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Contents

Highlights	1
Plant Breeding and Genetics Division	4
Entomology Division	15
Food Science Division	21
Soil Science Division	29
Socio-Economic Impact	35
Publications	37
Funded Research Projects	39
Manpower	41
Promotions/Transfers/Retirements	44
Events Calendar 2014 Organized	45
NIFA in Pictures	46

HIGHLIGHTS

This report covers the R & D activities of NIFA for the year 2014. During this period, the aims of research and development efforts were i) enhancement of crop productivity through development of new varieties, integrated plant nutrient and soil management practices and improved crop protection measures/approaches, ii) Preservation and value addition of food commodities. Salient research and development activities carried out during the report period are described below:

Plant Breeding & Genetics

The Plant Breeding and Genetics Division is committed to provide regular assistance to the farming communities of Khyber Pakhtunkhwa by developing improved varieties to increase per acre yield. Consistent efforts are being made to maintain the seed purity and a total of 15 tons quality seed of NIFA released wheat varieties was produced. The seed was distributed to Agric. Extension Department, seed companies and farming communities of KPK. A newly developed recombinant wheat line NRL0707 that proved its worth for yellow rust resistance coupled with high yield will participate in the varietal release competition in the Provincial Seed Council. Two newly developed candidate lines, i.e. CT-09137 and SRN-09111 included in the national trials performed well and out yielded all the candidate varieties. Elite drought tolerant wheat lines NRL 1123, NRL 1130 and NRL 1139 secured 1st, 2nd and 3rd position in Khyber Pakhtunkhwa wheat yield trials. Genetically pure seed of oilseed brassica varieties i.e. Abasin-95, Durr-e-NIFA and NIFAGold-2013 was produced. Under variety popularization program, 10 demonstration plots were laid on farmers fields in KPK and an average yield of 2800 Kg per hectare was achieved by farmers. Under Pulses improvement program 25 Chickpea mutants produced significantly higher yield than the check variety. Similarly 75 advanced mungbean mutants/recombinants out yielded the check variety Ramzan in different yield trials conducted at the institute. The candidate mungbean lines NIFA mung-1, NIFA mung-2 and NIFA mung-3 produced 10, 17 and 30% higher seed yield, respectively than national check in National Uniform Yield Trials. The biotechnology group mainly deals with sugar crops, i.e., sugarcane and stevia. Seed of higher cane and sugar yield sugarcane lines CPSG-1550, CSSG-1402, CPSG-468 and CPSG-169 was multiplied for confirmation and testing in the multilocational trials for varietal development. Selections were carried out for higher yield and steviosides content in callus irradiated material. Seven selected mutant plants were analyzed on HPLC for stevioside and rebaudioside-A contents. The Plant Pathology group analyzed the yellow rust resistance genes Yr1, Yr5, Yr6, Yr7, Yr8, Yr9, Yr10, Yr15, Yr17, Yr18, Yr24, Yr2, Yr27, Yr32 and YrSp in Avocet background that behaved differentially across Khyber Pakhtunkhwa. No virulence was found against Yr5, Yr10 and Yr15 which is reported in number of genotypes and can be used in wheat improvement program.

Entomology

The Entomology Division is engaged in the integrated control of fruit flies, termites, peach flat-headed borer, and chickpea pod borer. Under the Integrated pest management (IPM) program, we are employing different IPM components (chemical, biological, cultural, phytosanitary and irradiation to reduce pest losses. Citrus and mangoes are the two leading fruits of Pakistan in terms of area, production, and export. The division has close collaboration with the International Atomic Energy Agency (IAEA) on the development of generic irradiation doses for pests of quarantine importance and in post harvest life extension of fresh commodities. Under the integrated vector management control (IVM) program, the division has active collaboration with the national and international organizations in devising short and long term control strategies for the control of insects spreading deadly disease of animals and human beings.

Food Science

The overall focus of R&D in the Food Science Division is to devise ways and means to ensure food safety and security. Scientists in this division are working on value addition and shelf life extension of agricultural commodities through gamma irradiation and other modern techniques. R&D work on project entitled “Development of Innovative Nutraceuticals Products from Indigenous Herbal Ingredients for Improving Socio-economics Status of the Communities” was continued. During the study period, three products were developed including 1. Cardio-NIFA, 2. Nutra-N and 3. Gastro-NIF. All developed products were analyzed microbiologically for total bacterial and fungal count. No growth was observed in any sample, hence the products were found safe for human consumption. In the project Development of irradiated foods for immunocompromised patients and other target groups the 3rd efficacy trial of irradiated food was conducted on cancer patients at INOR hospital, Abbottabad. Drastic decrease in body weight was recorded in control group as compared to test group patients in which the body weight was maintained during the entire period of one month study. From the data, it was also noted that Hemoglobin content of

patients served on treated diets was significantly increased during study period of four week, while no significant difference was recorded in the patients served on normal hospital diets. Pesticide residue monitoring in fruits and vegetables was carried out under the PSF funded research project “Development and Validation of Technologies for Pesticide Residue Management in Fruit and Vegetable Produce”. Cabbage samples were found most contaminated with mean pesticide residue concentration of 0.74 mg/kg followed by 0.51 mg/kg in cauliflower and 0.46 mg/kg in spinach samples. Residues of variety of compounds were detected in the vegetable. Pesticide residue in peel and pulp of peach were used to study pesticide migration. Significant amounts of thiamethoxame and imidachloprid residue migrated from peel to pulp while majority of heptachlor, chlorpyrifos and cypermethrin residues remained on the peach peel. Effect of washing was least effective for pesticides with higher tendency of migration in pulp.

NIFA Food Nutritionists developed a commercial based rapid test kits for the estimation of Iodine in salt. Under this project studies were conducted to determine the efficacy of these Rapid Test Kits (RTK) for the estimation of iodine in salt samples collected from District Nowshera, Peshawar and Charsadda and compared with already developed Standard RTK and with Standard titration method. Shelf life of iodized salt was studied for four months. There was a non-significant difference ($p > 0.05$) between results of iodine contents of salt samples determined by Standard Titration method and Standard RTK method and were positively correlated with each other. The same group also conducted the influence of genotype and sowing date on phytic acid contents and other physic-chemical characteristics of wheat grain. The Food Nutrition Group also worked on development of package of technology for poultry feed irradiation in Pakistan. Cost economics was worked out on chicks fed on irradiated feed and those fed on commercial feed with added antibiotics. The group is also busy in the development of nutrient enriched food products. Another aspect of economical and nutritional importance on which this group is working as quality improvement of cotton seed oil by fortification of Flax Seed oil. Food Nutrition and Technology Group of FSD is working on development of market life enhancement technology of persimmon and its dissemination to growers. The section is also working on development of snack product through extrusion cooking and development of method for preservation of Strawberries. The team working on mushroom cultivation and popularization has arranged several training in Swat and Hazara this year also and trained many potential growers. Model Mushroom farms were also established at 8 new vicinities.

Soil Science

To achieve food security and reduce the environmental footprints of agricultural sector we need to make better use of arable land, water and nutrients, we have to maximize the potential of using climate smart agricultural practices to improve soil health, quality and water use efficiency and to increase crop productivity. The scientists of soil science division are trying to overcome these apprehensions through best management and conservation of these natural resources. During the period under report the idea of growing off season vegetables was conceptualized and the high tunnel farming technique having drip or sprinkler irrigation systems was developed and perfected at experimental level. The yield data indicated that maximum tomato fruit yield of 3800 kg/10 Marla tunnel was obtained by applying NPK at 80 N + 80 P_2O_5 + 90 K_2O kg.ha^{-1} after 30 days interval (after transplanting) till mid of June. Cucumber fruit yield of 3500 kg/10 Marla was recorded in the treatment receiving NPK at 125 N + 200 P_2O_5 + 250 K_2O kg ha^{-1} (soil application) + B spray (0.1%) at 15 days interval till mid of May (Four sprays).

The hydroponics studies on zinc (Zn) efficiency revealed that genotype NRL-1243 has the maximum dry matter production at 40 pM Zn^{+2} which was 7.59 g.pot^{-1}. In the Zn deficient solutions (2 pM Zn^{+2}), shoot dry matter production was distinctly lower. By exploiting these variations in dry matter production the efficiency of genotypes was calculated that varied between 16 to 59 %. Out of 10 genotypes 4 have been identified as Zn efficient and 4 as Zn-inefficient. The results from solution culture experiments are only reliable when they have been tested under field conditions. Keeping in view, 10 genotypes, (4 Zn-efficient, 2 medium, 4 Zn-inefficient) were tested at two levels of Zn (0, 5 kg.ha^{-1}) and it was observed that all the genotypes maintained the efficiency ranking assigned to them in hydroponic studies. Phosphorus acquisition is a variable among crop species and even in cultivars which can be exploited to develop P efficient crop varieties. The study on this aspect indicated that wheat genotypes NRL-1105 and NRL-1120 were found P-efficient while NRL-1101 and NRL-1129 were found P in-efficient genotypes. The results of another study indicated that maximum grain yield of (33.6 gm.pot^{-1}) was recorded in treatment where TSP + 5 tons FYM.ha^{-1} was applied followed by the treatment SSP + 5 tons FYM.ha^{-1}. Under PSF funded project, the effect of foliar applied NPK, humic acid and Zn on plum fruit orchards was studied at NIFA research farm and farmers fields in Nowshera. Maximum fruit yield at all experimental sites was recorded in foliar applied NPK and humic acid treatment. The studies on water use efficiency indicated that Fakhr-e-Sarhad (50 kg.ha^{-1}.mm^{-1}) and Bathoor (17 kg.ha^{-1}.mm^{-1}) were the most water use efficient varieties under rain-fed and irrigated conditions, respectively.

Publications

Twenty (20) research papers were published in national and international journals (Pages 37-38).

Funded Projects

Nineteen (19) research projects funded by national as well international agencies (PSF, ALP, and IAEA) are going on at NIFA (Page 39-40).

Training Courses/Workshops

Seventeen (17) national/international training courses/workshops were organized by NIFA scientists including those given on page 45.

Acknowledgments

The team work of NIFA scientists and staff members has been commendable throughout the report period and certainly deserves appreciation and acknowledgment. On behalf of NIFA employees and myself, I sincerely thank the PAEC authorities for their continued financial and moral support in helping the Institute to achieve its mandatory objectives.

Director NIFA

PLANT BREEDING & GENETICS DIVISION

Wheat Improvement

Wheat being the staple food crop occupies strategic space in the agricultural policy and covering about 58% of the food crop area in Khyber Pakhtunkhwa (KPK) Province. It is grown in diversified agro-climatic zones like north western hilly tracts, the central irrigated/semi-irrigated plans and southern mixed dry/hot areas in the province. The crop is always exposed to different biotic and abiotic stresses on account of which per acre yield is the lowest as compared to that achieved in other provinces of the country. Realizing the facts, NIFA wheat breeders are making concerted efforts for developing potential cultivars to meet the need of the farming communities for breaking the yield barriers coupled with tolerating the adverse climatic conditions. The research efforts to entertain the problems of irrigated/rainfed areas during the reported period are summarized as under:

Wheat - Irrigated

Seed production and maintenance of NIFA released wheat varieties

NIFA since its establishment has released a number of improved varieties for irrigated areas like Fakhre Sarhad and Bathoor that are continuously performing well in the province and there is an increasing seed demand from government organizations, seed companies and farming community. Consistent efforts are being made by wheat breeding team at NIFA to maintain seed purity and produce quality seed as well in the best interest of the farming community. Progeny rows / blocks of NIFA wheat varieties were planted on the available land at the institute. Progeny rows / blocks having off-type plants were discarded. Breeder nucleus seed was planted for production of Pre-basic / Basic seed duly inspected by the FSC & RD officials. A total of 5674 kg quality seed of these varieties was produced and after processing and certification by FSC & RD the seed was distributed to Agric. Extention Department, seed companies and farming communities of KPK.

Popularization and demonstration plots on Farmer`s field

The plantation of demonstration plots on Farmer's field help sin quick popularization of NIFA varieties with subsequent seed proliferation. Selected demonstration plots (54) one acre each of the released variety were planted in 10 districts of KPK on farmers field (Source seed plus fertilizer were provided free of cost from WPEP project) for quick proliferation of the variety. A total of 90.17 tons of seed was produced which was sufficient for planting 2250 acres of wheat crop.

Evaluation of candidate wheat lines in National Uniform Yield Trials under irrigated conditions

The country-wide field evaluation of candidate varieties provided by wheat breeder's are a vital link between genetic improvement and the production environment. The evaluation of candidate wheat lines in national uniform yield trials is a pre-requisite for the release of new varieties. Two newly developed candidate lines, i.e. CT-09137 and SRN-09111 were included for evaluation in the national trials. The lines perform well and out yielded all the varieties included in the trial in Khyber Pakhtunkhwa. On the basis of its yield performance and disease resistance these lines were again included in the 2014-15 NUYT trials for the second year mandatory evaluation. The lines were also found resistant to leaf and yellow rust as reported by Crop Disease Research Institute (CDRI report 2014).

Evaluation of advanced wheat lines in KPWYT under irrigated conditions of KPK

Multilocation testing / zonal trials of advanced wheat lines is a pre-requisite for development of new genotypes with wider adaptability and selection of suitable candidate varieties for evaluation in national uniform yield trials. For assessment of grain yield stability 06 promising genotypes (CT 10164, CT 10187, SRN 10013, SRN 10023, SRN 10055 and SRN 10103) along with local commercial check cultivar (NIFA Bathoor) were tested across 13 different locations in the KPK. The genotype CT-10164 secured the second position across these locations under normal planting regime.

Agronomic evaluation of elite wheat genotypes in advanced yield trials under irrigated conditions

Evaluation of desirable selections on the basis of better field performance in preliminary yield trials is a prerequisite for attaining the elite status. The selected elite genotypes are being regularly tested in advanced yield trials conducted at the institute, as well as on few selected locations in Peshawar valley. A total of 36 genotypes were evaluated in two advanced selection yield trials under both normal and late planting conditions at NIFA. In ASYT-1 eleven genotypes out yielded both the check cultivars; (Bathoor-08; 3721 $kg.ha^{-1}$);

Pirsabak-2008 (3699 kg.ha^{-1}). In ASYT-2, six genotypes out yielded both the check cultivars (Bathoor-08; 3832 kg.ha^{-1}); Pirsabak-2008 (3765 kg.ha^{-1}) produced higher yield with no disease symptoms. Six genotypes CT-10035, CT-12016, CT-12176, CT-12201, CT-12225 and IC-1206 were selected for evaluation in KPWYT based on high yield and resistance to prevailing diseases of wheat.

Preliminary evaluation of new genotypes

Preliminary yield trials provides an important plate form for detailed assessment with regards to yield/ yield components of the newly selected wheat genotypes isolated from non-replicated observation nurseries, mutant population and recombinants. One hundred genotypes were evaluated in PYT-I & PYT- 2 including three check varieties (Fakhre Sarhad, Bathoor-08 and Pirsabak-2008) in each trial under both normal and late planting conditions at NIFA. Based on yield performance and disease reaction, 32 genotypes were selected for further evaluation. Out of the selected genotypes, 30 produced higher grain yield than the high yielding check, Pirsabak 08 while 2 of the selected genotypes out yielded the low yielding check. The highest yield was produced by SRN-13121 (6831 kg.ha^{-1}) followed by CT-13022 (6614 kg.ha^{-1}) and CT-13081 (6264 kg.ha^{-1}).

Field evaluation of exotic wheat germplasm

Global exchange of wheat germplasm, in particular, CIMMYT / ICARDA through provision of observation nurseries to cooperating institutions always play a positive role for having desirable idiotypes by the breeders. International Bread Wheat Screening Nursery (46th IBWSN) consisting of 329 genotypes received from CIMMYT, Mexico, was evaluated with local checks Bathoor-08. Based on plant type, yield performance and disease reaction (Yr and Lr) a total of 77 genotypes were initially selected based on field observations and yield data. The selected genotypes, out yielded the check genotype Bathoor 08 (7491 kg.ha^{-1}) by producing grain yield in the range of 7599 to 9900 kg.ha^{-1}. Stem Rust Nursery (8th SRN-2013-14) consisting of 200 genotypes was also evaluated for yield performance and disease (Yr) reaction with local check Bathoor-08. Out of 150 genotypes, 28 were selected for further evaluation and confirmation of their desired traits. The selected genotypes out yielded the check variety (9006 kg.ha^{-1}) by producing grain yield in the range of 9066 to 10532 kg.ha^{-1}.

Raising of segregating populations and creation of genetic variability

Continued raising of different segregating populations achieved through gene pyramiding and single gene mutation is the most important breeding strategy that ultimately results in the availability of homozygous genotypes. A crossing block consisting of 182 variable genotypes was planted on three different dates for acquiring floral synchrony among early and late flowering parents. Based on transfer of genes for disease resistance and other economically important traits to otherwise well adapted cultivars/genotypes, twenty nine fresh cross combinations among desirable wheat genotypes were attempted and F_0 seeds were harvested from sixteen successful cross combinations. F_1 generation resulted from twenty six successful cross-combinations was harvested and raised at Summer Wheat Research Station (SWRS) Kaghan for advancement. Fourteen desirable recombinants were selected from F_3 generation resulted from twenty nine successful cross combinations and were planted at SWRS Kaghan for advancement. Forty one uniform families from 8, 11, 13 and 7 cross combinations of F_4, F_5, F_6, F_7 populations, respectively were screened in the field for disease resistance and other desired agronomic traits. Out of 41, 25 desirable families were retained for further screening and planted SWRS Kaghan for advancement. The selected populations were harvested and planted at NIFA for advancement of generation and selection under artificial disease pressure.

Wheat - Rainfed

NIFA new candidate line “NRL0913” in NUWYT-R

An outstanding NIFA rainfed wheat line NRL0913 having parentage of PRL / SARA // TSI / VEE # 5 / 3/WBLL1 selected from 26th SAWSN (Entry # 3053) along with twenty three genotypes of different institutes were tested in first year mandatory testing under national uniform wheat yield trials (NUWYT- Rainfed). The line produced an average grain yield of 3058 kg.ha^{-1} on country basis. The line was also found to be resistant to leaf and yellow rust as reported by Crop Disease Research Institute (CDRI report 2014).

Botanical characterization of NIFA candidate lines

Four candidate lines (NRL 0913, NRL 1123, NRL 1130 and NRL 1139) that showed high yield performance and wider adaptation were grown for plant characterization. As a pre-requisite for varietal release, detailed botanical characteristics

were recorded for each individual line at different growth stages.

Khyber Pakhtunkhwa Wheat Yield trials (KPWYT-R)

The relative effects of environment, genotypes and their interaction on grain yield and agronomic attributes were assayed using 20 promising bread wheat genotypes grown in replicated trials at the plains, southern parts and northern part of Khyber Pakhtunkhwa. The trails were fertilized under typical cultural conditions and no irrigation was applied. NIFA elite lines NRL 1123, NRL 1130 and NRL 1139 secured 1st, 2nd and 3rd position respectively by producing 18-25% higher grain yield than the check (Shahkar 2013). These lines also showed resistance to yellow and leaf rust. The lines NRL 1123 and NRL 1130 were selected for testing in national trials during 2014-15.

Advanced Barani trials (ABT)

Twenty promising genotypes were evaluated for grain yield, yield components and disease resistance along with check cultivar Lalma in two advanced barani trials (ABT-I and ABT-II) at the institute. Based on grain yield and disease resistance 11 promising genotypes were selected. NRL1213 produced the highest grain yield (4849 $kg.ha^{-1}$) followed by NRL1206 (4670 $kg.ha^{-1}$). The other selected genotypes produced yield in the range of 3359 $kg.ha^{-1}$ to 4344 $kg.ha^{-1}$. The elite line NRL 1213 out yielded the check cultivar Lalma by a wide margin of 22%.

Preliminary Barani Trials (PBT)

Thirty six wheat genotypes along with local checks NIFA Lalma and Barsat were tested for grain yield, disease resistance and other agronomic traits in 03 preliminary yield trials (PBT-1, PBT-2 and PBT-3) under moisture stress conditions at the institute. Twenty genotypes were selected on the basis of higher yield and disease resistance (Yr & Lr). Highest grain yield (6556 $kg.ha^{-1}$) was produced by NRL1306 followed by NRL1301 (5703 $kg.ha^{-1}$) and NRL1302 (4908 $kg.ha^{-1}$). NRL 1306 out yielded the check cultivar Lalma by 25% and Barsat by a huge margin of 66%.

International Wheat Observation Nurseries

Two international wheat screening nurseries i.e. 31st SAWSN (Semi-Arid Wheat Screening Nursery) and 8th HTWSN (Heat Tolerant wheat screening nursery) comprising of 219 and 121 exotic genotypes respectively were field evaluated in a non-replicated fashion under moisture stress conditions at the institute. Data with regards to yield, yield components and disease were recorded for each genotype. Based on field performance 50 best genotypes were identified and selected. These entries also expressed resistance against the prevailing rust races. The data was further submitted to national wheat coordinator NARC.

