, weed control (59 %) and paddy yield (3.2 t/ha) was recorded in the plots where Orthoxysulfomuron was applied.

Table 1: Effect of herbicide application as a pre-emergence on Weed survival, %weed control and paddy yield (t/ha)

Treatments	Percent weed control	Paddy Yield t/ha
Triafamone + Ethoxy sulfurone methyl	80	3.5
Orthoxysulfomuron	59	3.2
Control	-	1.7
LSD	-	0.7

Bio-fortification of coarse grain rice varieties with zinc and iron

The study was designed in split plot design to assess the response of promising coarse grain rice varieties to foliar application of micronutrients, zinc and iron for bio fortification of rice grains aimed to improving nutritional value of rice grain. A considerable increase in the zinc contents of grains was recorded in KS 282 and KSK 434, the former being at the top in response (Fig. 15). The maximum yield 5.55 and 5.45 t/ha was obtained when foliar application of 0.1% zinc (Zn) solution and 0.2 % iron (Fe) solution was applied at milking and dough stages in KSK 434 and KS 282, respectively.

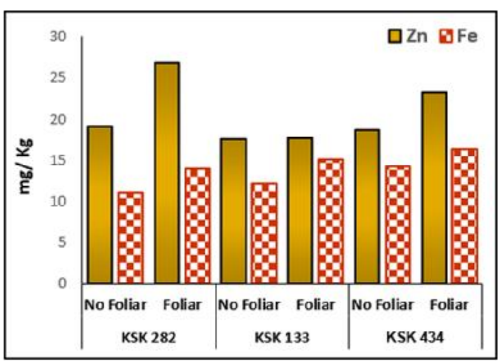

Fig. 15: Zn and Fe contents in coarse grain rice varieties

Maximum Zn contents (26.8 mg/ Kg) in grain was found in KS 282 while maximum iron contents in grain were observed in KSK 434 (16.3 mg/ Kg).

Effect of tillage systems on rice crop growth and productivity in rice-wheat cropping system

To find out an appropriate tillage-residue (TR) system for productivity enhancement of rice-wheat cropping system through resource conservation, an experiment was laid in RCBD with split plot arrangement.

Table 2: Effect of different tillage- residue system on paddy yield of fine grain rice

Treatments	Wheat Yield (t/ha)	Paddy yield (t/ha)	Average
TR – CT (partial burning)	3.5 bc	3.5 ab	3.4
TR – CT (incorporation)	3.0 c	2.9 cde	3.0
DSR – ZT (partial retention)	3.7 a	3.4 ab	3.6
TR – ZT (partial retention)	3.4 ab	3.6 ab	3.5
DSR (ZT) - ZT (full retention)	3.7 ab	3.0 bc	3.3
LSD	0.3	0.3	

Maximum paddy yield was achieved (Table 2) in transplanted rice with partial retention of wheat residue which is at par with transplanted rice with partial burning and DSR partial retention, 3.6, 3.5 and 3.4 t/ha, respectively.

Effect of transplanting dates (Fine & Coarse) on the rice yield

The study was aimed to find out the optimum period of transplanting for fine and coarse grain lines/ varieties to harvest maximum paddy yield and better quality of rice. An experiment was laid out in RCBD (factorial) with standard crop management practices. Significantly the highest average fine grain paddy yield (6.01 t/ha) was achieved with PK-BB 15-6 when transplanted on June 15 (Fig. 16).

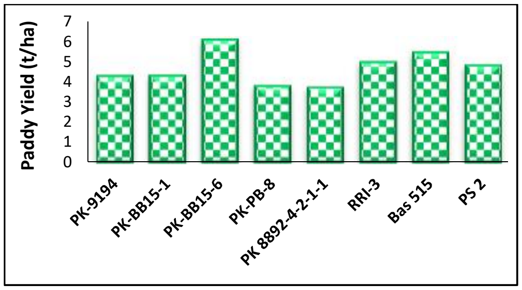

Fig. 16: Effect of transplanting dates (June 15) on paddy yield of fine grain lines/ varieties

In case of coarse lines/ varieties, the highest paddy yield 8.13 and 8.01 t/ha was recorded in case of KSK 480 and KSK 434, respectively, when transplanted on 27th May (Fig. 17). Over all maximum average yield of all transplanted dates 7.72 and 7.56 t/ha was also recorded in case of KSK 480 and KSK 476, when transplanted on 27th May and 18th June, respectively.

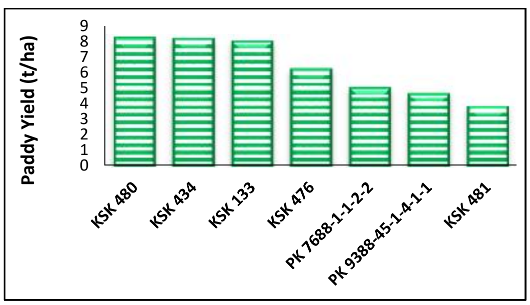

Fig. 17: Effect of transplanting date (May 27) on paddy yield of coarse grain lines/varieties

Provincial coordinated yield trial for newly evolved fine and coarse grain rice varieties/ lines

The trial was conducted to find out the performance of newly evolved basmati and coarse lines/ varieties in five different ecological zones (Gujranwala, Faisalabad, Farooqabad, and Kala Shah Kaku).

