PAKISTAN ATOMIC ENERGY COMMISSION

NIFA

Annual Report 2011

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Nuclear Institute for Food & Agriculture
Peshawar, Pakistan

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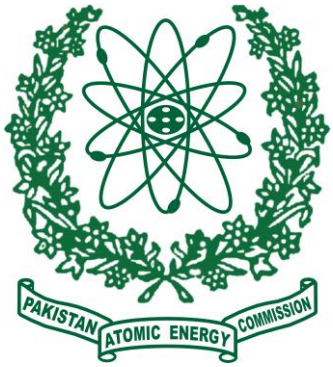

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Annual Report
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Nuclear Institute For Food & Agriculture (NIFA)
Tarnab, Peshawar, Pakistan

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HIGHLIGHTS

This report covers the R & D activities of NIFA for the year 2011. During this period, the aim of research and development efforts were i) Enhancement of crop productivity through a) development of new varieties, b) integrated plant nutrient and soil management practices and c) 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

A new improved candidate wheat variety "NRL-0517" consistently proved its worth for higher yield, disease resistance and drought tolerance during mandatory field evaluation both at provincial and national levels. It exceeded check varieties for grain yield and ranked 2nd in the country. Two new candidate varieties "NIFA-V15" and "CT-04192" included in the national trials excelled the check varieties in grain yield under normal and late planting conditions. A total of 204 new selections were made in different yield trials and nurseries on the basis of grain yield and disease response under irrigated / rainfed environments. Under pre-breeding program segregating populations of different F_i/ M_i generations were raised with the objective to isolate desirable ideotypes. Quality seed (10.8 t) of NIFA released varieties i.e., Fakhre Sarhad, NIFA-Bathoor-08, Tatara and NIFA-Barsat-10 was produced and certified by FSC & RD. It was distributed among agricultural departments and private seed companies in Khyber Pakhtunkhwa.

Promising sugarcane genotypes were evaluated at NIFA for frost tolerance, high cane and sugar yield. Frost data was recorded on visual observations. Out of 53 lines, 18 were less affected by frost/freeze damage. Their apical portions remained green and lateral buds were normal. Juice quality of six lines; CSSG-668, CSSG-676, CPSG244, HOSG-1145, HOSG-104 and QSG-69 was not affected. The remaining 35 lines were completely damaged by freeze/frost injuries. The highest recovery of 12.86 % was recorded in line HOSG-1325 followed by Line HOSG-1021 with recovery of 12.57 %. Highest yield (80 t.ha^{-1}) was recorded in line HOSG-679 followed by line CPSG-668 (79.8 t.ha^{-1}).

NIFA rapeseed hybrid line performed extremely well and produced third highest yield amongst 30 candidate lines in the National Rapeseed Uniform Yield Trial, 2010-11. It has out yielded Hyola-401 (control) by 4% on mean basis. It is characterized with high seed and oil yield, early maturity and disease tolerance. Its proposal for approval as new improved variety will be submitted soon to Provincial Seed Council, Khyber Pakhtunkhwa (KPK), Peshawar.

Entomology

The Entomology division is actively engaged in integrated control of insect pests such as fruit fly, termite, peach flat headed borer, chickpea pod borer, and medically important insects such as mosquitoes and house flies. Results from guava squash and protein hydrolysate blend with methyl eugenol at various combinations on fruit fly catch for 16 weeks post application indicated maximum number of 295.5 flies per trap in standard methyl eugenol trap as compared to guava squash blend with methyl eugenol. Similarly, combination of two lures; cue-lure and methyl eugenol attracted 3 species i.e. *B. cucurbitae, B, zonata and B. dorsalis*. The relative abundance of each species revealed that *B. cucurbitae* was dominant ranging from 57 to 89 %. Regarding work on development of slow-acting toxicant bait, around 1100 monitoring stakes were installed at different locations of Peshawar and Mardan districts. Thirty (30) of these were found infested with *Heterotermes indicola* and *Odototermes sp.* Population of termites varied from 500 to 20,000 termites per foraging point. Experiments on the effect of drying speed, drying time, temperature (10, 15, 20) and storage conditions of wet, dry and bulk for *Anopheles arabiensis* Patton eggs showed that eggs dried at 1.0 m.s^{-1} or 1.80 m.s^{-1} were not significantly different from control. Eggs stored at 20°C, 75% ± 5 RH in bulk performed better than those stored in wet or dry condition at 10°C or 15°C. No significant change in percent hatch, larval duration and survival was recorded up to 8 days storage period in bulk at 20°C. Reduction in flight performance of irradiated and unirradiated males was not seen until 8 days post storage period at the same temperature.

Food Science

Food science division is engaged in R&D for food security, safety and value addition. Consumption of contaminated food crops, meat and milk significantly increased concentration of trace metals in human blood. Cu, Zn and Mn concentrations were significantly higher ($p < 0.05$) in the blood samples collected from the industrially polluted area as compared to the control area. Moreover, metal levels in blood increased with age and was higher for males. Vegetable samples from markets of Peshawar were found with incurred pesticide residues exceeding the maximum residue limit. White rot fungi viz. *Agaricus bisporus* and *Pleurotus ostreatus* showed remediation potential for endosulfan residues in *in-vitro* studies. Nutritional stability and microbial safety of target specific meals prepared for special groups was demonstrated by tetra pack packaging and use of irradiation treatments under CRP/IAEA project. The irradiation treatment of 20 kGy was found effective for microbial decontamination that also increased dry weight yield, flavonoids, tannin, steroids contents and the scavenging activity of some plants of medicinal importance. In another study, different storage temperatures and irradiation treatments significantly affected the microbial load and the qualitative traits of the peanuts and almonds in storage.