Hybridization

Segregating population of Tatara/NR390, Barsat/NR395, Barsat/NRL3066, NRL 1107/Lalma, RIL 0815/Barsat, Lama/Barsat, Marvi/RIL0815, NRL 0707/Barsat, Tatara/Tdm, Tatara/Seher, Tatara/SGMT, Marvi/Tatara, Tdm/Tatara, Lalma/Tatara, Lalma/Marvi, RIL0815/WX58, Marvi/Tatara//WX58 and Barsat/WX175 were raised as F_i generation (F_1 to F_4) at NIFA experimental farm. Desirable selections will be made on the basis of yield and disease resistance. The population was planted at SWRS-Kaghan in the month of June, 2014 for generation advancement.

In order to create genetic variability for high grain yield and disease resistance, fresh crosses of wheat cultivars / genotypes were carried out. Nine F_1 generations of different recombinants were also raised. Seed of the F_1 populations are harvested and seed was bulked and stored after proper labeling.

Response of wheat genotypes to disease reaction

Rust is one of the main factors that limits wheat yield in Khyber Pakhtunkhwa. Eighteen newly selected rainfed wheat genotypes were screened for stripe / leaf rusts at hot spots in the country in National Wheat Diseases Screening Nursery (NWDSN). Morocco was used as a susceptible check. Fourteen advanced NIFA wheat lines showed high level of resistance both to leaf and yellow rust (CDRI Report 2014).

Development of wheat mutants for higher yield and improved efficiency of water and nitrogen use (RC # 17077)

With the increasing costs of nitrogen fertilizers, producers would benefit economically from more efficient varieties with improved response to N fertilizer. Varieties with these characteristics would also help protect the environment by reducing N applications, leaching, and greenhouse gas emissions. A study was conducted at two different experimental sites (NIFA Peshawar and CCRI Pirsabak) during 2013-14 to assess wheat genotypes for nitrogen and water use efficiency using split plot design. Both the experimental sites were different for soil physico-chemical properties. Soil at CCRI, Pirsabak was loamy sand in texture, low in organic matter (0.40-0.87 %) and total N

(0.028-0.05 %) where as soil at NIFA, Peshawar was silt loamy, low in organic matter (0.67-1.07 %) and total N (0.04-0.06 %). Nitrogen fertilizer was applied in the form of urea at the rate of 0, 25, 45 and 90Kg N/ha. Half of the nitrogen was applied at the time of sowing (seed bed preparation) while the remaining half during the tillering stage. No irrigation was applied during the whole growing season. Genotypic differences existed among the tested genotypes for grain yield and its components at different N fertilizer levels at both the experimental locations.

Grain yield of all the 03 genotypes increased with N fertilizer rate at both the experimental sites. Grain yield of wheat varieties was influenced by soil and N fertilizer management at both the experimental locations. Maximum grain yield was produced when nitrogen was applied @90 kg.ha^{-1}. The recombinant inbred line NRL 0707 produced maximum mean grain yield at both the sites averaged over different doses of nitrogen followed by the stay green mutant PM-376 HY, however grain yield at 45 kg.ha^{-1} and 90 kg.ha^{-1} nitrogen was significantly similar at both the experimental sites.

Maintenance and seed production of NIFA rainfed varieties

A total of 8524 kg quality seed of NIFA rainfed wheat varieties NIFA Lalma and Tatara was produced and certified by Federal seed certification and registration department (FSC & RD) at the institute. In addition, high yield cultivars Tatara and Lalma showed resistance to prevailing yellow rust. Seed requests have been received from the provincial agriculture departments, seed companies and progressive growers. The seed will be distributed among the provincial agricultural departments and farming community in KPK prior to next rabi season.

Popularization / Demonstration of NIFA rainfed wheat varieties

Uptil now NIFA has released 04 high yielding and disease resistant wheat varieties i.e. Tatara, Takbeer, Barsat and Lalma for the moisture stressed areas of the Khyber Pakhtunkhwa. These varieties are performing very well and there is an increasing seed demand from the government organizations, NGO's and farming community. Consistent efforts are being made by the NIFA wheat breeders to maintain seed purity and produce quality seed by growing Progeny rows / blocks of these varieties on the available land at the institute. The seed of newly released rainfed wheat variety NIFA Lalma was provided to 07 farmers along with necessary inputs under WPEP. The variety showed excellent performance in these demonstration blocks.

Oilseed Brassica

Genetic purity maintenance and popularization of Oilseed Brassica varieties

Maintenance of the genetic purity of approved/commercial varieties is mandatory to produce quality seed. In the follow up programme of released varieties during 2013-14, 10 progeny blocks each of Durr-e-NIFA, Abasin-95 and 28 of newly released rapeseed variety NIFA Gold were raised to produce BNS. True to type progeny blocks were selected on the basis of characteristics of varieties. A total of 184 kg BNS and 260 kg PBS of Durr-e-NIFA and Abasin-95 and NIFA Gold including 30 kg of NIFA Raya were produced. Following Varietal Popularization Programme among the farming community of KPK, 10 demonstration plots of Durr-e-NIFA and Abasin-95 were planted at the progressive farmers' fields in the districts of Swabi and Mardan. This approach yielded very encouraging results in the form of increased demand for seed in the following year. Farmers harvested almost 2800 kg.ha^{-1} of Durr-e-NIFA.

Improvement of rapeseed (*Brassica napus*) and mustard (*Brassica juncea*) through induced mutations and classical breeding techniques

Performance of four new candidate lines in National Uniform Rapeseed Yield Trial (NURYT) & National Uniform Mustard Yield Trial (NUMYT) 2013-14

Four candidate lines two each of rapeseed (04 K 8/13-18-2 and 04 K 9/13-9-2) and mustard (MM-III /06-3 and MM- III /06-12) were evaluated for the second year mandatory testing in National Uniform Rapeseed Yield Trial (NURYT) and National Mustard Yield Trial (NUMYT), along with other twenty two rapeseed and fifteen mustard candidate lines of other institutions of the country, respectively at eleven locations in Pakistan. The trial was laid out in RCBD, replicated thrice. Rapeseed line 04 K 9/13-9-2 surpassed the control Faisal Canola by producing 0.5 - 26% high seed yield at six stations. This data also revealed that the line has good potential to perform well under stress environment like BARI, Chakwal and NIA, Tando Jam, etc. while in case of mustard; the candidate line MM-III /06-3 outclassed the national control Khanpur Raya by 5.6 to 37% at three stations, however statistically it remained at par with control on the basis of mean seed yield.

Performance of recombinants and mutants of rapeseed in Multi-locations Adaptation Yield Trial, 2013-14

The best performing nine rapeseed mutants / recombinants viz., RM-I/08-29, RM-I/08-43, RM-I/08-6, 08 1/2-9, 08 1/2-21, RM-I/08-4, RM-I/08-35, 08 2/1-7 and RM-I/09-2 and a check (Punjab Sarson /Hyola-401) were evaluated for genetic stability and adaptability at eight diversified locations; Nuclear Institute for Food & Agriculture, Peshawar; Agricultural Research Station, Sari Naurang, Bannu; Agricultural Research Station, Buffa; Agricultural Research Institute, Mingora, Swat; Barani Agricultural Research Station, Kohat; Nuclear Institute of Agriculture & Biology, Faisalabad ; Arid Zone Research Institute, D.I. Khan and Barani Agricultural Research Institute Chakwal in KPK and Punjab for two consecutive years (2012-13 & 2013-14).

The results received from the four stations viz., AZRI, DI Khan; BARI, Chakwal; BARS, Kohat and NIFA, Peshawar revealed that four rapeseed lines viz., RM-I/08-29, RM-I/08-4, 08 2/1-7 and RM-I/09-2 achieved higher seed yield (1673, 1800, 1724 and 1711 kg.ha^{-1}, respectively) compared to control (1624 kg.ha^{-1}). The rapeseed mutants RM-I/08-29 and RM-I/09-2 were significantly earlier in achieving the physiological maturity (180 days) compared to the control (183 days).

Agronomic evaluation of mutants/recombinants in Advanced Yield Trials (AYTs) at NIFA, 2013-14

Top six rapeseed mutants/recombinants (RM-III/011-3, RM-III/011-7, 011-4/6-3, 011-5/6-11, 011-5/6-13 and 011-5/6-15) and five mustard mutants (MM-I/011-18, MM-I/011-25, MM-I/011-40, MM-I/011-43 and MM-I/011-56) were advanced from Preliminary Yield Trials (PYT) and evaluated separately in two Advanced Yield Trials (AYT-I, & AYT-II) along with rapeseed checks Hyola-401 and mustard check Khanpur Raya, respectively, at NIFA experimental farm, during 2013-14. The trial was laid out in RCBD, replicated thrice. The results revealed that two each rapeseed mutants and recombinants exhibited high seed yield viz., RM-III/011-3 (3056 kg.ha^{-1}), RM-III/011-7 (3278), 011-5/6-11(4083 kg.ha^{-1}) and 011-5/6-13 (3667 kg.ha^{-1}) compared to control Hyola-401 (2833 kg.ha^{-1}). These rapeseed entries achieved physiological maturity ten days earlier than the control. With regards to AYT-II (mustard trial), due to severe lodging, the data recorded did not correspond to the potential of the mustard mutants. Therefore, the trial was considered vitiated and will be repeated during 2014-15.

Performance of stable mutants for yield and other agronomic characteristics in Preliminary Yield Trials (PYTs), 2013-14 at NIFA

Stable and high yielding fourteen rapeseed mutants (RM 011 K-2-1, RM 011 K-2-3, RM 011 K-7-1, RM 011 K-11-1, RM 011 K-11-3, RM 011 K-16-3, RM 011 K-17-1, RM 011 K-17-2, RM 011K-18-2, RM 011 K-22-2, RM 011 K-22-3, RM 011K-30-1, RM 011 K-37-1 and RM 011 K-37-2) and four recombinants (RC 011 K 1/11- 5-1, RC 011 K 1/11-5-3, RC 011 K 1/11-5-4 and RC 011 K 1/11-5-5) were evaluated in the Preliminary Yield Trials; PYT-I and PYT-II, along with a commercial check, Hyola-401 at NIFA experimental farm, during 2013-14. The trial was laid out in RCBD, replicated thrice. In PYT-I, four rapeseed mutants RM 011 K-17-1, RM 011 K-17-2, RM 011K-18-2, RM 011 K-22-2 produced high seed yield 2861, 2722, 2500 and 2944 kg.ha^{-1} compared to control Hyola-401 (2417 kg.ha^{-1}). The rapeseed mutant RM 011 K-17-1 took 178 days to achieve physiological maturity earlier than the control (183 days). In PYT-II, none of the genotype could produce high seed yield than control but the recombinant RC 011 K 1/11-5-5 consumed 175 days to mature ahead of the control (182 days) and achieved seed yield (2444 kg.ha^{-1}) statistically at par with control (2722 kg.ha^{-1}).

Assessment of rapeseed and mutants/recombinants for yield and other agronomic characteristics in Non-replicated Yield Trial (NPRT), 2013-14 at NIFA

One hundred and four (104) rapeseed & mustard mutants/recombinants (comprising 83 rapeseed recombinants; 07 rapeseed mutants and 14 mustard mutants) were evaluated at an early stage (F_4/M_4) for stability of yield and other economic traits in a non-replicated trial planted in augmented design along with a commercial check Hyola-401 and mustard advanced line NM-1-10/11. The results indicated that 13 rapeseed recombinants and 05 mutants out yielded the commercial check Hyola-401 by producing 4 to 38% higher seed yield. The maximum yield potential was observed for RC 41-1 (5741 kg ha^{-1}) against the control (3556 kg.ha^{-1}). In case of mustard, two mutants MM 31-1 and MM 31-5 out yielded the respective control by producing 6 to 17 % higher seed yield.

Development of segregating populations $M_1/F_1/F_0$ generation

Healthy and uniform seeds of an advanced rapeseed line ECH-386 was exposed to three doses of gamma radiation (1.2 and 1.4 & 1.6 kGy)

with the view to incorporate earliness and reduced plant height. The treated seeds were directly planted in the field in isolation, dose wise. Normal cultural practices were carried out. Plots were bulk harvested dose wise at maturity and seed were manually threshed and bagged separately. First filial generation of nine cross combinations of inter specific crosses were discarded due to undesirable results.

The intra-specific crossing was achieved by hand pollination of 1050 rapeseed buds in 05 cross combinations to incorporate earliness, short stature, low erucic acid, glucosinolates and high yield in otherwise adapted varieties. Crossed pods were harvested combination wise separately as F_1 seed.

M_2 /F_2 generation

The M_2 /F_2 generation were developed from seven rapeseed entries. More than 60 single plant selections were made based on plant height (135 – 210 cm), number of primary branches per plant (4 – 14), number of pods, pod length (3 – 6 cm), number of seeds per pod (15 – 36) and seed yield per plant (≥75 g).

Plant-progeny rows (F_3/M_3)

Three hundred & forty two plant-to-progeny rows of rapeseed/mustard recombinants/mutants (F_3/M_3) were planted to confirm inherited desired selected traits on visual performance basis. Three meter long two rows per entry were planted. About sixty six single plants were re-selected following pedigree method of selection. The selected single plants yielded up to 122 g per plant.

Shuttle breeding programme at SARS, Kaghan

Summer Agricultural Research Station, Kaghan is used for generation advancement programme to curtail the breeding cycle for varietal development. A crossing block consisted of 12 rapeseed genotypes was planted. The intra-specific crossing was achieved by hand pollination of 100 rapeseed buds in 03 cross combinations to incorporate high seed yield and early maturity in the otherwise well adapted genotype. The single plant selection was delayed till next generation and representative samples at random were collected from M_2 population derived from irradiating a rapeseed genotype at three doses and sixty six F4/M4/F1M4 families.

Quality characterization of oilseeds through NIRS

Near Infrared Reflectance Spectroscopy (NIRS) technique established at NIFA, Peshawar is the most cost, time and labor-effective. No negative impacts on original seeds structure or texture or on the environment were observed. For ongoing project at NIFA, 1013 samples of oilseed germplasm and breeding materials were analyzed. The Routine Quality Analysis Service (oil, protein, fatty acid profile and glucosinolate) of 5292 samples of brassica and 1846 samples of sunflower were also provided to different stakeholders in the country.

Development of locally adapted canola (*Brassica napus* L.) F_1 hybrids using induced mutations and doubled haploidy technique

According to the second year work plan of the PSF funded project (202), analysis of segregation of induced male sterility and evaluation for embryogenesis through isolated microspore culture in rapeseed genotypes was investigated. Genetic progeny tests in F_1 developed from crosses of sibs (M_2 mutant fertile plant) or initial parental genotypes demonstrated that various segregation ratios of male sterility were induced by gamma mutagenesis. Four mutant pollen parents (sibs) segregated in 1:1 or 0:1 segregation ratio with more than 50% male sterility. This manner of segregation indicated that these four mutant pollen parents possessed sterility/partial sterility maintainer genes (msms) and theses maintainer mutant rapeseed lines are good candidate for the development of potential CMS rapeseed lines through cross breeding. Seven mutant pollen parents also expressed partial sterility with a range 20 to 36 % male sterility and confirmed maintainer gene in their nuclei. All the F1 crosses with initial parents produced plants with a range of 84 to 100% male fertility while two sib pollen mutant parents produced fertile plants with a 96% male fertility. These two sib mutant lines expressed the presence of MsMs genes in their nucleus. The both mutant sib could be used as potential restorer rapeseed lines as these genotypes indicated presence of nuclear genes responsible for male fertility.

All the nine F_1 progenies were observed as fit for segregation 3:1 ratio in F_2 under the present studies and determined the presence of one mutated gene msms in selected genotypes.

Induction of embryogenesis, development of organogenic calli and shoot regeneration was achieved. Four genotypes which have been observed for the good induction of embryogenesis, organogenic calli and shoot regeneration were identified.

Biotechnology

Sugarcane improvement

Evaluation of sugarcane genotypes in Preliminary yield trials

Fifteen sugarcane genotypes were evaluated at NIFA for high cane and sugar yield. CP 77/400 was included as a check variety and the plot size was 6 m^2. The experiment was laid out according to RCBD. The performances of the genotypes are summarized below:

Agronomic evaluation

Number of nodes/plant: Out of fifteen genotypes, the highest number of nodes (13) was recorded in line CPSG-93, CPSG-159, HOSG-200 and QSG-69. This was followed by line HOSG-1257 and HOSG-1257 with 12 number of nodes per plant.

Internode length: The highest internode length of 16 cm was recorded in line HOSG-945 followed by HOSG-1021 with 15 cm internode length. The lowest internode length of 9.5 cm was recorded in line CPSG-93.

Cane thickness: The data on cane thickness indicated variation among all the genotypes. The maximum cane thickness of 29mm was recorded in line CPSG-93 followed by line CPSG-90 with cane thickness of 27mm. The lowest cane thickness of 22 mm was recorded in line HOSG-945.

Stalk/plant: The highest stalk/plant (6.0) was recorded in line CPSG-93 Line HOSG-315, HOSG-1607 and HOSG-1657 were at par with CP 77/400 where 5.0 stalk/plant were recorded. The lowest stalk/plant of 4.0 was recorded in line HOSG-200, HOSG-104, HOSG-1021 and QSG-69.

Plant height: The data on plant height of all the genotypes showed significant variation. The highest plant height (260.0 cm) was recorded in Line HOSG-1607 followed by line QSG-69 with height of 249 cm. The lowest plant height of 221 cm was recorded in line CPSG-93.

Cane yield: Significant variations in yield were observed among all the genotypes under study. The highest yield of 75.5 $t.ha^{-1}$ was recorded in line HOSG-315 followed by line HOSG-955with 64 t/ha. The lowest yield of 40.8 t/ha was recorded in line HOSG-701.

Quality evaluation: Brix (%): The highest brix of 21.0% was recorded in line HOSG-104, HOSG-1021 and HOSG-1257 followed by line HOSG-315, HOSG945 and QSG-669 with 20.0 % brix.

Sugar Recovery (%): The data regarding sugar recovery of all the genotypes showed significant variation. According to the results, highest recovery of 11.2 % was recorded in line HOSG-104 and HOSG-1257 followed by Line HOSG-315 with recovery of 10.8 %. The lowest recovery of 9.0 % was recorded in line CPSG 159.

Purity (%): The highest purity of 85.57 % was recorded in line QSG-69 followed by line HOSG-1021 with purity of 94.82%. While the lowest purity of 90.73% was recorded in line CPSG- 159.

Pol%: The highest Pol of 19.37% was recorded in line HOSG-I021 followed by line HOSG-104 with18.0 % Pol.

Evaluation of Sugarcane advance yield trial

Sugarcane advance yield trial consisted of twelve genotypes with a commercial check CP 77/400. The trial was sown using standard plot size of 6 m^2 in RCBD. The highest plant height of 245 cm was recorded in line CPSG-169 followed by 241cm in line CPSG-468. The Longest internode length of 12 cm was also recorded in the same line. Similarly the highest number of nodes (19.6) and stock/plant (6) were recorded in line CPSG-25. The highest cane thickness of 33.7 mm was recorded in line CSSG-676. In quality characters, the highest recovery of 12.2% was recorded by line CPSG-1004. This was followed by Line CPSG-1550 with 11.01% recovery. Similarly the highest commercial cane sugar (CCS) of 13.6 % was recorded by line- CPSG-1004. The highest purity of 84.6 % was recorded in line CPSG-1004.

Performance of National uniform varietal Trial

National uniform verietal trial consisted of seven lines; three lines were received from ARRI, Faisalabad and two lines each from NARC and NSCRI Thatta. The trial was sown using standard plot size of 7 m^2. The commercial variety CP77/400 was used as check. The highest Stalk/plant (5.5), Internodes (13.4), Internodes length (11.05 cm) and plant height (197.78cm) was recorded in line S-2006-US-469. The highest cane thickness (28.6 mm) was recorded in line S-2006-US-272. The highest yield of 77.5 $t.ha^{-1}$ was also recorded in line S-2006-US-469. The highest recovery of 11.9 % was recorded in line S-2006-US-54 followed by S-2006-US-469 with recovery of 11.5 %. The highest brix of 22.5% was recorded in line S-2006-US-54 followed by line S-2006-US-469 with 21.0 % brix.

Seed multiplication of advanced lines

Seed of sugarcane lines CPSG-1550, CSSG-1402, CPSG-468 and CPSG-169 was multiplied. The plot size of each line was 10 x 20 meter, one meter apart. The lines will be tested in different locations for confirmation and testing in the National trials for varietal development.

Transplantation of seedlings from sugarcane fuzz

Sugarcane fuzz received from National Sugar Crops Research Institute, Thatta was sown in control environment in the lathe house. The highest germination was shown by HoTh-326 followed by CPSG-3453. Seedling plants of HoTh-326 were transplanted to the field for evaluation.

Screening and evaluation of sugarcane germplasm at farmer's field

Some promising genotypes including CPSG-1550, CPSG-169 and CPSG-1004 were sown on the farmer's field at Charsadda for agronomic and Gur quality evaluation.