Table 3: Performance of newly evolved basmati lines in different ecological zone (t/ha)

Lines/ Varieties	Gujranwala	Faisalabad	Kala Shah Kaku	Sheikhupura	Sargodha	Average
PK 8892-4-3-1-1	3.8	3.4	3.2	3.2	2.2	3.2
PK 9194	4.1	4.2	3.0	3.9	2.7	3.6
PK BB 15-1	3.3	3.2	3.2	2.9	1.9	2.9
PK BB 15-6	3.4	3.9	2.0	3.4	2.6	3.1
PK PB 8	3.4	3.8	4.5	3.9	2.2	3.6
PK 8892-4-2-1-1	3.5	3.1	2.6	3.3	2.0	2.9
RRI 3	3.5	4.1	4.2	3.9	2.2	3.6
Basmati 515 Check	3.4	2.6	4.0	3.5	2.4	3.2
Average	3.6	3.5	3.3	3.5	2.3	3.2

In case of fine lines (Table 3), RRI 3 out yielded all varieties with average yield at all locations (3.6 t/ha) than the check variety Basmati 515 (3.2 t/ha). Similarly, the new coarse promising line KSK 481 (Table 5), out yielded (5.2 t/ha) the check variety KSK 434 (4.9 t/ha).

Table 4: Performance of newly evolved coarse lines in different ecological zone (t/ha)

Lines/ Varieties	Gujranwala	Faisalabad	Kala Shah Kaku	Farooqabad	Average
KSK 434 (check)	3.9	5.1	4.8	5.7	4.9
KSK 449	3.9	5.0	4.5	5.3	4.7
KSK 476	3.3	4.9	4.1	5.8	4.5
KSK 480	3.6	5.1	4.2	5.6	4.6
KSK 481	4.5	5.8	4.3	6.0	5.2
PK-7888-1-1-2-2	4.1	4.8	4.4	5.9	4.8
9347	4.4	4.3	4.6	5.3	4.7

III. ENTOMOLOGY

Screening of pesticides for the effective control of different rice pests under field conditions

Efficacy of different pesticides along with standard treatments were observed for the effective control of rice leaffolder, whitebacked and brown planthoppers (WBPH and BPH) on Basmati 515 by using standard agronomic practices under field conditions. Percent effectiveness of pesticides showed that all the pesticides effectively control the target insect pests than untreated check (Fig. 18-20).

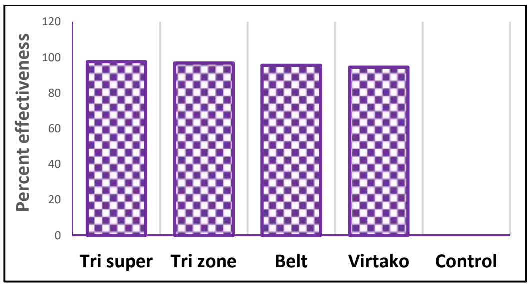

Fig. 18: Post- treatment percent effectiveness of insecticides against rice leaffolder with respect to control

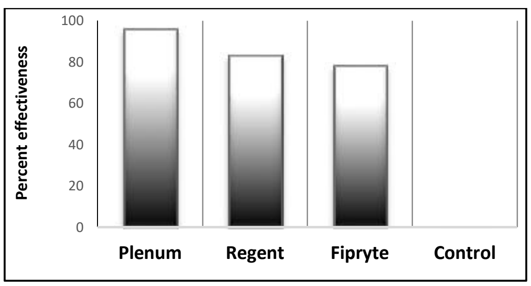

Fig. 19: Post- treatment percent effectiveness of insecticides against WBPH with respect to control

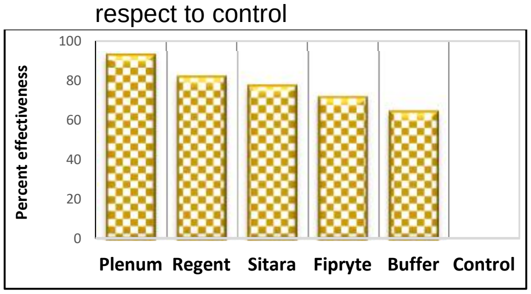

Fig. 20: Post- treatment percent effectiveness of insecticides against rice BPH with respect to control

Screening of breeding material for resistance against rice leaffolder under field conditions

Thirty six fine and eighteen coarse grain rice lines/ varieties of local origin were tested and analyzed for their respective response against leaffolder by using Standard Evaluation System (SES) for Rice, 2013 developed by the IRRI, Philippine. Keeping in view the percentage infestation of rice leaffolder, nine fine grain lines (PK 10306-15-5, PK 10306-15-5, PK 10355-13-1-1, PK 10749-18-1-1, PK 10350-7-2-1, PK 10683-12-1, PK 10348-7-1-3, PK PB-8 and PK 10395-8-1-1) and six coarse grain lines (KSK 476, RC- 8, KSK 483, KSK 485, IR 73014-59 and KSK 482) behaved as moderately resistant (Fig. 21).

