ANNUAL TECHNICAL REPORT

FOR THE YEAR

2020 – 2021

POST HARVEST RESEARCH CENTRE

AYUB AGRICULTURAL RESEARCH INSTITUTE

FAISALABAD

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INTRODUCTION

Post Harvest Research Centre was established in 1989-90 with assistance of ADP/UNDP. The Post harvest technology deals with "produce management after harvesting till consumption" and to maintain quality during storage in order to obtain the maximum market price. The major objective of this Research Centre is to conduct Research and Development work on postharvest quality, safety and marketability of fresh horticultural produce and to extend the research based information to the farmers and exporters.

In 2008-9 Food Technology Section and Bio-Chemistry Section were brought under the umbrella of Post Harvest Research Centre. The Food Technology Section was established in 1968 with the objective to carry out research and development studies on processing, preservation and development of new value added products from various fruits and vegetables. This section has potentially contributed in value addition by developing food products and has trained thousands of human resources both male and female in food processing and preservation techniques. Pilot scale production and sale of various food products is another allied objective, helping to popularize the use of good quality food products among the masses, as well as to deposit handsome income annually to the government treasury.

Accordingly, Bio-Chemistry Section undertakes research, relating to nutritional evaluation of crops and provides analytical services to the farmers, scientists, industrialists and Research Institutions for quality testing of their research materials and products. It also evaluates nutritive values of different varieties of fodder crops for animal feeding and develops strategies for utilization of agro-industrial products, by-products and wastes.

OBJECTIVES

- To conduct R & D work on post harvest management & value addition of fruits & vegetables
- To develop and disseminate on-farm primary storage technology.
- Quality testing, evaluation and product development of new varieties
- To introduce grading & packing technology
- To introduce modern techniques in cold stores management.
- To conduct training & demonstration programs
- To render advisory services to enterprises & growers

ORGANIZATION

Name of Director: Mr Anjum Javed

Other Technical Staff

Staff	Filled	Vacant	Total
Post Harvest			
Food Technologist (Physiology) BS-18+165	1	-	1
Food Technologist (G/P.S)) BS-18+165	1	-	1
Assistant Research Officer BS-17	3	-	3
Food Technology Section			
Food Technologist BS-18+165	1	-	1
Assistant Food Technologist BS-18	4	-	4
Assistant Research Officer BS-17	4	4	8
Bio-Chemistry Section			
Agricultural Chemist Bio BS -18+165	1	-	1
Assistant Chemist BS-18	1	-	1
Assistant Research Officer BS-17	5	-	5

BUDGET POSITION 2020-2021

Description	Allocation (M. Rs.)	Expenditure (M. Rs.)
Post Harvest		
Pay of officers	10.515540	10.515455
Pay of Establishment	8.526060	8.476458
Allowance	13.291500	13.004601
Contingencies	6.894075	6.887315
Total	**40.603575**	**40.244624**
Biochemistry Section		
Pay of officers	5.858000	5.856490
Pay of Establishment	2.692000	2.685518
Allowance	7.112630	7.082941
Contingencies	15.662630	15.624949
Total	1.935310	1.914789

RESEARCH AND DEVELOPMENT WORK

POST HARVEST RESEARCH CENTRE

1. IMPACT OF POST HARVEST TREATMENTS TO EXTEND SHELF STABILITY OF GREEN PEPPERS

Capsaicin is the main bioactive compound in chili peppers responsible for their unique pungent (hot) taste and most of their health benefits. Chili is rich in vitamin C and provitamin A, a good source of most B vitamins especially vitamin B6. It contains high amount of potassium, magnesium, and iron. Peppers in green form are used in salads and as seasoning or condiments in the preparation of culinary due to its pungency and typical flavor. Green peppers was harvested from vegetable Research Institute, AARI, Faisalabad. Chilies was sorted based on uniformity of shape, size and peel color and any defected peppers was discarded. Peppers was precooled immediately to remove field heat to slow down moisture loss and softening. Peppers was washed with 150ppm sodium hypochlorite solution air dried and subjected to different treatments as Preconditioning at 15°C and 10℃ for 24 hrs, Hot water treatment at 53℃ for 4 min, 1-MCP (1 µL/L) and MAP with 0.3% perforation. Treated peppers was stored at 7℃ and 95% RH for acceptable period. Data regarding color, weight loss, decay, vitamin C, TSS, Acidity and pH was recorded after 7 days interval .Green Chilies performed well in MAP with 0.3% perforation followed by green pepper treated with hot water at 53℃ for 4 min. Table: 1

2. STANDARDIZATION OF DEHYDRATION PROTOCOL FOR FIG FRUIT

The fig is a nutritious fruit, richer in fiber, potassium, calcium, iron and is free of sodium, fat and cholesterol. Figs are an important source of vitamins, amino acids and antioxidants. Varieties with dark skin contain higher levels of polyphenols, anthocyanins and flavonoids, together with higher antioxidant activity. Area and production of fig fruit in Punjab province is rapidly increasing and hence there is dire need to develop value added products. Fully ripe fig fruits was harvested and tested for skin color, TSS, vitamin C, firmness, moisture content and dry matter content. The fruits was washed and blanched at 90^0C for 2 minutes. Blanched treatments was dipped in 50^0 brix sugar solution for 24 hrs. Treated fruits was dried in dehydrator at 50-55℃ with less than 12% moisture level. Dried fruits was packed in polyethene bags and stored at ambient conditions.

The shelf stability of fruits was determined on the basis of physico-chemical and organoleptic evaluation at monthly basis during storage. Data regarding the skin color, water activity, moisture content and ash content was recorded. The Fig fruit which were given the blanching, sulphiting

treatment and then dipped in 50^0B syrup (T_3) performed good during drying process as well as during storage period. Table: 2

3. STANDARDIZATION OF PROTOCOL FOR RAISINS PRODUCTION

A raisin is a dried grape. These are commercially produced by drying harvested grape berries. Seventy-two percent of raisins on weight basis are sugars particularly fructose and glucose. They also contain 3% protein and 3.7%-6.8% dietary fiber. These are low in sodium and contain no cholesterol. Raisins are rich in dietary fiber, carbohydrates with a low glycemic index, and minerals like copper and iron, with a lower fat content. These help in controlling glucose level, aid in functioning of digestive system and regulation of blood pressure and hence are recommended as a snack for weight control. Grapes of promising variety (Sundar khani and Gola) was harvested at the stage when TSS value reaches to approximately 20^o. Grapes was evaluated for color, acidity, pH, TSS, sugars and Vitamin C. After manual grading, grapes were washed with tap water. Pre-treatments like blanching and sulphiting along with dipping in ethyl oleate and potassium carbonate was applied to grapes. Water/ solution was drained, treated grapes was air dried and then dehydrated up to > 15% moisture content in dryer at 55-60℃. Raisin thus obtained was graded on the basis of physical characters like color, burnt fruits etc. Raisins was packed in low density polyethene bags (LDPE of 400 guage) and shelf life was measured on the basis of physico-chemical and sensory characteristics at monthly interval during storage. Data for quality characteristics like skin color, water activity, moisture content and ash content was recorded after month. The grapes which were given the blanching, sulphiting treatment and then dipped in 2% Ethyl oleate (T_2) performed good during drying process as well as during storage period of six months. The original color of grapes is better conserved as the drying time is reduced to a significant level as compared to natural drying process. Moisture removal rate is high in early stage of drying. It is observed that approximately 60 % moisture is removed in 30% of total drying time. In early stage of drying process, more water is coming out of cutical and converted into vapor which is removed by fresh air and moisture level in the grape is maintained at 10- 12%. Table 3a, 3b.

4. USE OF ETHYLENE INHIBITOR TO EXTEND THE STORAGE LIFE OF MANGO FRUIT

1-MCP is a ripening retardant that brings about its action by competitive inhibition of ethylene receptors. Thus, 1-MCP has potential for the commercial control of ripening and senescence of

harvested fruits and vegetables. Modified atmosphere packaging (MAP) is a versatile technology to control the respiration and transpiration process. MAP is applicable to a wide range of fresh fruits and vegetables as their quality and shelf life relate to the rate of respiration. Mango fruit of chaunsa variety at Mature green stage was harvested from an orchard. For uniformity of shape and size, manual sorting and grading of mango fruit was done. Blemished or diseased fruit was discarded. The remaining fruit was dipped for 3 min in anti-fungal solution (TBZ: 200 ppm) and then air dried. The fruit was then exposed to 1-MCP application @ 50 µl /L for 24 hrs. Storage conditions at 12^0C and 90% relative humidity was maintained throughout the experiments. After 20 days storage of each treatment, fruit will be dipped into 1000 µl/L ethephon for 3 min and then stored at ambient conditions. Data regarding weight loss percentage, fruit firmness, TSS, acidity, reducing sugars and color was determined at 5 days interval. Treatments with 1-MCP application delayed onset of mango ripening, however treatment with 1-MCP application followed by ripening after 30 days showed better quality along with delayed ripening. Table: 4

5. **APPLICATION OF ANTIOXIDANTS TO IMPROVE POST-HARVEST LIFE OF GUAVA FRUIT**

Guava (Psidium guajava L.) is a rich source of vitamin C and pectin. Under tropical ambient conditions, fruits ripen rapidly after harvest and spoil. Guava fruits are climacteric in their respiratory behaviour with ethylene triggering the respiratory rise. Ethylene biosynthesis involves the action of free radicals. Antioxidants act as free radical scavengers will inhibit ethylene production. The postharvest application of antioxidants would be advantageous for both guava growers and traders if an easy acceptable technique is developed for extending the shelf-life of fruits with a minimum loss in their physico nutritional properties. Uniform firm Guava fruits (gola/sofaida variety) at breaker stage was harvested from the orchards of progressive growers. After manual grading and sorting, fruit was washed thoroughly with chlorinated water and subjected to different antioxidants treatments. The treatments included are three antioxidant chemicals: ascorbic acid (500 and 1000 ppm), benzyl adenine (25 and 50 ppm) and sodium benzoate (500 and 1000 ppm). The fruits was then dipped into 0.1 % tween as adhesive for 30 minutes, dried and packed in 300 guage polyethylene bags with 0.1 % ventilation. Fruit was kept at ambient conditions as well as stored at $8^0C \pm 2^0C$ with 85-90% RH for further studies. Data regarding weight loss percentage, fruit firmness, pH, TSS, acidity, reducing sugars, Ascorbic acid, total chlorophyll, phenolic and pectin content was determined at three days interval. Post harvest

application of antioxidants improved the shelf life of guava fruit by maintaining a superior physicochemical status. Benzyl adenine @ 50ppm was most effective in increasing shelf life of guava fruit upto 15 days followed by benzyl adenine at 25ppm. Table: 5

TABLES: 1-5

Table:1	**IMPACT OF POST HARVEST TREATMENTS TO EXTEND SHELF STABILITY OF GREEN PEPPERS**							
		Storage Days						
	Treatments	**0**	**4**	**8**	**12**	**16**	**20**	**Mean**
Firmness	T1	2.76	2.38	2.13	1.78	1.28	0.58	2 .15 a
	T2	2.76	2.45	2.23	1.92	1.4	1.05	2.13 a
	T3	2.76	2.56	2.34	1.95	1.53	1.15	2.06 b
	T4	2.76	2.67	2.28	2.04	1.64	1.21	1.96 c
	T5	2.76	2.61	2.31	2.07	1.75	1.37	1.82 d
	Mean	2.76 a	2.53 b	2.26 c	1.95 d	1.52 e	1.07 f	
		Storage Days						
TSS	Treatments	0	4	8	12	16	20	Mean
	T1	3.10	3.30	3.60	4.10	4.30	4.40	3.80 a
	T2	3.10	3.30	3.76	3.96	4.20	4.38	3.78 b
	T3	3.10	3.20	3.62	3.85	4.20	4.40	3.73 b
	T4	3.10	3.22	3.70	3.80	4.17	4.30	3.72 c
	T5	3.10	3.20	3.56	3.77	4.10	3.92	3.61 d
	Mean	3.10 f	3.24 e	3.65 d	3.90 c	4.19 b	4.28 a	
		Storage Days						
Acidity (%)	Treatments	0	4	8	12	16	20	Mean
	T1	1.10	0.8	0.5	0.55	0.44	0.39	0.63 e
	T2	1.10	0.86	0.68	0.45	0.46	0.46	0.66 d
	T3	1.10	0.88	0.77	0.61	0.51	0.52	0.73 c
	T4	1.10	0.86	0.74	0.64	0.57	0.54	0.74 b
	T5	1.10	0.9	0.72	0.68	0.69	0.66	0.79 a
	Mean	1.10 a	0.86 b	0.68 c	0.59 d	0.53 e	0.51 f	
		Storage Days						
Weight Loss (%)	Treatments	0	4	8	12	16	20	Mean
	T1	0.00	3.27	5.13	7.27	11.23	12.28	6.53 a
	T2	0.00	2.52	3.05	4.87	7.71	9.10	4.54 b
	T3	0.00	2.27	2.73	3.79	6.44	8.75	3.99 c
	T4	0.00	1.94	2.52	3.24	5.66	7.64	3.50 d
	T5	0.00	1.83	2.14	2.72	5.23	7.35	3.21 e
	Mean	0.00 f	2.37 e	3.14 d	4.38 c	7.25 b	9.02 a	

Table: 2 **Standardization of post harvest protocol for fig fruit**

		Storage Days							
	Treatments	**0**	**7**	**14**	**21**	**28**	**35**	**42**	**Mean**
Firmness	**T1**	1.08	0.00	0.00	0.00	0.00	0.00	0.00	**0.1543c**
	T2	0.43	0.36	0.45	0.27	0.44	0.00	0.00	**0.2786bc**
	T3	0.20	0.90	0.61	0.21	0.18	0.17	0.19	**0.3514ab**
	T4	0.42	0.89	0.57	0.80	0.49	0.00	0.00	**0.4529a**
	T5	0.54	0.44	0.87	0.42	0.27	0.26	0.28	**0.4414a**
	Mean	**0.534a**	**0.518a**	**0.500ab**	**0.34bc**	**0.278c**	**0.0940d**	**0.0860d**	**0.3357**
	LSD Value for days 0.1668				LSD Value for Treatments 0.141				
		Storage Days							
	Treatments	**0**	**7**	**14**	**21**	**28**	**35**	**42**	**Mean**
TSS	**T1**	6.30	0.00	0.00	0.00	0.00	0.00	0.00	**0.900c**
	T2	8.60	11.40	12.00	12.50	11.50	0.00	0.00	**8.00b**
	T3	9.60	14.00	8.90	7.00	11.20	16.00	22.00	**12.671a**
	T4	9.30	5.00	9.10	9.00	12.80	0.00	0.00	**6.457b**
	T5	5.60	11.10	12.30	7.50	7.00	7.80	8.30	**8.514b**
	Mean	**7.88a**	**8.3a**	**8.46a**	**7.20ab**	**8.5a**	**4.76b**	**6.06ab**	
	LSD Value for days 2.913				LSD Value for Treatments 2.4619				
		Storage Days							
	Treatments	**0**	**7**	**14**	**21**	**28**	**35**	**42**	**Mean**
Dry Matter	**T1**	79.45	0.00	0.00	0.00	0.00	0.00	0.00	**11.350c**
	T2	85.67	81.32	82.65	82.27	76.95	0.00	0.00	**58.409b**
	T3	81.73	83.73	84.22	64.57	77.55	79.95	82.87	**79.231a**
	T4	83.49	84.61	85.61	73.87	73.60	0.00	0.00	**57.311b**
	T5	83.83	84.41	85.80	82.10	85.12	84.27	84.27	**84.257a**
	Mean	**82.834a**	**66.814b**	**67.656ab**	**60.562b**	**62.644b**	**32.844c**	**33.428c**	
	LSD Value for days 15.527				LSD Value for Treatments 13.123				
		Storage Days							
	Treatments	**0**	**7**	**14**	**21**	**28**	**35**	**42**	**Mean**
Specific Gravity	**T1**	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.1429c**
	T2	0.9976	0.9963	0.9675	0.9964	0.9963	0.0000	0.0000	**0.7077b**
	T3	1.0000	0.9952	0.9952	1.0000	1.0000	1.0000	0.9987	**0.9984a**
	T4	1.0000	1.0000	1.0000	1.0001	1.0057	0.0000	0.0000	**0.7151b**
	T5	1.0000	0.9967	1.0000	0.9971	0.9953	0.9945	0.9953	**0.9970a**
	Mean	**0.9995a**	**0.7976b**	**0.7976b**	**0.7987b**	**0.7995b**	**0.3989c**	**0.3988c**	**0.7122**
	LSD Value for days 0.193				LSD Value for Treatments 0.1631				

Table: 3a	**STANDARDIZATION OF PROTOCOL FOR RAISINS PRODUCTION(Sundar Khani)**							
Moisture%		**Storage Days**						
	Treatments	**0**	**30**	**60**	**90**	**120**	**150**	**Mean**
	T1	7.52	7.68	8.32	8.69	9.30	9.72	8.54a
	T2	6.32	6.48	6.91	7.21	7.48	7.70	7.02d
	T3	6.88	6.96	7.24	7.56	7.94	8.34	7.49b
	T4	6.54	6.76	6.98	7.34	7.62	7.92	7.19c
	Mean	6.82f	6.97e	7.36d	7.7c	8.09b	8.42a	
Ash %		**Storage Days**						
	Treatments	**0**	**30**	**60**	**90**	**120**	**150**	**Mean**
	T1	2.48	2.44	2.42	2.40	2.36	2.34	2.41a
	T2	2.19	2.18	2.16	2.14	2.12	2.10	2.15c
	T3	2.15	2.14	2.12	2.10	2.08	2.06	2.11d
	T4	2.28	2.26	2.24	2.22	2.20	2.18	2.23b
	Mean	2.28a	2.26b	2.24c	2.22d	2.19e	2.17f	
Water Activity		**Storage Days**						
	Treatments	**0**	**150**					**Mean**
	T1	0.48	0.507					
	T2	0.48	0.530					
	T3	0.46	0.489					
	T4	0.48	0.508					
	Mean							

Table: 3b. STANDARDIZATION OF PROTOCOL FOR RAISINS PRODUCTION(Gola)							
	Storage Days						
Treatments	**0**	**30**	**60**	**90**	**120**	**150**	**Mean**
T1	7.24	8.32	8.48	8.64	9.20	9.47	8.56a
T2	6.58	6.62	6.86	7.06	7.24	7.62	7.00c
T3	6.86	6.94	7.28	7.88	8.46	8.30	7.62b
T4	6.88	7.14	7.26	7.54	7.82	7.80	7.41c
Mean	6.89f	7.26e	7.47d	7.78c	8.18b	8.30a	
	Storage Days						
Treatments	**0**	**30**	**60**	**90**	**120**	**150**	**Mean**
T1	2.19	2.17	2.14	2.10	1.89	1.84	2.06a
T2	2.17	2.15	2.18	2.18	2.20	1.94	2.14a
T3	2.18	2.16	2.14	2.13	2.12	2.10	2.14a
T4	2.15	2.14	2.12	2.11	2.10	2.08	2.12a
Mean	**2.17**	**2.16**	**2.15**	**2.13**	**2.08**	**1.99**	
	Storage Days						
Treatments	**0**					**150**	**Mean**
T1	0.48					0.50	
T2	0.48					0.49	
T3	0.49					0.49	
T4	0.49					0.50	
Mean							

Table:5	**APPLICATION OF ANTIOXIDANTS TO IMPROVE POST-HARVEST LIFE OF GUAVA FRUIT**								
Total Phenols %									
Treatments	**Storage days**								
	0	3	6	9	12	15	Mean		
T1	0.259	0.250	0.247	0.165	0.131	0.125	0.196		
T2	0.248	0.233	0.231	0.151	0.125	0.104	0.182		
T3	0.266	0.252	0.250	0.195	0.160	0.150	0.212		
T4	0.261	0.249	0.243	0.176	0.152	0.148	0.205		
T5	0.253	0.246	0.242	0.169	0.134	0.130	0.196		
T6	0.240	0.243	0.239	0.165	0.122	0.120	0.188		