Research and development work was carried out for shelf life extension of mushrooms through the use of gamma radiation, solar drying and different chemical treatments. Also several trainings were conducted to popularize mushroom farming technology among the farmers. In a comparative study with commonly available fruits, apple was found having the highest antioxidant content and activity. Moreover, effect of different processing methods on the antioxidant content and antioxidant activity in raw apple and apple products was also studied. Shelf life extension of plum fruit by modified atmospheric conditions was studied by the use of packing materials of varying translucencies at ambient temperature and refrigeration. Single screw extruder was modified and evaluated for online cutting of extrudes and variation in moisture levels during the extrusion process. Canning technology was evaluated for shelf life extension of sliced and pasted tomatoes over a period of ten months.

Gamma irradiation increased protein solubility, *in-vitro* protein digestibility, mineral solubility, per oxide and free fatty acid value of different brands of poultry feed. Moreover, irradiation treatment completely eliminated fungal and considerably reduced bacterial load in the feed samples. Iodine quality monitoring indicated that only 28% of table salt samples had desirable range of iodine content. Conventional vegetable oil source viz. canola oil was blended with *Silybum marianum* (Milk Thistle) oil in different proportions to improve its quality to meet requirements of the human body. The oil blends were evaluated for different quality parameters and fatty acid composition. Likewise, for nutritional enrichment the cereal foods, biscuits were prepared by supplementation with barley and milk thistle flour. Biscuits prepared from the modified recipes exhibited significantly improved nutritional and sensory attributes. Development and evaluation of low cost weaning food formulations based on common food ingredients is underway.

Soil Science

The main aim of soil science division research is to enhance nutrients and water use efficiency, and soil fertility. The soil scientists are also providing technical information to crop breeding division about the nutritional requirements of candidate varieties. Integrated NPK management (FMY + NPK) improved peach, plum and apricot fruit yield, nutritional status and soil organic fertility. It also increased the life span of these orchards. The organic amendments tested in vegetable cropping systems indicated that half of the NPK requirement of tomato crop can be fulfilled with application of filter cake @ 3 $t.C.ha^{-1}$. Pot experiment on screening of advanced wheat genotypes for high yield and quality on low fertility soils showed that CT-03457 and NIFA-V15 are zinc and boron efficient. In a field experiment, maximum potato tuber yield was obtained with foliar application of half NPK + Zn + B+ H.A ((0.03%). Likewise, foliar application of boron @ 700 $g.ha^{-1}$ increased yield (15.8%) and quality of Durr-e-NIFA. In another field experiment, NIFA advanced wheat genotype (CT-04192) produced maximum grain yield at low level of NPK (70-60-30 kg ha^{-1}). In case of vegetable pea, maximum pod yield (5.8 t ha^{-1}) was recorded in treatment receiving 0.5% value added compost followed by treatment receiving 0.5% ordinary compost (5.3 $t.ha^{-1}$) compared to control (3.2 $t.ha^{-1}$). In case of tomato, highest fruit yield (25.3 $t.ha^{-1}$) was recorded in treatment receiving 1% value added compost followed by full NPK (22.6 $t.ha^{-1}$) and 1% ordinary compost (22.4 $t.ha^{-1}$) compared to control (14.7 $t.ha^{-1}$. Maximum wheat grain yield (5.8 $t.ha^{-1}$) was recorded in case of recommended NPK followed by NIFA compost with125 kg urea per hectare (5.25 $t.ha^{-1}$). Maximum onion bulb yield (17.6 $t.ha^{-1}$) was observed in treatment receiving recommended NPK followed by treatment receiving ½ NPK + 0.05% humic acid (15.8 $t.ha^{-1}$) as compared to control (11.4 $t.ha^{-1}$). Increase over control was 55.7% and 39.8%, respectively.

Publications

Thirty (30) research papers were published in national and international journals (Page 32-34).

Funded Projects

Fifteen (15) research projects funded by various agencies (PSF, ALP, IAEA) are going on at NIFA (Page-35).

Training Courses/Workshops

A total of Eighteen (18) training courses/workshops were held in NIFA. (Page 41).

Acknowledgments

The team work of fellow 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 authorities at PAEC Head Quarter for their continued support that helped the Institute achieve its objectives. Special sense of gratitude is expressed for Director General (Agric. & Biotech.) for his continuous support, inspiration and motivation in compilation of this report.

Director NIFA

PLANT BREEDING & GENETICS DIVISION

Wheat Improvement

Wheat is the staple food crop and occupies a strategic space in the agricultural policy of the country. It cover about 58 % of the food crop area in Khyber Pakhtunkhwa (KPK). 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 resulting in the lowest per acre yield as compared to that in other provinces of the country. Realizing these 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 address the problems of irrigated/rainfed areas during the reported period are summarized as under:

Bread wheat improvement for irrigated areas

Evaluation of candidate wheat lines in national uniform wheat yield trials (NUWYT)

NIFA V-15 and CT-04192 were included in the NUWYT for the 2nd year. NIFA-V-15 produced 3% higher grain yield on 25 cites in Punjab, 8% higher grain yield on 7 sites in Sindh and 1% higher yield on 6 sites in KPK under normal planting. Similarly CT-04192 produced 0.5% higher yield on 25 cites in Punjab, 13% in Sindh and 5% higher yield in KPK under normal planting. However, under late planting, 2-12 % increase over local checks was recorded for NIFA V-15 in Punjab and Sindh at 25 and 7 locations respectively. In case of CT-04192 an increase in grain yield of 3%, 10% and 6% was recorded over the local checks in Punjab, Sindh and KPK respectively. NIFA-V-15 produced 4% higher yield than the local checks under normal and 3% higher seed yield under late planting conditions on Pakistan basis. CT-04192 produced 2% higher yield than the local check under normal planting on Pakistan basis.