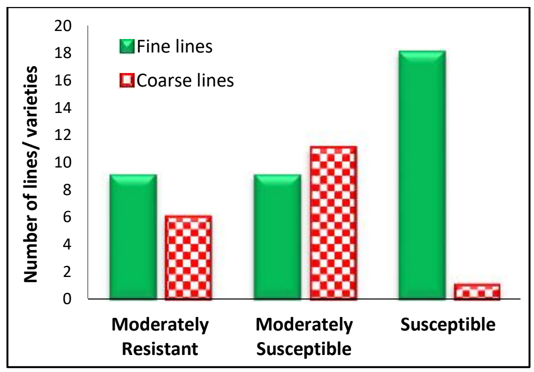

Fig. 21: Response of lines/ varieties against leaffolder

Monitoring of planthoppers on light traps and alternate host plants

Both the population of whitebacked and brown planthopper was firstly observed in the last week of September, 2017 (Fig. 22) contrary to previous years due to increase in temperature during 2017.

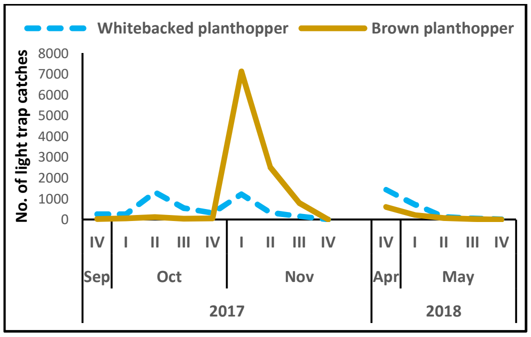

Fig. 22: Temporal weekly light trap catches of planthoppers

The maximum number of weekly light trap catches of WBPH were monitored in 2nd week of October (1311), while BPH during 1st week of November (7137). However, during 2018 both WBPH and BPH appeared during 4th week of April with their maximum number of catches (1434 and 600, respectively) which gradually declined till the end of May.

Similarly, temporal distribution of planthoppers was also monitored in rice- wheat- rice ecosystem on different alternate host plants for their timely and effective control. It was observed that the population of WBPH was observed on Wheat (*Triticum aestivum*), Oat (*Avena sativa*), Barley (*Hordeum vulgare*), Dhidan (*Echinochlo acrusgali*), Sawanki (*Echinochlo aclonal*), Barseem (*Trifolium alexandrinum*), Khabal (*Cynodon dactylon*), Sunflower (*Helianthus annuus*), Maize (*Zea mays*), Maina (*Medicago polymorpha*) and Sorghum (*Sorghum* sp.). However, the population of BPH was observed on Rice, stubbles, sprouts (*Oryza sativa*), Barseem (*Trifolium alexandrinum*), Maize (*Zea mays*) and Khabal grass (*Cynodon dactylon*) throughtout the year.

IV. PLANT PATHOLOGY

Screening of fungicides for the effective control of rice blast

Seven different fungicides were sprayed on rice variety Basmati C-622 to check their efficacy against rice blast disease. The treatment application of Amistar Top 325 SC gave efficient blast disease control and yield (Fig. 23).

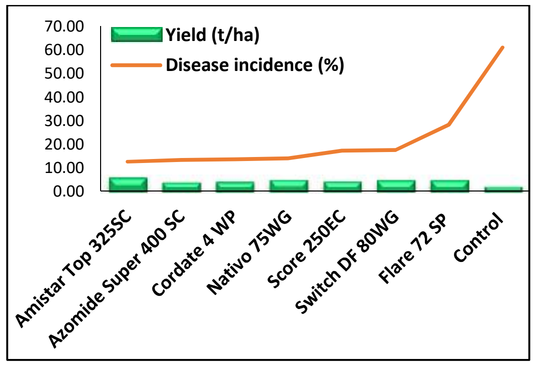

Fig. 23: Blast incidence percentage in comparison with paddy yield

Screening of spray chemicals for the effective control of bacterial leaf blight

Seven different chemicals were sprayed on rice variety Basmati-2000 to check their efficacy against bacterial leaf blight disease. The treatment application of Ev-Cin gave efficient disease control and yield (Fig. 24).

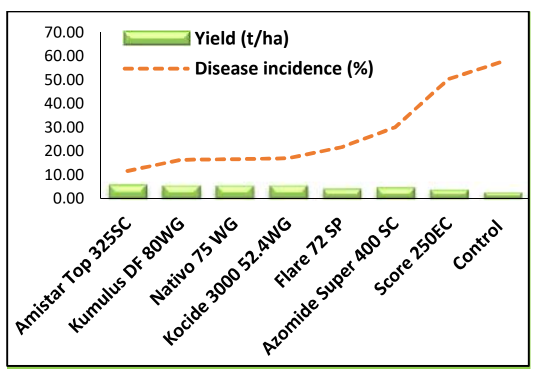

Fig. 24: BLB incidence percentage in comparison with paddy yield

Screening of spray fungicides for the effective control of brown leaf spot

Seven different fungicides were sprayed on rice variety Basmati Super to check their efficacy against brown leaf spot disease. The treatment application of Amistar Top 325 SC gave efficient disease control and yield (Fig. 25).