Control	0.239	0.237	0.225	0.121	0.104	0.094	0.170		
Mean	0.252	0.244	0.240	0.163	0.133	0.124	0.193		
Pectin %	0	3	6	9	12	15	Mean		
T1	0.72	0.63	0.53	0.41	0.24	0.15	0.45		
T2	0.73	0.64	0.56	0.42	0.27	0.18	0.47		
T3	0.71	0.69	0.67	0.59	0.47	0.41	0.59		
T4	0.75	0.72	0.69	0.63	0.51	0.49	0.63		
T5	0.74	0.69	0.58	0.47	0.33	0.25	0.51		
T6	0.72	0.65	0.53	0.41	0.31	0.27	0.48		
Control	0.73	0.61	0.57	0.38	0.20	0.18	0.45		
Mean	0.73	0.66	0.59	0.47	0.33	0.28	0.51		
Firmness kg/cm2	0	3	6	9	12	15	Mean		
T1	4.98	3.88	3.24	2.59	1.38	0.93	2.83		
T2	4.91	4.36	3.65	2.62	1.42	0.90	2.98		
T3	4.93	4.64	3.93	3.65	2.18	1.95	3.55		
T4	4.94	4.77	4.46	3.96	3.32	2.91	4.06		
T5	4.91	4.09	3.62	2.95	2.05	1.78	3.23		
T6	4.95	4.03	3.58	2.89	1.96	1.65	3.18		
Control	4.93	3.14	2.78	1.17	0.04	0.01	2.01		
Mean	4.94	4.13	3.61	2.83	1.76	1.45	3.12		
Reducing Sugar %									
	0	3	6	9	12	15	Mean		
T1	3.98	3.97	4.31	3.61	2.44	2.21	3.42		
T2	4.11	4.21	4.92	4.25	2.85	2.35	3.78		
T3	3.99	4.11	4.83	4.79	3.66	3.01	4.07		
T4	3.96	4.92	5.03	4.81	3.95	3.83	4.42		
T5	3.99	3.91	4.21	3.99	3.45	3.21	3.79		
T6	3.80	3.84	4.45	4.12	3.68	3.11	3.83		
Control	3.79	3.81	4.05	3.72	2.65	1.91	3.32		
Mean	3.95	4.11	4.54	4.18	3.24	2.80	3.80		
Total Chlorophyll mg/g									
	0	3	6	9	12	15	Mean		
T1	1.924	1.637	0.947	0.328	0.095	0.025	0.826		
T2	1.935	1.678	1.305	0.652	0.085	0.035	0.948		
T3	1.991	2.401	2.256	0.831	0.098	0.066	1.274		

T4	1.995	2.835	2.641	0.894	0.099	0.075	1.423		
T5	1.981	2.011	1.852	0.601	0.081	0.011	1.090		
T6	1.988	1.706	1.372	0.595	0.085	0.015	0.960		
Control	1.983	1.625	0.691	0.019	0.015	0.009	0.724		
Mean	1.971	1.985	1.581	0.560	0.080	0.034	1.035		
TSS %									
	0	3	6	9	12	15	Mean		
T1	8.1	8.6	8.8	9.3	9.8	10.6	9.2		
T2	8.2	8.8	9.1	9.5	9.9	10.6	9.4		
T3	8.1	8.5	8.9	9.2	9.5	9.8	9.0		
T4	8.3	8.5	8.6	8.9	9.1	9.3	8.8		
T5	8.2	8.9	9.2	9.7	10.3	10.9	9.5		
T6	8.1	8.7	9.5	9.9	10.2	10.8	9.5		
Control	8.1	9.2	9.5	10.3	10.7	11.2	9.8		
Mean	8.2	8.7	9.1	9.5	9.9	10.5	9.3		
Acidity %									
Treatments	**Storage days**								
	0	3	6	9	12	15	Mean		
T1	0.45	0.41	0.37	0.35	0.32	0.29	0.37		
T2	0.43	0.39	0.36	0.34	0.31	0.27	0.35		
T3	0.41	0.40	0.38	0.35	0.32	0.30	0.36		
T4	0.44	0.42	0.39	0.36	0.34	0.33	0.38		
T5	0.43	0.40	0.38	0.33	0.32	0.30	0.36		
T6	0.42	0.39	0.36	0.35	0.33	0.28	0.36		
Control	0.41	0.38	0.29	0.19	0.15	0.09	0.25		
Mean	0.43	0.40	0.36	0.32	0.30	0.27	0.35		
Vitamin C									
Treatments	**Storage days**								
	0	3	6	9	12	15	Mean		
T1	158.55	141.72	129.34	167.98	98.73	66.55	127.15		
T2	155.32	142.28	123.26	105.63	93.56	68.36	114.74		
T3	157.65	145.98	125.33	119.58	101.37	75.13	120.84		
T4	156.37	146.36	129.18	119.36	105.86	78.86	122.67		

T5	154.81	143.19	125.62	107.53	91.36	64.16	114.45		
T6	152.62	142.65	121.22	105.61	88.89	63.22	112.37		
Control	155.69	139.38	109.83	99.65	73.52	36.11	102.36		
Mean	155.86	143.08	123.40	117.91	93.33	64.63	116.37		
wt loss %									
Treatments	**Storage days**								
	0	3	6	9	12	15	Mean		
T1	0.00	2.90	6.05	10.93	13.16	16.20	8.21		
T2	0.00	2.10	5.92	9.85	12.57	15.36	7.63		
T3	0.00	1.62	4.32	5.49	6.31	7.35	4.18		
T4	0.00	1.37	3.92	4.73	5.98	5.14	3.52		
T5	0.00	2.82	5.11	10.91	15.25	18.19	8.71		
T6	0.00	2.63	6.19	11.98	16.37	19.55	9.45		
Control	0.00	5.61	11.23	19.26	29.86	40.31	17.71		
Mean	0.00	2.72	6.11	10.45	14.21	17.44	8.49		

BIO-CHEMISTRY SECTION

1 ASSESSMENT OF ANTIOXIDANT POTENTIAL OF DIFFERENT FRUITS AND VEGETABLES

INTRODUCTION

Antioxidant compounds in food play an important role as a health protecting factor. Scientific evidence suggests that antioxidants reduce the risk for chronic diseases including cancer and heart disease. Fruit and vegetable have higher contents of antioxidants i.e. phenolic and ascorbic acids. Therefore, the present study was planned to determine the antioxidants potential of different fruits and vegetables.

MATERIALS AND METHODS

The present study was conducted at Biochemistry Section, Ayub Agricultural Research Institute, Faisalabad during the year 2020-21 to assess the antioxidants in peach (*Prunus persica*), grapes (*Vitisv inifera*) grape fruit (*Citrus paradisi*), lychee (*Litchi chinensis*),bitter gourd (*Momordic acharantia*), pumpkin (*Cucurbita pepo*),Cauliflower (*Brassica oleracea*) and carrot (*Daucus carota*). Fifteen samples each of fruit and vegetables were collected from local market. The fruit samples were analyzed for vitamin-C, pH, TSS, total antioxidant activity and mineral matter. The pH was measured using pH meter and TSS by using Refracto meter PAL-1. The antioxidants were determined using the DPPH (1, 1-Diphenyl-2-picrylhydrazyl) method. Juice was added to methanol solution of DPPH and left for 30 minute in dark and read absorbance at 517 nm using spectrophotometer. DPPH with methanol was run as blank. Percent inhibition was calculated by the equation:

$$(\%\text{DPPH activity}) = [(Ao-A)/Ao] \times 100$$

Ao = Absorbance of DPPH (0.004%) with Methanol

A = Absorbance of test sample

Protein was determined by kjeldhal method, fat by Soxtec apparatus (ether extraction, Ash (Mineral matter) was determined by ignition at 600 ^{o}C and fiber by using hot plate.

RESULTS AND DISCUSSION

1). Fruits

Fresh fruit samples were used to prepare pulp and determine the total soluble solids TSS, total antioxidants, mineral matter and vitamin C and dry matter. The results regarding chemical composition of fruits and vegetables are given in table-

Total Soluble Solids (TSS)

Higher percentage of TSS (21.9±1.10%) was observed in grapes (*Vitis vinifera*) followed by lychee (17.63±0.58%)) compared to peach (*Prunu spersica*) and grape fruit (10 ± 0.31%).

Dry matter

Significantly higher dry matter (28.8± 0.845%) was observed in grapes (*Vitis vinifera*) compared to8.72 ± 0.603% of grape fruit (*Citrus paradisi*) being the lowest.

Total Antioxidant

Antioxidant activity (DPPH Scavenging activity) (92.17 ± 0.304 %) was found higher in peach. The lower value of antioxidant activity (64.9 ± 3.417%) was observed in grapes compared to grape fruit (75.9± 0.577%) and lychee (68.03± 4.078%).

Mineral matter

Significantly higher mineral matter (6.19 ± 0.358%) was found higher in lychee whereas less mineral matter (0.47 ± 0.018%) was found in grapes.

Vitamin C

Among the four fruits higher value of vitamin C (47.1 ± 1.104mg/100 g) was observed in grape fruit as compared to grapes where lower value of Vit. C (5.0 ± 1.056 mg/100g) was observed.

2). Vegetables

Vegetable samples were collected from local market. Ten samples of each vegetable (Bitter gourd, pumpkin, cauliflower and carrot) were sampled 1/3rd of the vegetables were oven dried and

dry matter was calculated. Rest of the vegetables was processed to take juice/pulp to determine mineral matter, Vit.C and total antioxidants.

Dry matter

Significantly higher dry matter (13.67± 0.507%) was observed in carrot (*Daucus carota*) compared to 5.44 ± 0.685% of cauliflower (*Brassica oleracea*) being the lowest.

Total Antioxidant

Antioxidant activity (DPPH Scavenging activity) (83.98 ± 0.803 %) was found higher in bitter gourd. The lower value of antioxidant activity (25.09 ± 2.428%) was observed in pumpkin compared to other vegetables of the experiment.

Mineral matter

Significantly higher mineral matter (0.82 ± 0.019%) was found higher in bitter gourd whereas less mineral matter (0.50 ± 0.057 %) was found in pumpkin.

Vitamin C

Among the four fruits higher value of vitamin C (55.6 ± 1.765 mg/100 g) was observed in bitter gourd as compared to carrot where lower value of Vit. C (5.9 ± 0.718 mg/100g) was observed.

CONCLUSION

Analysis of fruit samples showed that dry matter (28.8± 0.845%) was found higher in grapes, total antioxidants (83.98 ± 0.803 % DPPH activity) were observed higher in peach, Vitamin C (47.1 ± 1.104 mg/100 g) was higher in grape fruit and mineral matter (6.19 ± 0.358%) was found highest in lychee. Regarding vegetables (On fresh wt basis) higher value of mineral matter (0.82 ± 0.019%), Vitamin C (55.6 ± 1.765 mg/100 g) and antioxidants (83.98 ± 0.803 %) was observed higher in bitter gourd while dry matter (13.67± 0.507%) was observed higher in carrot compared to the other vegetables of the experiment.

Table : Chemical analysis of fruit and vegetables

Fruit/	Total antioxidants (% DPPH activity)	Mineral matter (%)	Vit. C (mg/100 ml)	Dry matter (%)
Peach	92.17±0.304	0.55± 0.020	6.07±0.384	16.07±1.464
Grapes	64.9± 3.417	0.47± 0.018	5.00±1.056	28.83±0.845
Grape fruits	75.9±0.577	3.19±0.472	47.1±1.104	8.72±0.603
Lychee	68.03±4.078	6.19±0.358	28.28± 3.003	10.8±0.764
B. gourd	83.98±0.803	0.82±0.019	55.6± 1.765	8.22±1.361
Pumpkin	25.09±2.428	0.50±0.057	13.9±0.884	5.44±0.685
Cauliflower	59.7±1.350	0.74±0.037	48.2±2.311	13.67±0.507
carrot	31.87±0.991	0.67±0.103	5.9±0.718	16.91±0.809

2. Nutritional comparison of advance rice lines grown in saline-sodic soils using different levels of NPK fertilizers

INTRODUCTION

A large area of Pakistan is suffering from salinity problem. Being situated in arid and semiarid region, the process of salinization and sodification remains in progress. Bringing these marginal lands into agriculture production is essential from food security perspectives for rapidly growing population. Rice (*Orzya sativa* L.) is the most important staple food for more than half of the world's population. Rice is being grown in salt effected soil but salt may affect the nutrition and quality of crop. Keeping in view, whether the use of salt effected soil may affect the nutrition of crop, the current experiment was designed to determine the quality of advance rice lines grown in saline-sodic soils.

MATERIALS AND METHODS

Experiment was conducted in collaboration with Soil Salinity Research Institute, Pindi Bhattian. A moderately saline-sodic field was selected. Experiment was conducted according to split plot design. Fertilizer rates was kept in sub plot, while rice advanced lines were kept in main plot. Whole P, K and 1/3 N was applied at the time of rice transplanting, while remaining N was applied in two splits i.e. 25 and 45 days after transplanting. Paddy samples were collected at harvesting. Samples were oven dried and ground for determination of crude fat, crude protein, crude fiber and mineral matter.

Treatments

A	**Rice advanced lines**
V1	SRI-23
V2	SRI-25
B	**Fertilizer doses (NPK kg ha^{-1})**
1	0-0-0
2	0-86-60
3	75-86-60
4	150-86-60
5	225-86-60
6	150-0-60
7	150-43-60
8	150-129-60
9	150-86-0
10	150-86-30
11	150-86-90

RESULTS AND DISCUSSION

The results regarding proximate analysis of rice varieties are given in table

Crude protein:-

Verities showed different percentage of crude protein. Regarding crude protein V1 (8.61%) showed significantly better result than V2 (6.89%). Fertilizer also showed significantly different effecton the percentage of crude protein in paddy. Higher percentage of crude protein (9.80%) was found in $T_5$of V1 where fertilizer dose was 225-86-60 NPK Kg ha^{-1} while minimum crude protein (6.05%) was found in T1 of V2 where no fertilizer was

applied. Crude protein in other treatments (fertilizer doses) was laid between these two values.

Crude fat:-

Verities showed different percentage of crude fat. Regarding crude fat V2 (1.12%) showed significantly better result than V1 (0.92%). Similarly fertilizer doses significantly affect the percentage of crude fat in paddy. Higher percentage of crude fat (1.29%) was found T_{11} of V2 where fertilizer dose was 150-86-90 NPK Kg ha^{-1} while minimum crude fat (0.90%) was found in T1 where no fertilizer was applied. Crude fat in other treatments (fertilizer doses) of both the varieties was laid between these two values.

Crude fiber:-

Verities showed different percentage of crude fiber. Regarding percentage of crude protein V1 (2.74%) showed significantly better result than V2 (2.17%). Higher percentage of crude fiber (3.44%) was found $T_5$of V1 where fertilizer dose was 225-86-60 NPK Kg ha^{-1} while minimum crude fiber (1.42%) was found in T1 of V2 where no fertilizer was applied. Crude fiber in other treatments (fertilizer doses) of both the verities was laid between these two values.

Ash content:-

Verities showed different percentage of ash contents. Regarding percentage of ash V1 (1.38%) showed better result compared to ash contents (0.77%) of V2. Fertilizer doses significantly affect the percentage of ash contents in paddy. Higher percentage of ash (1.56% and 1.16%V1 and V2 respectively) was found in T_5 where fertilizer dose was 225-86-60 NPK Kg ha^{-1} while minimum ash (1.23 and 0.62% v1 and V2 respectively) was found in T1 where no fertilizer was applied. Ash contents in other treatments (fertilizer doses) of both the varieties were laid between these two values

CONCLUSION

Rice was grown in moderately saline-sodic soil having pH 8.65, ECe 5.73 dSm^{-1}, SAR 35.39 mmol/L, available P 8.2 mg/kg, organic matter 0.4% and extractable K 106 mg/Kg at SSRI PindiBhattian. Rice crop was harvested and prepared the samples for proximate analysis. It was observed that V1 (SRI-25) is better than V2 (SRI-25) for all the proximate parameters except fat.

Fertilizer dose significantly affect the crude fat, crude protein, crude fiber and mineral matter (Ash).

Table: Effect of NPK fertilizers on crude fat contents of advance rice lines grown in saline-sodic soils

Treatments (NPK Kg ha^{-1})	**SRI-23** **Crude fat (%)**	**SRI-25** **Crude fat (%)**	**Mean**	**LSD Fertilizer**
T_1. 0-0-0	0.90	1.07	0.99 b	
T_2. 0-86-60	0.92	1.18	1.05 b	
T_3. 75-86-60	0.91	1.11	1.01 b	
T_4. 150-86-60	0.91	1.06	0.99 b	
T_5. 225-86-60	0.91	1.10	1.01 b	
T_6. 150-0-60	0.92	1.13	1.03 b	
T_7. 150-43-60	0.91	1.10	1.01 b	**0.0672**
T_8. 150-129-60	0.93	1.06	1.00 b	
T_9. 150-86-0	0.91	1.04	0.98 b	
T_{10}. 150-86-30	0.92	1.21	1.07 a	
T_{11}. 150-86-90	1.06	1.29	1.18 a	
Mean	**0.93 B**	**1.12 A**		
LSD Verities	**0.0286**			

Table: Effect of NPK fertilizers on crude protein of advance rice lines grown in saline-sodic soils

Treatments	**SRI-23**	**SRI-25**	**Mean**	**LSD fertilizer**

(NPK Kg ha^{-1})	**Crude Protein (%)**	**Crude Protein (%)**		
T_1. 0-0-0	6.83	6.08	6.68 de	
T_2. 0-86-60	6.56	6.50	6.30 e	
T_3. 75-86-60	8.31	7.32	7.83 bc	
T_4. 150-86-60	9.45	7.50	8.45 ab	
T_5. 225-86-60	9.80	8.22	8.12 ab	
T_6. 150-0-60	9.28	6.61	7.92 ab	
T_7. 150-43-60	9.19	6.90	8.04 ab	**0.6702**
T_8. 150-129-60	8.58	6.43	8.37 ab	
T_9. 150-86-0	8.05	6.30	7.19 cd	
T_{10}. 150-86-30	9.63	7.50	8.51 a	
T_{11}. 150-86-90	9.28	6.44	7.84 abc	
Mean	**8.61 A**	**6.89 B**		
LSD Verities	**0.2858**			

Table: - Effect of NPK fertilizers on crude fiber of advance rice lines grown in saline-sodic soils

Treatments (NPK Kg ha^{-1})	**SRI-23**	**SRI-25**	**Mean**	**LSD Fertilizer**
	Crude fiber (%)	**Crude fiber (%)**		
T_1. 0-0-0	2.62	1.42	2.45 bcd	
T_2. 0-86-60	2.89	2.82	2.85 ab	
T_3. 75-86-60	2.91	2.32	2.61 abcd	0.5158
T_4. 150-86-60	3.20	2.89	3.04 a	
T_5. 225-86-60	3.44	3.11	2.70 abc	

T_6. 150-0-60	3.41	1.61	2.51 bcd	
T_7. 150-43-60	2.28	2.28	2.43 bcd	
T_8. 150-129-60	2.83	1.70	2.26 cde	
T_9. 150-86-0	2.26	2.07	2.17 de	
T_{10}. 150-86-30	2.04	1.72	1.88 e	
T_{11}. 150-86-90	2.28	1.92	2.10 de	
Mean	**2.74 A**	**2.17 B**		
LSD Verities	0.2200			

Table: - Effect of NPK fertilizers on ash contents of advance rice lines grown in saline-sodic soils

Treatments (NPK Kg ha^{-1})	**SRI-23** **Ash (%)**	**SRI-25** **Ash (%)**	**Mean**	**LSD fertilizer**
T_1. 0-0-0	1.23	0.62	1.05 bcde	**0.2211**
T_2. 0-86-60	1.32	0.92	1.27 a	
T_3. 75-86-60	1.49	0.88	1.19 abcd	
T_4. 150-86-60	1.23	0.72	1.19 abc	
T_5. 225-86-60	1.56	1.16	1.07 abcde	
T_6. 150-0-60	1.50	0.63	0.92 e	
T_7. 150-43-60	1.51	0.86	1.24 ab	
T_8. 150-129-60	1.42	0.64	1.07 abcde	
T_9. 150-86-0	1.23	0.71	0.97 de	
T_{10}. 150-86-30	1.34	0.69	0.87 e	
T_{11}. 150-86-90	1.35	0.67	1.01 cde	
Mean	**1.38 A**	**0.77 B**		

LSD Verities	0.1907		

3. NUTRITIONAL QUALITY EVALUATION OF VARIOUS VARIETIES / LINES OF KHARIF FODDERS

INTRODUCTION Kharif fodders are sown in summer and harvested in late summer or during the rainy season. Some of the kharif fodders are maize, pearl millet, linseed, blackgram and cowpea etc. Fodder production during kharif is very important to feed animals. It contains sufficient quantity of nutrition like protein, fiber and minerals. Fodders quality is very important for sustainable milk production and animal health as well. Maize, sorghum, pearl millet, cowpea, jantar and mumbassa grass are commonly grown as kharif fodders in Punjab. The study was therefore planned to evaluate the nutritional quality of varieties/lines of these commonly grown fodders.