Maintenance and seed production of NIFA irrigated varieties

NIFA irrigated varieties i.e. Fakhr-e-Sarhad and NIFA Bathoor-2008 performed well on the farmer's field in the province. The provincial Agricultural Extension System and progressive farmers continued seed multiplication and distribution of these varieties. This year about 405 metric tons basic and certified seed was produced by different agencies. In addition, 6.36 tones of BNS and Pre-basic seed was produced at NIFA which has been distributed among the agricultural departments and seed companies in the province.

Performance of elite wheat genotypes in multilocational yield trials

Eight advanced wheat genotypes in MPT-I along with two checks i.e. NIFA-Bathoor-08 and Pirsabak- 2004 were evaluated at NIFA and six other locations in KPK. Highest grain yield was recorded for WL-08169 (5146 kg.ha^{-1}) followed by CT-09068 (4589 kg.ha^{-1}). In northern irrigated zone (Mansehra) none of the genotypes could exceed the high yielding check (NIFA-Bathoor-08; 5000 kg.ha^{-1}). However, CT-09068 (4889 kg.ha^{-1}), out yielded the low yielding check (PSK-04; 4667 kg.ha^{-1}). In Southern irrigated zone (Seri Naurang and D. I. Khan) CT-08024(4349 kg.ha^{-1}) followed by WL-08169(4299 kg.ha^{-1}) and WG-08033(4285 kg.ha^{-1}) exceeded the high yielding check (Bathoor-08; 3381 kg.ha^{-1}). Based on yield performance across all seven locations, WL-08169 (4788 kg.ha^{-1}) ranked 1st followed by CT-09068 (4400 kg.ha^{-1}); CT-08024 (4342 kg.ha^{-1}) and WG-08030 (4283 kg.ha^{-1}) in comparison with the high yielding check (Bathoor-08; 4140 kg.ha^{-1}).

Performance of promising genotypes in advanced selection yield trials (ASYT's)

A total of 70 genotypes were evaluated in four advanced selection yield trials under both normal and late planting conditions at NIFA and three other locations. In ASYT-1 none of the tested genotypes could exceed high yielding check cultivar (Bathoor-08; 4899 kg.ha^{-1}). However, genotypes SRN-72 (4609 kg.ha^{-1}), followed by WL-0912-1 (4477 kg.ha^{-1}) and SRN-94 (4596 kg.ha^{-1}) out yielded the low yielding check cultivar; Pirsabak-2004 (4450 kg.ha^{-1}). Four genotypes in ASYT-2, five in ASYT-3 and one genotype in ASYT-4 out yielded the respective high yielding check cultivars included in the trials. Under late planting conditions 19 genotypes out yielded the high yielding check.

Performance of new genotypes in preliminary yield trials (PYT's)

One hundred and seventy genotypes were evaluated in PYT-I to PYT- 9 under both normal

and late planting conditions at NIFA experimental farm. Based on yield performance and disease reaction, 52 genotypes out yielded both the check cultivars included in the trials (Bathoor-08 and Pirsabak 2004), whereas, 64 genotypes produced higher grain yield than the low yielding check, Pirsabak-04. The highest yield was produced by DSN-149 (6667 $kg.ha^{-1}$) followed by DSN-75 (6433 $kg.ha^{-1}$) and CT-09075 (6433 $kg.ha^{-1}$).

Evaluation of coordinated yield trials/nurseries at NIFA

The National Uniform Wheat Yield Trial (NUWYT) consisting of 20 candidate wheat genotypes including NIFA lines V-15 and CT-04192 were evaluated under both normal and late planting conditions. Similarly International Bread Wheat Screening Nursery (43rd IBWSN) consisting of 235 genotypes received from CIMMYT, Mexico, was also evaluated with local check Bathoor-08. Based on yield and disease reaction (Yr and Lr) a total of 59 new genotypes were selected for further evaluation. CIMMYT Stem Rust Nursery consising of 135 genotypes was evaluated in comparison with local check Bathoor-08. Based on yield and disease reaction (Yr and Lr) a total of 25 genotypes were selected for further evaluation.

Development of new breeding material

A crossing block consisting of 52 genotypes was planted on two different dates and crosses among desirable wheat genotypes were attempted. F_1 seeds were harvested from 19 successful crosses. F_1 generation resulted from four cross-combinations were harvested at maturity. Desirable recombinants were selected and harvested from F_2 segregating population resulted from 20 cross combinations. Fifteen desirable F_3 recombinants were harvested and threshed from 11 cross-combinations. Twelve desirable F_4 families resulted from 12 cross-combinations were selected and harvested at maturity. Seventeen uniform families of F_5 generation from 12 cross-combinations were selected and harvested.

Bread wheat improvement for rainfed areas

Performance of new candidate line

NIFA candidate variety "NRL-0517" was assessed subjected for 2nd year mandatory evaluation in National Uniform Wheat Yield Trials (NUWYT- Rainfed) at different sites in the country. NRL- 0517 also expressed high level of resistance with RRI value of almost 9.0 to the prevailing yellow / leaf rusts. It was also included in the registration trial for botanical descriptions.

