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ABRIDGED REPORT
(2016-17)

Sugarcane Section became one of the part of Ayub Agricultural Research Institute, Faisalabad in 1962 and was upgraded as Sugarcane Research Institute, Faisalabad in 1978.

Figure 1: Office of the Sugarcane Research Institute, Faisalabad

Sugarcane crop plays a significant role in our national economy next to cotton as a cash crop. It has 0.7% share in Gross Domestic Product (GDP). In Punjab, during 2016-17 sugarcane was planted on an area of 792 thousand hectare with a production of 48.03 million tones with an average cane yield of 60.4 t ha^{-1}. It provides raw material to sugarcane industry in particular and chemical & paper industries in general. It also helps to minimize the energy crises in the country. The sugarcane tops serve as fodder during scarcity of fodder in winter. The main objectives of this institute are to evolve high cane yield & Sugar recovery and biotic resistant varieties along with the development of improved production technology. Experiments on different aspects of sugarcane like breeding, Agronomy, Pathology, Entomology and Technology were under taken.

CURRENT SALIENT ACHIEVEMENTS

The promising clones, with potential yield and recovery are presented in Table below:

Sr. No.	Clone	Yield potential (t/ha)	Sugar recovery (%)
1.	S2003-US-778	130	12.45
2.	S2003-US-633	100	13.50
3.	S2003-US-127	125	12.60
4.	S2005-US-54	135	12.60
5.	S2006-US-272	135	12.60
6.	S2006-US-658	135	12.40

Figure 2: S2003-US-633

SUGARCANE BREEDING

The sub-station holds to experimental sites at Charrapani and Pail. Breeding material is maintained with the view point of hybridization to evolve elite clones. Station is striving for productivity to its full strength, effort are made to overcome the agro-climatic factors. One such effort was a construction of a small shed (high plastic tunnel) at Charrapani site. Prime objective was to protect the flowers to increase fuzz viability, however, lights

were also applied to provide extra reproductive days to already induced lines. In respect of induction, the experiment was unable to provide any pin point conclusion, however, in general observations, few lines (S-06-US-641 & 904, S-95-NSG-60 and S-03-US-410) inside the tunnel showed increased flags. These flags were found reluctant to emerge while inside the shed possibly due to day temperature that mostly used increase in shiny days.

Figure 3: Flowering at Chharapani, Murree

Fuzz viability will be tested by sowing the fuzz collected from treated clones and the ones under control (outside shed). During this season 10 hybridization crosses have been performed. For this season ~200 breeding lines are available for flowering behavior studies and good number of flags and arrows produced due to more favorable climatic conditions. So 84 breeding lines/varieties have produced 2236 stalks with flags and out of these, 1178 are able to emerge their arrows giving the best percentage of emergence for last 6 years. Sowing of fuzz obtained from these crosses and open pollination has been started and the data about seedlings produced will be completed in September/October.

Collection and Growing of Sugarcane Fuzz and Transplantation of Seedling into the Filed During, 2016

One hundred and seventy four (174) crosses from the fuzz. The fuzz received from Sri Lanka (149) and Murree, Pakistan (25), were sown for the development of seedlings in the research area of Sugarcane Institute, Faisalabad.

Figure 4: Potted seedlings

Well established seedlings of 13,222 in numbers were transplanted into the field during February/ March, 2017 for further evaluation.

Study of Sugarcane Seedlings in the Field and Selection of Superior Plant

During November 2016, the hundred and thirteen (313) sue selected superior seedlings plants were

selected from twenty thousand three hundred and ninety six (20396) plants and promoted to the nursery-I stage of variety development program.

Taxonomic Classification of Cane Varieties/ Clones

For the identification of new varieties/ clones 13 varieties were morphologically studied which include S-2008-FDF-17,S-2008-FDF-22, VMC-87-599, VMC-88-354, S-2008-MF-34, S-2008-MF-55, S-2009-SAF-8, SLF-96-175, SLF-96-62, SA-79, S-2008-AUSF-107, SA-8 and S-2008-AUS-134.

Gene-Pool Maintenance

Introduction: A breeding technique is used for the increase and to expand already available germplasm. During 2016-17, 130 varieties/ clones included in the experiment were harvested and maintained as root crop and 105 varieties were harvested and were sown as fresh crop during 2017.

Nursery-I

In Nursery-I, (2015-16), 638 clones received from Seedling, were tested in a single row non-replicated experiment having a net plot size of 4 x 1.2 m. These clones were compared with four standard varieties i.e. HSF-240, SPF-245, CPF-246 & CPF-247, keeping in view the desirable characters, such as growth vigor, erectness, brix %age, resistance to frost, lodging, insect pests and diseases. The brix reading was recorded by hand refracto-meter. After comparing the quantitative and qualitative characters, 113 clones were selected and promoted to Nursery-II while 525 clones were rejected due to undesirable characters. Lists of promoted clones is given below in the table.