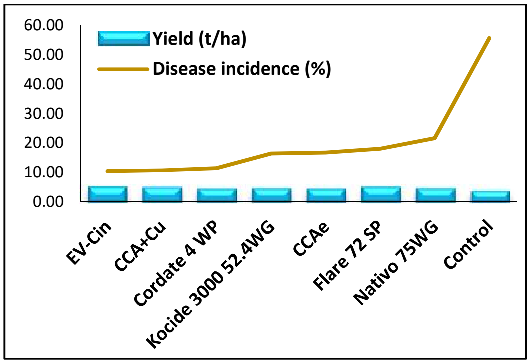

Fig. 25: Brown leaf spot incidence percentage in comparison with paddy yield

Screening of breeding material for resistance against bacterial leaf blight under field conditions

Forty nine fine and eighteen coarse grain rice lines/ varieties of local origin were tested and analyzed for their respective response against bacterial leaf blight by using Standard Evaluation System (SES) for Rice, 2005 developed by the IRRI, Philippine. Keeping in view the percentage disease infection of bacterial leaf blight (Fig. 26) twenty three varieties/lines behaved as resistant and sixteen as moderately resistant.

Fig. 26: Response of lines/ varieties against Bacterial leaf blight

V. RICE TECHNOLOGY

Studied on physiochemical characteristics of fine grain national uniform yield trials

Maximum Head Rice recovery (HR) of 56.0% was recorded for line NB 1395 followed by NB 13122 with 52.0 % HR (Fig 27). Maximum Average Grain Length (AGL) of 8.56 mm was shown by line PK BB 15-1 followed by Line PK PB-8 with 8.12 mm AGL. Maximum cooked grain length (CGL) of 17.5 mm was exhibited by line PK PB-8 followed by line NS-5 with 16.2 mm CGL.

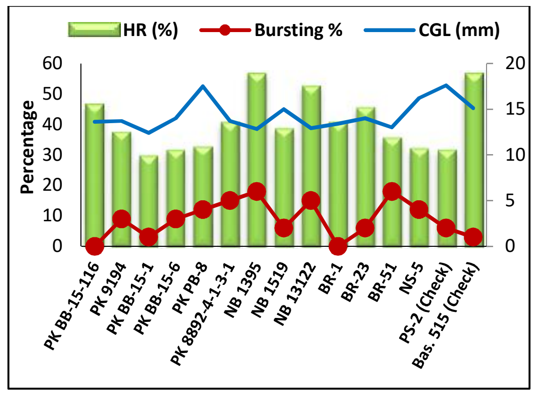

Fig. 27: Milling recovery and cooking quality of NUYT fine grain trial

Maximum elongation ratio of 2.155 was exhibited by the Line PK PB-8 followed by line NB 1519 2.038 elongation ratio. Lines NB 1395 and NB 13122 performed well but their cooking quality (CGL 12.8 mm and 12.9 mm respectively) is poor as compared to check varieties. Whereas lines PK PB-8, NB 1519 performed well both in milling recovery and cooking quality.

Effect of transplanting date on the quality characteristics of different fine grain rice lines

Maximum Head Rice recovery of 54.4 % was recorded on transplanting date of 5th August

2017 followed by the date of 14th July 2017 having 49.6 % HR. With respect to average of varieties/lines, Maximum HR of 56.3 % was recorded (Fig 28) for line PK 9194 followed by line PK BB-15-1 with 55.7 % HR. Line PK 8892-4-1-2-1 also showed good Head Rice Recovery (HR) of 53.1 % on all the dates. Lines PK 9194, PK PB-8, PK 8892-4-1-2-1 and PK BB-15-1 performed well in milling recovery.

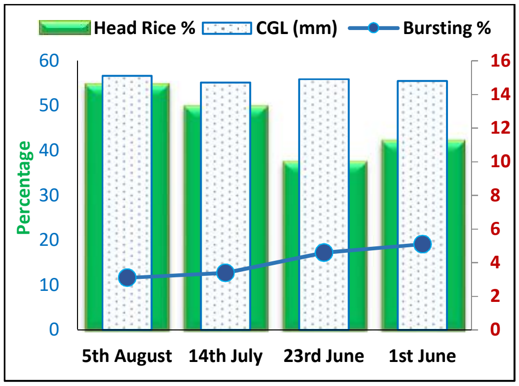

Fig. 28: Head rice recovery, bursting percentage and CGL of fine transplanting trial

Maximum cooked grain length (CGL) of 15.1 mm was recorded for the date of 5th August 2017 (Fig. 28) followed by transplanting date of 23rd June 2017 with 14.9 mm CGL. Maximum CGL of 16.8 mm was recorded for line PK PB-8 followed by line RRI-3 with 16.2 mm CGL.

Regional adaptability trial of fine rice

Maximum Head Rice recovery of 48.9 % was recorded at Sargodha followed by Faisalabad with 43.9 % HR (Fig. 29).Maximum Head Rice recovery of 56.0 % was observed by Line PK 8892-4-2-1-1 at Faisalabad followed by line PK 9194 at same location and by line PK 8892-4-3-1-1 with 53.0 % HR at Sargodha. Milling recoveries of fine lines remained relatively low in traditional Basmati area of Gujranwala and KSK then Sargodha and Faisalabad. This may be due to over drying of paddy samples in Gujranwala and KSK areas.