Quality seed production of "Tatara" and "NIFA Barsat-10"

NIFA rainfed varieties i.e. Tatara and NIFA-Barsat-10 performed well on the farmer's fields and the Agricultural Extension continued their seed multiplication at different farms. This year about 44.67 metric tons basic seed was produced by ADF in the province. In addition, 4.43 tons quality seed of these varieties was also produced at NIFA and was distributed among the agricultural departments and seed companies in the province for further multiplication.

Candidate lines

Five candidate lines (NRL-0517, NRL-0707, NRL-0709, NRL-0731 and NRL-0751) that showed high yield performance and wider adaptation were grown for quality seed production. Detailed botanical characteristics were recorded for each individual line which is a pre-requisite for varietal release. These will be tested in national uniform wheat yield trials (NUWYT-R) in the coming years.

Multi-locational micro-plot tests

The relative effects of environment, genotype and their interaction on grain yield and agronomic attributes were assayed using 08 promising bread wheat genotypes along with 02 commercial varieties i.e., Tatara and NIFA-Barsat-10. These entries were grown in replicated trials at the plains (Peshawar & Nowshera) southern parts (Kohat, Laki Marwat, & D.I. Khan) and northern part (Mansehra & Bunir) of Khyber Pakhtunkhwa. Significant G x E interaction was observed for all the studied traits. NRL-0808 produced high mean grain yield at all the locations and ranked 1st followed by Tatara. NRL-0832 and NRL-0834 were found promising and selected on the basis of grain yield stability coupled with disease resistance.

Advanced barani trials (ABT)

Twenty promising wheat genotypes including Tatara as check were field evaluated for grain yield, yield components and disease resistance in 02 different advanced barani trials (ABT-1 & ABT-2) at the institute. Based on grain yield and disease resistance 06 promising genotypes were selected in ABT-1. NRL-0903 ranked 1st by producing top grain yield followed by NRL-0904 and NRL 0905. Four entries were at par with the check variety Tatara in ABT-2.

Preliminary barani trials (PBT)

Thirty six newly selected wheat genotypes were tested for grain yield, disease resistance and other agronomic traits in 03 preliminary yield trials (PBT-1, PBT-2 & PBT-3) under moisture stress conditions at the institute. Tatara and NIFA-Barsat-10 were included as standard checks in each trial. NRL-1006 and NRL-1003 exceeded check variety Tatara in grain yield and were found resistant to YR in PBT-1. NRL-1011 & NRL-1013 were ranked as 2nd and 3rd, respectively, for grain yield in PBT-2. NRL-1025 produced 2nd top grain yield but was found susceptible to Yr. Based on possessing desirable traits for drought tolerance, high grain yield and Yr resistance, 16 selections were picked for further evaluation.

Varietal performance trials

NRL-0517 a new candidate variety was compared for grain yield and other traits under irrigated and rainfed conditions at the institute. Under rainfed conditions NRL-0517 ranked 4th for grain yield. Top grain yield was shown by Barsat-10 followed by Tatara in the same trial. Maximum thousand grain weight (TGW) was recorded for Seher-06 (50g) followed by NIFA-Barsat-10 (47g) and NRL-0517 (43g). Under irrigated condition NRL-0517 and PR-04 produced maximum grain yield followed by NIFA-Barsat-10, Seher and PM-376-HY. Maximum TGW was given by NIFA-Barsat-10 and Seher (48 g) followed by PR-04 (43 g) and NRL-0517 (42 g).

Wheat observation nurseries

Spring bread wheat observation nursery (11th SBWON)

The 11th International wheat screening nursery comprising of 160 exotic genotypes was field evaluated under moisture stress conditions. Data regarding yield, yield components and disease were recorded for each genotype.

Semi-arid wheat screening nursery (28th SAWSN)

The Semi arid wheat observation nursery was evaluated for selection of desirable exotic genotypes. A total of 60 genotypes were identified as having high grain yield potential, disease resistance and desirable plant architecture.

Hybridization

For creation of new desirable recombinants, varieties / genotypes / mutants were crossed in fashions. F_1 seeds were harvested from successful crosses to be raised as F_1 germination during the next cropping season.

Screening of wheat genotypes / mutants for *Yr* and *Lr* in NWDSN

Yellow rust is the main disease in Khyber Pakhtunkhwa that drastically reduces grain yield of wheat crop. Thirty newly selected genotypes were screened for stripe / leaf rusts at hot spots in the country in NWDSN. Morocco was used as a susceptible check with ACIs value ranging from 80 to 100. Most of the selections, in particular, NRL-1004, NRL-1012, NRL-1013, NRL-1025 and NRL-1026 showed high level of resistance against yellow rust (0 - 5R).

Biotechnology

Screening of sugarcane genotypes for frost tolerance, high cane and sugar yield

Promising sugarcane genotypes were evaluated at NIFA for frost tolerance, high cane and sugar yield using plot size of 3 m^2 with three replications. The data collected on various parameters is summarized below:

Frost/freeze damage: Frost/freezing started from second week of December and continued till the end of December 2010. The damage data was recorded on visual observations of apical portion/meristem, lateral buds and longitudinal slices of cane stalks. Out of 53 lines, 18 were less affected by frost/freeze damage. Their apical portions remained green and lateral buds were normal. Out of the 18 survived germplasm, juice quality of 12 lines was affected. While juice quality of six lines; CSSG-668, CSSG-676, CPSG244, HOSG-1145, HOSG-104 and QSG-69 was not affected. The remaining 35 lines were completely damaged by frost/freeze injuries.