Figure 5: Selection in of sugarcane clones

List of Clones Promoted From N-I to N-II (Oct 2016)

SR. #.	CLONE NO.	SR. #.	CLONE NO.
1	S-2015-SL-07	31	S-2015-SL-156
2	S-2015-SL-10	32	S-2015-SL-158
3	S-2015-SL-16	33	S-2015-SL-166
4	S-2015-SL-25	34	S-2015-SL-168
5	S-2015-SL-26	35	S-2015-SL-176
6	S-2015-SL-43	36	S-2015-SL-177
7	S-2015-SL-53	37	S-2015-SL-183
8	S-2015-SL-55	38	S-2015-SL-189
9	S-2015-SL-58	39	S-2015-SL-201
10	S-2015-SL-64	40	S-2015-SL-223
11	S-2015-SL-65	41	S-2015-SL-244
12	S-2015-SL-66	42	S-2015-SL-257
13	S-2015-SL-70	43	S-2015-SL-265
14	S-2015-SL-73	44	S-2015-SL-273
15	S-2015-SL-76	45	S-2015-SL-280
16	S-2015-SL-77	46	S-2015-SL-282

17	S-2015-SL-86	47	S-2015-SL-283
18	S-2015-SL-89	48	S-2015-SL-285
19	S-2015-SL-90	49	S-2015-SL-286
20	S-2015-SL-91	50	S-2015-SL-288
21	S-2015-SL-92	51	S-2015-SL-289
22	S-2015-SL-96	52	S-2015-SL-290
23	S-2015-SL-97	53	S-2015-SL-294
24	S-2015-SL-101	54	S-2015-SL-296
25	S-2015-SL-102	55	S-2015-SL-300
26	S-2015-SL-108	56	S-2015-SL-302
27	S-2015-SL-122	57	S-2015-SL-304
28	S-2015-SL-123	58	S-2015-SL-310
29	S-2015-SL-127	59	S-2015-SL-320
30	S-2015-SL-136	60	S-2015-SL-324

SR. #.	CLONE NO.	SR. #.	CLONE NO.
61	S-2015-SL-343	80	S-2015-SL-429
62	S-2015-SL-354	81	S-2015-SL-432
63	S-2015-SL-367	82	S-2015-SL-435
64	S-2015-SL-369	83	S-2015-SL-437
65	S-2015-SL-374	84	S-2015-SL-441
66	S-2015-SL-382	85	S-2015-SL-443
67	S-2015-SL-392	86	S-2015-SL-444
68	S-2015-SL-394	87	S-2015-SL-446
69	S-2015-SL-395	88	S-2015-SL-448
70	S-2015-SL-396	89	S-2015-SL-461
71	S-2015-SL-404	90	S-2015-SL-463
72	S-2015-SL-406	91	S-2015-SL-466
73	S-2015-SL-409	92	S-2015-SL-468
74	S-2015-SL-410	93	S-2015-SL-485
75	S-2015-SL-413	94	S-2015-SL-486
76	S-2015-SL-416	95	S-2015-SL-503
77	S-2015-SL-417	96	S-2015-SL-540
78	S-2015-SL-421	97	S-2015-SL-546
79	S-2015-SL-425	98	S-2015-SL-554
99	S-2015-SL-547	107	S-2015-SL-592
100	S-2015-SL-549	108	S-2015-SL-593
101	S-2015-SL-566	109	S-2015-SL-598
102	S-2015-SL-569	110	S-2015-SL-599
103	S-2015-SL-572	111	S-2015-SL-618
104	S-2015-SL-574	112	S-2015-SL-624
105	S-2015-SL-575	113	S-2015-SL-636
106	S-2015-SL-580		

Nursery-II

In Nursery-II, (2015-16), 610 clones were tested in a double row non-replicated experiment having a net plot size of 4 x 2.4 m. These clones were compared with four standard varieties i.e. HSF-240, SPF-245, CPF-246 & CPF-247. Keeping in view the desirable characters, such as growth vigor, erectness, brix %age, resistance to frost, lodging, insect pests and diseases. The brix reading was recorded by hand refracto-meter. After comparing the quantitative and qualitative characters, 125 clones were selected and promoted to Nursery-III, while 485 clones were rejected due to undesirable characters. Lists of promoted clones is given below in the table.

List of Clones Promoted From N-II to N-III (Oct 2016)

SR. #.	CLONE NO.	SR. #.	CLONE NO.
1	S2014-SL-347	*14*	S2014-SL-675
2	S2014-SL-349	*15*	S2014-SL-680
3	S2014-SL-353	*16*	S2014-SL-681
4	S2014-SL-360	*17*	S2014-SL-753
5	S2014-SL-365	*18*	S2014-SL-775
6	S2014-SL-367	*19*	S2014-SL-779
7	S2014-SL-380	*20*	S2014-SL-781
8	S2014-SL-389	*21*	S2014-SL-916
9	S2014-SL-396	*22*	S2014-SL-921
10	S2014-JG-525	*23*	S2014-SL-941
11	S2014-SL-592	*24*	S2014-SL-951
12	S2014-SL-602	*25*	S2014-SL-955
13	S2014-SL-636	*26*	S2014-SL-966
27	S2014-SL-968	*56*	S-2014-SL-1442
28	S-2014-SL-973	*57*	S-2014-SL-1469
29	S-2014-SL-974	*58*	S-2014-SL-1474
30	S-2014-SL-1022	*59*	S-2014-SL-1475
31	S-2014-SL-1024	*60*	S-2014-SL-1503
32	S-2014-SL-1079	*61*	S-2014-SL-1520
33	S-2014-SL-1081	*62*	S-2014-SL-1527
34	S-2014-SL-1087	*63*	S-2014-SL-1535
35	S-2014-SL-1089	*64*	S-2014-SL-1537
36	S-2014-SL-1103	*65*	S-2014-SL-1540
37	S-2014-SL-1116	*66*	S-2014-SL-1574
38	S-2014-SL-1125	*67*	S-2014-SL-1576
39	S-2014-SL-1145	*68*	S-2014-SL-1593
40	S-2014-SL-1179	*69*	S-2014-SL-1613
41	S-2014-SL-1212	*70*	S-2014-SL-1617
42	S-2014-SL-1215	*71*	S-2014-SL-1621
43	S-2014-SL-1224	*72*	S-2014-SL-1624
44	S-2014-SL-1288	*73*	S-2014-SL-1626
45	S-2014-SL-1307	*74*	S-2014-SL-1631
46	S-2014-SL-1322	*75*	S-2014-SL-1643
47	S-2014-SL-1336	*76*	S-2014-SL-1699