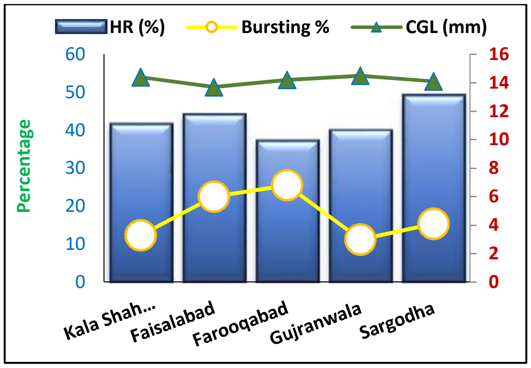

Fig. 29: Head rice recovery, bursting percentage and CGL of regional adaptability trial of fine rice

I. AGRICULTURAL ENGINEERING

Varietal performance of different rice cultivars in terms of yield and yield components as affected by irrigation regimes

To evaluate the four different rice varieties against four different Irrigation Regimes (IR), experiment designed to check their varietal performance in terms of yield and yield components.

To observe the effect of four different Irrigation Regimes (IR) on yield and yield components; four varieties (Punjab Basmati, Chenab Basmati, Kissan Basmati and Basmati 515) tested using their standard agronomic practices under field conditions in split plot (RCBD) in three replications. Standard method for AWD adopted throughout the rice season. Water Level (WL) inside the Perforated Tube (AWD tube) checked on daily basis with the help of a measuring tape. Irrigation applied when the WL dropped inside the AWD tube upto 15 cm (safe AWD), 20 cm and 25 down from the field surface. Depth of water applied in each irrigation was same (5cm above field surface). The average yield against three different irrigation regimes (Fig. 30)) showed the yield response of all four varieties against four different irrigation regimes. Chenab Basmati performed well than all other three varieties when the WL in AWD tubes was at 15 and at 20 cm below surface. Yield of Chenab basmati recorded higher (4.4 t/ha and 3.7 t/ha) at 15 and 20 cm WL respectively (Fig. 30). Basmati 515 obtained the higher yield (3.9 t/ha) at WL 25 cm.

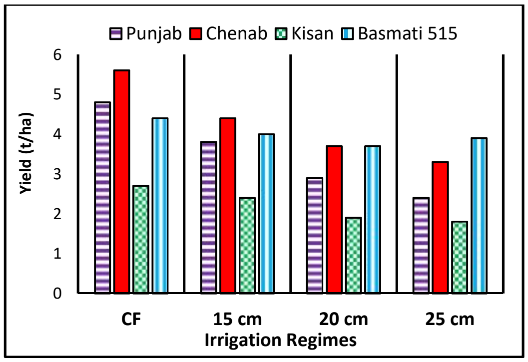

Fig. 30: Average yield against four different Irrigation Regimes

Poor yield performance was observed for Kissan Basmati not only at 15 cm, 20 cm and 25 cm level but even in continuous flooding (CF). At 20 cm WL no difference in yield of Chenab Basmati and Basmati 515 was recorded. The results further indicated that basmati 515 has resistance up to some extent against water stress and can survive in aerobic field condition so Basmati 515 suitable for dry seeding.

B. RICE RESEARCH STATION, BAHWALNAGER

I. RICE BREEDING

Fine grain yield trial

In fine grain group (Fig. 31) strain PK 8662-15-4 produced the highest paddy yield (5.9 t/ha) followed by PK 8749 (5.8 t/ha) as compared to standard variety Basmati 515 (4.8 t/ha).

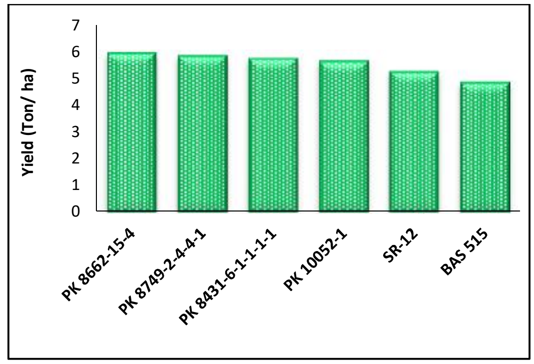

Fig. 31: Mean yield comparison of fine grain lines

Extra-long grain yield trial

In extra-long grain group (Fig. 32), strain PBR-1 produced the highest paddy yield (6.5 t/ha) as compared to standard variety PS 2 (5.7 t/ ha).

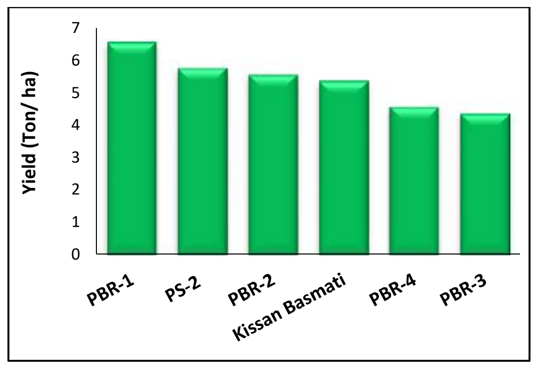

Fig. 32: Mean yield comparison of extra-long grain lines.