Quality evaluation: Highest Sugar recovery of 12.86 % was recorded in line HOSG-1325 followed by Line HOSG-1021 with recovery of 12.57 %. The lowest recovery of 8.47 % was recorded in line CPSG-375. Highest commercial cane sugar (11.19%) was recorded in Line HOSG-701 followed by Line CSSG-676 with 10.76% CCS. Highest purity of 89.34 % was recorded in line HOSG-955 followed by line HOSG-701 with purity of 88.75%. The lowest purity of 73.89% was recorded in line CPSG-

263. Highest brix of 22.5^{o} was recorded in line HOSG-1325 followed by line HOSG -1021, HOSG -1145 and HOSG-945 with 22^{o} brix. Highest Pol of 19.56% was recorded in line HOSG-1325 followed by line HOSG-1021 with 19.1% Pol.

Agronomic evaluation: Stalk/plant: The highest stalk/plant (5.0) was recorded in line CSSG-24 followed by line CPSG-2476 and CPSG-375 where 4.8 stalk/plant were recorded. The data on cane thickness indicated variation among all the germplasm. Maximum cane thickness (27.6mm) was recorded in line HOSG-1607 followed by line CPSG-85 with cane thickness of 27.0 mm. The lowest cane thickness of 11.2 mm was recorded in line HOSG-200. The highest number of nodes (18.3) was recorded in Line-HOSG-1607 followed by line HOSG-1021 with 18.0 nodes/ plant. The lowest nodes of 11.0 were recorded in line CPSG-85. Significant variations in yield were observed among the germplasm under study. Highest yield of 80 t.ha^{-1} was recorded in line HOSG-679 followed by line CPSG-668 with 79.8 t.ha^{-1}. The lowest yield of 43.3 t.ha^{-1}was recorded in line –CPSG-3481.

Tissue culture studies

Callus induction: Buds collected from mother plants of CP77/400 were surface sterilized with 70% (v/v) ethanol for 60 sec, followed by 0.1% (w/v) mercuric chloride ($HgCl_2$) solution for 1 min. The surface sterilized explants were cultured on Murashige and Skoog (MS) medium containing different plant growth regulators (PGRs). The effects of various PGRs such as BA, GA3, 2,4-D alone or in combination with BA 0.5-1.0 mg.l^{-1} were evaluated. Bud explants of CP77/400 responded to all PGRs. Best callus induction (85%) was recorded on MS medium supplemented with 3.0 mg.l^{-1} 2, 4-D. Callus induction recorded on 1 and 4 mg.l^{-1} 2, 4-D were 56% and 60%, whereas 70% callus was observed on 2 mg.l^{-1} 2, 4-D respectively. On 1 mg.l^{-1} 2,4-D (56%) was significantly lower than other PGRs, and no callus was observed on (MS) medium.

Regeneration: Data on organogenesis was determined after 5 weeks of sub-culture and the best shooting (92%) was recorded on media containing 2.0 mg.l^{-1} BA alone followed media containing 2.0 mg.l^{-1} BA and 0.5 mg.l^{-1} GA3. Contrarily, addition of 2, 4-D to medium incorporated with BA inhibited % shooting significantly.

Rooting: Shoots grown on shoot organogenesis medium were transferred to MS medium incorporated with different concentrations of IBA, IAA, NAA and BA for rooting. Optimum (89%) rooting was obtained on media having 2 mg.l^{-1} of BA followed by 0.5 mg.l^{-1} IAA (87%) and NAA (80%) respectively.

Acclimatization: After successful rooting in vitro plantlets were thoroughly washed with distilled water and transplanted to polythene tubes filled with sand and silt in 1:1 ratio. The hardened plantlets (30-40 days) were then transferred to the field and planted in one meter row to row spacing.

Plantation and evaluation of sugarcane NUYT trial at NIFA: During the reporting year sugarcane NUYT trial seed in the form of setts were received from National Co-ordinator Sugar Crops, NARC, Islamabad. The setts were sown for multiplication and standard trial has been planted from this material in autumn 2011.

Oilseed Brassica

Quality seed production of oilseed brassica varieties

To maintain the genetic purity of approved varieties viz. Abasin-95 (B. napus), NIFA-Raya (*B. juncea*) and Durr-e- NIFA (*B. napus*), 100 pod rows of each variety were raised from selected single plants and 175 progeny blocks planted for production of BNS of these varieties has been produced. A total of 254, 48 and 23 kgs pre-basic seed respectively of Abasin-95, NIFA-Raya and Durr-e- NIFA were produced at NIFA and Malakandir Farms of Agriculture University, Peshawar.

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

Performance of two new rapeseed candidate varieties in National Uniform Yield Trial (NURYT) 2010-11

Two newly developed rapeseed recombinant lines viz. RM-h/06-1 and 04K 12/13-10-1 were tested for the first year along with 28 other candidate varieties of different institutes/seed companies at 10 sites to identify the entries for high yield potential and better adaptability to agro-climatic condition of Pakistan. NIFA line 04K 12/13-10-1 produced 3rd highest yield among 30 lines and out yielded the two checks i.e. Punjab Sarsoon by a margin of 9.8% and Hyola-401 by 3.6%. The other line RM-h/06-1, produced comparable average yield with the

checks, (but out yielded Hyola 401 in 5 out of 10 sites and Punjab Sarsoon in 6 out of 10 sites). These lines are being evaluated for 2nd mandatory testing in National Trial 2011-12 for confirmation of results that is, assessing their genetic stability and adaptability over years & locations.