48	S-2014-SL-1339	*77*	S-2014-SL-1700
49	S-2014-SL-1351	*78*	S-2014-SL-1706
50	S-2014-SL-1359	*79*	S-2014-SL-1716
51	S-2014-SL-1362	*80*	S-2014-SL-1802
52	S-2014-SL-1372	*81*	S-2014-SL-1838
53	S-2014-SL-1399	*82*	S-2014-SL-1871
54	S-2014-SL-1412	*83*	S-2014-SL-1876
55	S-2014-SL-1425	*84*	S-2014-SL-1878

SR. #.	CLONE NO.	SR. #.	CLONE NO.
85	S-2014-SL-1882	*106*	S-2014-SL-2290
86	S-2014-SL-1933	*107*	S-2014-SL-2349
87	S-2014-SL-1936	*108*	S-2014-SL-2350
88	S-2014-SL-2006	*109*	S-2014-SL-2384
89	S-2014-SL-2045	*110*	S-2014-SL-2392
90	S-2014-SL-2049	*111*	S-2014-SL-2456
91	S-2014-SL-2069	*112*	S-2014-SL-2457
92	S-2014-SL-2070	*113*	S-2014-SL-2463
93	S-2014-SL-2076	*114*	S-2014-SL-2465
94	S-2014-SL-2128	*115*	S-2014-SL-2466
95	S-2014-SL-2133	116	S-2014-SL-2469
96	S-2014-SL-2136	*117*	S-2014-SL-2471
97	S-2014-SL-2138	*118*	S-2014-SL-2477
98	S-2014-SL-2142	*119*	S-2014-SL-2491
99	S-2014-SL-2143	*120*	S-2014-SL-2494
100	S-2014-SL-2154	*121*	S-2014-SL-2503
101	S-2014-SL-2176	*122*	S-2014-SL-2567
102	S-2014-SL-2186	*123*	S-2013-M-72
103	S-2014-SL-2200	*124*	S-2013-US-876
104	S-2014-SL-2201	*125*	S-2013-US-969
105	S-2014-SL-2246		

Preliminary Varietal Yield Trial 2016-17 (Nursery-III).

Three sets of preliminary varietal yield trial (N-III) consisting of 34 test entries and two check varieties (HSF-240 & CPF-247) were laid out in RCBD with 3 replications. Out of which 12 clones were selected and shifted to semifinal varietal trial for further study on the basis of good performance, while remaining 22 clones were rejected due to the poor performance/disease/ insect infestation.

Semi-Final Varietal Trial

The semi-final trial was comprised of 2 sets, each having 12 clones including 02 standards i.e. HSF 240 & CPF 246. The experiment was laid out in RCBD with five repeats (2 for periodic juice analysis) with net plot size of 9.6m × 4m. The data regarding germination, tillering, cane count, cane yield, lodging, pithiness, insect pest and disease tolerance were recorded. The periodic juice analysis of the clones was made on monthly basis from 15th October, 2016 to 15th February, 2017. On the basis of the data recorded, 8 out of 20 were rejected due to low in sugar recovery/disease susceptibility etc. while12 clones were promoted to final varietal stage of variety development.

Final Varietal Trial 2016-17

The field trial was carried out to study the quantitative and qualitative performance of thirteen (13) clones against two standard varieties HSF 240 and CPF 246. The experiment was laid out in RCBD with five repeats (2 for periodic juice analysis) having a net plot size of 4 m x 8.4 m. On an average, the highest cane yield (142.0 t ha^{-1}) was noted in S2008 FD-19 while the lowest (88.5 t ha^{-1}) was observed in S2008 FD-17. As regard of sugar yield, S2008-FD-19 surpassed all other

clones and standards by producing sugar yield of 17.0 t ha^{-1}. Out of 13 clones in this trial, four were rejected due to their susceptibility to diseases, poor growth & cane yield and sugar recovery whereas four clones *viz.* S2008-AUS-134, S2009-SA-8, S2011 SL-62 and VMC-88/354 were retained for further studies.

National Uniform Varietal Yield Trial (1st Year) 2016-18.

The experiment was carried out to study the growth, yield and qualitative performance of nine (9) varieties against standard variety CPF 248. The experiment was laid out in randomized complete block design with three replications. The clone S2008 FD-19 was found to be superior with highest cane and sugar yields of 108.5 and 12.5 t ha^{-1} as against the lowest (43.6 and 4.4 t ha^{-1}) for Th-1210, respectively.