Improvement of Stevia through in vitro culture techniques

In vitro regeneration of MV_1 plantlets from irradiated calli

Subsequently, fresh calli were irradiated with 13.33 Gy for creation of genetic variability. The irradiated callus was shifted to shoots regeneration MS-medium as optimized previously. Optimum callus growth (90%) was observed on MS-medium containing combination of BA (1.0 mg/L), NAA (0.3 mg/L), IBA (0.3 mg/L) and GA3 (0.3 mg/L). Best shoots regeneration (85%) and multiplication (88%) was recorded on MS-medium containing 1.0 and 2.0 mg/L of BA. The elongated shoots transferred to rooting medium containing ½ MS with IBA in combination with NAA (0.5 mg/L) showed 95% rooting response. These rooted shoots were successfully acclimatized (80%) in pots. The roots of *in vitro* grown mutant plants were thoroughly washed with sterile distilled water to remove agar and medium particles. Plastic pots were filled with autoclaved soil, sand and manure in 2:1:1 ratio for acclimatization. Before transferring of plants, the pots were sprinkled with water to retained humidity. The plants were shifted to pots and immediately covered with plastic bags to arrest maximum humidity. The plastic bags were periodically removed from the pot after 23 days of plantation. These mutant plants were then shifted to field conditions. After three months of acclimatization 7 plants (MV_1) were selected for Steviosides analysis on the basis of vigorous growth, higher number of leaves and branches as compared control plants.

Growth parameters of selected mutant plants in MV_1 generation

In the present study the highest number of leaves (193±09.71) was observed in MSIC-3 with 12±1.399 number of branches having 8.19±2.06 inches plant height as compared to control. However, maximum number of branches (13±2.12) was found in MSIC-1 but the plant height is lower (7.05±2.33) than MSIC-3 (8.19±2.06). Significantly, similar number of leaves (178±10.9; 178 ± 09) was observed in MSIC-2 and MSIC-7 but MSIC-2 showed higher number of branches (11±1.10) and plant height (8.33±1.2) than MSIC-7 (6±1.11; 7.5±1.60). MSIC-6 also showed acceptable number of leaves (179±08) with branches (8±1.02) and plant height (8.09±2.5) than control (112±08; 03±0.55; 12.33±1.8). In this study, the minimum number of branches (150±07) was observed in MSIC-4 but number of branches (7±0.99) is higher than MSIC-5 and height (9.31±1.6) is higher than MSIC-1, MSIC-2, MSIC-3, MSIC-6, and MSIC-7. However, MSIC-5 showed 172±06 numbers of leaves with 5±1.330 numbers of branches and height (11.9±2.7) as compared to control.

Steviol glycoside contents in selected mutant plants of MV_1 generation

Leaves from these selected mutant plants were exposed to HPLC for Steviosides and Rebaudioside-A contents determination. Presently the MSIC-2 showed the highest Steviosides contents (2.436±0.09 mg/g-DW) than other mutant plants and control (1.937±0.72 mg/g-DW). The MSIC-2 was followed by MSIC-1 which showed 2.232±0.04 mg/g-DW Steviosides contents as shown in table-3. MSIC-3 and MSIC-5 also showed higher biosynthesis of Steviosides contents (2.1414±0.07 and 2.087±0.19 mg/g-DW). However, MSIC-4 and MSIC-6 showed lower amount of Steviosides contents (1.927±0.47 and 1.733±0.63 mg/g-DW) than control. Furthermore, MSIC-7 also accumulated slightly higher Steviosides contents (1.982±0.20 mg/g-DW) than control. As compared to Steviosides contents, higher Rebaudioside-A content (1.638±0.43 mg/g-DW) was observed in MSIC-1 than control (1.636±0.41 mg/g-DW). Other mutant plants showed lower biosynthesis of Rebaudioside-A content than control plants.

Pulses Group

Chickpea

Three sets of advanced lines yield trials consisted of 37 high yielding mutants derived from C-44 and

Pb-91were conducted during 2013-2014 at NIFA. 25 mutants i.e., NDC-4-25-5, NDC-4-25-7, NDC-4-25-9, NDC-4-25-10, NDC-4-25-11, NDC-4-25-12, NDC-4-25-15, NDC-4-30-1, NDC-4-30-2, NDC-4-30-3, NDC-4-30-4, NDC-6-15-1, NDC-6-15-2, NDC-6-15-4, NDC-6-15-5, NDC-6-15-6, NDC-6-15-7, NDC-6-15-8, NDC-6-15-9, NDC-6-15-10, NDC-6-15-11, NDC-15-1, NDC-15-4, NDC-20-5 and NDC-25-13 produced statistically significantly ($p \leq 0.05$) higher seed yield (2278-3993 kg.ha^{-1}) as compared to the check variety NIFA 2005 (average yield of 2181 kg.ha^{-1}). All these high yielding mutants exhibited seed size 23-25 g per 100 seed weight. Three candidate mutants namely NIFA-1, NIFA-2 and NIFA-3 have been contributed to evaluate for seed yield and stability in National Uniform Yield Trials during 2014-2015, which are being conducted by National Pulses coordinator, NARC, Islamabad.

F_2 populations of six cross combinations viz., Thal-2006 x NIFA-2005, Balksar x NIFA-2005, Dasht x NIFA-2005, NIFA-88 x NIFA-2005, NIFA-2005 x NDC-6-I-6 and NIFA-2005 x NDC-6-I-7 were planted along with their parents and check. 468 single plant selections were made from these F2 populations on the basis of more pods, better plant stand and large seed size. Breeding behaviour of the mentioned selections will be confirmed in next generation during 2014-2015 cropping seasons.

5 new cross combinations i.e., NDC-6-15-6 x NIF-2005, CM541/05 x NIF-2005, CM156/05 x NIF-2005, BRC390 x NIF-2005 and PB2008 x NIF-2005 were attempted for accumulating high yielding genes in single recombinants. Genetic variability for high yield and seed size have also been generated through induced mutation by irradiating line CM 541/05 and Pb 2008 using gamma rays at the rate of 300 Gys. All M_1 plants were picked and threshed separately for raising M_2 during 2014-2015 cropping season.

Mungbean

127 advanced mungbean recombinants and mutants developed at NIFA, Peshawar were evaluated in 9 sets of replicated yield trials for seed yield and yield components during 2014. Out of 127 recombinants and mutants, 75 genotypes produced statistically significant ($p \leq 0.05$) higher seed yield (1549-2410 kg.ha^{-1}) i.e., 6-5, 7-13, 8-1, 12-6, 13-1, 3-3, 7-6, 8-22, 11-3, 12-7, 14-7, 14-5, 14-6, 14-7, 5-63-1, 5-63-2, 5-63-3, 5-63-5, 5-63-8, 5-63-10, 5-63-11, 5-63-14, 5-63-15, 5-63-16, 5-63-35, 5-63-48, 5-63-49, 5-63-51, 5-63-57, 5-36-1, 5-36-2, 5-36-4, 5-36-5, 5-36-6, 5-36-8, 5-36-11, 5-36-21, 5-36-24, 5-36-25, 5-36-26, 5-36-27, 5-36-29, 5-36-30, 5-36-33, 5-36-41, 5-36-45, 5-36-48, 5-36-49, 5-36-50, 5-36-51, 5-36-53, 5-36-55, 5-91-8, 5-91-19, 5-91-21, 5-91-24, 5-91-26, 5-91-28, 5-91-29, 5-91-33, 5-91-33, 5-91-34, 5-91-35, 5-91-40, 5-91-43, 92-2-23, 92-2-31, 92-2-34, 92-2-8, 92-3-4, 92-4-12, 98-2-7, 98-2-9, 98-2-22, 98-3-1 and 98-3-3 as compared to the check variety Ramzan (1317 kg.ha^{-1}). These genotypes exhibited 48-53 g per 1000 seed weight and better plant type. Their days to maturity ranged from 78-89 days. Three promising recombinants namely NIFA Mung-1, NIFA Mung-2 and NIFA Mung-3 have been contributed for second year to evaluate for seed yield and stability in National Uniform Yield Trials during kharif 2014, which are being conducted by National Pulses coordinator, NARC, Islamabad. NIFA mung-1, NIFA mung-2 and NIFA mung-3 had produced 10, 17 and 30 percent higher seed yield, respectively than national check at KPK location basis during first year in 2013.

F_1 generation of ML-5 x Kuram greenmung and Ramzan x Kuram greenmung were raised and hybrid plants were picked separately and threshed individually. 664 single plants selections were made during 2014 from F_2 populations of V 2709 x NM 92, Var. 6601x Ramzan, NM 51 x NM 98, NM 98 x NFM 5-36-24 and NFM 5-36-24 x NFM 5-36-18 to raise F3 during kharif 2015. 592 single plants selections were made on the basis of more pods per plant and better plant type from F3 populations of V 1128 x Ramzan, V 2802 x Ramzan, V 2817 x Ramzan, V 1128 x NM 2006, , V 2802 x NM 2006 and V 2817 x NM 2006 during 2013 for further evaluation during kharif 2015. Eight new cross combinations i.e., ML-5 x Sona mung, Sona mung x NM 2011, ML-5 x NM 2006, ML-5 x NM 2011, Kuram greenmung x Ramzan, Kuram greenmung x NM 2006, Kuram greenmung x NM 2011 and Kuram blackmung x Blackmung were attempted to combine high yielding genes of green mungbean in an individual recombinants and also to breed black seeded high yielding mungbean genotypes for Kuram Agency.

29 and 17 mutants were selected from M_2 populations of V2802 and 2709 (gamma rays at 400 Gys), respectively, on basis of more pods per plant. From M_3 generation of NFM 5-91-21 (gamma rays at 400 Gys), 32 high yielding single plants were selected to raise M_4 during next year. 71 true breeding mutant lines were selected as rows from NFM 5-91-21 (gamma rays at 400 Gys) to evaluate in replicated preliminary yield trials during next year to confirm their breeding behavior and seed yield.

Plant Pathology Group

Pre-breeding for wheat disease resistance

Disease resistance in wheat is an important factor for attaining sustainable food security in the

country and is therefore an integral component of the crop improvement program at NIFA focusing on pre-breeding activities such as surveillance, pathotyping, detection, monitoring and enhancement of novel sources and candidate genes.

Occurence of wheat diseases in Khyber Pakhtunkhaw

Occurrence of wheat diseases using stationary and mobile survey approaches were carried out at hot spot locations in southern, central and northeren zones of Khyber Pakhtunkhaw.

Yellow and leaf rusts

Yellow rust developed well at all test locations in Khyber Pakhtunkhaw (two in Peshawar and one each in Bannu, Nowshara, Hari Pur and Swat) with variable disease levels. Rust severity within each location at Peshawar, Bannu, Nowshara, Hari Pur and Swat ranged from 30-100%, 0-70%, 20-80%, 10-60%, 0-60%, respectively. Highest average rust severity was recorded at Peshawar1 (73.2%) which was followed by Peshawar 2 (68.4%), Nowshara (59.45%), Hari Pur (30.27) Bannu (26.74%), and Swat (13.28%). Leaf rust was rarely recorded with low severity in Peshawar only.

Powdery mildew and Barley Yellow Dwarf

Powdery mildew of wheat is caused by an obligate parasitic fungus Blumeria graminis f. sp. tritici which was recorded at southern, central and northern districts of Khyber Pakhtunkhwa during the last season. High prevalence was recorded on northern districts i.e. Mansehra and Swat where disease severity ranged from 20-80%. At Ahmadwala, Karak (Southern district) disease severity ranged from 10-30%. Least disease prevalence was recorded in central districts i.e. Mardan, Charsadda and Nowshera where disease severity ranged from 10-20%. Barley Yellow Dwarf (BYD) is a regularly occurring vector borne viral disease in KPK. BYD prevalence was recorded in central, southern and northern districts of our province. High BYD severity was recorded in central districts i.e. Peshawar, Nowshera, Mardan and Swabi ranged from 60-80% followed by northern districts i.e. Bunner, Mansehra and Swat ranged from 50-80%. Least occurrence and severity was recorded in southern districts i.e. D.I.Khan, Bannu, and Kohat ranged from 50-80%.

Seed diseases

Many of the wheat diseases have been reported as seed borne. Black point is one such fungal disease caused by Alternaria alternata (Fr.) Keissler. A total of 70 irrigated and rainfed wheat lines belong to NIFA wheat group were analyzed for black point infection. Hundred percent of these lines showed black point infection with varying level of % incidence. Black point incidence ranged between 1.8 to 26.8%.

Pathotyping and effectiveness of yellow rust resistance genes in Khyber Pakhtunkhaw

Breeding for rust resistance require information regarding the presence of rust pathotypes and associated virulences. In this regard, biological trap nurseries were used to monitor wheat yellow rust in the southern, central and northeren zones of Khyber Pakhtunkhaw which is the most vulnerable region in Pakistan. Nine yellow rust pathotypes including 0E0, 96E0, 115E160, 59E240, 102E24, 106E88, 102E176, 98E16 and 102E16 were established using field data. Yellow rust resistance genes Yr1, Yr5, Yr6, Yr7, Yr8, Yr9, Yr10, Yr15, Yr17, Yr18, Yr24, Yr2, Yr27, Yr32 and YrSp in Avocet background behaved differentially across Khyber Pakhtunkhaw. No virulence was found against Yr15 which is reported in number of genotypes that can be used in wheat improvement program.

Characterization of multiple disease resistance in Khyber Pakhtunkhaw

In order to search for novel sources of multiple disease resistance, more than one thousand wheat genotypes consisted of Set I (released cultivars: 37; Candidate Varieties: 37 and NIFA rainfed/irrigated germplasm: 35) and Set II (national elete genotypes: 560, CIMMYT advanced germplasm: 350 and local landraces: 163) were studied and characterized at six hotspot locations across Khyber Pakhtunkhaw. Set I was assessed at six locations while Set II at Peshawar only.

Yellow and leaf rust resistance

Yellow rust resistance in Set I genotypes including NIFA-7, NIFA-8, NIFA-9, NIFA-14, NIFA-23, NIFA-27, NIFA-28, NIFA-43, NIFA-44, NIFA-63, NIFA-66, NIFA-67, Faisalabad-85, Bahawalpur-83, Tatara, and Fakhr e Sarhad remained consistent in exhibiting resistance at all the tested six locations. Leaf rust evaluation of Set I genotypes was possible only at Peshawar where it was observed on a limited number of genotypes including NIFA-5, NIFA-6, Zardana-89, Shaheen-94, and Punjab-96 got low infection while, NIFA-8, NIFA-9, NIFA10, NIFA-11, and NIFA-17 expressed 40-80% severity.

One thousand and seventy three indigenous and exotic genotypes of Set II displayed variability in

resistance against yellow rust. Fifty genotypes (5 %) were postulated to carry effective race specific resistance while 230 genotypes (21%) were inferred to carry race nonspecific high resistance. NIFA genotypes of Set II which fall in this category of race nonspecific high resistance included, NRL 1027, NRL 1241, NRL 1101, NRL 1105, , NRL 1119, NRL 1120, NRL 1137, NRL 1139, NRL 0157, CT-096065, CT-09117, CT-09141, SRN-09048, SRN-09065, and SRN-09087. CIMMYT advanced germplasm of Set II introduced recently into the national wheat research system of Pakistan expressed the presence of an undesirable defeated rust genes (i.e. Lr26, Yr9, Sr31) translocation "1BL.1RS" in 28 genotypes which should not be selected and promoted for further development in the country to avoid possible future rust epidemic.

Powdery mildew and BYD resistance

Resistance studies against wheat powdery mildew in Set I genotypes was possible at two locations in Hari Pur and Swat. Disease was uniformly developed on Set I genotypes at Hari Pur and Swat. Five cultivars including Pirsabak-91, Tatara, Fakhr e Sarhad and Saleem-2000 was found resistant at Swat while all remaining genotypes of Set I were found susceptible to Powdery mildew. Set I genotypes i.e. NIFA-7, NIFA-8, NIFA-9, NIFA-10, NIFA-11, NIFA-14, NIFA-15, NIFA-16, NIFA-17, NIFA-26, NIFA-27, NIFA-32, NIFA-39, NIFA 41, NIFA-49, and NIFA 62 were found susceptible to BYD with %severity ranged from 10 to 80%. Resistance to BYD was assessed in Set II and it was found that about 75 genotypes were found sensitive and % disease severity ranged between 20 to 80%, which include Fakhr e Sarhad, Bathoor-08, Saleem 200, Faisalabad 83, Faisalabad 85, Khyber 87 and Morocco.

Identification of slow rusting durable resistance

Adult plant resistance is long lasting and is often associated with slow development of rusts and is considered as a key strategy for its management. About 589 genotypes were studied for slow rusting trait. Slow rusting variables for yellow rust development were assessed at NIFA Peshawar over time in the presence of virulence's v1, v2, v5, v6, v7, v8, v9, v15, v17, v18, v26, v27, v32, vA, vSP, vGaby, vSoissonnais vTP 981 along with standard susceptible control. Several assessments were made at weekly intervals to understand pattern of disease development during the season. Based on area under disease progress curve, studied germplasm can be classified into four groups including undesirable, slow ruster, medium slow ruster and fast ruster with percentages of genotypes in each was 43%, 33%, 20% and 4% respectively. Slow ruster group can be good source for selecting and development of future cultivars carrying durable rust resistance.

ENTOMOLOGY DIVISION

The Entomology Division of NIFA Peshawar is engaged in the integrated control of fruit flies, termites, peach flat-headed borer, and chickpea pod borer, and in honey bee management. Under the Integrated pest management (IPM) system, we are employing different IPM components such as chemicals, biological, cultural, phytosanitary and irradiation to reduce pest losses. Citrus and mangoes are the two leading fruits of Pakistan in terms of area, production and export. This division has close collaboration with the international atomic energy agency (IAEA) on the development of generic irradiation doses for pests of quarantine importance and post-harvest life extension of fresh commodities. Under the integrated vector management control (IVM) program, the division has active collaboration with national and international organizations in devising short and long term control strategies for medically important disease carrying insects including mosquitoes.

Fruit Fly Control

Fruit flies are the most destructive insect pests of the fruits and vegetables throughout the world. Among various species of fruit flies, Bactrocera are predominant in Pakistan attacking pear, peach, plum, apple, guava, mango and other fruits and vegetables. Their pre harvest control largely depends on the application of male annihilation techniques and post-harvest as irradiation or hot treatment. Research on fruit flies is therefore, directed towards improvement in the control strategy through environment friendly techniques such as cultural control, biological control, male/ female trapping and fruit irradiation for larval mortality.

Effect of combining Cue-lure with various chemicals on capturing fruit flies species

Cue lure @ 10% was mixed with other chemicals viz. molasses, yeast extract powder, DAP (Diammunium phosphate), Ammonium dihydrogen phosphate, protein hydrolysate, and ethyl acetate in the ratio of 1:9. Dipterex was included as toxicant. These chemicals alone as well as Cue-lure standard traps were installed as check. The results indicated that Maximum number of 212 flies /trap in protein and Cue combination followed by 78 , 74, 71, 69, and 65 flies/trap in mollases+lure , standard trap, yeast extract with cue lure, ethyl acetate +cue, and Ammonium dihydrogen phosphate, Ammonium dihydrogen phosphate+ lure, respectively. On the other hand, the number of flies cached /trap ranged between 1.25 to 17 flies /trap in the test chemicals without cue lure. This indicated that combination of these chemicals with lure greatly enhanced trapping efficiency.

Effect of mixing protein hydrolysate in Methyl eugenol for trapping fruit fly species in pear orchard at Nowshera

Oriental fruit fly *B. dorsalis* and peach fruit fly *B. zonata*, the two most destructive species attacking a wide verity of fruits and their males are attracted to methyle ugenol while melon fly is damaging melon and different cucurbitaceous vegetables, and cue-lure can be used to attract its male in the traps as male annihilation technique in the orchards. Protein hydrolysate attracts both sexes of many flies' species. To attract and kill both sexes of many species in a single trap in fruit orchard with adjacent/ intercropped cucurbits vegetables, protein hydrolysate was added @ 5, 10, 20, 30, 40 and 50%V/V in mthyle eugenol. 10% sugar and 5% Dipterex was added as food attracting and killing agents. Traps of standard methyl eugenol and only protein with sugar and dipterex were installed in the orchard as control. 5 ml of test material /trap was applied on cotton wicks. Traps were installed in pear orchard with nearby cucurbits vegetables in completely randomized design at a height of 2 meter above the ground. There were 8 treatments, each having 4 replicates. Flies captured and killed in each trap/week were brought in polythene bags for counting and species identification in laboratory.

The results indicated that 3 major species i.e. B. doraslis, *B. zonata* and *B. cucurbitae* were attracted in lure baited traps. Lowest population of 29 flies were observed in 40: 60 protein : methyleugenol combination followed by 31 and 41 flies in 20:80 and 30:70 combination respectively as compared to 41 and 72 flies in both checks loaded with only protein and methyleugenol standard ingredients. Maximum number of 104 flies was found in 50:50 combinations which proved to be the best formulation to attract and killed the three important species of fruit flies in a single trap in mixed plantation. Relative abundance study showed that in all treatments, melon fly was dominant species ranging from 88 to 98.2 % except methyleugenol chech where no melon fly was found. In only protein (check), melon fly ratio was 100% while the other check (methyl eugenol) attracted only oriental and peach fruit flies. The presence of *B.cucurbitae* in the protein combination with methyl eugenol was due to the effect of protein only.