MATERIAL AND METHODS

Sample of varieties/lines of mumbassa grass, sorghum, cowpea and dairy sorghum fodder were collected from Fodder Research Institute Sargodha during September and October 2020. After that samples were dried, ground and analyzed for dry matter, ash contents, crude fat, crude fiber and crude protein.

RESULT AND DISCUSSION

1- Sumbassa Grass

Results are given in table

Dry matter

Dry matter contents ranged from 28.0 to 30.8%. Maximum dry matter content (30.8%) was found in the line B and C of sumbassa grass. Minimum dry matter content (28.0%) was found in the line A of sumbassa grass.

Ash content

Ash contents ranged from 12.44 to 13.52%. Maximum ash content (13.52%) was found in the line A of sumbassa grass. Minimum ash content (12.44%) was found in the line C of sumbassa grass.

Crude fat

Crude fat contents varied from 1.19 to 1.68%. Maximum crude fat content (1.68%) was found in the line B of sumbassa grass. Minimum crude fat (21.19%) was found in the line A of sumbassa grass.

Crude fiber

Crude fiber contents varied from 31.1 to 36.3%. Maximum crude fiber content (36.3%) was found in the line A of sumbassa grass. Minimum crude fiber (31.1%) was found in the line B of sumbassa grass.

Crude protein

Crude protein contents varied from 9.71 to 10.59%. Maximum crude protein content (10.59%) was found in the line A of maize sumbassa grass. Minimum crude protein (9.71%) was found in the line C of sumbassa grass.

Table: Proximate nutritional composition of various varieties/lines of sumbassa grass fodder

Lines/varieties	Dry matter (%)	Ash (%)	Crude fat (%)	Crude protein (%)	Crude Fiber (%)
Sumbassa A	28.0 b	13.52 a	1.19 b	10.59 a	36.3 a
Sumbassa B	30.8 a	12.87 b	1.68 a	10.33 b	31.1 b
Sumbassa C	30.8 a	12.44 c	1.26 b	9.71 c	32.3 b
LSD	0.48	0.02	0.03	0.04	0.78

CONCLUSION

It is concluded that crude protein (10.59%), crude fiber (36.3%) and ash content (13.52%) were found higher in the line A of sumbassa grass.

2. Dairy Sorghum

Results are given in table

Dry matter

Dry matter contents ranged from 24.4 to 31.2%. Maximum dry matter content (31.2%) was found in the variety Sorghum 2011 of dairy sorghum. Minimum dry matter content (24.4%) was found in the variety SGD-03-2 of dairy sorghum.

Ash content

Ash contents ranged from 6.39 to 8.88%. Maximum ash content (8.88%) was found in the variety S-9901 of dairy sorghum. Minimum ash content (6.39%) was found in the varietySGD-03-2 of dairy sorghum.

Crude fat

Crude fat contents varied from 1.08 to 1.45%. Maximum crude fat content (1.45%) was found in the variety S-9901 of dairy sorghum fodder. Minimum crude fat (1.08%) was found in the variety SGD-03-1 of sorghum fodder.

Crude fiber

Crude fiber content ranged from 34.2 to 41.4%. Maximum crude fiber content (41.4%) was found in the variety Sorghum 2011 of dairy sorghum fodder. Minimum crude fiber (34.2%) was found in the variety SGD-03-2 of dairy sorghum fodder.

Crude protein

Crude protein contents differed from 8.84 to 9.36%. Maximum crude protein content (9.36%) was found in the variety S-9901 of dairy sorghum. Minimum crude protein (8.84%) was found in the variety SGD-03- 1 of dairy sorghum.

Table: Proximate nutritional composition of various varieties/lines of dairy sorghum fodder

Lines/varieties	Dry matter (%)	Ash (%)	Crude fat (%)	Crude protein (%)	Crude Fiber (%)
SGD-03-1	28.8 b	7.09 b	1.08 c	8.84 d	38.6 b
SGD-03-2	24.4 c	6.39 b	1.26 b	9.19 b	34.2 c
S-9901	28.8 b	8.88 a	1.45 a	9.36 a	40.5 a
Sorghum 2011	31.2 a	7.00 b	1.43 a	8.93 c	41.1 a
LSD	0.36	0.38	0.05	0.03	0.32

CONCLUSION

It is concluded that crude fiber (41.1%) and dry matter (31.2%) was found higher in the variety Sorghum 2011 while crude protein (9.36 %), crude fat (1.45%) and ash content (8.88) were found more in the variety S-9901 of dairy sorghum fodder.

3. Cowpea fodder

Results are given in table

Dry matter

Dry matter contents ranged from 21.2 to 25.2%. Maximum dry matter content (25.2%) was found in the line C of cowpea fodder. Minimum dry matter content (21.1%) was found in the line A of cowpea fodder.

Ash content

Ash contents ranged from 11.32to 12.00%. Maximum ash content (12.00%) was found in the line C of cowpea fodder. Minimum ash content (11.32%) was found in the line B of cowpea fodder.

Crude fat

Crude fat contents varied from 1.02 to 1.10%. Maximum crude fat content (1.10%) was found in the line A of cowpea fodder. Minimum crude fat (1.02%) was found in the line B of cowpea fodder.

Crude fiber

Crude fiber contents ranged from 25.3 to 30.2%. Maximum crude fiber content (30.2%) was found in the line C of cowpea. Minimum crude fiber (25.3%) was found in the line B of pearl millet fodder.

Crude protein

Crude protein contents differed from 13.21 to 14.09%. Maximum crude protein content (14.09%) was found in the line C of cowpea. Minimum crude protein (13.21%) was found in the line B of cowpea fodder.

Table: Proximate nutritional composition of various varieties/lines of cowpea fodder

Lines/varieties	Dry matter (%)	Ash (%)	Crude fat (%)	Crude protein (%)	Crude Fiber (%)
Cowpea A	21.1 c	11.71 b	1.10	13.56 b	27.3 b
Cowpea B	24.0 b	11.32 b	1.02	13.21 c	25.3c
Cowpea C	25.2 a	12.00 c	1.09	14.09 a	30.2 a
LSD	0.04	0.08	NS	0.03	0.07

CONCLUSIONS

It is concluded that ash (12.00%), dry matter (25.2%), crude fiber (30.2%) and crude protein (14.09%) were found higher in the line C of cowpea fodder.

4. Sorghum Fodder

Results are given in table

Dry matter

Dry matter contents ranged from 25.6 to 35.6%. Maximum dry matter content (35.6%) was found in the variety FRI-02 of sorghum fodder. Minimum dry matter content (25.6%) was found in the variety ABR-115 of sorghum fodder.

Ash content

Ash contents ranged from 8.93 to 10.11%. Maximum ash content (10.11%) was found in the line No.8008of sorghum fodder. Minimum ash content (8.93%) was found in the variety PARC of sorghum.

Crude fat

Crude fat contents varied from 1.24 to 2.04%. Maximum crude fat content (2.04%) was found in the line No 8008 of sorghum fodder. Minimum crude fat (1.24%) was found in the variety G.P 30of sorghum fodder.

Crude fiber

Crude fiber content ranged from 21.7 to 29.4%. Maximum crude fiber content (29.4%) was found in the variety ABR-115ofsorghum fodder. Minimum crude fiber (21.7%) was found in the line 1-6of sorghum fodder.

Crude protein

Crude protein contents differed from 7.35 to 8.23%. Maximum crude protein content (8.23%) was found in the variety ABR-115 of sorghum. Minimum crude protein (7.35%) was found in the line No. 6197of sorghum fodder.

Table: Proximate nutritional composition of various varieties/lines of sorghum fodder

Lines/varieties	Dry matter (%)	Ash (%)	Crude fat (%)	Crude protein (%)	Crude Fiber (%)
No. 1563	32.8 abcd	9.28 h	1.92 ab	7.88 abcd	27.7 bc
ABR-115	25.6 d	9.84 d	1.68 bc	8.23 a	29.4 a
FRI-02	35.6 a	8.96 k	1.85 abc	7.79 bcde	25.6 d
ABR-SG1	26.8 cd	9.42 f	1.78 abc	7.61 cdef	24.1 c
I-6	31.2 abcd	9.32 g	1.70 bc	7.79 bcde	21.7 g
No. 8008	32.4 abcd	10.11 a	2.04 a	8.05 ab	23.5 ef
G.P-30	34.4 abc	9.23 c	1.24 e	7.96 abc	28.8 ab
Y-23-4	34.8 ab	10.00 b	1.38 de	7.79 bcde	27.1 c
No. 6197	28.0 abcd	9.82 d	1.94 ab	7.35 f	27.5 c
No. 74724	29.6 abcd	9.99 bc	1.68 bc	7.53 def	28.9 ab
PARC	30.0 abcd	8.93 ab	1.94 ab	7.44 ef	25.6 d
No. 1572	28.8 abcd	9.72 cd	1.62 cd	7.70 bcdef	22.7 fg
No. 800810	27.2bcd	9.20 bc	1.71 bc	7.61 cdef	24.6 de
No. 10611	28.4 abcd	9.98 abc	1.77 abc	7.53def	22.6 fg
LSD	15.83	0.18	9.63	3.21	2.90

CONCLUSION

It is concluded that crude fiber (29.4%) and crude protein (8.23%) were found higher in the variety ABR-115 while crude fat (2.04 %) and ash content (10.11%) were found more in the line No. 8008 of sorghum fodder.

4. NUTRITIONAL COMPARISON OF QUINOA FLOUR (*Chenopodiumquinoe* Wild.) WITH OTHER CEREALS

INTRODUCTION

Quinoa belongs to family *Chenopodiaceae* and is related to well-known agricultural crops such as sugar beet (*Beta vulgaris*) and spinach (*Spinaciaoleracea*). It has high concentration of protein and minerals. Quinoa contains more phenols than other cereals. Quinoa is considered as a multipurpose agricultural crop because its seeds may be utilized for human food and in flour products because of its high nutritive value. It is cooked as rice and is used to make bread, soups, biscuits and drinks. It has potential to be grown as food, feed or as an oil seed crop. Therefore, this study was planned to compare the nutritional quality of quinoa flour with other cereals (rice, maize, wheat and barley).

MATERIAL AND METHODS

This experiment was conducted at Biochemistry Section, AARI, Faisalabad to study the nutritional comparison of quinoa flour with other cereals (wheat, rice, corn and barley). This experiment was laid out in CRD with ten replications. Grain samples of quinoa, maize, rice, wheat and barley were collected from concerned department. Samples were dried, ground and analyzed for Moisture content, ash contents, crude fat, crude fiber and crude protein.

RESULT AND DISCUSSION

Results are given in table

Moisture:-

Moisture contents in different cereals ranged from 6.70 to 9.76 %. Maximum moisture (9.76%) was found in Wheat flour. Minimum moisture content (6.70%) was found in Rice flour. Moisture content of Quinoa was 9.07 %.

Ash content

Ash contents ranged from 0.91 to 2.47%. Maximum ash content (2.47%) was found in Quinoa (UAf S21) flour while minimum ash content (0.91%) was found in Rice flour. Two to three times more mineral matter were found in Quinoa flour as compared to wheat flour which had 1.11% ash contents

Crude fat

Crude fat contents varied from 1.17 to 4.27% in various cereal grains. Maximum crude fat content (4.27%) was found in Quinoa (UAF S21) flour. Minimum crude fat (1.17%) was found in Wheat and Rice flour. Quinoa had three times more crude fat as compared to wheat and Rice.

Crude fiber

Crude fiber contents in different cereals flour ranged from 0.98 to 4.16 %. Maximum crude fiber content (4.16%) was found in Quinoa (UAF S46) flour. Minimum crude fiber (0.98%) was found in Wheat flour. Quinoa had three times more crude fiber as compared to wheat.

Crude protein

Crude protein contents ranged from 6.97 to 12.5% in various cereal grains. Maximum crude protein content (12.5%) was found in Barley and minimum crude protein (6.97%) was present in rice flour. Crude protein content in wheat was 10.6% which was at par with Quinoa (11.0%)

Table 13: Chemical composition of Quinoa flour and other cereals

S. No.	Cereals	Moisture (%)	Ash (%)	Crude fat (%)	Crude fiber (%)	Crude protein (%)
1.	Quinoa UAF S21	9.24 bc	2.47 a	4.27 a	4.14 a	10.8 bc
2.	Quinoa SAF S16	9.12 c	2.45 a	4.16 ab	4.11 a	11.0 ab
3.	Quinoa UAF S46	8.86 c	2.45 a	4.18 ab	4.16 a	11.0 b
4.	Wheat	9.76 ab	1.11 c	1.17 d	0.98 c	10.6 c
5.	Barley	7.88 d	2.31 b	1.45 c	4.08 a	12.5 a
6.	Maize	9.82 a	1.17 cd	4.08 b	2.08 b	7.13 d
7.	Rice	6.70 e	0.91 d	1.17 d	1.00 c	6.97 d

	LSD	0.26	0.19	0.07	0.05	0.56

CONCLUSION

It is concluded that quinoa had significantly higher concentration of crude fat and crude fiber as compared to other grains. Crude fat in quinoa was 4.16- 4.27% while in wheat it was 1.17% and in corn it was 4.08%. Similarly crude fiber in quinoa was 4.11- 4.16%. While in wheat it was 0.98%. Other parameters of quinoa did not vary significantly as compared to other cereals.

5. NUTRITIONAL EVALUATION OF Moringa leaves (*Moringa oleifera*) WITH OTHER FODDER CROP

INTRODUCTION

Moringa Oleifera is commonly known as drumstick-tree or horse radishtree. It is used as vegetable and also in Indian folk medicine for the treatment of various illnesses. Leaves of Moringaoleifera are a rich source of proteins but contain less carbohydrates and lipids. Contain more ascorbic acid and their leaves are a good dietary source for calcium, magnesium, manganese and copper. Conventionally moringa is used as medicinal purpose and for human consumptions as nutrient source and a rich source of protein with plenty of leaves. It may be used as fodder for animal consumption for improving the health of animals and milk production.

MATERIAL AND METHODS

This experiment was conducted at Biochemistry Section, AARI, Faisalabad in collaboration with Fodder Research Station, Sargodha to check the nutritional evaluation of moringa leaves as fodder with other conventional fodders (maize, sorghum, pearl millet, berseem, oat and lucern). This experiment was laid out in CRD design with fifteen replications. Samples of Moringa leaves were collected from Biochemistry Section and conventional fodders were collected from Fodder Research Station, Sargodha. Samples were dried, ground and analyzed for moisture content, ash contents, crude fat, crude fiber, crude protein, antioxidant activity and vitamin C.

RESULT AND DISCUSSION

The results regarding chemical composition of conventional fodders and moringa leaves are given in table-

Moringa leaves

Ash content in two different moringa varieties (Pakistan sufaid seed and PK-1 Indian) ranged from 10.0 to 11.2%, dry matter 28.7 to 29.4%, crude protein 27.9 to 27.7%, crude fat 4.32 to 4.91%, crude fiber 8.68 to 9.60%, vitamin C 209 to 211 mg/100g and antioxidant activity 77.1 to 78.2 % DPPH. Moringa variety (PK-I Indian) performed better due to high ash content (11.2%), dry matter (29.4%) and vitamin C (211 mg/100g). Moringa variety (Pakistan Sufaid Seed) had high crude protein (28.3%) and antioxidant activity (87.2%)

Fodders

Ash content

Ash contents in different fodders ranged from 8.49 to 12.4%. Maximum ash content (12.4%) was found in berseem fodder followed by lucern fodder (10.6%). Moringa leaves had more ash content (10.6%) as compared to maize fodder (8.49%), sorghum fodder (9.58%), pearl millet fodder (9.58%) and less ash content as compared to berseem fodder (12.4%).

Crude fat

Crude fat contents in different fodders varied from 0.93 to 2.79%. Maximum crude fat (2.79%) was found in Pearl millet fodder followed by berseem fodder (2.64%). Moringa leaves had more crude fat contents (4.62%) as compared to all other fodders maize (2.60%), sorghum (1.75%), oat (0.93%), berseem (2.64%), lucern (1.80%) and pearl millet (2.79%)

Crude fiber

Crude fiber contents in different fodders ranged from 20.6 to 27.6 %. Maximum crude fiber content (27.6%) was found in maize fodder followed by sorghum fodder (25.7%). Moringa leaves had less crude fiber contents (9.14%) as compared to all other fodders maize (27.6%), sorghum (25.7%), oat (22.1%), berseem (20.6%), lucern (22.1%) and pearl millet (21.9%)

Crude protein

Crude protein contents in various fodders ranged from 7.71 to 16.5%. Maximum crude protein content (16.5%) was found in berseem fodder. Moringa leaves had more crude protein contents (28.1%) as compared to all other fodders maize (12.3%), sorghum (7.71%), oat (9.73%), berseem (16.5%), lucern (9.73%) and pearl millet (9.15%)

CONCLUSION

It is concluded that Moringa leaves contained more crude protein (28.1%), crude fat (4.62%) as compared to other conventional fodders. While vitamin C (210mg/100g) and antioxidant activity (77.7% DPPH) are additional benefit to animal's if grazed on moringa leaves with conventional fodders.

Table: Chemical composition of conventional fodders

Fodders	**Ash (%)**	**Crude fat (%)**	**Crude fiber (%)**	**Crude protein (%)**
Maize	8.49 d	2.60 a	27.6 a	12.3 c
Sorghum	9.58 c	1.75 b	25.7 b	7.71 f
Pearl millet	9.58 c	2.79 a	21.9 c	9.15 e
Oat	10.5 b	0.93 c	22.1 c	9.73 d
Berseem	12.4 a	2.64 ab	20.6 c	16.5 b
Lucern	10.6 b	1.80 b	22.1 c	9.73 a
LSD	0.27	0.09	0.56	0.19

Table 15: Chemical composition of moringa leaves

Moringa varieties	Ash (%)	Crude fat (%)	Crude fiber (%)	Crude protein (%)	Dry Matter (%)	Vitamin C (mg/100g)	Antioxidant % DPPH
Pakistan Sufaid Seed	10.0 b	4.32	8.68 b	28.3 a	28.7 b	209	78.2
PK-1 Indian	11.2 a	4.91	9.60 a	27.9 b	29.4 a	211	77.1
LSD	0.14	NS	0.11	0.13	0.27	NS	NS

6. NUTRITIONAL QUALITY EVALUATION OF DIFFERENT PLUM (*Prunus domestica*) VARIETIES

INTRODUCTION

Plum **(*prunusdomestica* L.)** is a temperote zone fruit crop, which belong to the genus *Prunus* of subfamily *Amygdaloideae*, family *Roseaceae*. Plums have abundant of bioactive compounds such as antioxidants, organic acid, (citric and malic acids). Plum is an important stone fruit after peach in terms of area and production in Pakistan. The colour of the outer skin may vary considerably from yellow or dark red to purple or black. Plums are an excellent source of vitamins such as vitamin C (ascorbic acid). Present study is designed to evaluate the nutritional quality of different plum varieties grown at Horticultural Research Station, Nowshera (Soon Valley) Khushab.