National Uniform Varietal Yield Trial (2nd Year) 2015-17

The experiment was conducted to study the growth, yield and quality performance of five (5) sugarcane clones against standard variety CPF 247. The trial was laid out in randomized complete block design with four replications. The highest cane and sugar yield of 129.0 and 16.29 t ha^{-1} t ha^{-1} was associated with S2006 SP-93 and lowest (74.3 and 9.71 t ha^{-1}) was produced by CSSG-32, respectively.

Promising Varietal Trial 2016-17

A field trail including nine (9) promising sugarcane clones with standard variety HSF 240 were planted in spring to evaluate the cane yield potential and qualitative performance. The experiment was laid out in randomized complete block design (RCBD) having three replications with net plots size measuring 4 x 9.6 m^{-2}. The standard variety HSF 240 exhibited highest stripped cane yield of 148 t ha^{-1} and was at par with S2008 AUS-133(147 t ha^{-1}) against the lowest (101 t ha^{-1}) by S2009 SA-111.

Fourteen (14) clones were compared with standard varieties HSF 240 and CPF 246. The experiment was laid out in RCBD with five repeats (2 for periodic juice analysis) having a net plot size of 4 m x 9.6 m. Three clones namely S2008-AUS-130, S2008-AUS-133 and S2009-SA-111 were shifted to promising varietal yield trial whereas, seven (7) clones *viz.* S2008 FD-19, S2008 M-34, S2008 M-55, S2008 AUS-107, S2008 AUS-134, S2009 SA-8 and S2009 SA-79 were retained for further studies.

Zonal Varietal Trials

The trials were conducted in Feb-March 2016 consisting of advanced sugarcane clones/varieties along with four check varieties on eight diverse locations in RCBD with three replications to find out most suitable varieties for various agronomic trials along with insect and disease resistance for different ecological zones in Punjab. The sugarcane clones/varieties S2006-US-658 gave the better performance i.e. 138.4 t/ha cane yield than followed i.e. S2008-FD-19, CPF-249, CPF-247 and S2003-US-633, respectively.

SUGARCANE AGRONOMY

Weed-Crop Competition Studies in Sugarcane Planted At Different Row Spacing

The trial was conducted to find the minimum use of weedicide in sugarcane. Maximum cane yield of 89.78 t ha^{-1} was recorded in treatment $V_1R_1W_2$ when sugarcane crop i.e. S2006-US-272 was sown 4 feet apart and Ametryn + Atrazine pre-emergence + Sunstar 60 DAS (days after sowing) was sprayed.

Weed Management in Sugarcane

The trial was carried out to find the most effective weedicide to control weeds in sugarcane. Maximum cane yield of 97.23 t/ha was recorded in treatment T_3 (Mesotrione + S-metolachlor @ 1000 ml / acre pre-emergence (1-3 DAP) + earthing up 110-120 DAS.

Integrated Weed Management in Sugarcane

The trial was conducted to find out the most effective combination of weed control in sugarcane. Maximum cane yield of 98.55 t/ha was recorded in treatment T6 (Manual weeding 30 DAP+ one mechanical weeding 60 DAP + earthing up 90-100 DAP.

Figure 6: Mechanically weeding

Effect of Harvesting Dates on Yield and Quality of Different Sugarcane Varieties in Ratoon Crop

The trial was carried out to evaluate the ratooning potential of four (4) sugarcane clones against standard variety HSF 240 at different harvesting times of plant crop *viz.* 15th November, 15th December, 15th January, 15th February and 15th March. On an

average, all the clones exhibited highest ratoon cane yield when plant crop was harvested on 15th February and was maximum (74.1 t ha^{-1}) in subsequent ratoon of S2006-US 658 as against the lowest (57.5 t ha^{-1}) for CPF 247.

Figure 7: Sprouting of ratoon crop

Comparative Evaluation of Different Planting Methods

A trial was laid out under randomized complete block design with split plot arrangement having three repeats at farm area of Sugarcane Research Institute, Faisalabad. Four planting methods i.e. 1.2m apart dual rows planting (recommended), 0.75m apart single row planting (farmer practice), 1.5m apart dual rows and pits (R × R = 1.5m, Pit × Pit = 1m) planting were kept in main plot while 3 varieties/clones i.e. S2003-US-633 (having lodging tendency), CPF 248 (moderate in lodging), S2006-US-658 (very less or no lodging) were planted in sub plots. It was observed that the recommended practice (1.2m apart) produced 3 & 14% more cane yield (t ha^{-1}) over the 0.75m and 1.5m apart planting methods, respectively.

Figure 8: Pits making

There was negligible yield difference in recommended practice and pit planting but economic returns were 20, 17 & 10% more economic return by 1.2m, 0.75m & 1.5m, respectively over pit planting method. Clone S2006-US-658 excelled in cane yield (104.0 t ha^{-1}) and found suitable for all planting methods than CPF 248 (73.3 t ha^{-1}) and S2003-US-633 (82.6 t ha^{-1}).