Effect of two concentration of concentration of copper compounds as repellent of melon fly in cage study in laboratory

Copper compounds i.e. copper sulphate, Copper oxychloride and C hydroxide are known as antifungal and antibacterial. Similarly these chemicals also act as ovposition deterrent of olive and other fruit flies. To see their effect against local fruit flies, the experiment was planned to see their deterrent effect against melon fly, *B cucubitae* in cage study in the laboratory. Copper sulphate, commercial and analytical grade and copper oxychloride 50EC were tested @ 200 and 250g/100 liter water against melon fly. Aqueous solutions of desired concentrations of the test material were prepared in beakers. In each solution, Tinda (Maro), a susceptible host of melon fly, was dipped and thin air dried. For this purpose, maro of equal size were purchased. The average weight of fruit ranged between 113 to 120 grams. Fruits dipped in plan water were kept as control. Each treatment was replicated 4 times. The treated host after air drying was exposed in 4 cages containing to a large number of fruit fly populations for 24 hrs for egg lying in fruit. After one day, infested fruits were shifted to plastic buckets in petri dishes containing saw dust for pupation .Larvae, pupae were counted. Pupae were then kept in glass vials for adult emergence.

The results indicated that lower dose i.e. 200g, number of larvae; pupae and adults were not less than check. However at a dose of 250g/100liters, the larvae and pupae were minimum i.e.108 in Copper oxychloride to 223 in check. Similarly the number of larvae and pupae were 130 and191 in copper sulphate analytical, and commercial grade respectively. Larvae in all treatments pupated 100 %, however % adult emergence ranged between 71 to 78% in copper treatment as compared 81% in control. This indicated that dose of 250 g was found more effective than the lower dose to some extent. If further higher doses are studied, the results would be more prominent and clear.

Management of bruchids (Pulse beetles) damaging stored Mungbean

Evaluation of Mungbean genotypes for resistance to Bruchid beetle (*Callosobruchus maculatus*)

Bruchids beetles control in stored mungbean grains in the country relies solely upon the use of gaseous, synthetic chemicals and residual insecticide, both of which may pose serious hazards to the human health, environment and insect resistance to these chemicals. The bruchids tolerant genotypes can be bred through hybridization by transferring bruchids resistant gene from tolerant source to local high yielding genotypes. Such management method & option pertaining to bruchid beetle is cost effective, safe and eco-friendly and effective alternative to overcome the pest problem and successful sustainable management of mungbean bruchids beetle in storage.

Systematic and joint research efforts by mungbean breeders and entomologists at NIFA, Peshawar were carried out to achieve the project objective of incorporating bruchids tolerant gene from exotic germplasm into well-adapted mungbean genotypes through hybridization followed by field selection in segregating generations for seed yield and laboratory screening for bruchids.

For maintaining bruchids culture in the laboratory, adults of bruchids beetles i.e. males and females of uniform age (24 hrs day old) after eclosion were collected from isolated mungbean grains kept in a separate small test tubes.

The reported mungbean lines along with local adapted lines were screened for resistance to Bruchids (*Callosobruchus maculatus* F.). All the experiments were conducted under natural room temperature. Seed of the genotypes was thoroughly checked and cleaned. The clean & undamaged mungbean seed was used. 70 grains of each genotype were placed in glass jars. Each glass jar was considered as one replication. Five pairs of freshly emerged adults of bruchids were collected from stock culture and released in each jar covered with perforated lid to provide aeration. Relevant data were recorded. Resistance was assessed by measuring percent damage to the seeds. The total number of damaged seeds of each genotype was converted into percentages. The % seed damage was calculated-determined using the formula as below.

$$\% \text{ Seed damage} = \frac{\text{Number of damaged seeds} \times 100}{\text{Total number of seeds}}$$

Damage to seeds by bruchids was manifested by the round exit holes in the seed coat made by emerging adults of the tested genotype.

The seeds of available mungbean genotypes were screened for resistance to bruchids (*Callosobruchus maculatus* F.) along with the seeds of six parents (V1128, V2709, V2802, V2817, Ramazan and NM 2006) used in crosses under lab conditions. Only a genotype V1128 showed tolerance for bruchids in current screening. All evaluated recombinants were found susceptible.

Therefore, the bruchids tolerance of the reported bruchids tolerant lines' grains produced under agro-climatic conditions of Peshawar during summer 2014 will be confirmed in Thailand by screening under laboratory conditions against bruchids species prevailing in Thailand. This screening may answer about the production of biochemicals in mungbean seed harvested from Peshawar which are responsible for bruchids tolerance in mungbean. This screening may also verify the difference between Pakistani and Thai bruchids species. These results may be of great importance to breed first mungbean bruchids tolerant variety in Pakistan.

Stone fruit Insect pests and their control

Rearing of Peach flat-headed borer, *Sphenoptera dadkhani* (Oben.) on different artificial diets

Eight different artificial and natural diets were evaluated for successful rearing of peach flat-headed borer. Four artificial diets consisted of nutritional ingredients (sucrose, Wesson's salt mix, yeast, bactoagar, cortex dry; pre-autoclave portion (boiled soybeans); post-autoclaved portion (casein, sorbic acid, vanderzant vitamin mix, methyl paraben) and texurizing agent (cellulose) but only different bark saw dusts of plum, peach, apricot and poplar. In other four natural diets only simple saw dusts of plum, peach, apricot & poplar were used for rearing of flat-headed borer.

In four tested artificial diets, peach and plum base artificial diets are useful for rearing of peach flat-headed borer than other artificial apricot and poplar diets. In natural saw dusts, peach saw dusts is somewhat useful for rearing larvae and adult emergence as compared to other tested plum, apricot and poplar saw dusts.

In four natural tested diets, peach saw dusts is preferable and useful for rearing upto (33.33%) of all life stages of peach flat-headed borer followed by and minimum survival were recorded peach, plum & poplar based in artificial diets (12.0-17.50%).

Chemical Control of Peach flat-headed borer, *Sphenoptera dadkhani* (Oben.)

(a). Direct spray effect of several novel insecticides were tested against peach flat-headed borer adults, eggs and subsequent maximum level of gummosis. Efficacy of Confidor (30 ml), Nurelle-D (50 ml), Lorsban 40EC (50 ml), Fyfenon 57EC (50 ml), Perfekthion 57EC (50 ml), Curacron 500EC (50 ml) and Thiodan 35EC (50 ml) per 10 liters of water were found effective in reducing gum points/exit holes on plum trees trunks as compared to other tested insecticides even after 30 days in the months of May- April, July-August and October-November.

Termite Control

Use of phagostimulants in termite bait

Experiments were performed to explore the use of phagostimulants including sugars and urea to increase bait palatability. When fipronil was tested at a concentration of 1 or 3 ppm along with these additives (phagostimulants), no significant difference was observed in feeding preference of termite workers. As opposed to fipronil when urea and sucrose were added to boric acid or commercial formulations of hexaflumuron and noviflumuron, there was a marked increase in termite preference for at least staying at the bait containing these phagostimulants. Since the commercial formulations of hexaflumuron and noviflumuron were highly toxic and could not be used as slow-acting toxicants, we can use urea and sucrose to increase the palatability of boric acid bait.

We also found that a layers of blotting paper when offered as sandwich between poplar wooden slices was consumed more than when offered as rolled papers in plastic containers. This is an economical and efficient delivery system that can be used in the field as well as in the buildings.

Fipronil bait was tested in filed against the colonies of *Odontotermes* sp. and *Microtermes* sp. When 1-5 ppm of fipronil-treated paper was used as bait, it led to a consumption of the bait followed by suppression of population of both the species of subterranean termites. Boric acid bait was tested against *Odontotermes* sp. And *Microtermes* sp. The bait consisted of an impregnated blotting paper which was offered as a sandwich in poplar slices. It was fully consumed by the termites leading to suppression of the colony. Thus application of boric acid bait at a few detected foraging points is a simple and cost effective method for the control of *Odontotermes* sp. and *Microtermes* sp. When boric acid bait was tested against *H. indicola*, relatively lower bait consumption was observed which led to an overall decrease in colony population but not complete elimination or suppression. After the initial feeding, termites did not come back to the bait station. We found *H. indicola* to be more sensitive to the presence of bait toxicant after the initial feeding experience and did not continue to feed on the bait for a long period of time. A way to deal with this issue is to apply the bait on all the detected foraging points allowing initial feeding exposure of toxicant to a larger proportion of termites. This will lead to greater consumption of

the toxicant before the workers learn to avoid it and thus cause a significant suppression of termite population.

Hexaflumuron when used as HPLC-grade proved to be a very good slow-acting toxicant causing a delayed but complete mortality of termites. It was readily acceptable to termite feeding even when used at a high concentration of 5000 ppm. Hexaflumuron is an ideal toxicant for the bait but the only problem with it is to find pure sources of commercial scale active ingredient. HPLC-grade chemical is highly expensive and cannot be used in the bait. The Chinese brand of commercial scale chemical, we tested, was completely ineffective. There is need to find other reliable sources of hexaflumuron which can be used in the bait.

Quarantine Pests and their Control

Pakistan has a wide range of tropical, sub-tropical and temperate fruits and stands among the top ten citrus growing countries in the world. Pakistani Kinnow has good demand abroad, as foreign fruit vendors generally prefer it due to its peelable nature. Mango is ranked as second important fruit for export after citrus. The *citrus psylla*, *Diaphornia citri* Kuawayama, is the key pest of citrus in Pakistan and declared as quarantine pest in many parts of the word. Mango scales are quarantine pests of secondary importance. Pakistan consequently loose export of citrus and mangoes to the pest free countries as the immature stages, particularly eggs and nymphs, can be transmitted with fresh fruits to the importing countries. The WTO regulations for export of fresh commodities require disinfestations of the pests before export. Recently irradiation has been adopted as safe measure for disinfestations of the quarantine pests. Research data on the quarantine pests (*Citrus psylla* and scale insects) is very limited. Experiments were conducted to determine irradiation doses for the control of these pests prior to their export to foreign countries.

Effect of gamma irradiation on the mortality and growth inhibition of mango scale *Aspidiotus destructor* Signoret (Hemiptera: Diaspdidiae)

Dose response tests were conducted with eggs, 1st, 2nd stage nymphs and 3rd stage adult females of *Aspidiotus destructor* without eggs, and adult females with eggs at a series of irradiation doses between 100 and 300 Gy to determine the most tolerant stage. The egg stage was found as the most susceptible and 3rd stage nymphs as the most tolerant stage. A dose of 217.7 was determined to completely stop scale development to next stages.

Effect of gamma irradiation on the mortality and growth inhibition of citrus scale *Aonidiella aurantii* (Mask) (Hemiptera: Diaspdidiae)

Dose response tests were conducted with first, second stage nymphs and pre-oviposition females of *Aonidiella aurantii* at a series of irradiation doses range between 100 to 300 Gy to determine minimum dose require to inhibit normal adult emergence of the most tolerant stage. In general, irradiation affected all life stages of *A. aurantii*. The pattern of tolerance to irradiation in *A. aurantii* was eggs < 1st instar < 2nd instar < 3rd instar adults. Results indicated a minimum of 199 Gy dose for 99.99% inhibition of *A. aurantii* and therefore, should provide quarantine security for citrus scales on exported citrus and other commodities.

Medical Entomology

Surveillance and Management of Mosquitoes with special Emphasis on Dengue Vector (s)

Vector borne diseases are emerging threats in Pakistan and thus require particular attention. The recent spread warning of dengue vectors in Pakistan show the potential epidemics of these diseases in areas where the dengue vectors are present. Mosquito surveillance studies are required in the current situation of environmental and climatic changes occurrence worldwide. Vaccine is not available for many vector-borne diseases and chemical control of vectors is not safe. Therefore, new environment friendly approaches including Sterile Insect Techniques (SIT) are needed to reduce vector populations.

1. Entomological Surveillance of Dengue vector (s)

Results of entomological surveillance of vector species from over 170 sites of Khyber Pakhtunkhwa (KPK) province of Pakistan showed that Culex species (*Culex quinquefasciatus* and *Culex tritaeniorhynchus*) were the most abundant mosquito (78%) found in almost all habitats. Anopheles species were present in stream bed pools in fully exposed and partially shaded areas but absent from waters with foul smell. Aedes species were found in temporary standing pools, construction water tanks, disposable cans, empty water drums, tyres and desert coolers. *Culex quinquefasciatus*, *Cu. tritaneorincus* and other Culex species were the most abundant in almost

all types of habitats except in the small disposable containers.

The results of the indoor/outdoor surveillance were presented in the form of House and Breataeu index which highlights the alarming status of the *Aedes albopictus* in the both the standard parameters indexes. The House Index (HI= >5%) and Breteau index (BI = >20%) for *Aedes albopictus*) during September to November were at high risk for dengue transmission. *Aedes albopictus* were found higher outdoor near to animal dwellings and more vegetation.

Culex species (*Culex quinquefasciatus* and *Culex tritaeniorhynchus*) were the most abundant mosquito found throughout the year with wide range of habitats. Sewerage water and standing water bodies were the main habitat types for Culex throughout the study area. Population of Aedes and Anopheles increased from August to November. The preferred habitats for *Aedes albopictus* was old tyres, scarp materials, and fresh water sources and in rural areas standing water near vegetation.

2. Status of insecticide susceptibility/resistance in field strains of Aedes and Culex species

Chloropyrifos applied in different concentrations against adult mosquitoes of Cu. spp. yielded variable mortalities. Low level of mortality (30% and 43.06%) indicated evidence of resistance in Culex strains collected from Tarnab Colony and Hayatabad, respectively. Mortality was higher (79.54%) after 48 hours exposure. Highest mortality (100%) was recorded in mosquitoes collected from Azakhel Park and Sadaryab after 48 hours exposure period suggesting high susceptibility of Cu. spp. to insecticides at these sites. Lambdacylahothrin gave variable mortalities in Cu. spp., where mortalities were lower i.e. 41.95% and 46.94% in mosquitoes collected from Tarnab Colony and Taru Jabba, respectively. Mortality was higher (85.19%) after 48 hours exposure. Highest mortality (100%) was recorded in mosquitoes collected from Azakhel Park and Sadaryab after 48 hours exposure, which showed high susceptibility of Cu. spp. strains to Lambdacylahothrin insecticides at these locations. Deltamethrin yielded variable mortalities in Cu. spp. adult females. The adult mosquitoes collected from Tarnab Colony showed low level of mortality (39.17%) and thus resistance was developing.

Mortality was higher (91.20%) after 48 hours exposure period. Highest mortality (100%) was recorded in adult mosquitoes collected from Azakhel Park and Sadaryab after 24 hours. Similar higher mortalities (100%) was recorded in all sites except Tarnab Colony and Taru Jabba after 48 hours exposure period, which showed resistance in population collected from these sites. Considerable variations were observed in Cu. spp. adult mosquitoes collected from various sites and treated with Temephos. The population of Cu. spp. collected from Taru Jabba showed lowest mortality (50%). Percent mortality was higher (91.11%) after 48 hours exposure period. Highest mortality (100%) was recorded in mosquitoes collected from all sites except Tarnab Colony, Hayat Abad and Taru Jabba after 48 hours exposure period, which might be due to some resistance in the field populations at these sites.

Chloropyrifos treatment caused variable mortalities in Aedes spp. adult mosquitoes. The Aedes mosquitoes collected from NIFA Tarnab showed low level of mortality (45.28%). Percent mortality was higher 86.48% after 48 hours exposure. Highest percent mortality (100%) was recorded in adult mosquitoes collected from Military Farm Khaishk, Azakhel Park and Naguman after 24 and 48 hours exposure period suggesting high susceptibility of Ae. spp. to the insecticide at these sites. Aedes population collected from various sites showed considerable variations where Lambdacyhalothrin was used. Moderate mortality of 61.11% was recorded in mosquito collections from Toru. The highest mortality (93.70%) was noted after 48 hours period. The application of Lambdacyhalothrin showed highest mortality (100%) in collection from military dairy farm Khaishk, Azakhel park and Naguman, which showed its high susceptibility level at these locations. Deltamethrin insecticide applied against Ae. spp. adult females collected from different sites showed significant differences in mortalities. The adult mosquitoes collected from NIFA, Tarnab and Toru showed moderate level of mortalities of 56.11% and 56.94%, respectively. Mortality was higher (92.31%) after 48 hours exposure. Highest mortality (100%) was recorded in adult mosquitoes collected from Hayat Abad, Military Farm Khaishk, Azakhel Park and Naguman after 24 and 48 hours exposure period, which indicated its high susceptibility at these sites. Mortality was low in populations collected from Tannab and Toru. The application of Temephos against Ae. spp. collected from various sites showed considerable variations, where moderate mortalities of 61.94% and 65.83% was recorded in collections made from NIFA and Hayatabad, respectively. Mortality was higher of 90.93% and 97.31% after 24 and 48 hours exposure period. Highest mortality (100%) was noted in collections made from all sites except NIFA and Hayatabad after 24 and 48 hours exposure period, which indicated high susceptibility level in Ae. spp. to the tested insecticide at these sites.

3. Efficacy of Insect Growth Regulars (IGRs) against Aedes and Culex species

Results showed significant variations in mortalities with application of different IGRs against the 3rd instar larvae of Aedes and Culex spp. The IGRs exhibited significantly higher toxicity with LC50 (0.002 to 0.016 ppm), LC90 (0.008 to 0.115 ppm) and significantly higher adult emergence inhibition (79 to 99.5%) against the 3rd instars larvae of Aedes and Culex spp. The IGRs were ranked in terms of the tested parameters in the order of Pyriproxyfen 1.0 WDG > Pyriproxyfen 0.5 WDG > Methoprene. In case of field efficacy trials of IGRs, the pool results of the entire target treated sites showed that the adult emergence was negligible from water sampled of habitats that had been treated with the equivalent of 0.1g/m3 of pyriproxyfen 1.0 WDG. Four months after treatment, despite constant dilution of these habitats due to natural rainfall and despite the disturbance by animals activities, water sampled from these sources continued to be lethal to larvae and pupae. The desirable emergence inhibition was acceptable even up to six months period.

4. Evaluation of larvicidal properties of different botanical extracts

Various doses of plants crude extracts; Parthenium, Chrysanthemum, Neem extract, Neem Oil and Stevia resulted in significantly different variations against 3rd & 4th instars larvae of Culex and Aedes species after 24 and 48 hours periods. Parthenium extract was the best control agent against 3rd and 4th instars larvae of Culex and Aedes species resulting in 90-100% mortality after 24-48 hours period. Overall, LC50 & LC90 values were maximum for Stevia extract in dicating its low toxicity while Parthenium extract gave minimum LC50 & LC90 values that exhibited high toxicity against the two mosquito species. We ranked the five plant crude extracts in terms of efficiency and toxicity against the 3-4 instars larvae of both the tested insects as Parthenium > Chrysanthemum > Neem extract > neem oil > Stevia. Such results can be used in devising IPM strategies against the mosquito species in future.

FOOD SCIENCE DIVISION

The overall focus of R&D in the Food Science Division is to devise ways and means to ensure food safety and security. Scientists in this division are working on value addition and shelf life extension of agricultural commodities through gamma irradiation and other modern techniques. These efforts involve R & D for microbial safety, detoxification and new product development. Furthermore, commonly consumed diets are nutritionally enriched to overcome malnutrition and to meet requirements of special target groups. Training are imparted to generate self-employment opportunity. Also healthy foods and healthy food habits are promoted through awareness programs.

Food Irradiation & Microbiology

Technology Transfer on Mushroom Cultivation

The technology transfer efforts regarding Mushroom cultivation was continued unabatedly in the year 2014 also. Apart from arranging trainings to various farming communities in NIFA Mushroom farm, six outstation (Oghi, Hazara, Shinkiary, Hazara, Serai Nemat Khan, Hazara, Muradabad, Hazara, Guli Bagh, Swat and Balakot, Hazara) trainings were arranged for the potential growers of this highly nutritious but low input and high output fungal crop with the collaboration of Directorate of Science & Technology (DoST) Government of KPK.

Development of Innovative Nutraceuticals Products from Indigenous Herbal Ingredients for Improving Socio-economics Status of the Communities

Medicinal plants are the richest bioresource of drugs for traditional systems of medicine, modern medicines, nutraceuticals, food supplements, folk medicines, pharmaceutical intermediates and chemical entities for synthetic drugs. Pakistan is gifted with a rich source of wild plants (around 6,000 species) most of which are believed to have medicinal values. Nearly 80% of these plants are found in KPK and AJK belt. Our country having a loosely managed traditional system of medicine, which could not properly exploit its floral wealth in the pharmaceutical and herbals sectors. Almost, no finished or intermediary pharmaceutical and nutraceuticals products are made due to lack of information about the biologically active compounds of these plants. This hampers the commercial utilization of this renewable natural resource. In this endeavour, traditional herbal medicines must perforce be granted the benefits of modern science and technology to serve future global needs. Nutraceuticals development needs a special attention. From plant collection to the final prepared product, several phases are involved in nutraceuticals developments which are interlinked with each other. The use of appropriate plant material, extraction technology, manufacturing equipment, using a variety of methods from simple traditional technologies to advanced analytical techniques certainly help to produce a good quality nutraceuticals products.