Performance of new mustared candidate variety in National Uniform Yield Mustared Trial (NUMYT) 2010-11

A newly developed mustard mutant 7 x 1/05-4 was included for the first time in National Uniform Mustard Yield Trials (2010-11) and was tested along with 13 candidate varieties inclusive of check over 10 sites for genetic stability and adaptability to different agro-climatic condition of Pakistan. The mutant produced high seed yield and outclassed the check (Khanpur Raya) by 28.3% and 3.15% at NARC, Islamabad and ARI, Faisalabad, respectively and remained at par with the control at Auriga, Lahore, however; it could not out yield the control at other seven locations. The line is being tested for 2nd year in NUMYT 2011-12 for confirmation of results.

Performance of recombinants and mutants of rapeseed and mustard in multi locations adaptation yield trial

Adaptation yield trial, comprising of seven rapeseed mutants and recombinants and three mustard mutants along with commercial check Shiralee and BARD-I, respectively was conducted at five locations viz, Barani Agriculture Research Institute (BARI), Chakwal, Agriculture Research Station (ARS), Baffa, Mansehra, Agriculture Research Station (ARS), Sarai Naurang, Bannu, Nuclear Institute for Agriculture (NIA), Tando Jam, Nuclear Institute for Agriculture and Biology (NIAB), Faisalabd and NIFA, Peshawar during Rabi, 2010-11. The seed yield data of 10 genotypes from three locations was pooled and analysis of variance combined over locations was performed by GGE biplot. The results revealed significant differences between genotypes, locations and interaction between genotypes and locations (G X E). Mustard mutant line, MM-III/6-3, out yielded all entries and produced an average seed yield of 2680 kg.ha^{-1}. The rapeseed mutant RM-1/05-18 had GGE stability value near to zero (-0.407) which indicated most stable performance at three locations with an average seed yield of 1951 kg.ha^{-1}. Location wise results indicated that maximum average yield (2967 kg.ha^{-1}) was achieved at NIFA, Peshawar showing full exploitation of yield potential of all tested genotypes.

Agronomic evaluation of mutants/ hybrids in advanced yield trials (AYTs)

Best performing nineteen mutants/recombinants of rapeseed in Preliminary Yield Tests (PYT) last year, were evaluated separately in three AYTs along with check Durr-e-NIFA at NIFA experimental farm, during 2010-11. The results revealed that two lines took the minimum days to flowering (62 and 69 days, respectively) in AYT-I and AYT-III compared to check (110 days). Regarding plant height, all the hybrids and mutants attained same height along with the check except a hybrid 08 I/2-9 (197 cm) in AYT-II. With respect to seed yield, eleven mutants and five hybrids produced either less seed yield or at par with control while mutant RM-I/08-43 and hybrid 08 I/2-7 achieved non significant but more seed yield (3750 and 3778 kg.ha-1, respectively) compared with check variety (3722 kg.ha^{-1}).

Performance of stable mutants for yield and other agronomic characteristics in preliminary yield trial (PYT)

Stable and high yielding fourteen rapeseed mutant lines were evaluated in two preliminary yield trials. Seven lines were allocated to each trial along with the same check Durr-e-NIFA. In PYT-I, the mutant RM-I/09-4 and RM-I/09-24 produced significantly shorter plants (195 and 196 cm, respectively) compared to check (206 cm). While mutant RM-I/09-2 produced higher seed yield 3472 kg.ha^{-1} but statistically at par with check (3389 kg.ha^{-1}). In PYT-II, the mutant RM-I/09-24 took significantly lesser days (71) to flower comparing to check (82 days).

Assessment of rapeseed mutants for yield and other agronomic characteristics in in non-replicated yield trial (NPRT)

Stable and high yielding 24 rapeseed mutant lines of $M_{3:4}$ generations were evaluated for yield and other economic traits in a non-replicated trial planted in augmented design along with three commercial checks viz., Durr-e-NIFA, Abasin-95 and Shiralee replicated over blocks. The results indicated that all the mutants were significantly different (P<5%). Eleven mutants took lesser days to 50% flowering and more thousand seed weight (g). Seven produced high seed yield and exhibited more oil yield than the aggregate control means over the blocks.

Assessment of genetic stability of newly selected mutants/hybrids in M_3/F_3 plant-to-rows progenies

For the assessment of uniformity of mutants/hybrids for desirable agronomic characteristics, 90 single plants progeny rows (4 rows each) of M_3/F_3 inclusive of 13 parents were planted. Fourteen mutant lines were found stable and produced higher seed yield than their respective parents while 08 hybrids manifested heterotic effects over the parents. The seed yield advantage of selected rapeseed mutants ranged from 18.75 to 29.04%, and that of mustard mutants up to 21.87% over their respective parents. With regards to recombinants, rapeseed and mustard hybrids exhibited, respectively 9 to 10% and 18.77 to 38.0 % seed yield advantage over better or mid parent.

Development of segregating populations

M_0/M_1 generation

Healthy and uniform seeds of three rapeseed & two mustard varieties selected from National Uniform Rapeseed and Mustard Trials 2009-10, were exposed to three doses of gamma radiation (1.0, 1.2, and 1.4 KGy) with the view to get some desirable mutants with improved features. The treated seeds were directly planted in the field in isolation, dose/variety wise. Normal cultural practices were carried out. Plots were bulk harvested dose/variety wise at maturity and seed were manually threshed and bagged separately.