MATERIALS AND METHODS

This experiment was conducted in collaboration with Horticultural Research Station, Nowshera (Soon Valley) Khushab. Five varieties of plum Shakar Proon, Mathely, Santa Rosa, Heri Saminor and Red Bueat with fifteen replications were collected from Horticultural Research Station, Nowshera (Soon Valley) Khushab during the month of June 2021. Fifteen samples of each variety were collected and analyzed for malic acid, TSS, sugars, pulp %, fruit weight and firmness. Results are presented as average of fifteen samples

RESULT AND DISCUSSION

The results regarding chemical composition of plum varieties are given in table

Total soluble solids (TSS)

TSS of fresh plum samples ranged from 9.80 to 18.5 %. Maximum TSS (18.5 %) was recorded in variety Shakar Proon while minimum TSS (9.80 %) was recorded in variety Red Bueat.

Malic acid

Malic acid of different plum varieties ranged from 0.66 to 1.00 %. Maximum malic acid (1.00%) was recorded in variety Red Bueat and minimum (0.66%) was present in variety

Reducing sugar

Data regarding analysis of fresh plum juice for reducing sugar ranged from 6.32 to 7.27 %. Maximum reducing sugar (7.27%) was recorded in variety Methley while minimum reducing sugar (6.32%) was present in variety Red Bueat.

Total invert sugar

Total invert sugar recorded in fresh plum juice ranged from 10.5 to 13.0 %. Maximum total invert sugar (13.0%) was present in variety Shakar Proon while minimum total invert sugar (10.5%) was recorded in variety Santa Rosa.

Fruit Weight (g/fruit)

Fruit weight of plum varieties ranged from 13.21 to 52.66 g. Maximum fruit weight (52.66g) was observed in variety Red Bueat while minimum fruit weight (13.21 g) was noticed in variety Methley.

Firmness

Firmness recorded in fresh plum fruit ranged from 1.20 to 1.90 kg. Maximum firmness (1.90kg) wasobserved in variety Shakar Proon while minimum firmness (1.20kg) was recorded in variety Red Bueat.

Pulp %

Among the five plum varieties pulp % was higher in variety Red Bueat (83.9%) whereas lower value was observed in Methley (80.2%).

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Table-1: Chemical composition of different plum varieties

Varieties	Fruit Weight (g/fruit)	Firmness (kg)	Pulp %	Malic Acid (%)
Methley	13.21 c	1.48 b	80.2 b	0.93 a
ShakarParoon	18.85 d	1.90 a	81.3 ab	0.66 c
Santa Rosa	32.41 b	1.87 a	83.7 a	0.72 b
HeriSminor	28.03 c	1.79 a	83.4 a	0.93 a
Red bueat	52.66 a	1.20 c	83.9 a	1.00 a
LSD	1.34	0.13	1.41	0.11

Table-2: Nutritional composition of different plum varieties

Variety	TSS (%)	Reducing sugar (%)	Total sugar (%)
Methley	16.9 b	7.27 a	10.9 bc
ShakarParoon	18.5 a	7.00 a	13.0 a
Santa Rosa	15.2 c	6.48 bc	10.5 c

HeriSminor	13.2 d	6.69 b	10.6 c
Red bueat	9.80 e	6.32 c	11.5 b
LSD	0.48	0.14	0.48

CONCLUSION

It is concluded that variety Shakar Proon was comparatively found better than all other varieties due to higher TSS (18.5%) and total sugars (13.0%).

7. ASSESMENT OF NUTRITIONAL QUALITY OF PEARL MILLET GROWN BY USING BRACKISH WATER ALONG WITH VARIOUS AMENDMENTS

INTRODUCTION

Brackish water is water having more salinity than freshwater, but not as much as seawater. Being situated in arid and semiarid region, the process of salinization and sodication remains in progress. Pearl millet is a promising dual purpose, short duration, quick growing crop with good salinity tolerant characteristics. It is important crop to ensure supply of quality fodder for animals. This experiment is designed to produce optimum yield and batter quality of pearl millet fodder irrigated with brackish water by using different N-source.

MATERIALS AND METHODS

This experiment was conducted in collaboration with Rakh Research Farm, Soil Salinity Research Institute, Pindi Bhattian. Thirteen treatments with three replicationwere collected during the month of October and November 2020. After that samples were dried, ground and analyzed for dry matter, ash contents, crude fat, crude fiber and crude protein.

RESULT AND DISCUSSION

The results regarding chemical composition of pearl millet are given in table

Dry matter

Dry matter contents ranged from 24.3 to 34.6%. Maximum dry matter content (34.6%) was found in treatment T5 (Press mud on N equivalent basis). Minimum dry matter content (24.3%) was found in treatment T9 (Urea 50 % N + Farmyard manure 50 % N).

Ash content

Ash contents ranged from 8.96 to 10.90%. Maximum ash content (10.90%) was found in treatment T3 (CAN calcium ammonium nitrate). Minimum ash content (8.96%) was found in treatment T4 (Poultry manure on N-equivalent basis).

Crude fat

Crude fat contents varied from 2.48 to 2.97%. Maximum crude fat content (2.97%) was found in treatment T3 (CAN calcium ammonium nitrate). Minimum crude fat (2.48%) was found in treatment T10 (CAN 50 % N + Poultry manure 50 % N).

Crude fiber

Crude fiber contents varied from 18.1 to 25.6%. Maximum crude fiber content (25.6%) was found in treatment T11 (CAN 50 % N + Press mud 50 % N). Minimum crude fiber (18.1%) was found in treatment T7 (Urea 50 % N + Poultry manure 50 % N).

Crude protein

Crude protein contents varied from 8.26 to 11.00%. Maximum crude protein content (11.00%) was found in treatment T5 (Press mud on N equivalent basis). Minimum crude protein (8.26%) was found in treatment T10 (CAN 50 % N + Poultry manure 50 % N)

Table: Proximate nutritional composition of various treatments of organic sources of pearl millet

Sr. No	Treatments	Dry Matter (%)	Ash (%)	Crude fat (%)	Crude fiber (%)	Crude protein (%)

1.	Control	28.2 bcd	9.23 ef	2.80 abcd	20.9c	9.18ef
2.	Urea	25.5 cd	9.87 bcd	2.65 bcde	25.1 ab	8.46 b
3.	CAN (calcium ammonium nitrate)	27.4 bcd	10.9 a	2.97 a	24.9 ab	8.91 g
4.	Poultry manure (on N-equivalent basis)	31.6 abc	8.96 f	2.82 abcd	24.0 b	9.41 de
5.	Press mud (on N-equivalent basis)	34.6 a	9.01 f	2.65 bcde	18.8 d	11.00 a
6.	Farmyard manure (on N-equivalent basis)	24.3 d	9.73 bcde	2.62 cde	21.6 c	9.56 d
7.	Urea (50 % N) + Poultry manure (50 % N)	25.9 cd	9.70 bcde	2.93 ab	18.1 d	9.11 fg
8.	Urea (50 % N) + Press mud (50 % N)	26.7 bcd	9.97 bc	2.80 abcd	22.1 c	10.67 b
9.	Urea (50 % N) + Farmyard manure (50 % N)	24.3 d	9.83 bcd	2.51 de	24.4 ab	9.42de
10.	CAN (50 % N) + Poultry manure (50 % N)	23.2 d	10.22 b	2.48 e	20.8 c	8.26 h
11.	CAN (50 % N) + Press mud (50 % N)	26.8 bcd	10.01 b	2.54 de	25.6 a	10.25 c
12.	CAN (50 % N) + Farmyard manure (50 % N)	32.7 ab	9.40 cdef	2.88 abc	24.0 b	8.49 h
13.	T 13 = Urea (50 % N) + CAN (50 % N)	27.4 bcd	9.30 def	2.73 abcde	21.2 c	9.36 def
	LSD	3.03	0.29	0.15	0.64	0.12

CONCLUSION

It is concluded that crude protein (11.00%) and dry matter (34.6%) were found higher in treatment T5 where organic press mud was applied on N equivalent basis. Crude fiber (25.6%) was found higher in treatment T11 where 50 % CAN and 50% press mud was applied. Ash content (10.9%) and crude fat (2.97%) were found higher in treatment T3 where calcium ammonium nitrate was applied as an organic source.

8. EFFECT OF DIFFERENT LEVELS OF NPK ON YIELD AND NUTRITIONAL QUALITY OF PEARL MILLET FODDER.

INTRODUCTION

Pearl millet is well adapted to growing areas characterized by drought, low soil fertility and high temperature. It performs well in soils with high salinity or low pH. Because of its tolerance to difficult growing conditions, it can be grown in areas where other cereal crops, such as maize or wheat, would not survive. To improve the quality and quantity of green fodder per hectare, it is essential to determine its fertilizer requirement to get good quality biomass.

In Pakistan usually our farming community is not applying balanced fertilizer to the fodder crops despite of the fact that it has a key role in increasing crop yield and quality. Use of potassium is very less by the farming community to the major crops even. Keeping in view a study was planned to find out the better combination of NPK fertilizer to get good quality biomass and quality of pearl millet fodder.

MATERIALS AND METHODS

Crop was sown at farm area of Fodder Research Institute Sargodha by opting necessary agronomic practices following RCBD with three replications. Full dose of phosphorus and potassium was applied at the time of sowing while nitrogen was applied in two splits.

Treatments	Fertilizer Doses (kg ha^{-1})		
	Nitrogen	Phosphorus	Potassium

T1	46	36	27
T2	58	48	32
T3	70	60	37
T4	82	72	42
T5	94	84	47

Data regarding physical parameters were recorded at the time of harvesting. Fodder samples were collected from each plot, dried, ground and analyze for dry matter, crude protein, crude fiber, crude fat, ash, Phosphorous, Potassium & NFE. The data obtained were analyzed statistically using ANOVA techniques.

RESULTS AND DISCUSSION

The results regarding effect of NPK on yield and chemical composition of pearl millet fodder are given in table.

Fresh fodder yield:-

The fresh fodder yield of pearl millet fodder recorded at harvest ranged from 42.23 to 53.64 t ha^{-1}. Maximum fresh fodder yield (53.64 t ha^{-1}) was obtained with T5 (NPK 94-84-47 kg ha^{-1}) while minimum fresh fodder yield (42.23 t ha^{-1}) was recorded in T1 (control).

Dry matter:-

Data regarding dry matter content of pearl millet fodder samples ranged from 21.67 to 23.07 %. Maximum dry matter (23.07 %) was found in T5 (NPK 94-84-47 kg ha^{-1}) while minimum dry matter (21.67 %) was found in T1 (control). However results were statistically non significant.

Ash content:-

Data regarding ash content revealed that ash content in pearl millet fodder varied from 8.81 to 10.01 %. Maximum ash content (10.01 %) was obtained with T5 (NPK 94-84-47 kg ha^{-1}). Minimum ash content (10.61 %) was found in T1 (control).

Crude Fat:-

Data regarding analysis of pearl millet fodder for crude fat revealed that fat contents ranged from 2.23 to 2.48 %. Maximum crude fat was analyzed in T5 (2.48 %) followed by T4 (2.40 %). Minimum crude fat was analyzed in T1 (2.23 %).

Crude protein:-

The analysis result of pearl millet fodder showed that crude protein contents ranged from 10.47 to 12.10 %. Maximum crude protein content was analyzed in T5 (12.10 %) followed by T4 (11.75 %). Minimum crude protein content was analyzed in T1 (10.47 %).

Crude Fiber:-

Data regarding analysis of sorghum fodder for crude fiber revealed that crude fiber content ranged from 20.64 to 21.22 % but results were statistically non significant.

Phosphorus:-

Data regarding analysis of pearl millet fodder for phosphorus revealed that phosphorus content ranged from 0.185 to 0.208 %. Maximum Phosphorus was analyzed in T5 (0.208 %) followed by T4 (0.201 %). Minimum phosphorus was analyzed in T1 (0.185 %).

Potassium:-

Data regarding analysis of pearl millet fodder for potassium revealed that potassium content ranged from 1.03 to 1.40 %. Maximum potassium was analyzed in T5 (1.40 %). Minimum potassium was analyzed in T1 (1.03 %).

NFE:-

Data regarding NFE of pearl millet fodder revealed that NFE content ranged from 54.19 to 57.86 %. Maximum NFE was found in T1 (57.86 %) and minimum was found in T5 (54.19 %).

Conclusion

NPK application @ 94-84-47 kg ha^{-1} produced maximum fresh fodder yield (53.64 t ha^{-1}), ash (10.01 %), crude fat (2.48 %), crude protein (12.10 %), phosphorus (0.208 %) and potassium (1.40 %).

CHEMICAL COMPOSITION OF PEARL MILLET FODDER

Treatments	**Fresh Fodder Yield (t ha^{-1})**	**Dry matter (%)**	**Ash (%)**	**Crude Fat (%)**	**Crude Protein (%)**
T_1	42.23 b	21.67	8.81 b	2.23 b	10.47 c
T_2	47.97 ab	20.60	9.01 b	2.39 ab	10.73 c
T_3	50.55 ab	22.27	8.77 b	2.37 ab	11.00 bc
T_4	52.05 ab	21.73	9.51 ab	2.40 ab	11.75 ab
T_5	53.64 a	23.07	10.01 a	2.48 a	12.10 a
CV (%)	**12.25**	**NS**	**5.06**	**4.26**	**3.72**
LSD	**11.365**		**0.879**	**0.190**	**0.784**

Treatments	**Crude Fiber (%)**	**Phosphorus (%)**	**Potassium (%)**	**NFE (%)**
T_1	20.64	0.185 b	1.03 c	57.86 a
T_2	20.26	0.188 b	1.07 bc	57.61 ab
T_3	20.41	0.195 ab	1.27 ab	57.45 ab
T_4	20.96	0.201 ab	1.30 ab	55.38 ab

T_5	21.22	0.208 a	1.40 a	54.19 a
CV (%)	**NS**	**4.85**	**11.72**	**3.34**
LSD		**0.017**	**2.262**	**3.550**

9. IMPROVING THE NUTRITIONAL QUALITY AND YIELD OF BERSEEM BY THE USE OF PHOSPHORUS

Egyptian clover (*Trifolium alexandrinum*) commonly called as berseem, is a popular fodder of rabi season grown on large area. In the near vicinity of big cities, it is cultivated as cash crop. Due to multi cuts and high nutrition value, berseem is also known as king of fodders. It is a legume crop, thus enhances soil fertility and requires less nitrogen. Fodder is the basic need for livestock production. Supply of regular, adequate and nutritious fodder is essential for livestock production in order to meet the demand of milk, butter and other by-products for human consumption.

In Pakistan usually our farming community is not applying phosphorus to the fodder crops. Phosphorus has key role in improving quality and yield of fodder crops as well as major crops. Keeping in view, a study was therefore planned to see the effect of phosphorus on nutritional quality and yield of berseem.

MATERIALS AND METHODS

Crop was sown at farm area of Biochemistry Section, Post Harvest Research Center, AARI, Faisalabad by opting necessary agronomic practices following RCBD with three replications. Full dose of phosphorus was applied at the time of sowing while nitrogen was applied in splits.

Treatments	**Fertilizer Doses (kg ha^{-1})**	
	Nitrogen	**Phosphorus**
T1	40	control

T2	40	60
T3	40	80
T4	40	100
T5	40	120

Data regarding physical parameters were recorded at the time of harvesting of each cutting. Fodder samples were collected from each cutting from each plot, dried, ground and analyze for dry matter, crude protein, crude fiber, crude fat, ash, Phosphorous & NFE. The data obtained were analyzed statistically using ANOVA techniques.

RESULTS AND DISCUSSION

The results regarding effect of phosphorus on yield and chemical composition of berseem fodder are given in table.

1st Cutting:-

Data regarding 1st cutting of berseem fodder revealed that fresh fodder yield ranged from 15.33 to 18.99 t ha^{-1}. Ash ranged from 13.23 to 14.50 %, crude fat ranged from 3.03 to 3.31 %, crude protein ranged from 16.22 to 18.11 %, phosphorus ranged from 0.193 to 0.231 % and NFE from 45.25 to 49.11 %. However dry matter and crude fiber were statistically non significant.

Phosphorus application @ 120 kg ha^{-1} along with nitrogen application @ 40 kg ha^{-1} produced maximum fresh fodder yield (18.99 t ha^{-1}), ash (14.50 %), crude fat (3.31 %), crude protein (18.11 %) and phosphorus (0.231 %). Minimum yield and quality parameters were observed where no phosphorus was applied.

2nd Cutting:-

Data regarding 2nd cutting of berseem fodder revealed that fresh fodder yield ranged from 17.95 to 23.19 t ha^{-1}. Dry matter ranged from 12.15 to 12.97 %, crude fat ranged from 2.92 to 3.32 %, crude protein ranged from 17.73 to 19.51 %, phosphorus ranged from 0.196 to 0.229 % and NFE from 41.86 to 46.01 %. However ash, crude fiber and NFE were statistically non significant.

Phosphorus application @ 120 kg ha^{-1} along with nitrogen application @ 40 kg ha^{-1} produced maximum fresh fodder yield (18.99 t ha^{-1}), dry matter (12.97 %), crude fat (3.32 %), crude protein (19.51 %) and phosphorus (0.229 %). Minimum yield and quality parameters were observed where no phosphorus was applied. However overall an increasing trend in yield as well quality were observed as compare to 1st cutting.

3rd Cutting:-

Data regarding 3rd cutting of berseem fodder revealed that fresh fodder yield ranged from 20.12 to 25.52 t ha^{-1}. Ash ranged from 13.28 to 14.16 %, crude fat ranged from 3.09 to 3.50 %, crude protein ranged from 18.23 to 20.68 %, phosphorus ranged from 0.213 to 0.237 %. However dry matter and crude fiber were statistically non significant.

Phosphorus application @ 120 kg ha^{-1} along with nitrogen application @ 40 kg ha^{-1} produced maximum fresh fodder yield (25.52 t ha^{-1}), ash (14.16 %), crude fat (3.50 %), crude protein (20.68 %) and phosphorus (0.237 %). Minimum yield and quality parameters were observed where no phosphorus was applied. However overall an increasing trend in yield as well quality were observed as compare to 1st and 2nd cutting.

Conclusion

NP application @ 40-120 kg ha^{-1} produced maximum fresh fodder yield (18.99, 23.19, 25.52 t ha^{-1}), ash (14.50, 14.13, 14.16 %), crude fat (3.31, 3.32, 3.50 %), crude protein (18.11, 19.51, 20.68 %), phosphorus (0.231, 0.229, 0.237 %) in 1st, 2nd and 3rd cutting respectively.