During the study period, three products were developed including 1. Cardio-NIFA, 2. Nutra-N and 3. Gastro-NIF. All developed products were analyzed microbiologically for total bacterial and fungal count. No growth was observed even after 72 hours in any sample, hence the products found safe for human consumption. The main ingredients for these products are given below:

Cardio-NIFA: Nigella sativa (Black seed), Zingiber officinale (Ginger), Allium sativum (Garlic), Caruluma, tuberculata (choonga), Lemon Juice, Apple cider and Honey

Gastro-NIF: Nigella sativa (Black Seed), Foeniculum vulgare (Anes Seed), Rosa centifolia (Rose), Zingiber officinale (Dried Ginger), Cinnamomum camphora (Daar chini), Ilicium verum (Star Anes), Hyoscamus niger (ajwaen), Glyceriza galabra (Licorice) and Terminalia chebula (Hareerh)

Nutra-N: Morus alba (Mulbery), Ficus arabica (Fig), Nelumbu nucifera (Lotus), Vitis venifera (Dried grapes), Prunus domestica (dried Plum), and sucrose (Rock sugar)

The efficacy of developed nutraceuticals products were evaluated through clinical trials on human volunteers. Significant results proved claimed beneficial effects of the developed products. Different parameters for the three products i.e. Cardio- NIFA, Gastro- Nif and Nutra- N were statistically analyzed using statistix software through paired T Test and. The results of these analyses are presented for each parameter separately. The data statistically analyzed are also shown in figures. The tests conducted included ALT or SGPT, serum billirubin, alkaline phosphatase, total cholesterol, low density lipoprotein (LDL), high density lipoprotein (HDL), triglyceride, hemoglobin, red blood cells (RBC), total leukocyte count, neutrophils, lymphocytes, esoinophil, monocyte and platelet count.

Development of irradiated foods for immunocompromised patients and other target groups

In continuation to IAEA CRP 15116 on the subjected title, the 3rd efficacy trial of irradiated food was conducted on cancer patients at INOR hospital, Abbottabad. Different meals (Mince Meat + Peas, Chicken + Potato, Dal Channa and Mutton) were prepared and cooked under normal Kitchen conditions. All the samples were packed in multilayer retort pouches (Tetra pack), sealed under vacuum condition by vacuum sealing machine, and Irradiated at the dose of 8 kGy in commercial irradiation facility. The study period for the meals was one month. One group consisting of 30 cancer patients were served on treated meals while the other was fed on normal hospital diet. Physical and hematological parameters were carried out on weekly basis. The data regarding body weight is shown in Fig. 1.

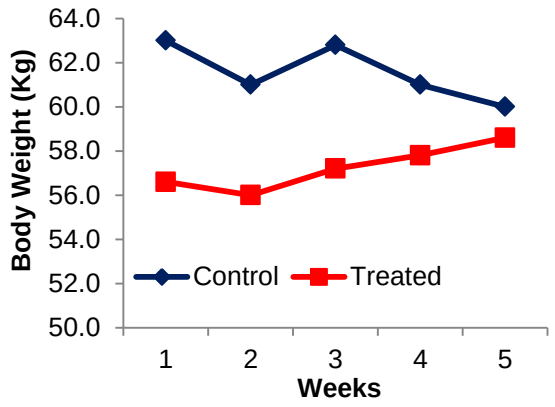

Figure 1. Average Body Weight of Test Group of Cancers Patients

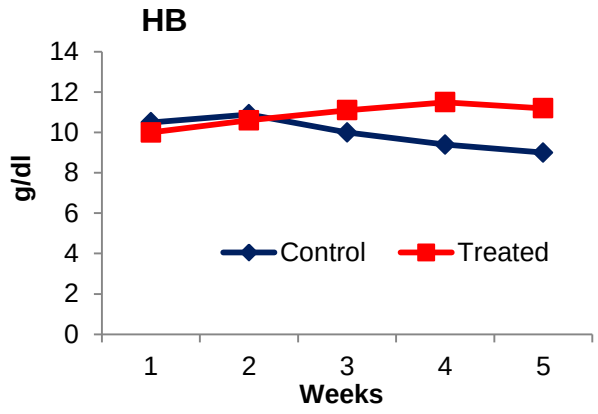

Figure 2. Hematological Parameters of Breast Patients.

Drastic decrease in body weight was recorded in control group as compared to test group patients in which the body weight was maintained during the entire period of one month study. The hematological data of third efficacy trial was compiled and analyzed statistically. From the data, it was noted that Hemoglobin content of patients served on treated diets was significantly increased during study period of four week, while no significant difference was recorded in the patients served on normal hospital diets. . On the basis of quality of life performa, it was evident that the patients served with treated meals acquired lesser secondary or food borne infections than the patients eating normal hospital diet.

According to the opinion of relevant doctors, increase in weight and Hb content was due to the serving of low bacterial diets and less attack of food borne diseases as compared to control groups of patients. No. clear picture was noted in some of the hematological parameters of both (test, control) groups of patients. However some trends of increase and decrease were noted in the hematological profile during the efficacy trial.

Pesticide Residues in Vegetables

Pesticide residue monitoring in fruit and vegetables was carried out under the PSF funded research project “Development and Validation of Technologies for Pesticide Residue Management in Fruit and Vegetable Produce”. Vegetable samples were collected from suburbs of Peshawar and Charsada areas. Modified QuEChERS extraction and cleanup method was used as sample preparation method for the analysis of organochlorine, organophosphate, carbamate and pyrethroid pesticide residues in spinach, cabbage and cauliflower by gas chromatography with electron capture detection (GC/ECD) and HPLC-UV/VIS. Cabbage samples were found most contaminated with mean pesticide residue concentration of 0.74 mg/kg followed by 0.51 mg/kg in cauliflower and 0.46 mg/kg in spinach samples. Residues of variety of compounds were detected in the vegetable Diazinon, Fenpropathrin and Imidacloprid were most frequently detected compounds in the vegetable samples (Fig. 3). Detection of Endosulfan and Heptachlor in some vegetable sample indicate pesticide adulteration or otherwise use of banned organochlorine compounds in vegetable fields for pest management in vegetables.

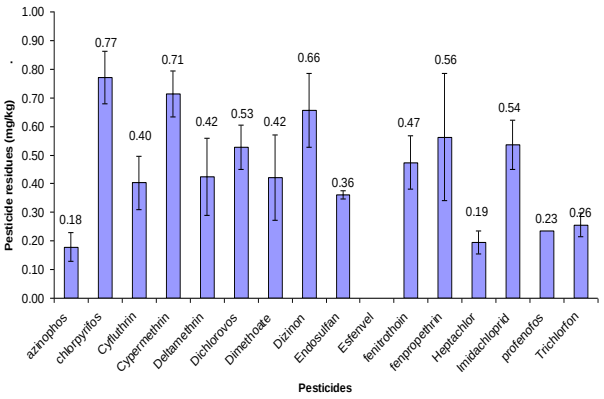

Figure 3.Pesticide residue spectrum in vegetable samples. (Error bars = ± standard error of mean)

A comprehensive study was also carried out for pesticide monitoring and management in peach fruits. Peach samples of three varieties viz. Early Grained, Florida King and Taxas were collected from peach orchards of University of Agriculture Peshawar (UOAP), Tarnab (TF), Nowshera (NRA), Swat (SWT) and from local fruit market of Peshawar (LMPWR). The peach fruit sample were sub-sampled and were analyzed as whole fruit, peel, pulp and washed whole fruits. Extraction and cleanup was done by modified QuEChERS method for the analysis of multi-class pesticide residues by GC-ECD and HPLC-UV/VIS. Description of the pesticide residues in peach is given in Table 1. Samples of Early Grained were most contaminated followed by Taxas and Florida King. Spatial variation in the pesticide residue frequency and concentration was also observed in the study areas. Peach samples from Tarnab farm and Swat were found most contaminated (Fig. 4).

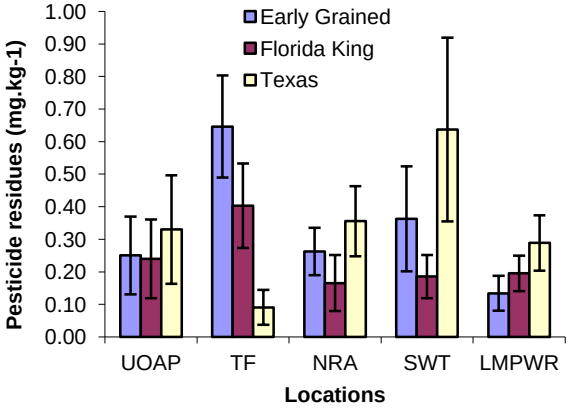

Figure 4.Mean pesticide residues in peach varieties at different locations

Pesticide residue in peel and pulp of peach were used to study pesticide migration (Figure 3). Significant amounts of thiamethoxame and imidachloprid residue migrated from peel to pulp while majority of heptachlor, chlorpyrifos and cypermethrin residues remained on the peach peel. Pesticide migration with found correlated with the octanol-water coefficient (Kow) of the pesticides. Pesticide behavior on the peach fruit also affected the washing treatment used for pesticide residue management. Washing treatment was able to reduce residues upto 35% in case of least migrated pesticide viz. Cypemethin and Imidachloprid. Effect of washing was least for pesticides with higher tendency of migration in pulp.

Development of Bio-pesticides Enhancement of Efficacy Synergism Development

These R&D was conducted in Environment Protection Labs. (i) Control of fruit fly in export related fruits and vegetables by the use of Bio-pesticides. (ii) Lab analysis of fruits and vegetable for toxic and heavy metals. (iii) Training of students from colleges and universities. (iv) Three products developed. (v) Two MoU signed with private companies for the developed products for the sale to stakeholders. Conducted training (one day) on Green Growth Technologies (GGT). Five students trained (3 M.Phil, 2 M.Sc., 2 B.Sc. (Hons.) in progress.

Field efficacy of the buffer based rapid test kits for the estimation of Iodine in salt

Iodine (I2) is an essential nutrient for performing many vital functions. Adults can store 15-20 mg of I2, which acts as a substrate for the formation of thyroid. Recommended Daily Allowance (RDA) for I2 is 150 ug and is sufficient to prevent iodine deficiency. Populations having iodine intake less than 10 ug.day^{-1} suffer from goiter. Health problems arising from deficiency due to iodine are all together known as iodine deficiency disorders (IDD). According to National Nutrition Survey of Pakistan (NNS, 2011) 50% of the country's population is iodine deficient. Also around 5 million babies born fail to develop fully because of iodine deficiency. Overall 42.8% of mothers in Pakistan have knowledge about iodine For the prevention of IDD, salt is a suitable vehicle for iodine fortification because iodination technology is straightforward and can be adopted at local level with low cost. Therefore universal salt iodization (USI) is the most commonly practiced technique for eradication of iodine deficiency disorders (IDDs).

Testing iodine in salt is an important indicator in order to monitor achievements in USI. Standard titration method is the commonly used method for estimation of iodine content, it requires a lot of

time, financial and manpower resources. Iodine spot-testing kits do not require any special setup, are relatively inexpensive and provide on spot results for rapid and useful feedback. These kits help in strong monitoring of the level of iodine in salt; also they are strong tools in order to promote good health in the community and to aware and educate the consumers about good health. However these test kits give only qualitative results and no idea about the level of iodine actually present in the salt samples. The ordinary kits have several drawbacks; they have short storage life and function in a limited pH range of salt. NIFA has developed new buffer based test kits.

Under this project studies were conducted to determine the efficacy of these Rapid Test Kits (RTK) for the estimation of iodine in salt samples collected from District Nowshera, Peshawar and Charsadda and compared with already developed Standard RTK and with Standard titration method. Shelf life of iodized salt was studied for four months. ****

Results indicated that a non-significant decrease ($p > 0.05$) in the iodine content of the iodized salt samples during storage over period of 4 months and iodine retention ranged from 70.4 – 72.4%. There was a non-significant difference ($p > 0.05$) between results of iodine contents of salt samples determined by Standard Titration method and Standard RTK method and were positively correlated with each other. Comparison of iodine contents of salt samples by Standard Titration method vs. Citrate Buffers showed non-significant differences mostly except for some of the Citrate buffers (No. 7, 10, 12, 14, 15, 16 and 18) and were rejected for future use while the rest were working well. The results of Citrate Buffers were positively correlated with Standard Titration method. Comparison of iodine contents of salt samples by Standard RTK against Citrate Buffers showed non-significant differences ($p > 0.05$). Positive correlations were found between results of standard RTK and citrate buffers. Iodine contents of salt samples by Standard Titration method against HCl Buffers showed non-significant difference except for Buffers 3 and 18 that showed significant differences ($p \leq 0.05$). Buffers 3 and 18 were rejected while all others can be used as semi-quantitative method. Positive correlation existed between results of the two methods. Results of iodine content determined by Standard RTK against HCl buffers showed non-significant differences ($p>0.05$). Positive correlation occurred between results of iodine content in salt samples determined by both the procedures. About 10% of the iodized salt samples had higher moisture level and 90% of the salt samples had higher level of impurities than the recommended levels. It was concluded that both Citrate and HCl buffers can be used as standard semi-quantitative methods due to similar efficacy.

Influence of genotype and sowing date on phytic acid contents and other physic-Chemical characteristics of wheat grain

Purpose of the present research was to study the effect of sowing date on phytic acid, inorganic phosphorous and other physic-chemical characteristics of wheat grain. Ten wheat genotypes belonging to wheat breeding program of NIFA were sown at two different dates using completely randomized design (CRD) with three replications. Seeds obtained after harvest were subjected to analysis for various parameters. Values for weight per seed ranged from 0.042 to 0.050g (average 0.045g) in the early sown wheat genotypes whereas the range for the same parameter was 0.040 to 0.046g (average 0.043g) among the late sown crop. Values for volume per seed ranged from 0.037 to 0.050cc (average 0.042cc) in the early sown wheat genotypes whereas the range for the same parameter was 0.034 to 0.046cc (average 0.039cc) among the late sown crop. Values for seed density ranged from 1.04 to 1.15g/ml (average 1.06 g/ml) in the early sown wheat genotypes, whereas the range for the same parameter was 1.04 to 1.21 g/ml (average 1.13 g/ml) among the late sown crop. Values for Phytic acid contents ranged from 1.12 to 1.54% (average 1.26%) in the early sown wheat genotypes whereas the range for the same parameter was 1.40 to 1.63% (average 1.56%) among the late sown crop. Values for total protein contents ranged from 10.0 to 12.3% (average 11.9%) in the early sown wheat genotypes whereas the range for the same parameter was 11.3 to 12.9% (average 11.5%) among the late sown crop. Effects of genotype on total protein were non-significant and sowing date significantly ($p=0.0319$) influenced it. Values for Protein Solubility contents ranged from 71.6 to 88.0% (average 81.1%) in the early sown wheat genotypes whereas the range for the same parameter was 71.0 to 87.6% (average 77.6%) among the late sown crop. Values for vitro Protein digestibility (IVDP) contents ranged from 44.3 to 58.6% (average 52.6%) in the early sown wheat genotypes whereas the range for the same parameter was 47.6 to 62.3% (average 56.3%) among the late sown crop. It is concluded that effect of genotypes and sowing time on Phytic acid was non-significant. Among all parameters studied, sowing date significantly influenced the total protein ($p=0.0319$) while genotypes had non-significant effects on these parameters.

Development of Package of Technology for Poultry Feed Irradiation in Pakistan

Gamma irradiation is a relatively newer technology applicable as a cool terminal process to inactivate/kill spoilage and disease causing microorganisms of poultry feeds. Industrial level application studies are needed on adopting this technological intervention for better feed provision system. Second year's work of the current project was aimed at studying the influence of gamma irradiation and packaging materials on the biological performance of the consuming broiler flock.

Experimental antibiotic-free broiler feed was got prepared in SB Feed Mills, Mandra and packed in 2 layered polypropylene woven + polyethylene (PP+PE) bags, or polypropylene woven (PP) bags. The treatment lot of the samples was irradiated at 5kGy dose of gamma radiation at Pakistan Radiation Services (PARAS) Lahore. All the samples were then transported to NIFA Peshawar for use in a replicated feeding trial on broiler chicks at farmer's shed. Results of the feeding trial and biological performance of the broiler chicks were reported previously.

Cost Economics

Although cost reduction or a better cost benefit ratio was not a specific objective of the current work, the findings showed a higher benefit to cost ratio with feeding irradiated than control feed. The overall objective of the project is to study the technical and economic feasibility of commercial scale production of antibiotic-free poultry feed, with a view to replace the practice of adding antibiotics to broiler feed with radiation treatment for the sake of better community health protection and prevention of the development and spread of antibiotics resistant microbial stains. The farmers and feed millers, however, may also be interested in direct monitory benefits out of the practice. Findings of the current experiment have pointed towards possible direct benefits as well.

The higher benefit to cost ratio has been the cumulative outcome of better feed economy, higher weight gain, and lower bird mortality with irradiated feed than control. The observed about 6% reduction in the FCR with irradiation might be due to better nutrient bioavailability. Although nutrient digestibility and metabolizable energy contents were not determined in any of the feeding trials of this project, there are ample reports in the literature indicating higher nutrient availability from radiation treated feed.

The overall conclusion of all the three years' work could be summarized as;

1. Feed packed in twin-layered non-porous packaging and subsequently irradiated at 5kGy has much longer storage stability than the in-vogue practice of non-irradiated feed packed in porous woven polypropylene bags. Feed packed in twin-layered non-porous packaging and irradiated at 5kGy also has the benefit of higher biological performance of the consuming flock resulting in higher economic returns.

2. The post packing radiation treatment as terminal process brings the fungal count to zero and the bacterial count to a drastically low level. The twin-layered non-porous packing prevents recontamination of the feed as well as absorption of moisture from the environment.

3. Feed packed in twin-layered non-porous packaging and irradiated at 5kGy also has the benefit of higher biological performance of the consuming flock resulting in higher economic returns.

Development of Nutrient Enriched Food Products

Prevalence of Undernourished people in Pakistan is 24% of total population while 37.5% population not receiving proper nourishment. While 6.9 million people in country are suffering from diabetes. As a result body become prone to attack of free radicals, suppresses immune system and reduces resistance to degenerative diseases. Enrichment of Wheat with other cereals and non conventional sources is needed to combat the mall nutritional problems. Because these ingredients are rich sources of carbohydrate ,protein, fibers, minerals photochemical ,antioxidants and other bioactive compounds and their intake improves the fat metabolism which in turn decrease the risk of liver / heart diseases ,obesity, hypertension , constipation and bowl disorder. The objectives of the study were to develop innovative, economical improved nutritional quality food products that deliver functional, ingredients in a sustainable fashion, for special target groups, as well as to those in the general population who wish to reduce their calorie intake.

Development of Nutrient Enriched Porridge

Porridge: is a cereal based dish cooked in Milk or water or both. It is used as nursing dish to help sick people in quick recovery from illness or as source of energy. The porridge has long shelf life

and could be used by all age groups. Enrichment of Wheat with Oat, Barley, Sorghum, and Milk Thistle in various proportions makes it nutracutical Porridge which provides additional health benefits beside nutrition. Milk Thistle, being a source of Silymarine a well known remedy for liver diseases which is expected to make the products hepato/Cardio protective.

Milk Thistle, Barley, Sorghum and Oat were grown at NIFA experimental farm while the wheat was obtained from PBG Division. To prepare the test porridge Seeds were cleaned, and blended in following formulation. Formula A was considered as control in which exclusively Wheat was used, while in Formula B, C and D Wheat, was used 80%, 60%, and 50% respectively while Sorghum was incorporated 8,%17 and 20% ,Barley 10%,205 and 35% similarly Milk Thistle was blended @25,35and5% respectively in each formulation. Proximate analysis was carried.