Coarse grain yield trial

In coarse grain group (Fig. 33), strain KSK 462 produced the highest paddy yield (7.8 t/ha) followed by KSK 434 (7.5 t/ha) as compared to standard variety KSK 133 (6.9 t/ha).

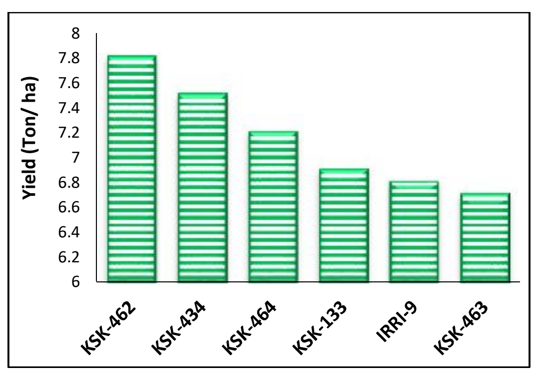

Fig. 33: Mean yield comparison of coarse grain strains

Breeding Studies

Hybridization

The objective of hybridization was to create new genetic combinations for earliness, plant vigor, extra-long grain size and to improve grain quality and yield of Basmati rice. In the year 2017-18, 42 crosses were attempted and 10 fruitful crosses were harvested for further evaluation.

Detail of successful crosses

Extra-long grain size	06
Yield and earliness	03
Plant vigor	01

II. AGRONOMY

Screening of herbicides for the effective control of different rice weeds

Six different herbicides were sprayed on rice variety PS 2 to check their efficacy against different weeds. The treatment application of Butachlor + Winsta gave the best weeds control (Fig. 34).

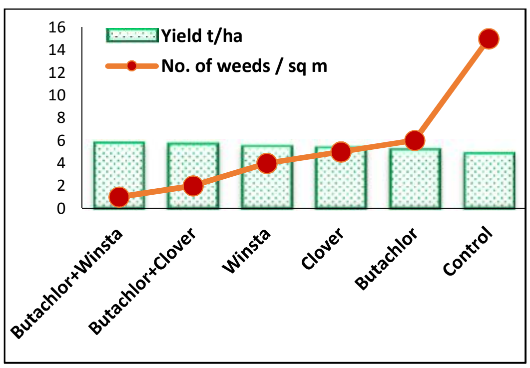

Fig. 34: Effectiveness of weedicides with respective yield comparison

Demonstration of direct seeding rice technology

In DSR group (Fig. 35), the data indicated that the strain Chenab Basmati produced the highest paddy yield (5.1 t/ha) as compared to standard variety PS 2 (4.9 t/ha).

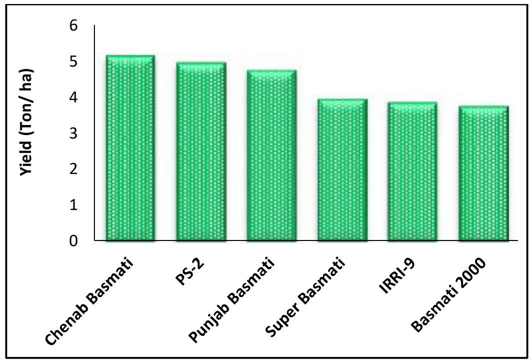

Fig. 35: Mean yield comparison of DSR lines

III. PLANT PATHOLOGY

Screening of fungicides for the effective control of rice blast

Eight different fungicides were sprayed on rice variety Kissan Basmati to test their efficacy for control of rice blast disease. The treatment application of Evito provided effective blast disease control and higher yields (Fig. 36).

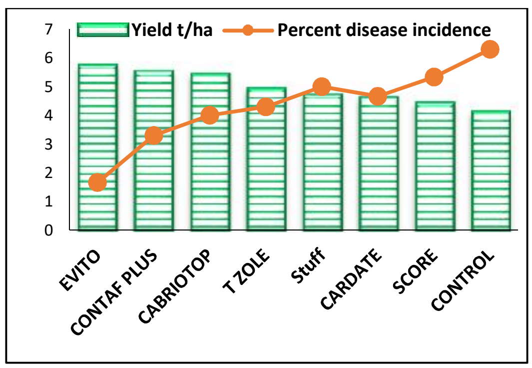

Fig. 36: Effectiveness of fungicides with respective yield comparison

Efficacy of different chemicals for the control of bacterial leaf blight disease

Six different chemicals were sprayed on rice variety Kissan Basmati to check their effectiveness for control of bacterial leaf blight disease. The treatment application of Flare gave effective disease control and higher yields (Fig. 37).