CHEMICAL COMPOSITION OF BERSEEM FODDER (1st CUTTING)

Treatments	Fresh Fodder Yield (t ha^{-1})	Dry matter (%)	Ash (%)	Crude Fat (%)
T_1	15.33 b	10.57	13.23 c	3.03 b
T_2	16.89 ab	11.07	13.62 bc	3.15 ab
T_3	17.74 ab	11.19	13.96 ab	3.23 ab

T_4	18.26 ab	11.44	14.10 ab	3.29 a
T_5	18.99 a	12.15	14.50 a	3.31 a
CV (%)	**9.40**		**2.57**	**4.17**
LSD	**3.087**	**NS**	**0.672**	**0.251**

Treatments	**Crude Fiber (%)**	**Crude Protein (%)**	**Phosphorus (%)**	**NFE (%)**
T_1	18.42	16.22 b	0.193 b	49.11 a
T_2	18.70	17.24 ab	0.210 ab	47.30 ab
T_3	18.39	17.47 a	0.217 a	46.93 b
T_4	19.53	17.62 a	0.223 a	45.46 b
T_5	18.83	18.11 a	0.231 a	45.25 b
CV (%)	**NS**	**3.34**	**5.30**	**2.43**
LSD		**1.090**	**0.021**	**2.144**

CHEMICAL COMPOSITION OF BERSEEM FODDER (2nd CUTTING)

Treatments	**Fresh Fodder Yield (t ha^{-1})**	**Dry matter (%)**	**Ash (%)**	**Crude Fat (%)**
T_1	17.95 b	12.15 b	13.87	2.92 c
T_2	20.20 b	12.29 b	13.92	3.02 bc
T_3	21.28 ab	12.83 a	14.09	3.26 a
T_4	21.92 ab	12.88 a	14.16	3.16 ab

T_5	23.19 a	12.97 a	14.13	3.32 a
CV (%)	**12.23**	**2.82**	**NS**	**3.59**
LSD	**4.813**	**0.431**		**0.211**

Treatments	**Crude Fiber (%)**	**Crude Protein (%)**	**Phosphorus (%)**	**NFE (%)**
T_1	19.10	17.73 b	0.196 b	46.38
T_2	18.84	18.64 ab	0.213 ab	45.58
T_3	19.08	18.90 ab	0.216 ab	44.67
T_4	19.14	19.13 ab	0.220 ab	44.41
T_5	18.88	19.51 a	0.229 a	44.19
CV (%)	**NS**	**4.90**	**6.14**	**NS**
LSD		**1.733**	**0.024**	

CHEMICAL COMPOSITION OF BERSEEM FODDER (3rd CUTTING)

Treatments	**Fresh Fodder Yield (t ha^{-1})**	**Dry matter (%)**	**Ash (%)**	**Crude Fat (%)**
T_1	20.12 b	13.84	13.28 b	3.09 b
T_2	21.08 b	14.13	13.44 ab	3.13 ab
T_3	22.97 ab	14.17	13.89 ab	3.40 ab
T_4	24.12 ab	14.80	13.96 ab	3.26 ab
T_5	25.52 a	15.21	14.16 a	3.50 a

CV (%)	**10.92**		**3.41**	**6.11**
LSD	**4.250**	**NS**	**0.880**	**0.380**

Treatments	**Crude Fiber (%)**	**Crude Protein (%)**	**Phosphorus (%)**	**NFE (%)**
T_1	19.40	18.23 c	0.213 b	46.01 a
T_2	19.21	18.38 bc	0.215 b	45.84 a
T_3	18.88	19.10 abc	0.223 ab	44.73 a
T_4	19.44	20.07 ab	0.229 ab	43.27 b
T_5	19.79	20.68 a	0.237 a	41.86 c
CV (%)	**NS**	**4.91**	**4.62**	**2.66**
LSD		**1.783**	**0.019**	**1.385**

10. EFFECT OF FOLIAR AND SOIL APPLICATION OF POTASSIUM ON NUTRITIONAL QUALITY AND YIELD OF WHEAT

INTRODUCTION

Wheat (*Triticum aestivum L.*) is an important food crop of Pakistan. It cultivated on the largest acreages in almost every part of the country and being used as a staple food by the people. It is a principal source of nutrition both for human beings and animals.

The major reasons for low productivity and instability includes: delayed harvesting of kharif crops like cotton, sugarcane and rice, and consequent late planting of wheat, non-availability of improved inputs like seed, inefficient fertilizer use, weed infestation, shortage of irrigation water, drought in rain fed and terminal heat stress, soil degradation, inefficient extension services. Moreover, farmers are not aware of modern technologies because of weak extension services system.

Potassium has key role in improving quality and yield of wheat and other crops as well. Our farming community is not applying potassium to the wheat according to the recommendation.

This study is therefore planned to see the effect of soil and foliar application of potassium on nutritional quality and yield of wheat.

MATERIALS AND METHODS

This experiment was conducted at Biochemistry Section AARI, Faisalabad. A promising variety of wheat Akbar was sown for this experiment. The experiment was laid out in RCBD with five treatments and three replications. The different fertilizer treatments are as under.

Treatments	**Fertilizer (kg ha^{-1})**	**K application method**
T1	NP (120-90)	Control
T2	NP (120-90) + K (60)	Soil
T3	NP (120-90) + K (1%)	Foliar
T4	NP (120-90) + K (2%)	Foliar
T5	NP (120-90) + K (3%)	Foliar

Full dose of potassium and phosphorus were applied at the time of sowing while nitrogen in two splits. Foliar application of potassium was applied at heading stage. All necessary agronomic practices were followed during the course of study. At the time of harvesting, data regarding yield were recorded. Representative samples were collected from each plot, thrashed, dried, ground and analyzed for its nutritional quality. The data obtained was analyzed statistically using ANOVA techniques.

RESULTS AND DISCUSSION

The results regarding effect of foliar and soil applied potassium on yield and chemical composition of wheat grain are given in table.

Grain yield:-

The grain yield of wheat recorded at harvest ranged from 3.74 to 5.03 ton ha^{-1}. Maximum grain yield (5.03 t ha^{-1}) was obtained with T5 where 3% foliar spray of potassium was applied while minimum grain yield (3.74 t ha^{-1}) was recorded in T1 (control) where no potassium was applied.

Dry matter:-

Data regarding dry matter content of wheat grain samples ranged from 94.68 to 95.57 %. However results were statistically non-significant.

Ash content:-

Data regarding ash content revealed that ash content in wheat varied from 1.67 to 2.11 %. Maximum ash content (2.11 %) was obtained with T5 where 3% foliar spray of potassium was applied. Minimum ash content (1.67 %) was found in T1 (control).

Crude Fat:-

Data regarding analysis of wheat for crude fat revealed that fat contents ranged from 2.01 to 2.20 %. Maximum crude fat was analyzed in T5 (2.20 %) followed by T4 (2.16 %). Minimum crude fat (2.01 %) was analyzed in T1.

Crude protein:-

The analysis result of wheat showed that crude protein contents ranged from 11.00 to 12.48 %. Maximum crude protein content was analyzed in T5 (12.48 %) followed by T4 (12.13 %). Minimum crude protein content was analyzed in T1 (11.00 %).

Crude Fiber:-

Data regarding analysis of wheat grain for crude fiber revealed that crude fiber content ranged from 3.41 to 3.64 % but results were statistically non significant.

Phosphorus:-

Data regarding analysis of wheat for phosphorus revealed that phosphorus content ranged from 0.180 to 0.191 %. Maximum Phosphorus was analyzed in T5 (0.191 %) followed by T4 (0.188 %). Minimum phosphorus was analyzed in T1 (0.180 %).

Potassium:-

Data regarding analysis of wheat for Potassium revealed that Potassium content ranged from 0.24 to 0.30 %. Maximum Potassium was analyzed in T5 (0.30 %). Minimum Potassium was analyzed in T1 (0.24 %).

CONCLUSION:-

Foliar application of potassium @ 3% along with standard dose of NP produced maximum grain yield (5.03 t ha^{-1}), ash (2.11 %), crude fat (2.20 %), crude protein (12.48 %), phosphorus (0.191 %) and potassium (0.30 %).

CHEMICAL COMPOSITION OF WHEAT

Treatments	**Grain Yield (t ha^{-1})**	**Dry matter (%)**	**Ash (%)**	**Crude Fat (%)**
T_1	3.74 c	95.47	1.67 b	2.01 b
T_2	4.41 abc	94.68	1.86 ab	2.13 ab
T_3	3.95 bc	95.33	1.84 ab	2.11 ab
T_4	4.69 ab	94.99	2.02 a	2.16 ab
T_5	5.03 a	95.57	2.11 a	2.20 a
CV (%)	**9.32**		**7.83**	**4.83**
LSD	**0.766**	**NS**	**0.280**	**0.153**

Treatments	Crude Fiber (%)	Crude Protein (%)	Phosphorus (%)	Potassium (%)
T_1	3.51	11.00 b	0.180 b	0.24 c
T_2	3.65	11.84 ab	0.184 ab	0.27 ab
T_3	3.61	11.64 ab	0.182 ab	0.25 bc
T_4	3.41	12.13 ab	0.188 ab	0.28 ab
T_5	3.64	12.48 a	0.191 a	0.30 a
CV (%)	**NS**	**6.21**	**4.23**	**6.19**
LSD		**1.382**	**0.011**	**0.031**

11. EVALUATION OF NUTRITIONAL STATUS OF DIFFERENT RABI AND KHARIF FODDERES

INTRODUCTION

Fodder crops are the main and nutritive source of feed for livestock. Various fodders vary in nutrition. The awareness regarding the nutrition of fodders is very important to manage the daily ration for livestock. Balanced nutrition is important for animals for ample meat and milk production. Present study was designed to evaluate nutritional status of different Rabi and Kharif fodders for the better management of feeding program for livestock.

MATERIALS AND METHODS

Samples of selected rabi and kharif fodders were collected from fodder research sub-station, AARI, Faisalabad during rabi and kharif season. The samples were collected at the stage when the fodder was ready for grazing. Then these samples were chopped, dried, grinded and analyzed for crude protein, crude fiber, ash and crude fat.

Sr. No.	Rabi Fodders	Sr. No.	Kharif Fodders
1	Lucern	5	Sorghum
2	Berseem	6	Maize

3	Oat	7	Pearl millet
4	Rye grass	8	Rhode grass

RESULTS AND DISCUSSION

Rabi fodders

The results regarding nutritional quality of different Rabi fodders are given in table-19

Crude protein

Crude protein in various rabi fodders varied from 8.71 % to 20.50 %. Maximum crude protein (20.50 %) was found in lucern and minimum crude protein (8.71%) was found in oat.

Crude fat

Crude fat in different Rabi fodders varied from 1.76% to 2.72 %. Maximum crude fat (2.72 %) was found in berseem and minimum crude fat (1.76%) was found in oat.

Crude fiber

Results depicted that crude fiber varied in various rabi fodders from 14.98 % to 23.08 %. Maximum crude fiber (23.08 %) was found in lucern and minimum crude fiber (14.98%) was found in berseem.

Ash content

Ash contents in different Rabi fodders varied from 9.91% to 11.20 %. Maximum ash contents (11.20 %) was found in berseem and minimum ash contents (9.91 %) was found in oat.

Kharif fodders

The results regarding nutritional quality of different kharif fodders are given in table-20

Crude protein

Crude protein in various kharif fodders varied from 7.43 % to 10.89 %. Maximum crude protein (10.89%) was found in rhode grass and minimum crude protein (7.43%) was found in sorghum.

Crude fat

Crude fat in different kharif fodders varied from 1.70% to 2.61 %. Maximum crude fat (2.61 %) was found in rhode grass and minimum crude fat (1.70%) was found in pearl millet.

Crude fiber

Results depicted that crude fiber varied in kharif fodders from 24.62 % to 28.75 %. Maximum crude fiber (28.75 %) was found in rhode grass and minimum crude fiber (24.62%) was found in sorghum.

Ash content

Ash contents in different kharif fodders varied from 7.35 % to 9.26 %. Maximum ash contents (9.26%) was found in rhode grass and minimum ash (7.35%) was found in sorghum fodder.

CONCLUSION

It is concluded that in Rabi fodders lucern and berseem are considered as good fodders due to having high protein contents 20.50 % and 18.46 % respectively. While in kharif fodders rhode grass and pearl millet are considered as good fodders due to having high protein contents 10.89 % and 9.01 % respectively.

Table: Chemical composition of Rabi fodders

Sr. No.	Name of fodders	Crude protein (%)	Crude fat (%)	Crude fiber (%)	Ash (%)
1	Lucern	20.50	2.48	23.08	9.98
2	Berseem	18.46	2.72	14.98	11.20
3	Oat	8.71	1.76	21.41	9.91

4	Rye grass	13.53	2.28	22.84	10.98

Table: Chemical composition of Kharif fodders

Sr. No.	Name of fodders	Crude protein (%)	Crude fat (%)	Crude fiber (%)	Ash (%)
1	Sorghum	7.43	2.51	24.62	7.35
2	Maize	8.78	2.24	26.10	7.70
3	Pearl millet	9.01	1.70	27.95	7.72
4	Rhode grass	10.89	2.61	28.75	9.26

12. ENHANCEMENT OF PROTEIN CONTENTS IN GRAM BY FERTILIZERS MANAGEMENT

INTRODUCTION

Pulses has important role in contributing to food and nutritional security. Pulses are rich in proteins and a cheap source of protein. Gram is an important pulses crop grown in Punjab on light and dry soils especially in the districts of Khushab, Bhakkar, Layyah and Karore. Gram is also high in fiber, as well as a significant source of iron, zinc, potassium and magnesium. By keeping in view the above importance of pulses in human diet, the present study was planned to enhance protein contents in gram by application of balanced fertilizers and inoculating the seed with microbial incoculum.

MATERIALS AND METHODS

A field experiment was conducted in collaboration with Pulses Research Institute, Faisalabad. Gram was sown in November-2020. Fertilizers were applied according to the treatment plan. Crop management practices were carried out. Experiment was laid out in RCBD with five treatments (fertilizer doses), two factors (Inoculum) and 3 replications. One set of treatment was applied to the crop sown without inoculum (control) while other set of treatments was applied to the crop grown by using seed treated with inoculum obtained from Soil Bacteriology Section

AARI, Faisalabad. Samples were collected from each treatment at harvesting, dried, grinded and analyzed for crude protein, crude fat, crude fiber and ash. Following treatments were applied.

Treatments	Fertilizer Dose
T_1	Control (No fertilizer)
T_2	N (30 kg/ha)
T_3	P (90 kg/ha)
T_4	K (30 kg/ha)
T_5	NPK (30+90+30) kg/ha

RESULTS AND DISCUSSION

The results regarding differential response of treatments towards nutritional quality is given in table-28 to 31.

Crude protein:

Fertilizer doses and inoculation increased the protein contents of chickpea. Result showed that crude protein contents ranged from 19.31 % to 23.69%. Maximum crude protein content (23.69%) was recorded in T_5 (NPK (30+90+30) kg/ha+inoculums) followed by T_5 (NPK (30+90+30) kg/ha) where crude protein was 23.14%. Minimum crude protein content (19.31%) was found in control treatment where no fertilizer and no inoculum was applied.

Crude fat:

Fertilizer doses and inoculation increased the crude fat contents of chickpea. Data regarding crude fat revealed that fat contents ranged from 2.92% to 3.77%. Maximum crude fat (3.77%) was analyzed in T_5 (NPK (30+90+30) kg/ha+Inoculum). Minimum crude fat was observed in control treatment where no fertilizer and no inoculums was applied.

Crude fiber:

Result showed that fertilizer and innoculum application had no significant effect on crude fiber while inoculation increased the crude fiber contents. Crude fiber ranged from 3.29 % to 3.83%. Maximum crude fiber (3.83%) was analyzed in treatment where (NPK (30+90+30) kg/ha+ inoculums) was applied. Minimum crude fiber (3.29%) was recorded in treatment where only k was applied @ 30 kg/ha.

Ash content:

Data regarding ash contents revealed that ash contents ranged from 2.36 % to 2.93%. Maximum ash content (2.93%) was found in T_4 where k was applied @ 30 kg/ha, while minimum ash content (2.36 %) was found in T_5 where (NPK (30+90+30) kg/ha) was applied.

CONCLUSION

Application of N, P and K alone as well as in combination had a significant effect on quality parameters like crude protein and crude fat, while crude fiber and ash did not effect by fertilizer application. Inoculum played a vital role in enhancing the crude protein, crude fat, crude fiber and ash contents. These parameters increased by treating the seed with inoculum before sowing. The better quality was obtained where NPK was applied (30-90-30 kg/ha) with and without microbial inoculation.

Table: Effect of Fertilizer and Inoculum application on crude protein (%) in gram.

Sr. No.	Fertilizer Dose	without Inoculum	with Inoculum	Mean
T_1	**No fertilizer**	19.31c	20.48bc	19.89c
T_2	**N (30kg/ha)**	22.34ab	23.01ab	22.67ab
T_3	**P (30kg/ha)**	20.79bc	21.48abc	21.13bc
T_4	**K (30kg/ha)**	20.96abc	21.44abc	21.21bc
T_5	**NPK (30:90:30) kg/ha**	23.14ab	23.69a	23.41a
	Mean	21.30a	22.02a	
	LSD for inoculums	**1.23**		

	LSD for treatment	**1.95**
	LSD for interaction	**2.76**

Table: Effect of Fertilizer and Inoculum application on crude fat (%) in gram.

Sr. No.	Fertilizer Dose	Without Inoculum	With Inoculum	Mean
T_1	**No fertilizer**	2.92e	3.15de	3.03c
T_2	**N (30 kg/ha)**	3.31cd	3.58ab	3.44ab
T_3	**P (30 kg/ha)**	3.26cd	3.52abc	3.39b
T_4	**K (30 kg/ha)**	3.39bcd	3.62ab	3.50ab
T_5	**NPK (30:90:30) kg/ha**	3.52abc	3.77a	3.63a
	Mean	3.27b	3.52a	
	LSD for inoculums	**0.12**		
	LSD for treatment	**0.19**		
	LSD for interaction	**0.26**		

Table: Effect of Fertilizer and Inoculum application on crude fiber (%) in gram.

Sr. No.	Fertilizer Dose	Without Inoculum	With Inoculum	Mean
T1	**No fertilizer**	3.53bc	3.48bc	3.50bc
T2	**N (30 kg/ha)**	3.41bc	3.55b	3.48bc
T3	**P (30 kg/ha)**	3.63ab	3.52bc	3.57ab
T4	**K (30 kg/ha)**	3.29c	3.45bc	3.37c
T5	**NPK (30:90:30) kg/ha**	3.59ab	3.83a	3.71a
	Mean	3.49a	3.56a	

	LSD for inoculums	**0.11**
	LSD for treatment	**0.17**
	LSD for interaction	**0.24**

Table: Effect of Fertilizer and Inoculum application on ash contents (%) in gram.

Sr. No.	Fertilizer Dose	Without Inoculum	With Inoculum	Mean
T_1	**No fertilizer**	2.51cd	2.73abc	2.61ab
T_2	**N (30 kg/ha)**	2.66abcd	2.88ab	2.77a
T_3	**P (30 kg/ha)**	2.55bcd	2.69abcd	2.62ab
T_4	**K (30 kg/ha)**	2.62abcd	2.93a	2.77a
T_5	**NPK (30:90:30) kg/ha**	2.36bcd	2.38d	2.37b
	Mean	2.53a	2.72a	
	LSD for inoculums	**0.15**		
	LSD for treatment	**0.24**		
	LSD for interaction	**0.34**		

13. EFFECT OF DRYING METHODS ON THE NUTRITIONAL STATUS OF VEGETABLES PRESERVED BY DRYING

INTRODUCTION

Vegetables are highly perishable due to their high water contents. It is imperative to preserve vegetables in their peak seasons to use them later on. There are number of methods being used for preservation of vegetables. Preservation by drying is the most common and oldest method of vegetable preservation. There are a number of drying methods that removes enough moisture to

prevent decay and spoilage. Present study was designed to evaluate nutritional loss of vegetables during drying and find out the best method of drying with least loss of nutrition.

MATERIALS AND METHODS

During the summer, the samples of four vegetables (bitter gourd, tomato, okra, brinjal) were collected. These vegetables were washed for dust removing and after blanching, the vegetables were sliced before drying by using various methods as mentioned in the following treatment plan. The drying process was continued till to the dryness of the vegetables. These dried samples were analyzed for quality parameters i.e. crude protein, crude fat, crude fiber, ash contents.

Treatments are as under:

Treatments	Drying Methods
T_1	Sun drying
T_2	Sun drying under shade
T_3	Oven drying by air circulating oven at 50°C
T_4	Oven drying by air circulating oven at 60°C
T_5	Drying by tunnel dryer at 50°C

RESULTS AND DISCUSSION

Drying methods had no significant effect on the nutritional quality of tomato, bitter gourd, brinjal and okra. All methods were found equally good for preservation of vegetables by drying. However, drying with tunnel dryer at 50°C proved comparatively better method of drying because it dried the vegetables in less time. The detail of results is given below.