Preparation of Nutri Biscuits

Snack foods such as biscuits and crackers have several important advantages i.e. Wide consumption, relatively long shelf life, good eating quality, highly palatable and acceptable these characteristics make nutrient rich biscuits attractive for the research work. For preparation of Nutri Biscuits Wheat, Barley and Milk thistle flour were blended for following formulation i.e. Control 100% wheat flour,80% wheat, 20% Milk thistle, 10% barley50% wheat, 30% Milk thistle, 20% barley, D 30% wheat, 40% Milk thistle, 30% barley, E (10% wheat, 50% Milk thistle, 40% barley. Baked in Lab oven .Proximate composition and Sensory evaluation of product was carried out using standard method. Results revealed that Protein, fat and fibers were significantly increased in test product than control. Sensory evaluation also showed a greater acceptability of test products over control .The incorporation of wheat flour with mentioned ingredients brought a desirable improvement in the nutritional and sensory characteristics and in bioavailability of micronutrients in staple foods. Such functionally enhanced flours could be used in several other food systems for the formulation of healthy foods. These ingredients prevent lipid per oxidation, balance the lipid and glucose metabolism

Quality Improvement of Cotton Seed oil by fortification of Flax Seed oil

The WHO recommended that in the dietary oil ratio of saturated, monounsaturated and polyunsaturated fatty acids as 1:1.5:1 & Omega6/Omega3 ratio of 5:10 that fulfill the nutritional requirements. Some vegetable oils do not meet this standard and not able reach consumer satisfaction in term of their nutritional status. Cotton Seed (CSO) is very commonly used by the public/oil industry. But the adverse health effects of its saturated fatty acids are well proven. Therefore Flax seed oil(FSO) was selected as fortificants to blend in CSO because of the reasons that it is indigenous , safe, economical and packed with micronutrients ,essential fatty acids (Omega 3,6) and natural antioxidants. The refining of crude flax seed oil was carried out using standard protocol. The CSO was blended @20%, 40%, 60% and 80%, with refined FSO. The samples were analyzed for quality attributes POV, FFA, Fatty acid profile,βcarotene, vitamin E by standard methods. Samples were kept under oxidative stress conditions (Sun& Artificial Light) for 04 months. The stability was measured by POV. The overall observations of study are as under.

Among all the blends, FSO: CSO (60:40) exhibited not only enhanced stability under all the test conditions but also showed a greater improvement in beta carotene and Vitamin E than other test samples, which act as biological antioxidant and impart stability. Maximum increase in linolenic acid was also found in (60:40) blend, while higher concentration of linolenic acid was observed in 20:80 blends. The distinguished character of study was reduction in palmatic acid which have negative health effects .Therefore this blend was found more nutritious and stable than control Blending of oil is the possible solution to achieve to manufacture edible oils of good characteristics to decrease the health related problems, and to fulfill the body nutritional needs. The test oil could be an attractive source of dietary oil for use in food preparation as such or as fortificants with other vegetable oils. However, more study is required to exploit other economical indigenous sources to improve the nutritional value of local edible oils.

Development of market life enhancement technology of persimmon and its dissemination to growers

The tropical agro climatic conditions of this province are well suited for production of persimmon fruit. However, persimmon plantation on commercial scale has been undertaken in KPK recently. The fruit has gained much popularity in Peshawar, Mardan, Malakand, Dir and Swat valleys.

Inspite of the agro climatic blessings and very obvious export potentials, only few persimmon growers are earning foreign exchange by exporting the fruits to Far East and Middle East markets. The global volume of persimmon exports is rather insignificant (less than 8000 tones in

1999) of which 82% was from Israel. The main hurdles encountered are its short market life, the presence of astringent taste due to phenolics in this fruit and lack of awareness among growers regarding the technologies for astringency removal of persimmon.

In order to utilize the persimmon season of 2013 some preliminary experiments on selection of picking time for persimmon growing areas Charsada, Swat and value addition of persimmon fruits were planned and conducted on relatively larger scale by using already available autoclave and growth chamber as close/controlled atmosphere chamber.

Persimmon from the orchard of Rashaki tehsil Shabqadar (Charsada) were collected at pre picking stage (greenish yellow), followed by sorting, washing, keeping for removal of adhering water and divided in to five lots. Control fruit kept in open crates (T1), kept in auto clave for 24 hrs in modified atmosphere chamber with addition of nitrogen (T2), kept in autoclave for 48 hrs with modified atmosphere chamber by the addition of nitrogen (T3), kept in growth chamber for 24 hrs with modified atmosphere chamber by the addition of nitrogen (T4), kept for 48 hrs in growth chamber with modified atmosphere by the addition of nitrogen (T5). The experiment was started on 23-9-2013 and completed on 21-10-2013. Due to high temperature compared to the period of past five years (2008-2012) in the month of September and October the weight loss were also significant during four weeks storage for control (2.93, 6.60, 10.85 and 20.3 %) as well as all the treatments. On the basis of weight loss, antioxidant and texture data, it can be concluded that storage of up to two weeks could be beneficial or the picking time (if possible) could be delayed from September/October to October/ November (if possible).

Persimmon from the orchard of Thana (swat) were collected at pre picking stage (greenish yellow) 31-9-2013, followed by sorting, washing, keeping for removal of adhering water and divided in to five lots Control fruit kept in open crates (T1 crates (T1), kept in auto clave for 24 hrs in modified atmosphere chamber with addition of nitrogen (T2), kept in autoclave for 48 hrs with modified atmosphere chamber by the addition of nitrogen (T3), kept in growth chamber for 24 hrs with modified atmosphere chamber by the addition of nitrogen (T4), kept for 48 hrs in growth chamber with modified atmosphere by the addition of nitrogen (T5). The fruits of this area were high in phenolic content as compared to Charsada fruits initially. These fruits were stored for two weeks due to high temperature resulting in severe weight loss of up to 15 % (T1), 11% (T2) and 9% in T3 samples. Regarding the fruits collected from swat orchards, although the modified atmosphere reduced the astringency significantly but fruits could not resist the change in temperature for longer storage period and the storage period may be extended by storing the fruits in the same environment after treatment.

Persimmon from the orchard of Thana (swat) were collected at picking stage (yellow), followed by sorting, washing, keeping for removal of adhering water and divided in to five lots Control fruit kept in open crates (T1 crates (T1), kept in auto clave for 24 hrs in modified atmosphere chamber with addition of nitrogen (T2), kept in autoclave for 48 hrs with modified atmosphere chamber by the addition of nitrogen (T3), kept in growth chamber for 24 hrs with modified atmosphere chamber by the addition of nitrogen (T4), kept for 48 hrs in growth chamber with modified atmosphere by the addition of nitrogen (T5). All the samples were analyzed for quality parameter (acidity, ascorbic acid, pH, TSS, water extractable total phenol) after 01 and 07th day to check the effect of modified atmosphere created in the autoclave and growth chamber by addition of nitrogen gas on the value addition of these fruits The experiment was started on 4-10-2013 and completed on 11-10-2013. Due to high temperature compared to the period of past five years (2008-2012) in the month of September and October resulted in prominent weight loss. On the basis of weight loss, antioxidant and texture data, it can be concluded that storage of up to seven days could be beneficial for the treated fruits picked at normal picking time and the treatment could also replace the application of carbide to fruits during packaging.

In the market a new trend was observed. Export quality fruit were found at fruit mandi, G. T Road Nasir Pur, Peshawar Persimmon were packaged in crates (with out carbide) were yellow in color with slight greenish ting, hard in texture and astringent taste. According to the fruit agents and supplier at the fruit mandi, these fruits were for export to Kabul, Afghanistan. As these fruits were very astringent in taste, the quality of these fruits can be improved by treating for lowering astringency. Keeping in view this objective, fruits of export quality were purchased on 1-11-2013 from fruit mandi. followed by sorting, washing, keeping for removal of adhering water and divided in to three lots Control fruit kept in open crates (T1), kept in growth chamber for 24 hrs with modified atmosphere chamber by the addition of nitrogen (T2), kept for 48 hrs in growth chamber with modified atmosphere by the addition of nitrogen (T3). All the treatments were conducted in triplicate. The experiment was started on 31-10-2013 and completed on 25-11-2013. The temperature ranged from 24.4 to 20.1 OC. Due to decrease in temperature compared to September

and October resulted in prolong storage of fruits treated at normal picking stage. On the basis of weight loss, antioxidant and texture data, it can be concluded that storage of up to 21 days could be possible for the treated fruits picked at normal picking time resulting in replacement of the application of carbide to fruits during packaging and value addition by decreasing of astringency.

Development of snack product through extrusion cooking

In order to develop a nutritious snack product, corn starch, sugar, chick pea flour, peanut flour and Sodium-bi-Carbonate formulation was prepared. Moisture content of the raw ingredients was measured. The ingredients were dry mixed, ground and passed through a 40 mesh screen. Moisture content was adjusted to 30%. The extruder was run at 150 rpm and heating was provided through the extruder barrel. The product temperature measured with thermocouple inside the die reached up to 134oC at the die, the extrudate expanded and came out as continuous rope. Inclusion of dry milk powder in the formulation significantly improved the texture and color of the product.

Development of Method for Preservation of Strawberries

Strawberry fruits were purchased from the local market of Peshawar and brought to the Food science division of NIFA for processing. They were washed, cut into halves and stored in sugar and calcium chloride solutions with various concentrations (0, 20, 40%) and (0, 05. and 1%) respectively, in tightly closed 250 ml plastic jar for a period of 90 days. All the samples were analyzed for physicochemical (TSS, VIT C, %Acidity, Anthocyanin value, pH etc.), microbiologically for total fungal count. The samples were also assessed for their color, texture and overall acceptability. From the result, it was observed that the samples preserved with 40% sugar syrup were found better and fit for human consumption during the entire storage period of 90 days. The anthocyanin content was completely leached out from the fruits into the syrup. The ratio of leaching was lesser in the samples treated with higher sugar content. No fungal contamination was noted in any sample irrespective of treatments while in controlled samples more than 103 TFC.gm^{-1} was noted and found unsuitable for human consumption. The sensory evaluation showed that all the samples were within the acceptable range except the control that were discarded after 7 days of storage. In a separate experiment slices of fresh strawberry were dried by solar as well as gas drier. The solar drying took about 3 days while the gas drying took 3 hours. However, final quality of the solar dried strawberries was more acceptable with respect to taste and color. In another another experiment strawberries were packed in sugar solutions of various concentration for 90 days in 500 ml PET bottles. The strawberries lost their color and texture during storage and seemed that this is not a suitable method for it preservation.

SOIL SCIENCE DIVISION

The major thrust of soil science division is to devise strategies for combat flow soil fertility menace, soil degradation, plants nutrition and water conservation by elevating soil organic matter (SOM) content in soil and by selecting nutrients/water use efficient varieties. Several goal oriented research projects have been initiated to enhance crop production, improve nutrients/water use efficiency and soil health. Soil Science Division is also a helping hand for the breeders of NIFA by evaluating newly evolved cultivars for their nutritional requirements and providing fertilizer recommendations for new crop varieties.

Fertile soil and water are the most important natural resources in agriculture. The management and effective use of these natural resources are essential for food security. The objective of Soil Science Division is to work out ways and means for efficient utilization of soil, water and plant nutrients. The techniques of integrated plant nutrients management system (IPNS), fertigation, foliar feeding, tunnel farming and development of organic fertilizer were the outcome of these successful attempts. Selection of genotypes with higher yield potential on low fertility soils of different crops is another task of this division to benefit farmers and the crop breeders.

Plant Nutrition

Integrated management of nutrients and water for growing off-season vegetables in high tunnels in moisture deficit areas

Fertilizer and water are the most costly inputs in farming system. The province of Khyber Pakhtunkhwa is being more severely affected by the shortage of water as its 50% cultivated area is rain-fed and the growers have small land holdings. They normally grow traditional crops through traditional methods of irrigation. Fruits and vegetables are the popular crops of the province but the production of these crops, particularly of vegetables, is very low. Growing of off-season vegetables in tunnels always produce higher yield, good quality and fetches higher price for the growers through minimum use of land and water

Introduction of high tunnel farming in Khyber Pakhtunkhwa has wide scope and likely to generate economic opportunities particularly for growing off-season vegetables and other high value crops. Off-season vegetables can be cultivated with limited moisture supply using high tunnel technology having efficient irrigation system, in which temperature is partially controlled during winter. The irrigation water and fertilizers are efficiently utilized in this package of technology. The technology is very suitable for small land holders having limited water source and in return they will get maximum profit compared to traditional farming. The livestock is a major component of rainfed farming system and farmyard manure is easily available in these areas that will be utilized properly in integrated nutrients management for growing off-season vegetables/ nursery. Other potential benefits of cultivation of off-season vegetables are higher yield and better quality. In addition to higher food production and improvement in socioeconomic status of small growers, this technology will also enhance the water/fertilizer use efficiency with minimum environmental pollution.

The idea of growing off season vegetables was conceptualized at NIFA and the high tunnel farming technique having drip or sprinkler irrigation systems was developed and perfected at experimental level. The effect of integrated NPK and FYM treatments was studied on the yield of hybrid tomatoes and cucumbers. The properly decomposed FYM @ 50 kg/Marla was applied before transplanting nursery while NPK was applied after establishment of crop (30 days after transplanting) at different intervals. The yield data indicated that maximum tomato fruit yield of 3800 kg/10 Marla tunnel was recorded in the treatment receiving NPK at 80 N + 80 P_2O_5 + 90 K_2O $kg.ha^{-1}$ after each 30 days interval starting after establishment of crop (30 days after transplanting) till mid of June. In another high tunnel cucumber was grown and the maximum fruit yield of 3500 kg/10 Marla tunnel was recorded in the treatment receiving NPK at 125 N + 200 P_2O_5 + 250 K_2O $kg.ha^{-1}$ (soil application) + B spray (0.1%) at 15 days interval starting after establishment of crop till mid of May (Four sprays). The results indicate that off-season tomatoes and cucumbers grown in high tunnel gave 10-15 times more income compared to conventional one. The technology of high tunnel farming and integrated nutrient management for tomato and cucumber was demonstrated to vegetable growers in workshops farmers' day held at NIFA during 2012, 2013 and 2014.

Biofortification of zinc in wheat for balanced human nutrition

a. Screening of wheat genotypes for Zn efficiency in chelate-buffered nutrient solution

Zinc (Zn) deficiency is recognized as a major problem of human nutrition world-wide. It has been estimated to affect up to one-third of the world's population. Inadequate dietary intake of bioavailable forms of Zn is considered the most

frequent cause of Zn deficiency. The risk of insufficient dietary Zn intake is particularly high in populations depending on sources with low levels of absorbable Zn such as cereals and with no or only limited access to sources rich in bio-available Zn such as meat. This situation is wide - spread in arid regions of developing countries. In the developing world; cereal grains provide nearly 50% of the daily calorie intake of the population, and up to 70% in rural areas. While the problem of Zn deficiency in developing countries was recognized already decades ago, it is only rather recently that a relationship between human Zn deficiency and low Zn levels in soils and crops has been found. Building on this link between soil and human nutrition, biofortification of food plants has been proposed as a new strategy to fight Zn malnutrition in developing countries. As Zn deficiency is a widespread nutrition problem in several key crops, plant breeders, soil scientists and agronomists are continuously searching for the cultivars which can be grown successfully on Zn-deficient soils where it may be difficult to supplement their low Zn supplies. In view of these considerations, a study was undertaken to investigate the relative Zn-efficiencies of a range of cultivars of wheat. Ten wheat cultivars were grown in chelate-buffered nutrient solution in a net house under prevailing environmental conditions. The seeds were surface sterilized with sodium hypochlorite and germinated on moist filter papers in Petri dishes in an incubator at 20 ± 1^{o}C until ready for transplanting. Three days after germination, 2 seedlings of each cultivar were transplanted into white thermo pore sheet placed in stainless steel container of 50L capacity filled with 40L of the chelate-buffered nutrient solution. Zn^{+2} activities of 2, 10 and 40 pM were employed to the plant. The plants were initially grown in nutrient solutions containing half strengths of all macro and micronutrients, except for Zn and K_3HEDTA (which were at full strength) until day 10 after which the full-strength solutions were used. The nutrient solutions were replaced with fresh mixtures on days 10, 15, 19, 24, 28 and 32 following transplantation. The pH values of the solutions were adjusted to 6.0 ±0.01 with 0.1 M HCl or 0.1 M KOH as required. Harvesting of the plants was carried out on day 35 after transplantation. The tissue samples were then air dried on paper towels and later dried in a forced draught oven at 70 ± 1 °C for 48 hours (until constant weight) and were analyzed for micronutrients and P by standard procedures of analysis. The results depicted that stunted growth was the first visual symptom of Zn deficiency appeared and then whitish- brown necrotic spots developed on the middle parts of the plant. Three different levels of Zn^{+2} activities in solution had a significant effect on the growth of the wheat plants. In the culture solutions with higher Zn^{+2} activities, the plants showed enhanced growth and dry matter production. The genotype NRL-1243 has the maximum dry matter production at 40 pM Zn^{+2} which was 7.59 g/pot. In the Zn deficient solutions (2 pM Zn^{+2}), shoot dry matter production was distinctly lower. By exploiting this variation in dry matter production at different Zn activities, the efficiency of genotypes varied between 16 to 59 %. Out of 10 genotypes 4 have been identified as Zn efficient and 4 as Zn-inefficient. The Zn-inefficient cultivars i.e. NRL-1207 and NRl-1201produced significantly lower dry matter yields than the Zn-efficient cultivars NRL-1220 and NRL-707 at the Zn-deficient level. It was also observed that Zn concentrations in the shoots of the different cultivars varied between 9.4µg g-1 and 43.4 µg.g^{-1}. Generally, the Zn-inefficient cultivars (NRL-1201 and NRl-1213) had lower Zn concentrations (9.4 and 9.7 µg.g^{-1}) than the Zn-efficient ones. The uptake of Zn in plant shoots varied between 24.0 and 847.3 µg/pot. The cultivars which had been classed as Zn-efficient showed higher Zn uptake than the Zn-inefficient cultivars in low Zn culture solutions (2 pM Zn^{+2}). The Zn-efficient cultivars NRL-707 and NRL-1220 had Zn uptakes of 103.2 and 101.7 µg/pot respectively, whereas the Zn-inefficient cultivars NRL-1201 and NRL-1213, had uptakes of 23.6, and 25.9 µg Zn/pot, respectively.

b. Screening of wheat genotypes for Zn efficiency under field condition

The results from solution culture experiments are only reliable when they have been tested under field conditions. Keeping in view, 10 genotypes, (4 Zn-efficient, 2 medium, 4 Zn-inefficient) were tested at two levels of Zn (0, 5 kg.ha^{-1}) under field conditions for their Zn efficiency. The experiment was laid out according to Split Plot design with wheat genotypes in the main plot and Zn treatments in subplots. Prior to initiation of experiment, soil samples were collected from different fields and analyzed for available Zn so as to select Zn deficient site. The available Zn in experimental site was 0.38 µg.g^{-1}. The soil also contained 0.82% O.M, 5.6 µg.g^{-1}Olsen P having pH 8.0 and ECe 1.4 dSm-1. The basal dose of P (90 kg.ha^{-1}) was applied to the entire experimental site at the time of sowing whereas N (120 kg.ha^{-1}) was split into two portions. One half was applied at the time of sowing and the remaining portion was applied with first irrigation. Results indicated that biological yield increased with increasing Zn level up to 5 kg.ha^{-1}, however, response of different genotypes was variable. The wheat genotype NRL-1013 produced the highest biological yield of 15.2 t.ha^{-1} with application of 5 kg.Zn.ha^{-1} which was significantly higher than rest of the genotypes. The response of Zn-inefficient genotypes was very conspicuous to the application of Zn as compared to the Zn-efficient

genotypes in terms of grain production. The Zn-inefficient genotypes (NRL-1009 and NRL- 1243) produced the highest grain harvest of 5852 and 5926 kg.ha^{-1} at 5 kg.ha^{-1} Zn level however, the yield of these genotypes reduced to 3037 and 2593 kg.ha^{-1} when grown without Zn. On the other hand, the Zn-efficient genotypes were less responsive to Zn application, however all the genotypes maintained the efficiency ranking assigned to them in hydroponic studies.

Differential growth and phosphorus uptake by wheat cultivars at different P levels

Application of P fertilizers is recommended to cope wide spread P deficiency in agricultural soils around the globe. However, ever-rising prices of P fertilizers and its low use efficiency makes this practice both uneconomical and environmentally unsafe. A wide variation exists among crop species and even cultivars for P acquisition form soil and its utilization within plant body. These variations can be exploited through selection and breeding for P efficient crop genotypes to sustain crop productivity and soil health. Therefore, solution culture study was planned to evaluate genetic variations among ten advance wheat genotypes which is an important cereal crop of Pakistan.