M_2 generation

The M_2 generation of rapeseed (B. napus) and mustard (B. juncea) cultivars was raised from mutagenized population of three gamma radiation doses. On the basis of visual observations, 88 putative mutant plants in rapeseed and 76 in mustard were selected. Selections were based on plant height, number of primary branches per plant, number of pods, pod length, number of seeds per pod and yield per plant, while selection for quality traits was based on quality analysis on NIRS system at Oilseed quality Laboratory, NIFA, Peshawar.

F_0/F_1 generations

The intra-specific crossing was achieved by hand pollination of 1325 rapeseed and 230 mustard buds (totaling to 1555 buds) from 22 rapeseed and 07 mustard cross combinations with the objective to incorporate earliness, short stature, low erucic acid & glucosinolates and high yield potential. F_1 seed of successful crosses were harvested at maturity cross combination wise separately.

The F_1 seed (2009-10) developed from 61 rapeseed and 25 mustard cross combinations were planted as F_1 generations in separate blocks cross combination wise at NIFA along with parents at extreme end. The progenies resembling exactly any of the parents were discarded and rest harvested separately.

F_1/F_2 generation

Seed of different F_1 progenies of two mustard and three rapeseed cross combinations were planted in separate blocks to grow F_2 generation for selection of desirable recombinants. The parents were planted at two extremes of each plot for easy comparison. Total 102 single plants of both rapeseed and mustard were selected for early maturity, short stature, heavy bearing, and pest resistance/tolerance. The seed quality assessment of the selected recombinants was carried out through NIRS analysis in Laboratory. Majority of the selected single plants showed above 45% oil content in seeds. The whole seed screening through NIRS identified 13 plants with low glucosinolates while 18 plants were found with low erucic acid content.

Shuttle breeding at summer agricultural research station, kaghan

In order to speed up breeding cycle for development of improved variety, shuttle breeding programme between NIFA and SARS Kaghan was pursued. Early breeding generation material consisting of F_1 derived from 21 rapeseed and 01 mustard combinations, F_2 developed from 07 cross combinations of rapeseed, M_1 of three rapeseed and two mustard genotypes irradiated at 1.8 and 2.0 kGy and M_2 of three rapeseed and two mustard genotypes irradiated at 1.0 and 1.2 kGy doses was planted at SARS, Kaghan on 24.5.2011. Experiments are in progress.

Quality characterization of oilseeds through NIRS

The seed quality analysis through Near Infrared Reflectance Spectroscopy (NIRS) of rapeseed and mustard crop is a regular feature of oilseed brassica breeding program at NIFA. During reporting period, 2727 seed samples of brassica species were analyzed for total oil, protein, glucosinolate content and fatty acid profile on NIRS. The analyzed samples consisted of 1645 entries of oilseed brassica breeding material of NIFA and 1082 samples were received from

following research organization throughout the country.

- Ayub Agricultural Research Institute, Faisalabad
- Quad-e-Azam University, Islamabad
- National Agricultural Research Centre (NARC), Islamabad
- National Institute of Biotechnology & Genetic Engineering (NIBGE), Faisalabad
- University of Agriculture, Faisalabad
- Khyber Pakhtukhwa (KP) Agricultural University, Peshawar
- Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi
- Provincial Oilseed Development Board (PODB), Lahore
- Federal Seed Certification & Registration Department (FSC&RD), Islamabad

Pulses

The main emphasis of the group is to improve seed yield, seed size and plant type of mungbean through induced mutation and cross breeding techniques. During the report period 112 recombinant and 23 mutant lines derived from ten cross combinations attempted at NIFA i.e. VC1971A x NM92, VC1560D x NM9, NM93 x NM92, VC1482C x NM92, 6601 x NM92, VC3736 x NM36, NM93 x NM92, NM92 x Black Mung, NM92 x Pusa Baisaki and NM98 x VC3902A and two parents i.e. NM92 and NM98, respectively were evaluated in nine sets of preliminary yield trials (PYTs). In PYT-1, four recombinants produced significantly higher seed yield ranging from 1156 kg.ha^{-1}-1710 kg.ha^{-1} as compared to the check variety Ramzan (1140 kg.ha^{-1}). In PYT-2, three recombinants, in PYT-3, eight recombinants, in PYT-4, six recombinants, in PYT-5, seven recombinants and in PYT-6, produced higher seed yields (1044 kg.ha^{-1}-1689 1156 kg.ha^{-1}) as compared to the standard check Ramzan (1042-1315 kg.ha^{-1}). Eight recombinants in PYT-7, one recombinant and five mutants in PYT-8 and five mutants in PYT-9 produced higher seed yields ranging from 948-1453 kg.ha^{-1} as compared to Ramzan (940-1113 kg.ha^{-1}). In order to create genetic variability for higher seed yield and good plant type, two mungbean breeding lines namely NFM-12-3 and NFM-5-91-21 were irradiated at 300 Gys each and M_1 generation was raised during summer 2011. From NFM-12-3, 564 single plants and from NFM-5-91-21, 627 single plants were picked and bagged individually. F_0 generations of three cross combinations i.e. 6601 x Ramzan, NM51 x NM98 and NFM-5-36-24 x NFM-5-63-18 have been obtained during summer 2011.

The high yielding mungbean lines along with other breeding material have been re-planted as kharif-2011 crop. The crop has germinated and emerged well and different field data will be collected in due course of time.