Tomato

Crude protein, crude fat, crude fiber and ash contents ranged from 1.09 to1.21%, 0.35 to 0.48%, 3.44 to 4.11 and 4.88 to 5.23% respectively. Maximum crude protein and crude fiber were observed by the method in which drying was made at 50^0 C by tunnel dryer, While maximum ash and crude fat was found in drying under shade method. Lowest value for crude protein, crude fat and crude fiber was observed in method where vegetables were dried at 60^0 C in air drying oven, while lowest value for ash was observed by tunnel drying method.

Bitter gourd

Crude protein, crude fat, crude fiber and ash contents ranged from 1.08 to 1.21%, 0.39 to 0.57%, 1.01 to 1.14 and 0.29 to 0.42% respectively. Maximum crude protein and crude fiber was observed by the method tunnel drying at 50^0 C. While maximum crude fat and ash was found in drying method of sun drying. Lowest value for ash, crude protein, crude fat and crude fiber was observed in method where vegetables were dried at 60^0 C in air drying oven and sun drying under shade method.

Brinjal

Crude protein, crude fat, crude fiber and ash contents ranged from 1.09 to1.21%, 0.21 to 0.35%, 0.58 to 0.72 and 0.69 to 0.82% respectively. Maximum ash and crude fat were observed by the method in which sun drying under shade method. While maximum crude protein and crude fiber was found in oven drying at 50^0 C method. Lowest value for crude protein, crude fat, ash and crude fiber was observed in method where vegetables were dried at 60^0 C by oven drying method.

Okra

Crude protein, crude fat, crude fiber and ash contents ranged from 2.23 to 2.42%, 0.31 to 0.49%, 0.61 to 0.76 and 1.05 to 1.21% respectively. Maximum crude protein, crude fat and crude fiber were observed by the method in which drying was made by sun, While maximum ash was found in tunnel drying method at 50^0 C. Lowest value for crude protein and crude fat was observed in method where vegetables were dried by tunnel drying methods at 50^0 C, while ash and crude fiber were observed by drying at 50^0 C and 60^0 C in air drying oven respectively.

CONCLUSION

Drying methods had no significant effect on the nutritional quality of tomato, bitter gourd, brinjal and okra. All methods were found equally good for preservation of vegetables by drying.

Table: Effect of drying methods on nutritional composition of tomato.

Drying Methods	**Ash (%)**	**Crude protein (%)**	**Crude fat (%)**	**Crude fiber (%)**
Sun drying	0.91	1.18	0.41	0.78
Sun drying under shade	0.96	1.15	0.48	0.82
Oven drying by air circulating oven at 50º C	0.88	1.11	0.38	0.75
Oven drying by air circulating oven at 60 º C	0.85	1.09	0.35	0.73
Drying by tunnel dryer at 50ºC	0.82	1.21	0.44	0.86
LSD	**NS**	**NS**	**NS**	**NS**

Table: Effect of drying methods on nutritional composition of bitter gourd

Drying Methods	**Ash (%)**	**Crude protein (%)**	**Crude fat (%)**	**Crude fiber (%)**
Sun drying	0.42	1.18	0.57	1.07
Sun drying under shade	0.38	1.13	0.49	1.01
Oven drying by air circulating oven at 50º C	0.33	1.11	0.42	1.11
Oven drying by air circulating oven at 60 º C	0.29	1.08	0.39	1.04
Drying by tunnel dryer at 50 º C	0.36	1.21	0.53	1.14
LSD	**NS**	**NS**	**NS**	**NS**

Table: Effect of drying methods on nutritional composition of brinjal

Drying Methods	Ash (%)	Crude protein (%)	Crude fat (%)	Crude fiber (%)
Sun drying	0.78	1.11	0.31	0.69
Sun drying under shade	0.82	1.17	0.35	0.66
Oven drying by air circulating oven at 50º C	0.77	1.21	0.28	0.72
Oven drying by air circulating oven at 60 º C	0.69	1.09	0.21	0.58
Drying by tunnel dryer at 50 º C	0.72	1.18	0.24	0.61
LSD	**NS**	**NS**	**NS**	**NS**

Table: Effect of drying methods on nutritional composition of okra

Drying Methods	Ash (%)	Crude protein (%)	Crude fat (%)	Crude fiber (%)
Sun drying	1.11	2.42	0.49	0.76
Sun drying under shade	1.13	2.39	0.44	0.64
Oven drying by air circulating oven at 50o C	1.05	2.31	0.39	0.69
Oven drying by air circulating oven at 60 o C	1.18	2.28	0.33	0.61
Drying by tunnel dryer at 50 o C	1.21	2.23	0.31	0.72
LSD	**NS**	**NS**	**NS**	**NS**

14. FODDER YIELD AND QUALITATIVE RESPONSE OF SORGHUM PLANTED ALONE AND IN MIXTURE WITH GUAR AND JANTAR

INTRODUCTION

Mixed cropping is among the most economical and effective agronomic strategies to boost forage biomass production and nutritional quality. Typically a mixture of legumes and cereals or tuber crops is a common practice in marginal agro-ecological environments, which fulfills a variety of functions including complementary use of growth factors, such as soil nutrients, light and water. It help farmers to avoid reliance on a single crop and result in a variety of products of a different nature such as forages, oil and pulses. Growing of leguminous and non-leguminous crops in combination may improve the yield and nutritional quality of fodder crops. Keeping in view the importance of mixed cropping for nutrients enhancement this experiment was designed to determine the best combination of leguminous and non-leguminous fodders for best quality fodder and maximum green fodder yield.

METHDOLOGY

This experiment was conducted in collaboration with agronomy (Forage Production) Section, AARI, Faisalabad during the year 2019-20. The experiment was sown by broadcast method with recommended fertilizer dose (NPK80-60-25kg ha^{-1}) having plot size 3m × 6m in RCBD with 3 replications. All Agronomic practices were kept uniform. After harvesting samples were collected and analyzed for Crude Protein, Crude fat, Crude fiber and ash.

Treatments are as under:

T_1	Sorghum alone
T_2	Guar alone
T_3	Jantar alone
T_4	Sorghum (50%) + Guar (50%)
T_5	Sorghum (50%) + Jantar (50%)

T_6	Sorghum (50%) + Guar (25%) + Jantar (25%)

RESULTS AND DISCUSSION

Sr. No.	Treatments	Ash (%)	Crude Protein (%)	Crude Fat (%)	Crude Fiber (%)
1	**T_1-Sorghum alone**	8.71b	9.23c	2.35b	27.12a
2	**T_2-Guar alone**	10.11a	19.66a	1.15c	20.23d
3	**T_3-Jantar alone**	10.39a	19.12a	2.41b	18.04d
4	**T_4-Sorghum (50%) + Guar (50%)**	10.54ab	12.71b	2.55ab	25.24bc
5	**T_5-Sorghum (50%) + Jantar (50%)**	10.83a	12.29b	2.72a	23.11c
6	**T_6-Sorghum (50%) + Guar (25%) + Jantar (25%)**	9.61ab	11.37bc	2.49ab	25.73ab
LSD		1.48	2.45	0.25	2.20

Ash content:

Ash contents ranged from 8.70 to 10.83%. Maximum ash content (10.83%) was found in treatment where guar and jantar were planted together. similarly minimum ash contents (8.70%) were found in sorghum which was planted alone.

Crude protein:

The analysis results of different fodders planted alone and in mixture depicted that crude protein contents varied from 9.23 to 19.66%. Maximum crude protein content (19.66%) was found in guar fodder while minimum crude protein (9.23%) was present in sorghum.

Crude Fat:

Results of different fodders for crude fat contents ranged from 1.15 to 2.72%. Maximum crude fat content (2.72%) was found in treatment where guar and jantar were sown together at equal percentage. while Minimum crude fat (1.15%) was found in a treatment where guar applied alone.

Crude fiber

Crude fiber contents ranged from 18.04 to 27.12 %. Maximum crude fiber content (27.12%) was found in sorghum. While minimum crude fiber (18.04%) was found in Jantar.

CONCLUSION

It is concluded that ash, crude protein and crude fat contents of sorghum fodder was observed high when planted in a mixture with guar and jantar as compare to planted alone. On the other hand crude fiber contents were not increased when sorghum was planted in a combination of guar and janatr. So based on present study it can be concluded that planting of sorghum in a mixture with a guar and jantar will a good source of quality components for grazing animals.

A. ANALYSIS SERVICE EXTENDED TO VARIOUS INSTITUTIONS DURING 2020-21

1) Twenty four samples of mung bean grain received from Agronomy (Fiber crop) Research Institute, Faisalabad analyzed for moisture, ash, crude fat, crude protein and crude fiber.
2) Twenty two samples of kharif fodders received from Fodder Research Institute, Sargodha and analyzed for dry matter, ash, crude fat, crude protein and crude fiber.

Treatments	Moisture %	Ash %	Crude fat (%)	Crude protein (%)	Crude fiber (%)
T1R1	8.20	4.08	1.22	22.1	3.18
T1R2	8.52	4.17	1.47	21.7	3.98
T1R3	7.94	4.15	1.28	21.3	3.40
T2R1	7.73	3.41	1.22	20.9	4.14
T2R2	7.91	3.11	1.17	20.4	3.44
T2R3	7.97	3.05	1.10	20.5	3.18
T3R1	8.57	3.41	1.21	20.6	3.82
T3R2	8.97	3.97	1.16	21.3	4.23
T3R3	9.05	3.58	1.09	22.8	3.49
T4R1	9.85	3.57	1.17	23.2	3.32
T4R2	7.68	3.77	1.43	21.4	3.99
T4R3	6.54	3.54	1.53	21.7	3.66
T5R1	7.65	3.38	1.38	22.4	3.33
T5R2	7.93	3.44	1.54	20.4	3.66
T5R3	6.93	3.23	1.41	21.4	3.63
T6R1	6.48	3.23	1.47	22.0	3.32
T6R2	7.11	3.57	1.40	21.5	4.23
T6R3	7.45	3.35	1.39	21.1	3.94
T7R1	7.99	3.38	1.23	22.3	4.07
T7R2	7.14	3.12	1.25	21.8	3.46
T7R3	7.91	3.24	1.23	21.3	3.63
T8R1	6.26	4.10	1.18	21.1	3.95
T8R2	6.68	4.41	1.25	22.7	4.05

Treatments	Dry Matter %	Ash %	Crude fat (%)	Crude protein (%)	Crude fiber (%)
	Maize fodder				
P1	42.0	8.18	1.87	10.1	22.9
P2	40.4	7.25	2.02	9.54	23.6
P3	39.6	8.41	1.76	9.87	22.0
P4	46.4	7.12	1.95	11.2	21.5
P5	43.2	7.50	1.97	9.98	23.4
P6	50.8	8.65	1.98	10.9	24.5
P7	38.8	7.94	2.13	9.71	22.0
P8	42.0	7.99	1.93	10.2	25.8
P9	42.0	7.77	2.06	10.6	22.2
	Maize fodder new varieties				

Sahiwal gold maki	32.0	7.85	1.80	10.5	24.5
Y/H 5427-2	39.6	7.50	1.98	9.6	23.1
Y/H 1893-3	26.4	8.00	2.00	11.0	24.8
Gold maki	32.8	7.52	2.09	10.1	23.4
	Maize silage				
1	39.6	8.65	2.09	10.9	23.7
2	37.9	7.65	1.94	10.5	24.3
3	40.9	8.79	2.02	10.0	24.7
4	42.5	7.29	1.99	11.9	22.7
5	37.2	7.72	2.03	10.7	25.0
6	37.7	8.71	2.08	11.6	25.8
7	38.0	8.03	2.01	10.6	23.7
8	39.5	8.26	2.04	11.0	26.4
9	39.7	7.98	1.96	11.1	24.3

3) Nine samples of Sorghum fodders received from Fodder Research Institute, Sargodha and analyzed for HCN (mg/kg) content.

Sorghum Fodder	**HCN (mg/kg)**	**Sorghum Fodder**	**HCN (mg/kg)**
YS 16	260.0	FRI-06	357.5
ABR MS	390.0	F-208	377.0
AMR SGD 1	227.5	Ballo	292.5
i-7	325.0	Sorghum 2011	276.3
K-94	292.5		

4) 120 samples of cotton seed received from Cotton Research Station, Faisalabad and analyzed for crude fat contents.

Sample ID	**Crude Fat (%)**	**Sample ID**	**Crude Fat (%)**	**Sample ID**	**Crude Fat (%)**
1	27.5	41	24.5	81	22.7
2	28.3	42	23.6	82	23.5
3	24.1	43	25.1	83	23.2
4	24.7	44	26.2	84	25.3

5	26.3	45	23.4	85	22.9
6	22.5	46	25.7	86	22.6
7	26.5	47	24.2	87	23.1
8	28.3	48	22.7	88	23.8
9	25.6	49	25.7	89	22.3
10	26.9	50	22.1	90	23.1
11	23.9	51	22.8	91	27.3
12	24.9	52	24.8	92	28.3
13	22.9	53	20.1	93	26.6
14	28.2	54	23.1	94	23.0
15	Missing	55	27.9	95	22.7
16	26.6	56	25.9	96	22.4
17	23.6	57	Missing	97	24.7
18	25.1	58	25.2	98	26.1
19	28.7	59	24.8	99	22.2
20	25.0	60	23.5	100	26.8
21	27.5	61	23.8	101	22.7
22	23.5	62	24.6	102	23.8
23	24.0	63	24.6	103	24.0
24	26.8	64	27.0	104	26.3
25	22.7	65	24.7	105	23.6
26	28.0	66	27.6	106	22.1
27	23.6	67	22.7	107	21.0
28	26.1	68	27.2	108	22.1

29	26.9	69	25.2	109	21.2
30	27.7	70	22.7	110	27.0
31	27.7	71	25.4	111	24.9
32	24.6	72	27.6	112	27.2
33	24.3	73	28.3	113	20.5
34	26.6	74	26.2	114	25.3
35	24.0	75	26.3	115	22.2
36	23.5	76	24.6	116	21.9
37	28.4	77	25.2	117	21.7
38	23.0	78	24.5	118	25.2
39	28.0	79	26.0	119	27.2
40	26.2	80	23.2	120	23.7

5) 30 samples of cotton seed received from Cotton Research Station, Faisalabad and analyzed for crude fat contents.

Sample ID	**Crude Fat (%)**	**Sample ID**	**Crude Fat (%)**	**Sample ID**	**Crude Fat (%)**
121	26.3	131	24.0	141	21.8
122	28.1	132	25.2	142	22.5
123	23.3	133	21.4	143	27.0
124	21.7	134	25.2	144	25.0
125	25.8	135	24.9	145	22.8
126	22.6	136	23.2	146	22.3
127	22.0	137	22.8	147	21.9

128	20.5	138	21.5	148	23.3
129	25.2	139	27.2	149	23.6
130	22.3	140	23.4	150	21.3

6) Three samples of avocado furit received from Hill Fruit Research Station, Sunny Bank, Murree and were analyzed for ash, crude fat, crude protein and crude fiber.

Avocado Fruit

Sample	Moisture %	Ash %	Crude Fat (%)	Crude Protein (%)	Crude Fiber (%)	Antioxidant % DPPH activity
M.G 60	70.1	1.94	11.7	2.28	5.62	89.4
C.L 33	69.4	1.46	12.3	3.15	6.87	89.4
C.B 19	69.5	1.14	11.4	3.15	6.37	92.0

Sample	Vitamin C (mg/100g)	TSS	Acidity (%)	pH	Total Sugar (%)
M.G 60	13.2	6.3	0.17	6.34	Not detected
C.L 33	12.6	7.5	0.15	6.65	Not detected
C.B 19	11.2	6.1	0.17	6.40	Not detected

Avocado Seed

Sample	Moisture %	Ash %	Crude Fat (%)	Crude Protein (%)	Crude Fiber (%)	Antioxidant % DPPH activity
M.G 60	59.7	0.86	7.81	2.19	6.51	74.6
C.L 33	60.9	1.09	9.44	2.89	7.72	66.1
C.B 19	57.7	0.79	7.73	1.40	6.81	71.6

7) Two samples of walnut received from Hill Fruit Research Station, Sunny Bank, Murree and were analyzed for ash, crude fat, crude protein and crude fiber. The results are as under.

Sample	Moisture %	Ash %	Crude Fat (%)	Crude Protein (%)	Crude Fiber (%)	Antioxidant % DPPH activity
Walnut OMS	2.53	1.67	51.1	15.58	7.48	85.8
Walnut (check)	2.81	1.84	58.9	16.10	7.73	84.3

8) Forty eight samples of turnip received from Soil Salinity Research Institute, Pindi Bhattian and were analyzed for ash, crude fat, crude protein and crude fiber.

Sr.No	Salinity levels	Salicylic acid levels	Ash (%)	Crude Fat (%)	Crude Protein (%)	Crude Fiber (%)
1	Control	NS 1	12.6	1.62	4.55	12.5
2		2	13.3	1.59	4.73	11.3
3		3	12.7	1.33	5.08	10.3
4		150 1	12.1	1.84	5.25	12.2
5		2	11.3	1.66	5.43	13.9
6		3	12.9	1.64	5.08	11.1
7		300 1	13.6	1.68	4.38	12.2
8		2	12.1	1.52	4.90	11.9
9		3	11.2	1.59	5.25	13.1
10		450 1	13.9	1.43	5.43	11.3
11		2	10.5	1.48	5.08	11.9
12		3	11.1	1.36	5.78	12.6
13	3ds/m	NS 1	13.9	1.17	6.13	14.5
14		2	11.3	1.41	6.48	13.6
15		3	10.4	1.37	6.30	11.0
16		150 1	12.8	1.75	6.65	11.9

17		2	10.9	1.32	6.83	14.0
18		3	11.5	1.57	6.48	10.7
19		300 1	12.6	1.40	6.65	13.5
20		2	10.0	1.29	6.83	13.6
21		3	10.9	1.34	6.48	11.0
22		450 1	13.1	1.59	6.83	12.9
23		2	12.0	1.48	7.00	11.6
24		3	10.7	1.67	7.35	11.9
25	5ds/m	NS 1	12.1	1.65	8.23	11.2
26		2	11.1	1.47	8.75	11.7
27		3	11.7	1.50	9.10	11.2
28		150 1	13.5	1.41	8.75	14.9
29		2	10.9	1.38	9.28	14.3
30		3	11.0	1.42	9.63	14.7
31		300 1	12.9	1.47	9.80	15.0
32		2	12.6	1.34	9.45	14.1
33		3	11.0	1.46	9.98	14.5
34		450 1	13.0	1.50	9.98	14.0
35		2	10.4	1.46	9.63	13.8
36		3	10.0	1.58	10.15	12.4
37	7ds/m	NS 1	11.8	1.64	10.33	13.5
38		2	11.1	1.54	10.15	13.9
39		3	10.8	1.49	10.33	14.5
40		150 1	12.8	1.63	10.68	15.2

41		2	10.1	1.60	10.50	14.3
42		3	11.3	1.59	10.33	14.0
43		300 1	11.4	1.58	10.68	14.9
44		2	10.1	1.51	10.33	13.7
45		3	10.6	1.55	10.85	12.5
46		450 1	13.5	1.60	11.03	13.8
47		2	11.3	1.66	11.20	14.8
48		3	10.6	1.67	11.38	14.6

9) 85 samples of cotton seed received from Cotton Research Station, Faisalabad and analyzed for crude fat contents.