Seeds of 10 wheat genotypes were sown in plastic trays containing distilled water washed gravels. After germination, five days old seedlings were transplanted in foam plugged holes of thermopole sheet floating on a continuously aerated modified Johnson nutrient solution contained in two stainless steel tubs of 50 L capacity. Two phosphorus levels were established by using ammonium phosphate ($NH_4H_2PO_4$) salt; adequate (250 µM) and deficient (25 µM) P levels. The pH of the solution was maintained at 5.5 ± 0.5 with HCl or NaOH. Treatments were arranged according to completely randomized factorial design. Each treatment had three replications. Two seedlings were transplanted in one hole of a thermopole sheet and each hole was considered as one repeat. Experiment was harvested 30 days after transplanting and the data were recorded for dry biomass. Substantial differences in growth parameters such as total plant dry matter (TDM), shoot dry matter (SDM), root dry matter (RDM), root: shoot ratio and phosphorus related parameters were obvious at deficient and adequate P levels. Total dry matter ranged from 0.135 to 0.495 and 0.365 to 0.715 g.plants^{-1} at deficient and adequate P levels, respectively. Genotype NRL-1120 produced almost three times more SDM than NRL-1213 at deficient P level while NRL-1120 produced the highest RDM at adequate P level. Differences in SDM indicated that 60 % of genotypes produced SDM less than the mean average shoot dry matter at both the P levels. The differences for phosphorus utilization efficiency and phosphorus stress factor (PSF) were also observed among these genotypes. Three out of ten genotypes depicted PSF less than 50% and the rest more than 50%. Only two genotypes NRL-1120 and NRL-1206 showed PSF < 30 %. Significant (P≤ 0.05) differences for P uptake, absorption rate and utilization rates were also observed in wheat genotypes at deficient and adequate P levels. Maximum root shoot ratio was exhibited by NRL 1201 and minimum by NRL 1220 at deficient P, however, root shoot ratio was higher at deficient P level than that at adequate P level. Wheat genotypes NRL-1220, NRL-1206 and NRL-1217 were found P-efficient while NRL-1213, NRL-1205 and NRL-1201 were found P in-efficient genotypes. Results showed the existence of genetic differences among wheat genotypes with regard to P absorption and utilization. These P efficient genotypes will be tested under field conditions during 2014-2015 to confirm hydroponic results. A field study was executed during 2013-14 to confirm the results of 2012-13 hydroponic experiment. The results showed that wheat genotypes NRL-1105 and NRL-1120 were found P-efficient while NRL-1101 and NRL-1129 were found P in-efficient genotypes.

The effect of integrated P-management on wheat yield and P uptake

Soils of Pakistan are generally alkaline and calcareous in nature and deficient in available phosphorous, where wheat crop mostly suffers from P deficiency. In alkaline calcareous soil various factors including pH, nature and amount of clay minerals, Fe and Al oxides and presence of free calcium carbonate controlled P availability. Application of inorganic P fertilizer in combination with organic fertilizer (FYM) was found effective in enhancing the effectiveness of inorganic P fertilizers. Organic manures after decomposition convert relatively unavailable native and residual P to chemical forms. During this process, CO_2, produced which forms H_2CO_3 in the soil solution, resulting in the dissolution of primary P-containing minerals. Organic acids released during decomposition also help to dissolve soil mineral P. In soils with high P-fixing capacities; organic compounds released during decomposition processes may increase P availability. Repeated incorporation of FYM can decrease soil bulk density, increase soil aggregation and moisture retention. All these factors may also help to increase P uptake by increasing root and mycorrrhizal growth. Therefore, judicious and efficient use of inorganic P fertilizer and recycling of organic amendments is inevitable to maximize agricultural productivity on sustainable basis. This study was therefore, initiated with the objective of increasing the efficiency of applied P fertilizers

through integration with organic matter using wheat as a test crop.

Bulk surface soil (0-15 cm) samples were collected from NIFA, experimental research farm. Five kilogram of prepared soil was weighed and filled into glazed pots. The treatments included; control, FYM (5 and 2.5 tons FYM.ha^{-1}), TSP @ 60 P.ha^{-1}, SSP@ 60 P.ha^{-1}, RP@ 60 P.ha^{-1}, TSP+ 5 tons FYM.ha^{-1}, SSP+ 5 tons FYM.ha^{-1}, RP+ 5 tons FYM.ha^{-1}, TSP+ 2.5 tons FYM.ha^{-1}, SSP+ 2.5 tons FYM.ha-1, RP+ 2.5 tons FYM ha^{-1}. Triple super phosphate was applied to supply 100 mg P_2O_5 per kg soil while farmyard manure was added @ 10 g.kg^{-1}. Soil in pots were irrigated up to their respective saturation percentage. After a week when soil reached to field capacity, pots were emptied and soil was remixed and refilled in the pots. This process was repeated thrice and various treatments were imposed in triplicate. Wheat genotype (NIFA- Lalma) was sown and five uniform plants per pot were allowed to grow after germination. Moisture contents in pots were maintained with distilled water at about 60% of the water-holding capacity during the growth period of plants. Experiment was harvested at maturity and the yield data were recorded.

The results indicated that maximum grain yield of (33.6 gm/pot) was recorded in treatment where TSP + 5 t.FYM.ha^{-1} was applied followed by the treatment SSP + 5 t.FYM.ha^{-1}. The minimum yield was observed in control treatment. The yield of wheat from the pots treated with Rock phosphate (RP) was lower than TSP and SSP treated Pots due to slow availability of phosphorus.

Effect of various levels of NPK on yield of advance wheat lines evaluated at NIFA

NPK requirements of advance wheat lines (MPT 7, WL 8169) evolved at NIFA were determined in a field experiment during Rabi 2013-2014. Split plot design was used where wheat lines were kept in main plots and fertilizer treatments in sub plots. Three nitrogen (N) rates (0, 70,140 kg.ha^{-1} applied as urea), two P rates (60, 90 kg.ha^{-1} applied as SSP) and two K rates (30, 60 kg.ha^{-1} applied as SOP) were imposed in three replications. The net size of plot was 2.5 m × 2 m. Experiment was sown in second week of November and harvested on physiological maturity in May 2014. The soil analysis showed that texture of experimental field was silty loam with pH 7.7, organic matter 0.85%, 0.041% N and 5 µg.g^{-1} available P. Phosphorus and K fertilizers were applied at the time of sowing along with 1/3 dose of N. The remaining N was applied in two equal splits with first irrigation and at booting stage. Results showed that the highest grain yield of 5.6 t.ha^{-1} was obtained from the treatment where NPK was applied at 70-60-30 kg.ha^{-1}, followed by the treatment 70-90-60 kg NPK.ha^{-1} which yielded 5.4 t.ha^{-1}. Maximum N-uptake of 94.1 and 88.0 kg.ha^{-1} was found in the respective treatments. The wheat line MPT 7 depicted the maximum grain yield of 5.1 t.ha^{-1} when applied with NPK at 140-90-0 kg.ha^{-1}. It can be concluded from the study that wheat line Wl 8169 perform better than other genotype under test even at low level of N (70 kg.ha^{-1}) when applied in splits and at proper time.

Nutrient management of deciduous orchards (plum) through foliar feeding. (PSF funded project No.253)

The studies on "Nutrient management of deciduous orchards (plum) through foliar feeding" funded by PSF remained in progress. the already selected plum fields were subject to fertilizer treatments as follows; T_1 NPK (360 g N +250 g P + 360 g.K.tree^{-1}), T_2 (Farm yard manure (FYM) soil application (on N basis 360 gm N per tree-1), T_3 (½ NPK + ½ FYM soil application , T_4 (½ NPK+ ½ FYM (soil appl) + foliar N (0.5% N), T_5 (½ NPK+ ½ FYM (soil appl) + foliar N (0.5% N) + Zn (0.1%)., T_6 (½ NPK+ ½ FYM (soil appl) + foliar N (0.5% N) + humic acid (0.05%) and T_7 (½ NPK+ ½ FYM (soil appl) + foliar N (0.5%N) + Zn 0.1%+ humic acid (0.05%). All the mineral fertilizers and FYM were applied to the periphery of tree canopy. Half N fertilizer was applied before flowering and half with combination of P and K after fruit picking. Leaves samples from the orchards were collected in mid of September to November 2013 and mid of April – July 2014. According to the treatment plan half dose of inorganic N (urea) with farm yard manure was applied before bud sprouting in January. Results showed that fruit yield was significantly increased in all treatments in all orchards. Mera kachori orchard yielded more fruit than sites at NIFA and Khushmuqam. Among the treatment T_6 (½ NPK+ ½ FYM (soil appl) + foliar N (0.5% N) + h umic acid (0.05%) at all sites gave significantly higher fruit yield compared to other treatments. Maximum fruit yield (69.78, 67.97 and 91.12) kg.tree^{-1} was recorded in the same treatment at NIFA, Khushmuqam and Mera Kachori orchards respectively witch led to an increase of 24, 26 and 41% respectively over control. The nutrients concentration data indicated a decreasing trend in leaves as total N 2.20 % in September was lowered to 1.69 % in November 2013 and Zn from 31.4 to 1.15 µg.g^{-1} in the same period. The concentration of N and Zn in the plum leaves increase during April to July 2014. The N concentration was increased from rang of 2.24% to 2.42% while Zn from 16.65 to 19.76 µg.g^{-1} on monthly bases. So far it is concluded from the experiment that combination of soil and foliar application of different fertilizers significantly improved the yield of plum fruits and concentration of N and Zn in leaves.

Effect of boron application on oil seed brassica yield and quality

Four varieties/advanced lines, two from Napus group (NIFA-Gold and NH-97-5/2-4) and two from Junccia group (NIFA Raya and 7x1/05-4) were tested in an experimental trail conducted at NIFA experimental farm. The experiment was laid out according to split plot design, keeping varieties/lines in main plot and B levels in sub plot. Basal dose of NPK was applied to the entire experimental site at the time of sowing. Different levels of boron were applied as foliar spray on crop in three splits at vegetative growth, flowering and pod formation stage. The results showed that maximum increase in grain yield over control (23.8%) was recorded for NIFA- Gold (Napus) and NIFA Raya Juncia by the application of 700 g.B.ha^{-1}. The advance line of Juncia (7 x 1/05-4) yielded (20.8 %) more production than control at 1000 g.B.ha^{-1}, while minimum (19.3 %) increase over control in grain yield was recorded for NH-97-5/2-4 at 700 g.B.ha^{-1}. Boron concentration in brassica leaves increased with the increase of application.

Effect of Foliar Application of Boron on Fruit Productivity of Orchards.

Forty-eight newly fruit bearing plants of uniform sizes, were selected for the study at NIFA experimental farm. The trees are arranged in four replicates having 12 trees per replicate, four treatments having 3 trees per treatment in RCB design. The treatments T_1 (0 mg/tree) control, T_2 (25 mg.tree^{-1}), T_3 (50 mg/tree) and T_4 (100 mg/tree) boron in solution were sprayed twice in a year on each trees at flowering stage and after fruit picking. Composite soil samples from 0 to 60 cm depth i.e (0-15, 16-30 and 31-60 cm) and leaves samples were collected from plum orchard. The collected soil samples were analyzed for physio-chemical properties. The pH of the soil was from 7.44, 7.48 and 7.57 in 0-15, 16-30 and 31-60 cm depth respectively. The conductivity of the soil samples was from 0.45 ds.m^{-1} to 0.5 ds.m^{-1}, organic matter was from 1.2 % to 0.2 % phosphorus P ranging from (13.5 – 5.6 ppm), potassium K was from 100 ppm to 20 ppm respectively and boron concentration was less than 0.4 ppm when we move from 0-15 cm depth to 31-60 cm depth down word in the soil. The leaves sample collected shows that the average boron concentration was 30.4, 36.2, 44.6 and 48.3 ppm in T_1, T_2, T_3 and T_4 respectively. The plum fruit were picked on June 20th, 2014. The fruits harvested/picked from trees vary from 0.4 kg to 8 kg/tree with the average of 2 kg.tree^{-1} to 3 kg.tree^{-1} in T_1 to T_4 respectively.

Soil Biology

Studies on the improvement of agro-waste compost and bio-geyser.

a. Agro-waste compost for sustainable soil fertility

This was a long term field experiment, conducted for three consecutive years (to determine the sustainable beneficial effect (fertilizing effect) of agro-waste compost on vegetables. (3 consecutives crops of Tomato & Potato). The study revealed that agro-waste compost application improved the yield and quality of vegetables due to its slow-release nutrients supply. The residual effect of compost application can be realized in tomato crop for consecutive three years with 38%, 25% and 10% increase in yield respectively. Almost similar beneficial effect was observed in potato.

b. Effect of bio-power on the grain & biomass yield of Wheat

A field study was conducted to assess the effect of bio-power on the grain and biomass yield of wheat. The study revealed that no significant increase in grain or biomass yield was observed by using bio-power with 80% and 100% NPK.

c. Efforts to patent the Bio-Geyser technology

A case to patent the bio-geyser has been submitted with patent office Karachi. Number (332/2012) is being allotted and the comments/querries of patent examiner were received in May 2013. A modified case in light of the comments of patent examiner was re-submitted in June 2013. Again after one year some quarries from the examiner were received and the case was resubmitted in June 2014. Two MoU were signed between NIFA, UET Peshawar and PARD for transfer of bio-geyser technology.

Effect of fulvic acid and inorganic fertilizers on yield of potato and tomato

A field study was conducted on the ‘’Effect of fulvic acid and inorganic fertilizer on yield/quality of potato and tomato’’. The study revealed that maximum potato tuber yield (11.6 t.h^{-1}) was recorded in treatment receiving half NPK + 0.1% F.A (Foliar) + Zinc 7.5 kg.ha^{-1} followed by the treatment receiving half NPK + 0.1% F.A (Foliar) + Zinc 5 kg.ha^{-1} which yielded 10.3 t/ha. The increase over control became 45 and 26.6% respectively. Plant height and Chlorophyll content was also higher in both the treatments.

In case of tomato, maximum fruit yield (84.5 t/ha) was recorded in treatment receiving half NPK + 0.05 % F.A(foliar) + Zinc 2.5 kg.ha^{-1} followed by treatment receiving 0.05 % fulvic acid foliar plus zinc 5.0 kg.ha^{-1} .

Studies on water and nutrient uptake of wheat genotypes in relation with root traits

Field experiments were conducted at NIFA experimental farm during Rabi 2013-14 to test the yield performance of three wheat genotypes (Fakhr-e-Sarhad, Bathoor, Barsat) in conjunction with water uptake and root yield. Experiments were established in two environmental conditions, irrigated and rain-fed. Experiments were laid out in randomized complete block design with three replicates. Neutron moisture probe was used to monitor changes in soil water content for determining water use efficiency. Significant ($P \leq 0.05$) differences were observed between irrigation treatments as higher grain yield was produced in irrigated condition than under rain-fed condition. The C.V. Bathoor was the leading grain producer (6.6 t.ha^{-1}) under irrigated conditions while Fakhr-e-Sarhad produced the highest grain yield (5.3 t.ha^{-1}) under rain-fed conditions.

Significant differences ($P \leq 0.05$) were observed among varieties and irrigation treatments for root yield (0-50cm) and rooting depth. Varieties had higher root yield in irrigated conditions than under rain-fed conditions. Fakhr-e-Sarhad was the leading root yielder and produced 3.97 and 2.96 t.ha^{-1} under irrigated and rain-fed conditions, respectively. Varieties had higher rooting depth in rain-fed conditions than under irrigated conditions. Fakhr-e-Sarhad was the deep rooted amongst all varieties under both irrigated (73cm) and rain-fed conditions (93cm). Significant ($P \leq 0.05$) differences were observed between irrigation treatments while varieties did not differ significantly in water use efficiency. Varieties had higher water use efficiency under rain-fed conditions than under irrigated conditions. Fakhr-e-Sarhad (50 kg.ha^{-1}.mm-1) and Bathoor (17 kg.ha^{-1}.mm-1) were the most water use efficient varieties under rain-fed and irrigated conditions, respectively.

Significant ($P \leq 0.05$) differences were found among varieties and treatments for chlorophyll content. Varieties maintained higher chlorophyll content in rain-fed conditions than under irrigated conditions. Barsat maintained the highest chlorophyll content under both irrigated (46%) and rain-fed (47%) conditions. Varieties exhibited higher nitrogen uptake under irrigated conditions than under rain-fed conditions. Fakhr-e-Sarhad had the highest nitrogen uptake under both irrigated (129 mg.plant^{-1}) and rain-fed (120 mg.plant^{-1}) conditions.

Based on high grain yield, high root yield, rooting depth and water use efficiency under rain-fed conditions, Fakhr-e-Sarhad can be a suitable parent for further use in breeding program dedicated towards evolution of drought tolerant varieties. This study provided base line first year data for further use in simulation studies to hypothesize an ideotpye for water limited conditions.

Studies on nitrogen enrichment of composts and diet preferences of earth worms

Local species of earthworms were tested for their efficacy to enhance nitrogen content of compost prepared from plant residues. Three plastic tubs were filled with 15kg of compost and 100 earth worms were released in each tub. Experiments were maintained for three months period to assess enrichment in nitrogen content of composts due to activities of earth worms. It was found that local species of earth worms do not enrich the compost for nitrogen content.

Diet preferences of local species of earth worms were investigated under controlled conditions in laboratory. The study involved four diets (compost, grass clippings, wheat straw, farm yard manure) being tested in three replicates in a completely randomized design. Plastic jars were filled with one kilogram of diet and ten earth worms were released in each jar. Diets were moistened to provide optimum conditions for survival of earth worms and mouths of jars were covered with muslin cloth. It was found that earth worms did not survive on the diets tested over a one week period indicating that they did not prefer either of these diets.

SOCIO-ECONOMIC IMPACT

Plant Breeding and Genetics Division

High yielding, disease resistant and widely adopted varieties of wheat, oilseed brassica, chickpea and mungbean developed at NIFA are continuously playing a key role in boosting per acre yield coupled with upgrading the financial status of the farmers of KPK. These varieties have yield advantage of at least 10-15% over other commercial varieties. Twelve tons quality seed was produced and duly certified by Federal Seed Certification and Registration Department. As per standard procedure the seed was then collected by provincial agricultural extension linked with selected progressive growers in Khyber Pakhtunkhwa. The addition of two recent releases, i.e. NIFA Lalma-2013 (wheat) and NIFA Gold (oilseed brassica) has further filled the gap by their adaptation in a range of environments in the country.

Entomology Division

Fruits and vegetables are good sources of income for the farmers of KP. Fresh fruits and vegetables are used both locally and has great potential for export to foreign countries. The developed IPM technologies i.e. male annihilation technique (MAT) for fruit fly trapping coupled with use of irradiation for control of quarantine pests has led to positive socio-economic impact in terms of fruit quality, production and relaxation in the export of fruits and vegetables. Termite surveillance of subterranean termites in the fields and termite proofing of buildings has also put major impact on the socio-economic uplift of the province. Trainings were conducted on basic honeybee keeping to the unemployed youth, fruit growers, farmers and extension workers of agriculture department. Training of beekeepers on beekeeping has created employment opportunities for unemployed youth in the poor rural areas of the province. In view of need for control of emerging vector borne diseases in poor rural community, various trainings were arranged on vector control and disease management strategies. NIFA Housefly bait for fly control was registered for patent. Its application at homes, restaurants, poultry farms and fruit stores will reduce fly population and will have positive impact on living style of farmers and general public. Dengue Guard was introduced for protection against dengue and malaria carrying mosquitoes. Its application by the poor farmers will protect them from vector borne diseases and improve their health for better work environment.

Food Science Division

The R & D efforts of are gradually geared to create a positive socio-economic outcome on the society. These activities are diversified and cover almost all domains of post-harvest scenario of food sector. The primary work of this division revolves round the use of gamma irradiation technology to prolong the shelf life of horticultural commodities. The research work completed at NIFA provided basis for a commercial irradiator with the name PARAS established at Lahore. PARAS is commercially irradiating food items destined for export, thus directly impacting the enhancement of Pakistani food exports to global market. Another break through, made by FSD, is the development of Meal Ready to Eat (MRE) with a shelf life of about 2 years. The MRE technology has been adopted by Pak Army for use as emergency ration for its troops engaged in combat areas. The technology has helped the army to save precious foreign exchange that it used to spend on importing MREs from Canada. Thus the division has played an important role in import substitution by development of the MRE.

The Nutrition Section of FSD developed a rapid test kit (RTK) that is a quality field test for determination of iodine in commercial salts. Sale of these kits to MI generated Rs. 2.9 m that was deposited in NIFA income generation head. The social impact of the iodine kit project is for more important than the economic benefit. As the iodine kit precisely determines the presence or absence of iodine in commercial iodized salts, these kits play a vital role in ensuring the provision of iodine to the masses in true sense. The establishment of iodine reference lab in FSD is also a joint leap in this direction. The food processing section generated a net income of Rs.0.3 m this year besides providing purely fruit based products to consumers at relatively lower cost. The Mushroom cultivation project is yet another activity of NIFA that has tremendous socio- economic impact largely on the unemployed youth, domestic women and landless farmers. About Rs.0.25 m was deposited in NIFA income generation fund and 320 persons inclusive of women were trained in NIFA as well as in remote areas of Chitral and Swat valleys during the year under repot. These activities have triggered further economic activities which are helping not only in generation of self –employment but also in provision of nutritious diet to consumers. Recently the division has embarked on non-food sector of irradiation of gemstones for value addition. The activity was started in April 2013 with the approval of worthy Chairman PAEC and in the year 2014 it generated an income of

Rs.0.90 m. The planning to enhance the capacity of gemstone radiation is underway. A recent area of commercial activities is the signing of memorandum of understanding with an entrepreneur to popularized the FSD developed herbal based biopesticide and bio-fertilizers which are fast gaining momentum among the farmers largely the cause of their efficacy, less residue leaving quality and economy of cost.