Response of Promising Sugarcane Clones/Varieties under Different Moisture Regime

All irrigation co-efficient level i.e. 1.0, 0.8 & 0.6 produced all contributing factors, the germination %, tillers/plant, No. of canes/ha, cane yield t/ha and CCS % statistically at par with one another.

Varieties: - the sugarcane clone/variety S2006-US-272 produced statistically

significant yield which was followed by S2008-FD-19 and CPF-248, whereas CCS% concerned S2003-US-127 gave significant results as compared to others.

Managing the plant population through different planting /placement techniques

The trial was laid out in RCBD with split plot arrangement having three repeats. Three planting techniques i.e. 4 ft apart, 4 ft apart (Ladder planting), 2.5 ft apart were kept in main plot while different seed rates i.e. 40000, 50000, 60000 and 70000 TBS/ha of clone S2006-US-658 were used in sub plots.

Figure 9: Ladder planting

The highest cane yield (160.1 t/ha) was recorded in ladder planting at the seed rate of 70000 TBS/ha while the lowest, and statistically similar, cane yields were recorded in 2.5 feet apart planting methods at all seed rates. Both the 4 feet apart planting methods are statistically similar but better than 2.5 feet apart in sugar recovery while cane seed rates has no effect on sugar recovery at all.

Performance of sugarcane under late plantation

To check the feasibility of sugarcane varieties/clones for late planting, especially after wheat harvesting a trial was laid out under randomized complete block design with split plot arrangement having three repeats at farm area of Sugarcane Research Institute, Faisalabad. Six planting dates i.e. 15th March, 30th March, 15th April, 30th April, 15th May and 30th May were kept in main plots while 2 variety/clone S2003-US-633 (early maturing) and HSF 240 (commercial variety) were planted in sub plots.

Data regarding germination and tillering were taken during formative phase, while cane count, cane yield and quality parameters, at the time of harvest. If we see the interaction of planting dates and varieties given in the table the highest cane yield (88.89 t ha^{-1}) was observed on 15th March while least (22.92 t ha^{-1}) in 30th May, the last planting date. The planting dates, 30th March, 15th April and 30th April were statistically similar in respect to sugar recoveries of 12.97, 12.73 and 13.52%, respectively with clone S2003-US-633 depicting that the clone S2003-

US-633 can be planted after wheat harvesting.

Response of Sugarcane Clones/ Varieties at Different N Levels

In this two factors were studied i. Fertilizers level ii. Sugarcane clone/variety. The fertilizers level F_1: 126-112-112 NPK kg ha^{-1} & F_4: 252-112-112 NPK kg ha^{-1} gave the statistically significant can yield but CCS% all (4) levels statistically at par.

Varieties:- The sugarcane varieties S2006-US-272, S2006-US-658 and S2005-US-54 gave significantly can yield respectively which are statistically at par with one another. The varieties CPF-246 produced statistically the lowest cane yield. Higher CCS% produced by S2003-US-633 but the lowest by S2006-US-272.

Performance of Sugarcane Clones at Various Harvesting Dates

The trial was consisting of five (5) sugarcane varieties to investigate the cane yield and quality performance at various harvesting times *viz.* 15th November, 15th December, 15th January, 15th February and 15th March. The experiment was laid out in RCBD split plot arrangements with three replications. The sugarcane clones S2008 AUS-130 exhibited highest cane yield of 112 t ha^{-1} as against the lowest (82.2 t ha^{-1}) for S2009 SA-111. The sugar recovery was found non-significant for all the clones. The different harvesting times also have non-significant effect on cane yield of sugarcane varieties whereas, sugarcane recovery was observed significant for the harvesting times and was recorded highest of 13.13% at 15th March which was at par with 15th February showing average sugar recovery of 13.04% compared to the lowest at 15th November and 15th December having sugar recovery of 10.97 and 10.87%, respectively.

Performance of Promising Sugarcane Varieties Sown In Autumn

The experiment comprising of eight varieties was conduct in RCBD with three repeats having net plot size of 4× 9.6. The experiment was sown @ 5100 TBS/ha in first week of September. It is obvious from data recorded that S2008-AUS-130 gave maximum stripped cane yield of 118 t/ha having sugar recovery of 12.39%. It produced 14-47 t/ha sugar, proving itself the best variety. S2006-SP-93 was followed producing 97 t/ha stripped cane yield and 11.49 t/ha sugar.

Effect of Inter Cropping on Yield and Quality of Autumn Planted Sugarcane

Lentil, linseed, canola and onion were intercropped in sugarcane promising clone S2011-FD-19. The data recorded that maximum cane yield (138.44 t/ha), sugar yield (16.56 t/ha) and net income Rs. 542810 /ha was obtained in lentil+ sugarcane intercropping system. While comparatively lower cane yield (117.16 t/ha), sugar yield (16.56 t/ha) and net income Rs. 42696/ ha was achieved when linseed was intercropped in sugarcane.