Sample ID	**Crude Fat (%)**	**Sample ID**	**Crude Fat (%)**	**Sample ID**	**Crude Fat (%)**
151	20.5	179	25.6	207	21.5
152	21.8	180	25.1	208	27.1
153	24.0	181	28.3	209	22.1
154	26.8	182	24.4	210	27.7
155	21.9	183	26.2	211	24.6
156	23.9	184	26.6	212	26.2
157	22.9	185	27.2	213	27.5
158	23.3	186	27.1	214	25.5
159	23.0	187	24.9	215	24.6
160	23.1	188	26.7	216	24.5
161	20.3	189	26.3	217	26.3
162	22.3	190	23.5	218	25.7

163	22.1	191	22.8	219	27.1
164	21.7	192	25.2	220	22.0
165	22.8	193	24.3	221	26.7
166	25.2	194	25.6	222	25.2
167	24.8	195	22.6	223	26.5
168	25.1	196	23.0	224	24.0
169	26.2	197	21.6	225	25.9
170	22.0	198	21.5	226	25.8
171	23.2	199	23.1	227	25.3
172	23.5	200	26.8	228	26.2
173	25.8	201	22.9	229	27.2
174	28.7	202	22.6	230	25.8
175	25.0	203	27.2	231	26.3
176	27.0	204	21.8	232	27.1
177	25.6	205	25.8	233	26.7
178	26.6	206	22.6	234	26.3
				235	25.7

10) 150 samples of different research trials on pulses received from Pulses Research Institute, Faisalabad and analyzed for its quality.

Response of chickpea to *rhizobium* and PGPR co-inoculation

Sample No.	**Ash %**	**Crude Protein %**	**Crude Fat %**	**Crude Fiber %**
T1R1	3.44	21.33	2.59	2.47

T1R2	3.48	21.26	2.64	2.40
T1R3	3.39	21.40	2.56	2.42
T2R1	3.58	21.72	2.87	2.51
T2R2	3.60	21.47	2.83	2.58
T2R3	3.64	21.55	2.90	2.63
T3R1	3.84	21.95	2.93	2.74
T3R2	3.79	21.90	2.98	2.67
T3R3	3.95	22.05	3.06	2.90
T4R1	3.50	21.25	2.60	2.40
T4R2	3.57	20.98	2.44	2.35
T4R3	3.62	21.10	2.52	2.41
T5R1	3.54	21.40	2.47	2.46
T5R2	3.68	21.33	2.55	2.40
T5R3	3.72	21.25	2.60	2.58
T6R1	3.94	22.06	3.10	2.70
T6R2	3.92	21.98	3.06	2.78
T6R3	3.88	21.90	2.88	2.85

Biofortification of Lentil by zinc and iron application

Sample No.	Ash %	Crude Protein %	Crude Fat %	Crude Fiber %
T1R1	3.16	22.39	0.88	3.64
T1R2	3.07	22.10	0.80	3.60
T1R3	3.18	22.48	0.78	3.52
T2R1	3.22	22.54	0.96	3.68
T2R2	3.20	22.48	0.90	3.60
T2R3	3.33	22.50	0.96	3.55
T3R1	3.39	22.68	0.98	3.75
T3R2	3.42	22.70	0.94	3.70
T3R3	3.36	22.65	0.95	3.76
T4R1	3.28	23.08	1.03	3.57
T4R2	3.32	23.10	0.98	3.50
T4R3	3.36	23.35	1.08	3.53
T5R1	3.44	23.60	1.15	3.70
T5R2	3.37	22.70	1.18	3.88
T5R3	3.58	23.40	1.09	3.74
T6R1	3.81	23.78	1.19	3.98
T6R2	3.60	23.70	1.21	4.18
T6R3	3.76	23.60	1.25	4.03
T7R1	3.95	23.95	1.28	4.26

T7R2	3.90	23.90	1.32	4.40
T7R3	3.84	23.72	1.40	4.22
T8R1	3.99	24.21	1.31	4.53
T8R2	3.92	24.40	1.33	4.60
T8R3	3.96	24.28	1.35	4.47
T9R1	4.00	24.66	1.39	4.79
T9R2	4.09	24.60	1.32	4.84
T9R3	4.16	24.52	1.40	4.66
T10R1	4.24	24.90	1.44	5.10
T10R2	4.33	24.98	1.42	4.90
T10R3	4.19	24.75	1.38	4.98

Biofortification of Chickpea (Kabuli) by zinc and iron application

Sample No.	**Ash %**	**Crude Protein %**	**Crude Fat %**	**Crude Fiber %**
T1R1	3.55	20.21	2.35	2.20
T1R2	3.43	20.10	2.30	2.25
T1R3	3.50	20.06	2.38	2.10
T2R1	3.37	20.48	2.48	2.34
T2R2	3.30	20.55	2.53	2.34
T2R3	3.42	20.60	2.50	2.28
T3R1	3.48	20.74	2.55	2.41

T3R2	3.44	20.66	2.52	2.45
T3R3	3.35	20.78	2.60	2.45
T4R1	3.42	21.18	2.67	2.47
T4R2	3.48	21.35	2.62	2.55
T4R3	3.52	21.15	2.74	2.52
T5R1	3.55	21.44	2.80	2.55
T5R2	3.50	21.40	2.90	2.60
T5R3	3.56	21.33	2.84	2.53
T6R1	3.62	22.49	2.93	2.61
T6R2	3.73	22.08	2.87	2.58
T6R3	3.76	22.55	2.98	2.56
T7R1	3.81	22.75	3.05	2.65
T7R2	3.85	22.60	3.10	2.69
T7R3	3.90	22.74	3.13	2.64
T8R1	3.97	22.93	2.55	2.52
T8R2	3.90	22.86	2.78	2.60
T8R3	3.88	22.94	2.59	2.67
T9R1	4.02	23.01	3.26	2.70
T9R2	4.06	23.18	3.30	2.72
T9R3	4.12	23.30	3.35	2.75
T10R1	4.16	23.36	3.40	2.82
T10R2	4.25	23.40	3.55	2.90
T10R3	4.18	23.35	3.46	2.96

Biofortification of Chickpea (Desi) by zinc and iron application

Sample No.	Ash %	Crude Protein %	Crude Fat %	Crude Fiber %
T1R1	3.01	19.08	2.11	1.75
T1R2	2.95	19.13	2.13	1.80
T1R3	2.98	19.25	2.08	1.84
T2R1	3.09	19.43	2.18	1.91
T2R2	3.07	19.20	2.05	1.93
T2R3	3.11	19.33	2.12	1.86
T3R1	3.13	19.60	2.26	2.04
T3R2	3.17	19.44	2.20	2.10
T3R3	3.09	19.58	2.29	2.08
T4R1	3.20	19.78	2.39	2.17
T4R2	3.25	19.70	2.32	2.24
T4R3	3.16	19.25	2.40	2.19
T5R1	3.38	20.48	2.45	2.28
T5R2	3.26	20.35	2.41	2.32
T5R3	3.30	20.10	2.35	2.27
T6R1	3.42	20.56	2.56	2.35
T6R2	3.38	20.60	2.50	2.39
T6R3	3.41	20.66	2.44	2.45
T7R1	3.47	20.74	2.78	2.41
T7R2	3.54	20.60	2.80	2.44
T7R3	3.44	20.54	2.65	2.49

T8R1	3.56	20.56	2.70	2.52
T8R2	3.50	20.60	2.64	2.60
T8R3	3.53	20.47	2.76	2.46
T9R1	3.59	21.35	2.84	2.57
T9R2	3.64	21.10	2.90	2.50
T9R3	3.52	21.19	2.81	2.62
T10R1	3.60	21.88	2.90	2.64
T10R2	3.74	21.80	2.86	2.70
T10R3	3.81	21.65	2.94	2.60

Nutritional quality evaluation of chickpea (Desi and Kabuli) genotypes due to microbial inoculation

Sample No.	**Ash %**	**Crude Protein %**	**Crude Fat %**	**Crude Fiber %**
Kabuli				
Noor-2013 R1 Un-Inoculated	3.37	20.53	2.47	2.40
Noor-2013 R2 Un-Inoculated	3.38	20.88	2.66	2.46
Noor-2013 R3 Un-Inoculated	3.52	21.53	2.75	2.48
Noor-2013 R1 Inoculated	3.70	21.73	2.71	2.60
Noor-2013 R2 Inoculated	3.85	22.14	3.10	2.61
Noor-2013 R3 Inoculated	3.88	22.62	3.15	2.73
Noor-2009 R1 Un-Inoculated	3.34	20.20	2.57	2.36

Noor-2009 R2 Un-Inoculated	3.31	20.48	2.53	2.32
Noor-2009 R3 Un-Inoculated	3.47	20.96	2.63	2.42
Noor-2009 R1 Inoculated	3.72	21.66	2.85	2.55
Noor-2009 R2 Inoculated	3.75	21.48	2.75	2.57
Noor-2009 R3 Inoculated	3.75	21.50	2.70	2.63
K-70005 R1 Un-Inoculated	3.43	20.72	2.60	2.40
K-70005 R2 Un-Inoculated	3.64	21.75	2.92	2.53
K-70005 R3 Un-Inoculated	3.56	21.34	2.69	2.49
K-70005 R1 Inoculated	3.82	22.25	3.08	2.69
K-70005 R2 Inoculated	4.04	22.60	3.21	2.80
K-70005 R3 Inoculated	4.00	22.50	3.20	2.78
Desi				
Bittal-2016 R1 Un-Inoculated	3.23	19.96	2.33	2.13
Bittal-2016 R2 Un-Inoculated	3.27	19.97	2.31	2.07
Bittal-2016 R3 Un-Inoculated	3.19	19.88	2.29	2.14
Bittal-2016 R1 Inoculated	3.67	21.64	2.89	2.57
Bittal-2016 R2 Inoculated	3.71	21.71	2.68	2.57
Bittal-2016 R3 Inoculated	3.81	22.18	3.05	2.64
Pb-2008 R1 Un-Inoculated	3.28	19.65	2.23	1.98
Pb-2008 R2 Un-Inoculated	3.24	19.66	2.23	1.97
Pb-2008 R3 Un-Inoculated	3.19	19.62	2.22	2.03

Pb-2008 R1 Inoculated	3.59	21.61	2.71	2.51
Pb-2008 R2 Inoculated	3.70	21.60	2.95	2.57
Pb-2008 R3 Inoculated	3.77	21.75	2.63	2.52
D-10008 R1 Un-Inoculated	3.31	20.05	2.36	2.28
D-10008 R2 Un-Inoculated	3.22	20.18	2.45	2.27
D-10008 R3 Un-Inoculated	3.31	20.17	2.41	2.23
D-10008 R1 Inoculated	3.69	21.68	2.70	2.60
D-10008 R2 Inoculated	3.74	21.62	2.77	2.54
D-10008 R3 Inoculated	3.84	21.65	2.83	2.74

11) Four samples of Guava was received from Agronomic Research Institute, Faisalabad and analyzed for TSS

Sample ID	**TSS (Brix %)**
1	10.9
GS 111	11.1
3	8.3
4	7.8

12) Three samples of Sangtra were received from Horticulture Research Institute, Faisalabad and analyzed for TSS, acidity, total sugar, vitamin C and antioxidant.

Sample	**TSS**	**Acidity (%)**	**Total Sugar (%)**	**Vitamin C (mg/100g)**	**Antioxidant % DPPH activity**
Sangtra 1	9.9	1.30	8.77	23.8	38.1
Sangtra 2	9.7	1.23	8.38	22.8	39.3
Sangtra 3	10.1	1.26	8.51	23.5	40.6

13) Three samples of Star fruit were received from Horticulture Research Institute, Faisalabad and analyzed for TSS, acidity, total sugar, vitamin C and antioxidant.

Sample	TSS	Acidity (%)	Total Sugar (%)	Vitamin C (mg/100g)	Antioxidant % DPPH activity
Star Fruit 1	6.2	1.11	4.01	29.5	29.4
Star Fruit 2	6.1	0.98	3.90	28.8	27.3
Star Fruit 3	6.5	1.02	3.97	30.0	29.8

14) Four samples of gram were received from Pulses Research Institute, Faisalabad and analyzed for moisture, ash, crude fat, crude protein and crude fiber.

Varieties / lines	Moisture (%)	Ash (%)	Crude Fat (%)	Crude Protein (%)	Crude Fiber (%)
C 144	7.54	3.47	3.69	20.9	4.00
D 16029	6.57	3.00	3.79	21.7	4.19
D 15024	7.09	3.19	3.64	19.1	3.81
Bittal 2016	6.67	3.16	3.78	22.3	4.08

15) Forty Five samples of cotton seed were received from Cotton Research Institute, Faisalabad and analyzed for crude fat.

Sample ID	Crude Fat (%)	Sample ID	Crude Fat (%)	Sample ID	Crude Fat (%)
236	23.8	251	26.6	266	23.5
237	24.8	252	25.2	267	25.8
238	23.2	253	23.6	268	24.6
239	25.3	254	26.5	269	25.7
240	25.2	255	22.1	270	26.2
241	23.8	256	20.6	271	25.7

242	25.9	257	22.8	272	22.4
243	24.0	258	24.8	273	25.6
244	23.8	259	25.5	274	23.3
245	25.6	260	23.1	275	26.0
246	24.7	261	21.4	276	26.4
247	22.0	262	24.3	277	22.3
248	22.1	263	25.7	278	23.4
249	26.7	264	22.9	279	26.0
250	23.3	265	26.1	280	23.4

16) Sixteen samples of Soybean grain were received from Soil bacteriology Section Faisalabad and analyzed for moisture, ash, crude fat, crude protein and crude fiber. The results are as under

Sample ID	**Moisture (%)**	**Ash (%)**	**Crude Fat (%)**	**Crude Protein (%)**	**Crude Fiber (%)**
1	4.90	5.37	17.0	33.8	4.29
2	4.52	5.40	18.8	32.6	4.00
3	6.14	4.94	18.2	35.0	4.34
4	5.86	5.80	18.4	36.1	4.19
5	4.51	5.19	16.5	37.1	4.36
6	4.63	5.18	16.3	36.6	3.81
7	4.27	5.18	22.7	37.6	3.64
8	4.78	5.13	23.0	38.0	4.08
9	4.50	5.11	19.9	38.5	4.02
10	5.67	5.67	18.1	37.8	4.07
11	5.26	5.08	17.5	38.9	3.83

12	4.91	5.25	17.8	38.3	3.51
13	4.42	5.26	16.9	37.3	4.28
14	4.35	5.23	16.0	37.8	4.58
15	4.71	5.16	18.1	37.3	4.84
16	4.53	5.37	18.9	38.2	4.26

17) 45 samples of cotton seed were received from Cotton Research Institute, Faisalabad and analyzed for crude fat.

Sample ID	**Crude Fat (%)**	**Sample ID**	**Crude Fat (%)**	**Sample ID**	**Crude Fat (%)**
281	22.7	296	21.9	311	24.0
282	24.0	297	23.4	312	25.7
283	20.3	298	26.5	313	21.4
284	21.4	299	21.2	314	25.8
285	25.8	300	22.9	315	24.0
286	24.8	301	25.5	316	20.2
287	22.5	302	24.0	317	22.0
288	26.0	303	25.9	318	25.6
289	21.7	304	21.4	319	24.4
290	25.2	305	22.6	320	26.1
291	24.0	306	24.1	321	22.9
292	25.1	307	23.8	322	21.7
293	23.7	308	25.5	323	24.3
294	26.4	309	24.7	324	23.8
295	24.7	310	25.4	325	25.0

18) One sample of citrus was received from Agronomic Research Institute, Faisalabad and analyzed for TSS. The results are as under

Sample	TSS (Brix %)
Citrus	14.4

19) 27 samples of maize grain received from Soil chemistry section, were analyzed for ash, crude protein and crude fiber.

Sample No.	Ash (%)	Crude protein (%)	Crude fiber (%)	Sample No.	Ash (%)	Crude protein (%)	Crude fiber (%)
1	1.13	8.49	1.92	**16**	1.29	9.01	1.91
2	0.98	8.11	2.02	**17**	1.09	8.78	2.07
3	1.04	8.87	2.12	**18**	1.16	8.56	1.75
4	1.11	8.61	1.82	**19**	1.31	9.28	2.11
5	1.21	9.36	1.89	**20**	1.23	8.91	2.23
6	1.27	8.15	1.96	**21**	1.21	8.78	1.99
7	1.13	9.87	1.99	**22**	1.11	8.11	1.93
8	1.26	9.36	2.13	**23**	1.01	8.27	2.01
9	1.08	8.91	1.85	**24**	1.22	8.57	2.15
10	1.28	9.42	2.04	**25**	1.31	8.16	1.93
11	1.12	9.63	2.17	**26**	1.22	8.31	2.01
12	1.02	9.11	1.91	**27**	1.15	8.08	1.85
13	1.18	8.93	2.09				

14	1.31	9.38	2.21				
15	1.13	8.78	2.33				

20) Two samples of chickpea were received from Regional Agricultural Research Institute, Bahawalpur and analyzed for moisture, ash, crude fat, crude protein and crude fiber.

Varieties / lines	**Moisture (%)**	**Ash (%)**	**Crude fat (%)**	**Crude protein (%)**	**Crude fiber (%)**
BRC-474 (Desi)	7.08	3.18	3.38	20.0	3.26
Bittle-2016 (Check)	6.78	3.29	3.68	22.1	3.83

21) orange juice samples received from Post-Harvest Research Centre AARI Faisalabad were analyzed for antioxidants reducing, non-reducing and total sugar

Treatment	**Reducing sugar (%)**	**Non reducing sugar (%)**	**Total Sugar (%)**	**Antioxidants (%DPPH activity)**
T1	3.9	5.0	9.27	74.4
T2	2.8	6.8	10.04	76.4
T3	1.7	4.2	6.06	77.3
T4	2.8	3.0	6	82.3

22) 5 sugarcane juice samples received from Post-Harvest Research Centre AARI Faisalabad were analyzed for antioxidants reducing, non-reducing and total sugar

Sample code	**Reducing sugar (%)**	**Non reducing sugar (%)**	**Total Sugar (%)**	**Antioxidants (%DPPH activity)**
G1	0	13.3	13.3	22.45
C1	0	18.4	18.4	96.65
C2	0	22.8	22.8	28.85
L2	0	23.2	23.2	55.05
K2	0	23.8	23.8	60.05

23) Samples of three (3) varieties / lines of oats fodders received from Fodder Research Institute Sargodha and analyzed for dry matter, crude fat, fiber, protein, ash and NFE

Variety / Line	**Dry matter (%)**	**Ash (%)**	**Crude fat (%)**	**Crude fiber (%)**	**Crude protein (%)**	**NFE (%)**
FRI-01	16.3	11.3	2.51	19.4	10.6	56.2
Sargodha Oats 2011	16.1	10.9	2.45	20.8	9. 9	55.9
Super Green Oats	15.9	9.8	2.25	21.4	10.2	56.4

24) Analyzed 7 samples of potato received from potato Research Institute Sahiwal for starch contents, total minerals, crude protein, vitamin C, total sugar, antioxidant activity

Variety name	**Starch contents (%)**	**Dry matter (%)**	**Crude Protein (%)**
Sahiwal red	15.7	18.7	7.79
Simply red	18.0	19.4	8.58
Sahiwal white	19.0	14.4	8.23
Punjab (FD 18-1)	19.5	20.3	8.31
SANTA	16.6	18.5	8.49
Satluj (FD 76-59)	17.2	19.2	8.40
Kashmir (FD 73-44)	16.5	19.2	7.79

Potato Varieties	**Vitamin C (mg/100g)**	**Total Sugar (%)**	**Total Minerals (%)**
Sahiwal Red	20.7	0.93	5.42
Simply Red	21.0	1.01	4.43
Sahiwal White	19.5	1.04	4.91
Punjab (FD 81-1)	17.9	0.95	4.64
SANTA	19.3	0.96	4.83

Satluj (FD 76-59)	19.7	1.07	5.21
Kashmir (FD 73-44)	20.0	0.98	4.66

25) Samples of different research trials on pulses received from Pulses Research Institute, Faisalabad and analyzed for its quality.