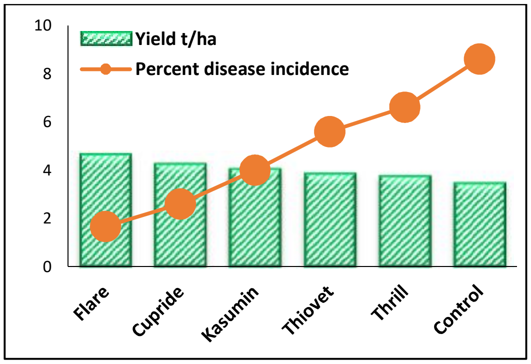

Fig.37: Effectiveness of bactericide chemicals with respective yield comparison

Efficacy of different insecticides for the control of stem borer under field conditions

Six different insecticides were applied to rice variety PS 2 to check their efficiency for control of rice stem borer. The treatment application of Padan gave maximum insect control with higher yields (Fig. 38).

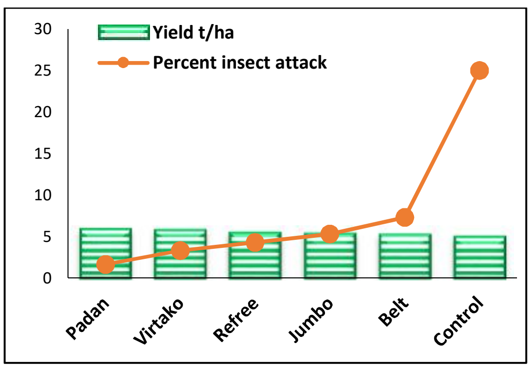

Fig. 38: Effectiveness of insecticides with respective yield comparison

IV. SOIL SCIENCE

Effect of potash on rice growth and yield

The data (Fig. 39) indicates that the treatment (90 Kg potash /ha) produced the highest paddy yield (5.9 t/ha) as compared to control (3.9 t/ha).

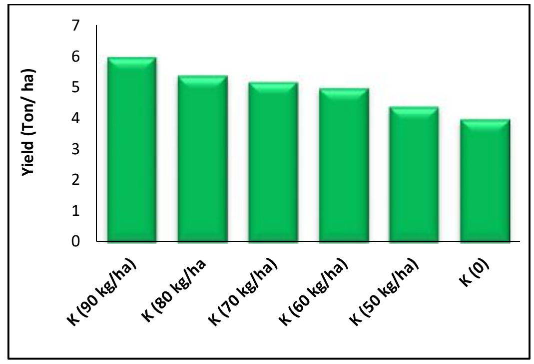

Fig. 39: Paddy yield comparison of different Potash fertilizer treatments.

C. PUBLICATIONS

Refereed Research Papers

1. Akhter, M., H. Sher, M.A. Raza, Z. Haider, U. Saleem, R.A.R. Khan and A. Mahmood, 2017. Multivariate Analysis of Physico-Chemical, Grain Shape and Cooking Quality Parameters of Some Advance Indica Rice (*Oryza Sativa* L.) Lines Under Irrigated Condition. International Journal of Nutritional Science and Food Technology, 3(2): 53-56.
2. Akhter, M., M. Ali, Z. Haider, A. Mahmood and U. Saleem, 2017. Comparison of Yield and Water Productivity of Rice (*Oryza sativa* L.) Hybrids in Response to Transplanting Dates and Crop Maturity Durations in Irrigated Environment. Irrigation and Drainage Systems Engineering, 6: 180.
3. Ali, K., M. Sagheer, M. Hassan, C.M.H. Shahid, S. Malik, M. Rizwan and A. Rashid, 2017. Medicinal response of *Moringa olifera* and *Nicotiana tobacum* as repellent and toxicant against *Trogoderma granarium* and *Rhyzopertha dominica*. Z Arznei-Gewurzpfls, 22(3): 132-135.
4. Shabir, G., K. Aslam, , A. R. Khan, M. Shahid, , H. Manzoor, S. Noreen, M. A.

Khan, M. Baber and M. Sabar, S. M. Shah and M. Arif, 2017. Rice molecular markers and genetic mapping: Current status and Prospects. Journal of Integrative Agriculture, 16(9): 1879-1891.