Figure 10: Intercropping in September plantation

SUGARCANE TECHNOLOGY

Quality Evaluation of Sugarcane Clones

Three (03) different sets of sugarcane clones (fifteen (15) clones as final varietal trial, twelve (12) as semifinal varietal trial set-I & twelve (12) as set-II) were studied for evaluation of best juice quality to assess the stage of maturity. The analysis of various clones was conducted for juice quality parameters starting from October-2016 till March-2017 on monthly basis. In final varietal trial, the mean maximum CCS% was recorded by SA-8 (12.43) followed by AUS-107 (12.29) as compared to HSF-240 (12.08) & CPF-246 (13.48) as standard. Similarly, in semi-final varietal trial set-I, mean maximum CCS% was analyzed in SL-426 (12.57) followed by SL-424 (12.42), SL-443 (11.78) as compared to HSF-240 (11.63) & CPF-246 (12.79) as standard and in set-II, maximum CCS% was analyzed in PSR-97-41 (12.61) followed by S2012-M-780 (12.50), S2012-M-1379 (12.44) as compared to HSF-240 (12.28) & CPF-246 (13.85) as standard.

Screening of Promising Sugarcane Clones for Gur Production and Quality.

Gur was prepared of five different promising varieties / lines (S2006-US-272, S2006-US-658, S2008-AUS-130, S2008-AUS-133 & CPF-248) and analyzed for moisture, color, mineral matter, reducing sugars and net rendements, before and after storage of 90 days. The analysis results revealed that sugarcane clones S2006-US-272, CPF-248 and S2006-US-658 gave significantly higher contents of mineral mater (3.69, 3.58 & 3.19%) respectively with less contents of reducing sugars (4.79, 4.95 & 5.35%) with comparatively lighter color intensity (41.49, 48.49 & 45.33%) colorimetric units along with comparatively higher contents of net

rendements (75.40, 77.30 & 74.83) respectively as compared to other clones under test. Therefore, it was concluded that with respect to lighter color, good nutritional aspect and good keeping quality, Sugarcane clones S2006-US-272, S2006-US-658 and CPF-248 were found better as compared to clones S2008-AUS-130 & S2008-AUS-133. On the other hand storage effect for 90 days at ambient conditions showed darkening of color and moisture reduction in the gur of all cane clones.

Effect of NPK Doses on Yield and Quality of Promising Sugarcane Clones

Three different fertilizer levels i.e. NPK @ 126-84-84, 210-140-140 and 252-168-168 kg ha^{-1} were tested with the standard NPK dose 168-112-112 kg ha^{-1} on the two different promising sugarcane clones S2006-US-658 and S2006-US-272 under field conditions. Crop was raised and data regarding yield, quality parameters were recorded at harvest. The results regarding Germination and Cane yield were found statistically significant while the results of CCS and Sugar recovery did not show significance in treatment means. Significantly mean maximum sugarcane yields of clones S2006-US-658 & S2006-US-272 (100.24 & 99.55 t ha^{-1}) were obtained respectively from the treatment T4 where fertilizers were applied @ NPK 252-168-168 kg ha^{-1} which remained statistically at par with NPK doses @ 210-140-140 and 168-112-112 (recommended dose). Mean maximum CCS (13.53 & 12.64%) and Sugar Recovery (12.72 & 11.88%) level was obtained respectively from the same treatment T4. From this study it was concluded that statistically the best economical yield and sugar recovery from both the sugarcane clones S2006-US-658 and S2006-US-272 was obtained with the application of standard fertilizer dose NPK @ 168-112-112 kg ha^{-1}

Effect of Zinc on Growth and Juice Quality of Up-Coming Sugarcane Clones

Effect of soil application of zinc sulphate (33%) along with standard NPK fertilizer dose was studied on yield and quality parameters of two up-coming sugarcane clones S2006-US-658 and S2008-FD-19 under field conditions. Four zinc levels (12.5, 25.0, 37.5 & 50.0 kg ha^{-1}) were compared with standard NPK level. The results regarding Tillers per plant were found statistically significant while Germination, Cane Count, Cane Yield, CCS and Sugar recovery did not show significance in treatment means. Maximum sugarcane yields of clones S2006-US-658 & S2008-FD-19 (110.60 & 109.90 t ha^{-1}) were obtained respectively from the treatment T5 where maximum dose (50 kg ha^{-1}) of zinc fertilizers was added with recommended dose of NPK fertilizers. Mean maximum CCS (14.73 & 13.69%) and Sugar Recovery (13.85 & 12.87%) level was obtained by clones S2006-US-658 & S2008-FD-19 respectively from the

same treatment T5. From the study it was concluded that the soil application of zinc sulphate @ 12.50 kg ha^{-1} along with standard dose of NPK @ 168-112-112 kg ha^{-1} improved the sugarcane yield more than 1 % over control in both the clones under test. Zinc application more than 12.50 kg ha^{-1} improved sugar recovery about 2% over control in cane clone S2008-US-658 but was found un-economical. Zinc availability to plants was related to soil and environmental conditions.