Response of mash to rhizobium and PGPR co-inoculation

Sample No.	**Treatment**	**Crude Protein (%)**	**Crude Fat (%)**	**Crude Fiber (%)**	**Ash (%)**
1	T1R1	22.35	0.90	4.06	3.05
2	T1R2	22.98	1.25	3.72	2.90
3	T1R3	22.42	1.05	3.90	3.20
4	T2R1	23.10	1.21	4.40	3.35
5	T2R2	23.25	1.30	4.21	3.42
6	T2R3	23.50	1.26	4.60	3.70
7	T3R1	22.30	1.22	4.52	3.20
8	T3R2	22.52	1.32	4.40	3.50
9	T3R3	22.10	1.27	4.48	3.28
10	T4R1	22.98	1.33	4.55	3.31
11	T4R2	22.62	1.42	4.78	3.52
12	T4R3	22.48	1.28	4.64	3.60
13	T5R1	23.60	1.14	4.90	3.82
14	T5R2	23.48	1.42	4.86	3.85

15	T5R3	24.08	1.30	4.80	3.71
16	T6R1	24.12	1.48	4.78	3.62
17	T6R2	24.26	1.52	4.90	3.54
18	T6R3	23.90	1.57	5.10	3.51

Biofortification of mung by zinc and iron application

Sample No.	**Treatment**	**Crude Protein (%)**	**Crude Fat (%)**	**Crude Fiber (%)**	**Ash (%)**
1	T1R1	21.90	1.08	4.30	3.10
2	T1R2	21.72	1.11	4.42	2.95
3	T1R3	21.89	1.27	4.11	3.19
4	T2R1	22.90	1.16	4.22	3.56
5	T2R2	23.05	1.26	4.74	3.60
6	T2R3	23.16	1.38	4.33	3.74
7	T3R1	22.75	1.25	4.57	3.32
8	T3R2	23.25	1.28	4.49	3.55
9	T3R3	23.48	1.20	4.60	3.22
10	T4R1	22.32	1.35	4.90	3.41
11	T4R2	22.71	1.15	4.98	3.03
12	T4R3	22.93	1.26	4.91	3.32
13	T5R1	23.28	1.33	4.60	3.19
14	T5R2	23.26	1.29	4.55	3.35
15	T5R3	22.89	1.37	4.82	3.38
16	T6R1	23.07	1.42	5.16	3.70

17	T6R2	22.60	1.19	5.08	3.43
18	T6R3	22.90	1.57	4.80	3.50
19	T7R1	23.12	1.28	4.72	3.20
20	T7R2	22.70	1.42	5.20	3.55
21	T7R3	22.80	1.12	4.60	3.22
22	T8R1	23.21	1.44	5.10	3.60
23	T8R2	22.98	1.38	4.90	3.45
24	T8R3	23.32	1.20	4.80	3.20
25	T9R1	23.55	1.25	4.83	3.60
26	T9R2	23.29	1.56	5.24	3.49
27	T9R3	23.05	1.33	4.20	3.50
28	T10R1	23.52	1.52	5.30	3.90
29	T10R2	22.70	1.40	5.40	3.40
30	T10R3	22.10	1.58	5.10	3.50

Biofortification of mash by zinc and iron application

Sample No.	**Treatment**	**Crude Protein (%)**	**Crude Fat (%)**	**Crude Fiber (%)**	**Ash (%)**
1	R1T1	22.80	1.50	3.51	3.57
2	R1T2	23.90	1.42	3.27	3.15
3	R1T3	24.10	1.21	3.43	3.27
4	R1T4	24.35	1.36	3.32	3.39
5	R1T5	24.49	1.32	3.40	3.46
6	R1T6	23.70	1.40	3.37	3.53

7	R1T7	24.32	1.31	3.59	3.79
8	R1T8	24.10	1.45	3.69	3.65
9	R1T9	24.40	1.19	3.76	3.48
10	R1T10	24.10	1.40	3.80	3.58
11	R2T1	23.15	1.54	3.55	3.54
12	R2T2	24.10	1.58	3.20	3.13
13	R2T3	24.20	1.28	3.50	3.32
14	R2T4	24.40	1.24	3.35	3.39
15	R2T5	24.30	1.39	3.48	3.65
16	R2T6	23.08	1.45	3.35	3.45
17	R2T7	24.16	1.37	3.70	3.60
18	R2T8	24.30	1.31	3.60	3.68
19	R2T9	24.50	1.26	3.80	3.55
20	R2T10	24.12	1.55	3.94	3.60
21	R3T1	22.60	1.60	3.66	3.60
22	R3T2	24.60	1.39	3.31	3.23
23	R3T3	24.20	1.45	3.55	3.30
24	R3T4	24.40	1.34	3.70	3.55
25	R3T5	24.39	1.43	3.51	3.70
26	R3T6	23.82	1.48	3.44	3.42
27	R3T7	24.10	1.40	3.87	3.67
28	R3T8	23.93	1.46	3.83	3.60
29	R3T9	24.68	1.32	3.89	3.50
30	R3T10	24.35	1.59	4.00	3.70

26) Analyzed 12 samples of banana received from Post-harvest Research Centre AARI, Faisalabad

Sr. No	Total antioxidant (%DPPH activity)	Sr. No	Total antioxidant (%DPPH activity)
1	14.3	7	11.3
2	13.3	8	19.0
3	10.2	9	12.3
4	10.5	10	12.7
5	11.0	11	11.9
6	9.6	12	11.1

27) 13 samples of wheat grain received from Wheat Research Institute, Faisalabad, were analyzed for ash, crude fat, crude fiber and Crude protein.

Sr. No	Samples ID	Ash (%)	Crude fat (%)	Crude fiber (%)	Crude protein (%)
1	T_0	0.91	1.17	0.93	9.0
2	T_1	1.01	1.15	1.01	10.2
3	T_2	1.02	1.22	1.08	9.2
4	T_3	0.94	1.21	1.03	9.4
5	T_4	0.97	1.27	0.98	9.9
6	T_5	1.04	1.19	1.09	9.6
7	PG-1	-	-	0.92	10.4
8	PG-2	-	-	1.01	10.1
9	PG-3	-	-	0.99	10.5
10	PG-4	-	-	1.08	9.6
11	X	-	-	-	10.3

12	Y	-	-	-	9.2
13	Z	-	-	-	9.2

28) 04 samples of wheat flour received from wheat Research Institute, Faisalabad, were analyzed for crude protein.

Sr. No.	Samples ID	Crude protein (%)	Sr. No.	Samples ID	Crude protein (%)
1	Finished Flour/Maida	9.1	3	I-S-2	9.6
2	I-S-1	9.8	4	I-R	9.4

29) Analysis report of 5 sugarcane juice samples received from Post-Harvest Research Centre AARI Faisalabad

Sample code	Reducing sugar (%)	Non reducing sugar (%)	Total Sugar (%)	Antioxidants (%DPPH activity)
G1	14.25	13.42	27.7	34.20
C1	15.16	14.84	30.0	38.10
C2	18.75	17.33	36.1	62.34
L2	23.75	10.18	33.9	30.30
K2	21.92	3.30	25.2	38.96

30) Fifteen samples of carrot product received from Post Harvest Research Centre, AARI, Faisalabad and were analyzed for dry matter, ash content, antioxidants and beta carotene.

Sr. No	Carrot Product	Sample ID	Dry Matter (%)	Mineral Matter (%)	Antioxidant Activity (%)	Beta Carotene (µg/100g)

1	Carrot Candy	Y3LT3K3	38.9	0.61	33.1	4056
2		Y3K2L16	28.0	0.86	31.4	4829
3		Y3K1L6	34.5	0.72	30.2	4091
4		T-29	31.7	0.72	30.0	4390
5		Y3K1L33	38.5	0.82	29.6	4214
6	Carrot Jam	Y3LT3K3	-	0.03	28.3	1137
7		Y3K2L16	-	0.10	27.9	1067
8		Y3K1L6	-	0.15	29.4	962
9		T-29	-	0.16	26.3	1067
10		Y3K1L33	-	0.05	27.7	1032
11	Carrot Juice	Y3LT3K3	-	0.62	38.5	5410
12		Y3K2L16	-	0.62	35.5	5761
13		Y3K1L6	-	0.36	36.1	6043
14		T-29	-	0.59	38.6	6500
15		Y3K1L33	-	0.58	35.8	5867

31) 03 samples of guar received from Principal Scientist (Guar), Agricultural Research Station, Bahawalpur has been analyzed for gum, germ + meal, husk, crude protein.

Sr. No.	**Samples**	**Gum (%)**	**Germ+Meal (%)**	**Husk (%)**	**Crude protein (%)**
1	**S-6161**	33.52	38.44	9.48	30.39
2	**S-6547**	34.90	35.10	10.18	33.30
3	**S-6642**	34.40	36.62	9.22	28.73

Summary of samples received from other institutes

Sr. No.	Name of Institute	Type of samples	No. of samples
1	Agronomic Research Institute, Faisalabad	Mung bean	24
		Guava	4
		Citrus	1

		Sub-total	167
2	Fodder Research Institute Sargodha	Oat fodder	3
		Maize	22
		Sorghum	3
		Sub-total	28
3	Post-Harvest Research Centre, Faisalabad	Carrots	30
		Banana	12
		Orange juice	4
		Sugarcane juice	10
		Sub-total	56
4	Soil Chemistry Section, AARI, Faisalabad	Maize grain	27
5	Cotton Research Institute, Faisalabad	Cotton seed	325
6	Hill Fruit Research Station Muree	Avocado	3
		Walnut	3
		Sub-total	6
7	Regional Agricultural Research Institute, Bahawalpur	Chickpea	4
		Guar	3
		Sub-total	7
8	Horticulture Research Institute, Faisalabad	Sangtra	3
		Star fruit	3

		Sub-total	6
9	Wheat Research Institute, Faisalabad	Wheat grain	13
		Wheat flour	4
		Sub-total	17
10	Potato Research Institute Sahiwal	Potato	7
11	Fodder Research Institute Sargodha	Maize	22
		Sorghum	3
		Oats	3
		Sub-total	28
12	Pulses Research Institute Faisalabad	Chickpea	112
		Mung bean	30
		Mash bean	48
		Lentil	30
		Sub-total	220
13	Soil Salinity Research Institute Pindi Bhattian	Turnip	48
14	Soil Bacteriology Section, Faisalabad	Soybean	16
Grand Total			**961**

MISCELLANEOUS ACTIVITIES

- An amount of Rs. 3249869/- from pilot plant production was deposited into the Government Treasury.
- 360 ladies; farmers and entrepreneurs have been trained at 12 different places, throughout the Punjab province.
- 26 Radio talks were got recorded for broadcasting.
- Supervised 30 students and internees from different Universities and Colleges throughout Punjab Province.

RUNNING PROJECT DETAIL

1. PARB Project No. 914

One projects (as Team leader)

Title: Development, Optimization and Technology Dissemination of value added products of selected fruits and vegetables

Duration: 2017-2021 (3 years)

Project is initiated to develop stable pulp/juice from selected fruits and vegetables for longer shelf life under ambient conditions through evaluation by physico-chemical characteristics. Three trainings were given to farmers at Gujranwala and sharaqpur regarding pulp preparation from different fruit and vegetables and to preserve for future use to make value added products. They were also informed to which industries they can sell the pulp.

2. PARB Project No. 929

Another projects (as Team leader)

Title: phenotypic and genotypic exploration of worldwide carrot germplasm to enhance its value added application in pakistan

Duration: 2019-2021 (3 years)

Nutritional profile of 73 carrot accessions was performed and five best accessions was selected on the basis of nutrional profile to develop different value added products (candies, drink, jam). These products were stored for six months to assess the quality during storage. Product was distributed among school going children to combat malnutrition.

3. PARB Project No. 904

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

Duration: 2017-2022 (5 years)

Project is initiated to address the issue of malnutrition in human by bio fortification of various crops and fruits. During the year 2020-21, section analyzed a total of 964 samples including maize (38), chickpea and mung bean (63), citrus (66), wheat (707) mango (78) and tomato (12) for different quality parameters.

PUBLICATION:

- Rabia Kanwal, Hadeed Ashraf, Muhammad Sultan, Irum Babu, Zarina Yasmin, Muhammad Nadeem, Muhammad Asghar, Redmond R. Shamshiri, Sobhy M. Ibrahim, Nisar Ahmad, Muhammad A. Imran, Yuguand Zou and Riaz Ahmad. 2020. Effect of 1-Methyl cyclopropane and modified atmosphere packaging on the storage of okra (*Abelmoschus esculantus L.*): Theory and Experiments. Sustainability 12, no. 18: 7547.
- Microwave assisted drying and extraction technique; kinetic modelling, energy consumption and influence on antioxidant compounds of fenugreek leaves. 2020. Muhammad Kashif Iqbal khan, Yasir Mahmood Ghauri, Tayyaba Alvi, Usman Amin, Muhammad Issa Khan, Akmal Nazir, Farhan Saeed, Rana Muhammad Aadil, Muhammad Tahir Nadeem, Irrum Babu, Abid Aslam Maan. Food Science and Technology.
- Zahra, Tehreem, Muhammad Irfan, Muhammad Nadeem, Misbah Ghazanfar, Qurratulain Ahmad, Shaukat Ali, Farzana Siddique, Zarina Yasmeen, and Marcelo Franco. "Cellulase Production by Trichoderma viride in Submerged Fermentation using Response Surface Methodology." Punjab University Journal of Zoology 35, no. 2 (2020): 223-228.
- Ahmad, Uswa, Rabia Shabir Ahmad, Muhammad Shahbaz, Ali Imran, Muhammad Haseeb, Farzana Siddique, Zarina Yasmin, Ijaz Ashraf, Ashir Masroor, and Abdul Basit. "Hematological and toxicological effects of aqueous leaf extract of Stevia rebaudiana Bertoni in normal rat modals." Pakistan Journal of Pharmaceutical Sciences 33 (2020).
- Ahmad Din, Muhammad Farhan Jahangir Chughtai, Tariq Mehmood, Adnan Khaliq, Muhammad Nadeem, Samreen Ahsan, Rai Muhammad Amir, Muhammad Abrar, Kanza Saeed & Muhammad Sajid Manzoor (2021) Shelf Life Extension of Mango Fruit by using Non-Preservative Technique, International Journal of Fruit Science, 21:1, 232-241, DOI: 10.1080/15538362.2020.1868381

- Usman, Muhammad, Prasanna Jagannath Patil, Muhammad Faisal Manzoor, Muhammad Bilal, Shabbir Ahmed, Mian Anjum Murtaza, Haroon Shah, Nida Nawaz, Sohail Amjad, Muhammad Abrar. Dough rheology and the impact of zinc sulfate on the quality of cookies. Food Science and Technology [online]. 2021 [Accessed 10 August 2021], Available from: <https://doi.org/10.1590/fst.34220>. Epub 03 Feb 2021. ISSN 1678-457X. https://doi.org/10.1590/fst.34220.
- Anwaar Ahmed, Hafiz Muhammad Rizwan Abid, Asif Ahmad, Naeem Khalid, Sahar Shibli, Rai Muhammad Amir, Arshad Mahmood Malik, Muhammad Asghar. Utilization of mango peel in development of instant drink. Asian J Agric & Biol. 2020;8(3):260-267.
- Development of apricot (Prunus armeniaca L.) powder and its food application. 2020. Anwaar Ahmed, Ali Raza, Naeem Khalid, Arshad Mehmood Malik, Muhammad Asghar and Hafiz Muhammad Rizwan Abid. Journal of pure and applied agriculture, (2020) 5(2): 26-33.
- Muhammad Abdullah, Makhdoom Hussain, Muhammad Zulkiffal, Sadaf Shamim, Hira Shair, Javed Ahmed, Majid Nadeem, Nauman Ali, Muhammad Owais, Muhammad Hammad Tanveer, Javed Anwar, Sikandar Ali Cheema, Muhammad Zeeshan, Amna Kanwal, Anjum Javed, Muhammad Asghar, Aftab Ahmed Khan and Muhammad Yaqub Mujahid. 2020. Qualitative estimation and quantitative confirmation of micro elements in bread wheat genotypes by multivariate study. Bioscience Research, 2020 17(2):1147-1155.
- F. Shabir, M. Sultan, S. Noor, G. Hussain, T. Miyazaki, A. Shakoor, R. Kanwal, Y. Niaz, M. A. Imran, M. Khalid (2021). Study on adsorption equilibrium of adsorbent-refrigerant pairs for adsorption cooling system application. Fresenius Environmental Bulletin, 30(1), 216-224.
- S. Ashraf, M. Sultan, G. Hussain, S. Noor, H. Ashraf, T. Miyazaki, R. R. Shamshiri, R. Kanwal, M. H. Mahmood, Y. R. Taseer, Y. Niaz (2021). Investigation of water-vapor adsorption onto metal-organic frameworks (MOFs) for greenhouse air-conditioning application. Fresenius Environ Bull.
- A paper entitled “Biocontrol of Fusarium oxysporum through alteration in root exudates of maize by microbial inoculation” published in Journal of Agricultural Research 59(1), 29-34; 2021.

- A paper entitled "Foliar and soil applied micronutrients improve yield and quality of kinnow" published in Pakistan Journal of Agricultural Sciences 57(6), 1539-1547;2020.

Seminar/conference attended

- Seminar on "Celebration of Kashmir Solidarity Day" on 05-02-2021 in AARI, FSD.

TRAININGS ATTENDED:

1. Attended Two days training on "general awareness training on Good hygiene practices on processing" on 16-17 Feb 2021 by Establishment of Model Farms Linked with Improved Supply Chain and Value Addition at Potato Research Institute, Sahiwal.

- One day training on "Project management" by National Productivity Organization under the ministry of Industries and Production.
- Attended two days training on "General awareness training on sanitary and phytosanitary (SPS) measures and protocol" at Potato Research Institute Sahiwal.
- Attended NPO Training programs on "Risk Management".
- One day training on "mendley reference management" on 03-06-21.
- On day training on "Determination of soil texture and NH4OAC extractable K" from ISCES Faisalabad.
- Two days training on "Method validation and verification ISO 17025:2017" held at AARI, Faisalabad from 3rd December to 4th December.
- One day training on "Determination of soil texture and NH4OAC extractable K" on 29th December 2021 at ISCES, Faisalabad

MEETINGS ATTENDED

Sr. No.	Date	Meeting agenda	Venue
1	13-10-21	Attended meeting of Annual Program of Research Work for the year 2021-22.	PHRC, AARI, Faisalabad
2	01-09-21	Attend the annual performance review meeting of research wing (FY 2019-20)	AARI, Faisalabad
3	11-08-21	Attended the Progress review meeting of PARB-904 Project	AARI, Faisalabad

REPORTS SUBMITTED DURING 2020-21

The following reports were submitted

- 12-Monthly progress reports.
- 12-Monthly progress reports for Secretary Agriculture
- One Annual technical report for the year 2019-20
- One Abridged report for the year 2019-20
- Progress report of PARB-904.
- Administrative and financial report PARB Project-904
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SENIOR SCIENTISTS

1. Mr. Anjum Javed
   Director
   Cell: # 0300-7242844
   Email:anjumjaved2023@gmail.com
2. Dr. Ata-Ur-Rehman
   Food Technologist
   Cell: # 0333-6603579
   Email: ata_rehman479@hotmail.com
   Email: dr.ata.foodtechnologist@gmail.co
3. Dr. Muhammad Abrar
   Food Technologist
   Cell; # 0300-7273025
   Email: mabrarft@gmail.com
4. Mr. Muhammad Asghar
   Food Technologist
   Cell: # 0300-6070366
   Malikasghar66@gmail.com.
5. Mr. Nisar Ahmad

Agri. Chemist (Bio)

Cell: # 0300-9664642

Email: acbiochem@hotmail.com

6. Mr. Khalid Hussain

   Assistant Agri. Chemist

   Cell # 0301-7083510

   Email: mujtabaa142@gmail.com

7. Ms. Zarina Yasmin

   Assistant Food Technologist

   Cell: # 0301-7151500

   Email: zaareena@gmail.com

8. Mr. Abdul Rahim Khan

   Assistant Food Technologist

   Cell: # 03216684658

   Email: khakan01@gmail.com