Soil Science Division

The economical and climate smart package of integrated nutrient and water management practices for field, horticultural crops and off-season vegetables under tunnel farming are used by farmers. The farmers are getting high net return and 10-15% higher yield due to adoption of NIFA developed technologies. The technology of agro waste composting with bio-geyser as a by- product was disseminated to the end users and MoU was signed with DOST, PARD and UET Peshawar

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20. Zaman, A., I. Ihsanullah, A. A. Shah, T. N. Khattak, S. Gul, I. U. Muhammadzai. 2013. Combined effect of gamma irradiation and hot water dipping on the selected nutrients and shelf life of peach, Journal of Radioanalytical and Nuclear Chemistry. 298: 1665-1672, 2013 DOI 10.007/s. 10967-013-2656-y.

Presentations/Proceedings

1. Ahmad, T. 2014. Nutritional and health Attributes of Palm Oil Paper presented in 3rd Malaysia – Pakistan 2014 Palm Oil trade Fair & Seminar). Electronic Presentation Available on www.mpob.mpoc.gov.my.
2. Ihsanullah, A. Zeb and S. Gul. 2014. Proceeding of International Workshop on Commercial Exploitation of Food Irradiation Technology in Pakistan, Opportunities and Challenges, held October 2-3 2013, Lahore, Pakistan.
3. Zahida A., Bashir, M. Khan, Javedullah and M. Khan. 2014. Effect of different food additives on the physicochemical and microbiologocal quality of stored strawberries. Presented in 5th International Conference on Agriculture, Food Security and Climate Change at UP-Rawalakot, AJK.
4. Dr. Ihsanullah, Director, Nuclear Institute for food and Agriculture (NIFA) Peshawar NIFA, Peshawar delivered a plenary presentation on “Current Activities of Food Irradiation as Sanitary and Phytosanitary Treatment in Asia and the Pacific Region and its comparison with advanced countries” in the IAEA/FAO International Symposium on Food Safety and Quality: Applications of Nuclear and Related Techniques held at IAEA Headquarters, Vienna, Austria from November 10-13, 2014.
5. Dr. Ihsanullah, also participated in the one day workshop on “Food Control Systems and the Role of the Different Stakeholders in the Food supply Chain”, held on 14th November 2014 VIC, Austria.

FUNDED RESEARCH PROJECTS

S. No.	Title of the Project	Duration	Allocation	Principal Investigator
1.	Pak-US wheat productivity enhancement initiative. PAK-US.	2011-2015	$113,572	Mr. Abdul Jabbar Khan, DCS
2.	Selection and assessment of wheat germplasm for higher yield and improved water and nitrogen use efficiencies. IAEA.	2011-2015	€ 40,000	Mr. Abdul Jabbar Khan, DCS
3.	Development of locally adapted canola (*Brassica napus* L.) F_1 hybrids using induced mutations and double haploidy techniques. PSF.	2012-2015	Rs. 2.463 m	Mr. Iftikhar Ali, DCS
4.	Plant mutation breeding of bio-energy crops for optimizing marginal land productivity- RAS201 2011.	2014-2015	IAEA, RCA	Dr. Iftikhar Ali, DCS
5.	Improvement of Stevia through induced mutations and in vitro somaclonal variations. PSF	2011-2014	Rs. 2.17 m	Mr. Shahid Akbar Khalil, SS
6.	Breeding for bruchids resistance in mungbean (*Vigna radiata* (L.) Wilczek). PSF.	2011-2014	Rs. 2.43 m	Dr. Gul Sanat Shah, PS
7.	Promoting the Sharing of Expertise and Infrastructure for dengue vector surveillance towards Integration of the sterile insect technique with conventional control methods among South and South East Asian Countries	2014-2018	€ 2000 (PA)	Mr. Alamzeb, DCS
8.	Exploring Mechanical and Nutritional Methods of Sex Separation in Aedes albopictus Specie of Mosquitoes	2013-2018	€ 30,000	Mr. Gul Zamin, PS
9.	Use of Irradiation as Phytosanitary Treatment for the Control of *Citrus psyllids, Diaphoronia citri* and Scale Insects". IAEA.	2011-2014	€ 10,000 (PA)	Dr. Inamullah Khan, PS
10.	Integrated management of Peach Flat-headed borer, Sphenoptera dadkhani damaging trees of stone fruit orchards. PSF.	2011-2014	Rs. 1.9 m	Mr. Muhammad Zahid, PS
11.	Best practice for phytosanitary applications of food irradiation (RAS5057)	2012-2014	-	Dr. Ihsanullah, DCS

12.	Storage stability of iodine in iodized salt in under different climatic conditions. MI, Pakistan.	2014-2015	Rs. 7.200 m	Dr. Aurang Zeb, DCS
13.	Development of irradiated foods for Immunocompromised patient and other potential target group. IAEA.	2010-2015	€ 35,500	Mr. Misal Khan, PS
15.	Standardization of market life enhancement technology of persimmon and its dissemination to growers. ALP	2012-2015	Rs. 4.737 m	Ms. Nizakat Bibi, DCS
16.	Proposal for human resource development through transfer of technology "to arrange training courses for "mushroom cultivation" in various zones of Khyber Pakhtunkhwa DoST.	2012-2014	Rs. 1.2 m	Mr. Fazal Mahmood, DCS
17.	Development of innovative Nutraceutical Products from Indigenous Herbal Ingredient for Improving Socio-economic status of Communities, PSF/NSLP/KP-NIFA	2012-2014	Rs. 3.9 m	Dr. Ihsanullah, DCS
18	Development and validation of technologies for pesticide residue management in fruit and vegetable produce, PSF.	2012-2015	Rs. 2.843 m	Dr. Azhar Rashid, PS
19	Nutrient management of deciduous orchards (Plum) through foliar feeding. PSF/NLSP/KP-NIFA- 253.	2013-2016	Rs. 2.9103	Dr. Azam Shah, PS

Manpower

Manpower Position at NIFA

A. Scientists/Officers

S. No.	Officers	Sanctioned	In Position	Vacant	Total
1.	Scientists	48	44	04	48
2.	Engineer	01	01	-	01
3.	Non-technical	06	06	-	06
	Total	55	51	04	55

B. Staff (Technical/Non-technical)

S.No.	Staff	Sanctioned	In Position	Vacant	Total
1.	Scientific Staff	51	50	01	51
2.	Technical	18	16	02	18
3.	Non-technical	70	67	03	70
4.	Security & Chowkidars	24	23	01	24
	Total	163	156	07	163

C. Details of Present Scientific Strength

S.No.	Category	CS	DCS	PS	PE	SS	SRO	JS	ARO	Total
1.	Male	01	08	14	01	14	-	01	04	43
2.	Female	-	01	-	-	01	-	-	-	02
3.	Ph. Ds	01	04	07	01	04	-	-	-	17
4.	Abroad for Ph. D	-	-	-	-	01	-	01	01	03
	Total	01	9	14	01	15	-	01	04	45

D. List of Officers

	Name	Designation
I.	Dr. Ihsanullah, Ph. D (Chemistry)	CS/Director
II.	PLANT BREEDNG & GENETICS DIVISION	
	Mr. Abdul Jabbar Khan, M.Sc. (Botany)	DCS/Head PBGD
	Dr. Iftikhar Ali, Ph. D (PBG)	DCS
	Dr. Syed Jawad Ahmad Shah, Ph.D. (Plant Pathology)	PS
	Dr. Gul Sanat Shah Khattak, Ph.D. (Botany)	PS
	Mr. Roshan Zamir, M.Sc. (Hons. Agric.)	PS
	Dr. Fazle Subhan, Ph.D. (Agronomy)	PS
	Mr. Hafiz Munir Ahmad, M.Sc. (Hons. Agric.)	PS
	Dr. Muhammad Irfaq Khan, Ph.D. (Plant Breeding & Genetics)	SS
	Mr. Muhammad Amin, M.Sc. (Statistics)	SS
	Dr. Farooq-i-Azam, Ph.D (Crop Genetics & Breeding)	SS
	Mr. Shahid Akbar, M.Sc. (Hons. Agric.)	SS
	Mr. Muhammad Ibrahim, M.Sc. (Hons. Agric.)	SS
	Dr. Syed Tariq Shah, Ph.D (Crop Genetics & Breeding)	SS
	Mr. Iqbal Saeed, M.Sc. (Hons. Agric.)	JS
	Mr. Akhtar Ali, M.Sc. (Hons. Agric.)	ARO
	Mr. Mumtaz Ahmad, (M. Phil Biotechnology)	ARO
III.	FOOD SCIENCE DIVISION	
	Mr. Fazal Mahmood, M.Sc. (Chemistry)	DCS/Head
	Dr. Aurang Zeb, Ph.D. (Nutrition)	DCS/Head TSD
	Mrs. Nizakat Bibi, M. Phil. (Physical Chemistry)	DCS
	Dr. Taufiq Ahmad, Ph.D. (Chemistry)	DCS
	Dr. Maazullah, Ph.D. (Agricultural Engineering)	PE
	Mr. Misal Khan, M.Sc. (Hons. Agric.)	PS
	Dr. Azhar Rashid, Ph.D. (Biology)	PS
	Mrs. Tasnim Sharafat, M. Phil. (Microbiology)	SRO
	Mr. Zahid Mehmood, M.Sc. (Hons. Agric.)	SS
	Mr. Mishbah Ahmad, (M.Sc.) Medical Physics	SS
	Mr. Dawood Khan, M.Sc (Chemistry)	SS
	Mr. Alamgir, (M.Sc.) Medical Physics	SS
	Mr. Saeed Gul, B. Sc. (Chemistry)	ARO
	Mr. Tariq Nawaz, M. Sc. (Chemistry)	ARO

IV. ENTOMOLOGY DIVISION

Mr. Alam Zeb, M.Sc. (Hons. Agric.)	DCS/Head
Mr. Amanullah Khan, M.Sc. (Zoology)	DCS
Mr. Muhammad Zahid, M.Sc. (Hons. Agric.)	PS
Dr. Inamullah Khan, Ph.D. (Entomology)	PS
Dr. Gul Zamin, M. Sc. (Entomology)	PS
Mr. Misbahul Haq, M.Sc. (Hons. Agric.)	SS

V. SOIL SCIENCE DIVISION

Dr. Wisal Mohammad, Ph.D. (Soil and Envir. Science)	DCS/Head
Mr. Haider Khan, M.Sc. (Botany)	DCS
Dr. Imtiaz Ahmad, Ph.D. (Soil Science)	PS
Mr. Mukhtiar Ali, M.Sc. (Hons. Agric.)	PS
Dr. Syed Azam Shah, Ph.D. (Agronomy)	PS
Dr. Amir Raza, Ph.D. (Agric. Sciences)	SS
Mr. Zahid Ali, M.Sc. (Hons. Agric.)	SS
Miss. Samreen Shahzadi, M.Sc. (Hons.) Agric.	SS
Mr. Parvez Khan, M.Sc. (Hons. Agric.)	SS

VI. ADMINISTRATION & ACCOUNTS

Mr. Latif Zaman, B.Sc. MBA (HRM)	DC Admin Officer
Mr. Yousaf Khattak, FCMA	Pr. Accts. Officer
Mr. Ihsan-Ul-Haq, MBA	Admin Officer
Mr. Umar Sajjad, MBA	Admin Officer
Mr. Raufullah, M.L.I.Sc.	Sr. Librarian
Mr. Wahid Gul, BA, LLB	Superintendent

PROMOTIONS/TRANSFERS/RETIREMENT

Promotions

S.No.	Name	From	To	On
1.	Dr. Ihsanullah	DCS	CS	01-12-2014
2.	Dr. Gul Zamin Khan	SS	PS	01-12-2014
3	Mr. Hafiz Munir Ahmad	SS	PS	01-12-2014
4.	Mr. Hassan Khan	Fire Fighter	Fire Leader	02-05-2014
5.	Mr. Ghulam Akbar	General Attd.-II	General Attd.-I	02-05-2014
6.	Mr. Muhtaj Gul	General Attd.-II	General Attd.-I	18-09-2014

Transfers/Posting

	Name	From	To	On
1.	Mr. Aurang Zeb, CLT	C1, Chashma	NIFA, Peshawar	18-06-2014
2.	Mr. Riaz Hussain, SAO	NIFA, Peshawar	DINAR, D.I. Khan	25-07-2014
3.	Mr. Abdul Zaman, Gen. Attd.-II	DNFS, Islamabad	NIFA, Peshawar	14-07-2014
4.	Mr. Alamgir Khan, SS	BINOR, Bannu	NIFA, Peshawar	24-07-2014
5.	Mr. Umar Sajjad, AO	DINAR, D.I. Khan	NIFA, Peshawar	23-08-2014
6.	Syed Muhammad Kamran, Tech-I	Y-Lab, Chashma	NIFA, Peshawar	19-09-2014
7.	Mr. Rashid Nawaz, Khan, JE-I (Admin)	NIFA, Peshawar	C-3/4 Chashma	10-06-2014
8.	Mr. Muhammad Yousaf Khattak, PAO	DEUP-II, Kohat	NIFA, Peshawar	14-11-2014
9.	Mr. Saif-ur-Rahman, Sr. Asstt.	X-Lab, Chashma	NIFA, Peshawar	14-11-2014
10.	Mr. Ali Zaman, Sr. Asstt. (Admin)	NIFA, Peshawar	SINOR, Swat	14-11-2014
11.	Mr. Mishbah Ahmad, SS	SINOR, Swat	NIFA, Peshawar	27-11-2014
12.	Mr. Muhammad Jamil, AO	NIFA, Peshawar	DEUP-II, Kohat	03-12-2014
13.	Dr. Abid Farid, PS	NIFA, Peshawar	Univ. of Haripur	25-09-2014

Retirement

	Name	Date
1.	Mr. Jan Pervez, Chief Tech.	12-02-2014
2	Mr. Habib Khan, Sr. Asstt. (Admin)	28-02-2014
3	Mr. Liaqat Ali, Gen Attdt-I	22-03-2014
4.	Mr. Yousaf Ali, PSA	10-04-2014
5	Mr. Nowroz Khan, Mali-I	01-07-2014

Abbr.: CS: Chief Scientist, DCS: Deputy Chief Scientist, PS: Principal Scientist, PE: Principal Engineer, SS: Senior Scientist, SRO: Senior Research Officer, JS: Junior Scientist, ARO: Assistant Research Officer, PSA: Principal Scientific Assistant, SSA: Senior Scientific Assistant, SA-I: Scientific Assistant-I, SA-II: Scientific Assistant–II, Pr. Tech.: Principal Technician, Sr. Tech.: Senior Technician, Tech-I: Technician-I, Tech-II: Technician-II, Jr. Asstt. Accts.: Junior Assistant Accounts; Adm. Asstt.: Administration Assistant

Nuclear Institute for Food and Agriculture

Scientific Events Calendar 2014

Workshops | **Farmer's/Field Day** | **Trainings** | **Conference**

http://www.nifa.org.pk

January

06-10 JAN
One-week Food Analysis Course for PAF Officers
Organizer: Food Science Division
Contact: *Mr. Misal Khan, PS*
Mr. Saeed Gul, ARO
Cell: 0344 8807660, 0333 9375638
E-mail: misalkhattak@yahoo.com; saeedgul60@gmail.com

21 JAN
A conference on Application of Radiation for Value Addition of Gem Stones
Organizer: Food Science Division
Contact: *Dr. Ihsanullah, Director*
Cell: 0301 8580029
E-mail: ihsanullahdrnifa@yahoo.com

28 JAN
One-day Workshop on Mushroom Cultivation (for males)
Organizer: Food Science Division
Contact: Mr. Fazal Mahmood, DCS / Head FSD
Cell: 0301 8580108
E-mail: fazalmahmood55@yahoo.com

February

18 FEB
One-day Workshop on Mushroom Cultivation (for females)
Organizer: Food Science Division
Contact: Mr. Fazal Mahmood, DCS / Head FSD
Cell: 0301 8580108
E-mail: fazalmahmood55@yahoo.com

25 FEB
One-day Workshop on Biopesticides and Environmentally Friendly Farming
Organizer: Food Science Division
Contact: Mr. Tariq Nawaz, ARO
Cell: 0300 9360856
E-mail: tariq_libra34@yahoo.com

March

4 MAR
One-day Workshop on Off Season Vegetable Farming in high and Walk-in-tunnels
Organizer: Soil Science Division
Contact: *Dr. Wisal Mohammad, DCS / Head SS*
Mr. Parvez Khan, SS
Cell: 0345 57666611
0333 9386824
E-mail: wisalyasir@hotmail.com; parvez_08@yahoo.com

March

18 MAR
Farmer's Day
Organizer: Plant Breeding & Genetic Division
Contact: *Mr. Abdul Jabbar Khan, DCS / Head PBGD*
Dr. Iftikhar Ali, DCS
Cell: 0301 8580083, 0333 9102990
Email: abduljabbarnifa@yahoo.com iali63@yahoo.com

April

09 APR
One-day Training on Honey Bee Keeping and Management at Farmer's Field Naguman
Organizer: Entomology Division
Contact: *Mr. Alamzeb, DCS / Head ED*
Cell: 0333 9407406
E-mail: alamzeb@nifa.org.pk; mails@nifa.org.pk

23 APR
One-day workshop on Managment of Peach Flat-headed Borer in Stone Fruits
Organizer: Entomology Division
Contact: *Mr. Muhammad Zahid, PS*
Cell: 0300 5926757
E-mail: zahidnifa200028@yahoo.com

May

13 - 14 MAY
Two-day Workshop on the Application Tissue Culture and Molecular Techniques in Crop Improvement
Organizer: Plant Breeding & Genetic Division
Contact: *Mr. Roshan Zamir, PS*
Cell: 0301 8580109
Email: roshan_zamir@rocketmail.com

June

10 JUN
One-day Workshop on Preparation of Value-added Products from Fruits and Vegetables
Organizer: Food Science Division
Contact: *Mrs. Nizakat Bibi, DCS*
Mr. Zahid Mehmood, SS
Phone: 091 2964673
0333 5033898
E-mail: nizakatbibi@yahoo.co.uk; zahid152@yahoo.com

August

27 AUG
One-day Workshop on IPM Approaches for Insect Pests of Agriculture Importance
Organizer: EntomologyDivision
Contact: *Mr. Amanullah, DCS*
Cell: 0333 9360389
E-mail: mails@nifa.org.pk

September

15 - 26 SEP
30th Postgraduate Training Course on The Use of Nuclear and Other Techniques in Food and Agricultural Research
Organizer: NIFA
Contact: *Dr. Azhar Rashid, PS*
Cell: 0334 5326024
E-mail: azoo74@yahoo.com

October

08 OCT
Development of Irradiated Food for Immuno-compromised patient and Other Target Groups
Organizer: Food Science Division
Contact: *Mr. Misal Khan, PS*
Mr. Saeed Gul, ARO
Cell: 03448807660
0333 9375638
E-mail: misalkhattak@yahoo.com; saeedgul60@gmail.com

21 OCT
One-day workshop on Insect Pests of Medical Importance and their Control
Organizer: Entomology Division
Contact: *Dr. Inamullah Khan, PS*
Cell: 0334 9059180
E-mail: inamullah_nifa@yahoo.com

November

11 NOV
One-day Workshop on Agrowaste Composting & Biogeyser Technology
Organizer: Soil Science Division
Contact: *Mr. Haider Khan, DCS*
Cell: 0334 9138064
E-mail: hh.khan@yahoo.com

December

09 DEC
One-day Training on Water Quality for Plant & Human Health
Organizer: Food Science Division
CContact: *Mr. Misal Khan, PS*
Mr. Saeed Gul, ARO
Cell: 03448807660
0333 9375638
E-mail: misalkhattak@yahoo.com; saeedgul60@gmail.com

Contact Information: *Fazal Mahmood , DCS*
Incharge Outreach Cell
Cell: 0301 8580108

Nuclear Institute for Food and Agriculture (NIFA), Peshawar, KPK
Mail: P.O.Box 446, Peshawar, 25000 E-mail: mails@nifa.org.pk
Ph: 091-2964058 Fax: 091-2964059

NIFA in Pictures

Chairman PAEC presiding over ceremony of MRE Workshop

Testing of MRE at NIFA

Commandant ASC, Nowshera presenting Souvenir to Chairman PAEC

Chairman PAEC listening to NIFA employees

Inauguration of Modified Atmosphere Chamber for Persimmon

Member Science presiding the 1st National Conference on Gemstone Irradiation

Minister for Agriculture, KP, Mr. Shahram Khan Tarakai, Inaugurating Farmer's Day

Participants of Coordination Meeting at NIAB. June 12-14, 2014

Director NIFA & DG PARD signing MoU on Bio-geyser Technology

Director NIFA & VC, UET Peshawar signing MoU on Bio-geyser Technology

Food Science Division

Plant Breeding and Genetics Division

Entomology Division

Soil Science Division

Technical Services Division

Administration Section

IT Cell Staff with Director NIFA

Director’s Office Staff

Field Staff with Director NIFA

Canteen Staff with Director NIFA

NIFA Drivers with Director

Sanitary Staff with Director NIFA