Impact of Humic Acid and other Organic Sources on Sugarcane

Impact of Humic Acid (Granular 40%) @20 kg ha^{-1}, Press Mud @20 t ha^{-1} and Bio-Fertilizer (BOP 20%) @ 250 kg ha^{-1} application under two NPK fertilizer levels (F1=100% & F2=75% of standard dose) was compared with NPK alone on sugarcane variety CPF-248 with respect to yield and quality parameters in field conditions. The results showed that germination & tillers per plant were statistically significant while the cane count, cane yield, CCS and Sugar Recovery were non-significant. Maximum cane yield (102.51 & 94.59 t ha^{-1}) in case of both the fertilizer levels (F1 & F2) respectively were recorded in the treatment (T4) of Bio-Fertilizer. The humic acid treatment (T2) performed next close to it. Maximum CCS (14.30 & 13.75%) and Sugar Recovery (13.45 & 12.93%) were recorded in (F1 & F2) levels respectively in the same treatment (T4) followed by (T2). From the study, it was concluded that application of all the organic sources (Humic Acid, Press Mud and Bio-Fertilizer) gave better cane yields and sugar recovery along with 100% recommended NPK fertilizer dose i.e. @168-112-112 kg ha^{-1} as compared to 75% NPK fertilizer dose i.e. @126-84-84 kg ha^{-1} and control i.e. NPK fertilizer alone. Among the organic sources Humic Acid (Granular 40%) @20 kg ha^{-1} & Bio-Fertilizer (BOP 20%) @ 250 kg ha^{-1} performed equally better than the Press Mud @ 20 t ha^{-1} treatment as compared to control.

SUGARCANE PATHOLOGY

Main emphasis was given in selecting disease resistant/ tolerant varieties/lines at various selection stages under natural as well as under artificial inoculations.

Screening of sugarcane lines against red rot (*Collectotrichum falcatum Went*)

Seven hundred and thirty nine (739) sugarcane clones were subjected to artificial inoculations.

The test clones were injected with disease inoculum using plug technique. Among the 739 clones, 527 were found resistant, 85 moderately resistant, 60 moderately susceptible and 67 susceptible.

Figure 11: Inoculated sugarcane clones

Figure 12: Screening of different red rot strains

Screening of sugarcane lines against whip smut caused by *Ustillago scitaminea*

One hundred and twenty one (121) sugarcane clones were screened out by artificial inoculation. Setts were dipped in spore suspension of *Ustillago scitaminea* at sowing time.

Out of 121 clones, 98 were found resistant, 11 moderately resistant, 10 moderately susceptible and 9 were found susceptible.

Screening of sugarcane clones against pokkah boeing caused by *Fusarium moniliformae.*

One hundred and twenty one (121) sugarcane clones were screened out by injecting causal organism near the growing points of standing canes. Assessment of the disease was made on the basis of disease appearance. 109 were resistant to the diseases 4 moderately resistant and 8 were found susceptible.

Screening of sugarcane clones against sugarcane mosaic disease caused by virus.

One hundred and twenty one (121) sugarcane clones were screened under natural condition. Assessment of the disease was made on the basis of disease appearance. Out of 121 clones/ advanced lines 85 were resistant, 15 were moderately susceptible and 21 were susceptible.

Screening of sugarcane clones against red stripe caused by *Xanthomonas rubrillineans*

121 sugarcane clones were screened out by injecting causal bacterium near the growing points of standing canes. Assessment of the disease was made on the basis of reddish streaks and top rotting. All the entries were found resistant to the disease.

Screening of sugarcane clones against sugarcane rust caused by *Puccinea melanocephala.*

One hundred and twenty one (121) clones were screened against sugarcane rust. A highly susceptible variety BF-162 was planted between test lines. Rust intensity was recorded by counting rust Pastules on the young leaves. All 121 lines were found resistant.

Management of Whip Smut Disease of Sugarcane Through the Use of Fungi Toxicants

Last year sugarcane variety S2003-US-618 was included in the experiment. Since the mentioned variety (S2003-US-618) is highly susceptible to whip smut. Therefore none of the fungicide was found to be effective in controlling the disease.

Drenching Of Fungicides to Control Sugarcane Red Rot

The results were found statistically significant. Thiophenate methyl, Fosetyl-A and Fluitriafol + Azoxystrobin showed the better result in controlling the disease under field condition respectively.

Figure 13: Susceptible vs resistant variety

SUGARCANE ENTOMOLOGY

Screening of varieties / advance clones of Final & Semi-final varietal trials against sugarcane borers (insecticide applied).

Twenty seven (27) clones/ varieties in all field and semifinal varietal trial were screened for resistance against sugarcane clones viz. Top, stem and root borer. Out of 27 varieties/ clones, 26 were found resistant and one variety was found moderately resistant against sugarcane borer.

Screening of varieties / advance clones of National Uniform Varietal Yield Trial (NUVYT) for resistance against sugarcane borers.

Sixteen (16) clones/varieties in National Uniform Varietal Yield Trial were screened for resistance against sugarcane borer viz. top, stem and root borers. Out of sixteen varieties eight were found resistant, six moderately resistant and two were found moderately susceptible against sugarcane borers.

Screening of varieties/advance clones of final varietal trials for resistance against sugarcane borers under natural conditions (Without Insecticides application).

Thirty two (32) varieties/clones in final and semifinal varietal trials were screened for resistance against sugarcane borers, all recommended inputs were given except insecticide application. Out of thirty two (32) clones, 17 were found resistant, 12 moderately resistant and 2 were found moderately susceptible against sugarcane borers.

Efficacy of different granular insecticides against sugar borers.

Three (3) different granular insecticides viz. Ferterra 0.4G, Vertoko 0.6G and Toss 4G were tested at recommended doses against sugarcanes clones. Ferterra 0.4G gave minimum internode damage (10.49) against 24.88 % in control pest. However Toss 4G gave less results for dead heart 5age followed by Ferterra 0.4G (5.05%) against 13.66% in control plots, Vertoko

0.6G treated plots also gave maximum yield of 102.16 tha^{-1} followed by Toss 4G (99.86 tha^{-1}) against 77.86 tha^{-1} in control plots.