5. Ayub, M.A., M.M. Ayub, M.D. Gogi, B. Atta, M.A. Farooq and M.J. Nisar, 2017. Impact of different formulations of some Insect Growth Regulators (IGRs) on mortality and natality of adult female *Phenacoccus solenopsis* (Hemiptera: Pseudococcidae), Journal of Agricultural Research, 55(4): 651-660.
6. Bibi, T., A. Riaz, T. Mahmood, M. Akhtar, Z. Haider and M. Riaz, 2017. Genetic divergence of quantitative traits in *Brassica Juncea* L. genotypes based on multivariate analysis. Asian Research Journal of Agriculture, 3(4): 1-8.
7. Haider Z., M. Akhter, A. Mahmood and R.A.R. Khan, 2017. Comparison of GGE biplot and AMMI analysis of multi-environment trial (MET) data to assess adaptability and stability of rice genotypes. African Journal of Agricultural Research, 12(51): 3542-3548.
8. Halima, Q., A. Riaz and M. Akhter, 2017. Evaluation of rice germplasm for resistance against *Pyricularia oryzae* the cause of rice leaf blast. Asian Research Journal of Agriculture, 4(3): 1-6.
9. Halima, Q., M. Akhter, A. Riaz, Z. Haider and A. Mahmood, 2017. Comparative Efficacy of Different Chemical Treatments for Paddy Blast, Brown Leaf Spot and Bacterial Leaf Blight Diseases in Rice (*Oryza sativa* L.). Applied Microbiology: Open Access, 3(3): 138.
10. Iram, A., T.H. Awan, A. Tanveer, N. Akbar, M. F. Saleem and M.E. Safdar, 2017. Optimization of cobalt and nitrogen for improving seed yield, protein content and nitrogen efficiency in mungbean. Journal of Environment & Agriulture, 2(1): 173-179.
11. Khalid, U.B., Z. Haider, S. Iqbal, M.R. Jabbar, M.A. Raza, 2018. Nutritional, physico-chemical and milling quality traits in aromatic pure Basmati rice lines as affected by different transplanting dates. Journal of Nutrition & Food Sciences, 8: 657
12. Masood, S.A., H.U. Rehman, A. Malik, N. Ahmad, H.G. Abbas, F. Illahi, N.U. Shehzad, R. Shahid and Q. Ali, 2018. Genetic analysis and inheritance pattern for yield and yield contributing traits of *Brassica napus*. International Journal of Biology, Pharmacy and Allied Sciences, 7(5): 631-645.
13. Nadeem, I., M.U. Saleem, T.H. Awan, U.B. Khalid, S. Iqbal, A. Iram and M. Akhter, 2017. Effective weed management in dry direct seeded rice for sustainable productivity. Applied Sciences and Business Economics. 4(1): 1-8.
14. Riaz, M., M. Akhter, T. Latif, M. Iqbal, A.R. Khan and N. Shahzadi, 2017. Evaluation of Different Rice Hybrids on Morphological and Traits and Quality Attributes in Adaptability Yield Trials. Asian Research Journal of Agriculture, 7(1): 1-6.
15. Riaz, M., M. Iqbal, M. Akhtar, T. Latif., A.R. Khan and T. Bibi. 2017. Assessment of Genetic Combinations for Hybrid Rice in the Germplasm of Pakistan. Asian Research Journal of Agriculture, 4(3): 1-8.
16. Shahbaz, M., S. Rasheed, M. Aamer, A. Zafar, A. Muktar and M.M. Javed, 2017. Weed management in transplanted rice through different weedicides at Rice

Research Station Bahawalnagar. Asian Journal of Plant Science and Research, 7(3): 11-13.

17. Tariq, M., S. Rashid, A. Jahangeer, M. Arshad, A.R. Khan, A. Majeed, S. Mustafa, 2018. Effect of Phosphorous and Potash fertilizer on green fodder and seed yield of Berseem (Egyptian Clover) under Faisalabad conditions. International Journal of Sciences: Basic and applied research (IJSBAR), 38(2): 8-12.

Book/ booklet

18. Akhter, M., M.U. Saleem and A. M. Sabir¸ 2017. Dhaan ki jaded kasht (Urdu). ISBN 978-969-7582-00-6, RRI, KSK, Pak. P: 64.
19. Akhter, M., T.H. Awan, M.U. Saleem and H. Qudsia, 2017. *Dhaan ki bazarya beej brahey raast kaasht*. Rice Research Institute, Kala Shah Kaku.

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E. METROLOGICAL DATA

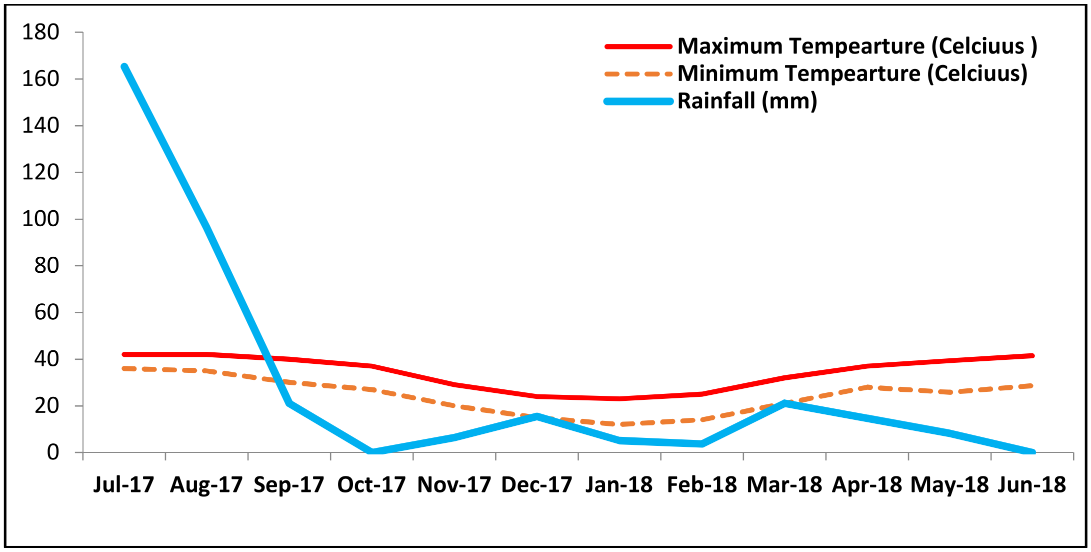

Fig. 40: Metrological data of Kala Shah Kaku