SUGARCANE RESEARCH STATION, KHANPUR & SUGARCANE RESEARCH SUB-STATION, BAHAWALPUR.

Preliminary varietal trial of sugarcane

This genotypic experiment consisted of 8 sugarcane strains including CPF-248 as standard. The investigation was laid out in RCBD with three replications and a net plot size of 4.8 x 7 m. The statistical analysis of the data embodied in table-1 depict that the differences among the final cane yield of the collated strains were gorgeous enough to reach the level of significance. Sugarcane strain SL-96-128 gave the highest final cane yield of 109.72 t/ha. The clone S2009-SA-8 surpassed the list in sugar yield and it produced 11.03 t/ha of sugar.

Semifinal varietal trial of sugarcane

The experiment was laid out in RCBD with three replications and a net plot size of 4.8 x 7 m to collate eight promising sugarcane genomes. The statistical analysis of the data presented in table-2 depicts that the differences among the final cane yield of the tested varieties were significant. The approved sugarcane variety CPF-246 surpassed the set of clones with a final cane yield of 103.67 t/ha. The top yielder is also good in quality and as such it fetched maximum sugar yield of 13.05 t/ha.

Final varietal trial of sugarcane

Eight promising sugarcane strains were compared in yield and quality with two standard cultivars CPF-247 and SPF-234. The trial was planted in RCBD with three replications and a net plot size of 4.8 x 7 m. Statistically analyzed data set out in table-3 evince significant cane yield differences among the tested lines. The promising sugarcane variety S2006-US-658 yielded best among the other strains with a final tonnage of 109.42 t/ha and was matchingly followed by S2006-AUS-133. The follower strain S2006-AUS-133 is a good quality genotype and as such it collected maximum sugar yield of 13.17 t/ha.

Autumn planted sugarcane varietal trial

This experiment consisted of ten sugarcane strains planted for their quantitative as well as qualitative evaluation under extended growth period by planting them in the month of September. The genotypic trial was laid out in RCBD with a net plot size of 3.6 x 10 m and three replications. The data presented in table-4 reveal significant cane yield differences among the tested genomes. The clone SL-96-128 surpassed the list in cane yield by producing 118.80 t/ha and it was matchingly followed by S2006-AUS-133. The follower strain S2006-AUS-133 is a good quality genotype and as such it collected maximum sugar yield of 13.06 t/ha.

Autumn planted sugarcane varietal trial, set-II

Seven promising sugarcane genotypes were included in this experiment for their comparison in yield and quality with the standard SPF-234 under extended growth period by sowing in September. The trial was sown in RCBD with three replications and a net plot size of 3.6 x 10 m. Statistically analyzed data exhibited significant cane yield differences among the tested varieties. The promising cane variety S2008-FD-19 gave the highest cane yield of 115.37 t/ha which was followed by S2008-AUS-138 (113.80 t/ha). The latter is a good quality genotype and as such it gave maximum sugar yield of 14.99 t/ha.

Ratoonability Of Promising Sugarcane Varieties

Ratooning is one of the most desirable characters of a sugarcane variety which directly affects the final cane yield of sugarcane ratoon crop. The present study was conducted to explore the ratooning potential of ten promising sugarcane strains. The experiment was planted in RCBD with three replications and a net plot size of 3.6 x 10 m. Statistically analyzed data presented in table-5 explicate significant ratoon cane yield differences among the tested strains. The variety S2006-US-658 gave the highest cane yield of 96.57 t/ha which was matchingly followed by S2008-AUS-133. The promising clone S2008-AUS-138 is good in quality and as such it produced highest sugar yield of 11.29 t/ha.

Pit Planting Of Sugarcane

This trial has been conducted to quantify the impact of different sowing methods on the yield and quality of Sugarcane. Three treatments were included in the trial *i.e.,* Pit planting (3 x 3 ft), Pit planting (2 x 2 ft) and Trench planting (RxR = 5ft). The experiment was planted in RCBD with three replications and a net plot size of 15 x 24 ft. The data presented in table-6 depict non-significant impact of treatments on the final cane yield. However, the maximum cane yield of 84.99t/ha has been recorded in the treatment No.1 *i.e.* Pit planting (3 x 3 ft).

Sowing Method Trial Of Sugarcane

This trial has been conducted to quantify the impact of different sowing methods on the yield and quality of Sugarcane. The treatments comprised of Pit planting (2 x 2 ft), Trench planting (RxR=5ft), Bed planting (RxR = 5ft) and Furrow planting (RxR = 2.5ft). The data presented in table-7 depict that pit and trench planting gave statistically similar final cane harvests of 81.56 and 79.70 t/ha, respectively.

Sugarcane varietal trial at SRSS, BWP

The experiment was laid out in RCBD with three replications and a net plot size of 3.6 x 9 m to collate eight promising sugarcane genomes. The statistically analyzed data presented in table-8 revealed that the differences among the final cane yield of the tested varieties were significant. The

new promising clone S2006-US-658 surpassed the set of tested genotypes with a final cane yield of 114.60 t/ha, however it was statistically at par with S2008-AUS-138.

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