Plant Pathology

Wheat yellow rust monitoring in Khyber Pakhtunkhwa

As an integral component of breeding for rust resistance, 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 to this disease in Pakistan. Five prominent pathotypes including 71E144, 71E16, 103E144, 0E16 and 64E0 were proposed in the region. Nine virulences including v6, v7, v8, v9, v17 (isoline), v27, v32 (isoline), vA and vSu were frequently observed to which released and candidate varieties behaved differentially while compatibility of NIFA lines including NRL-0707, WG-08030, CT-08055, NRL-0809, NRL-0818 and CT-08068 was not observed with prevelent pathotypes in Khyber Pakhtunkhwa. Effective yellow rust resistance genes found were Yr3 (Vilmorin 23 and Nord Desprez), Yr5, Yr6+2 (Heines Peko), Yr7 + (Reichersberg 42), Yr10, Yr15 (except northeren region), Yr17 (VPM1), Yr24, Yr26, Yr32, YrSp and YrSd. Introgressions of these effective genes are suggested in wheat cultivars like Bakhtawar-92 and Inqilab-91 for enhancing their rust resistance.

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. More than six hundred land races, elite and candidate wheat genotypes were studied for slow rusting trait. Slow rusting variables for yellow rust development were assessed over time under the epidemic of pathotype 71E144 along with a standard susceptible control. Several assessments were made at weekly intervals to understand pattern of disease development during the season. None of the wheat land races displayed vertical resistance against pathotype 71E144 while 29% of the elite and 50% of the candidate genotypes were suspected to carry it. Area under disease progress curve indicated low to high levels of slow rusting in the remaining genotypes from which future cultivars could be selected.

Assessment of resistance to powdery mildew

Powdery mildew (PM) caused by *Blumeria graminis* (DC.) E.O. Speer f. sp. tritici Ém. Marchal (syn. *Erysiphe graminis* f. sp. tritici), is one of the most common diseases of wheat that can reduce crop yield by 45%. In Pakistan, PM was reported 40 years ago in fields adjacent to the Himalayan Mountains but its occurrence away from this region makes it a future challenge for sustainable wheat production in the country. Field trials were conducted at a hotspot location in northeren zone including commercial cultivars, candidate varieties of NUWYT 2009-10 cycle and NIFA breeding lines. Mildew severity was scored on the whole canopy 109 genotypes using modified Cobb scale. Results indicated that almost all test genotypes were found sensitive and no genotype was assessed as disease free. Mean disease severity was <60% while it varied between 25-100%.

Studies on viral diseases of wheat

About 14 viral diseases occur naturally on bread wheat. Barley Yellow Dwarf (BYD) or Cereal Yellow Dwarf (CYD) is a common and regularly occurring disease of wheat in Khyber Pakhtunkhwa Province of Pakistan. BYD/CYD incidence and severity is increasingly observed in wheat varieties grown in the region. Four BYDV/CYDV vectors including *Rhopalosiphum padi*, *R. maidis*, *Sitobion avenae* and *Schizaphus graminum* were detected and identified in wheat crop at NIFA. Barley Yellow Dwarf Virus is transmitted through a late viruliferous vector (mostly *Rhopalosiphum padi*) which arrive in mid December and the first visible disease symptoms can be exhibited in mid of February during wheat tillering stage. Secondary infection is caused mainly through *apterous viruliferous* vectors from established hot spots to surrounding wheat plantation in short distances. Vectors population (*Rhopalosiphum padi*, *R. madis*, *Sitobion avenae* and *Schizaphus graminum*) in this study was high from mid of February to mid of March exhibiting high level of foliar chlorosis, the typical symptoms of BYD. BYDV-PAV was confirmed as the dominant virus possibly because of the abundance of its vectors and less species specific association between vectors and virus.

Disease resistance characterization services

Resistance characterization of 1049 wheat genotypes were carried out under epidemic development of *Puccinia striiformis* f. sp. tritic and barley yellow dwarf planted in local, national and international nurseries through assessment of infected tillers/plot, % leaf area with rust/BYDV symptoms and rust infection types. Results were conveyed to the concerned collaborator for further utilization in wheat improvement program.

ENTOMOLOGY DIVISION

The Entomology division is engaged in the integrated control of various insect pests of field and fruit crops such as fruit flies, termites, peach flat-headed borer, chickpea pod borer and medically important disease carrying insects such as mosquitoes and house flies. The division is also conducting R&D activities on integrated management of honey bee and honey production. Under integrated pest management system, we are employing different IPM components to reduce losses caused by insect pests and the disease they transmit in plants and animals.

Fruit Fly Control

Fruit flies are the most destructive insect pests of 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 fleshy fruits and vegetables. Their control largely depends on the application of male annihilation techniques. Research on fruit flies is therefore, geared towards improvement in the fruit fly bait and tapping system.

Flies catch assessment on combinations of guava squash and protein hydrolysate with methyl eugenol

Guava squash and protein hydrolysate were mixed with methyl eugenol @ 0, 50, and 75% to see their effects on fruit fly catch in fruit orchards at Peshawar for 16 weeks. The results indicated that maximum flies (295.5 flies per trap) were caught in standard methyl eugenol trap. The number of flies captured reduce to 169 and 69.75 flies/trap, respectively when 50 and 75 % guava squash was added in mehyl eugenol. Similarly blending of 50 and 75 % Protein hydrolysate in methyl eugenol resulted in reduction of flies per trap from 295.5 to 123 and 96.2, respectively. No flies were observed in pure guava squash and protein traps. Trap loaded with methyleugenol and guava squash attracted two species, i.e. *Bactrocera zonata* (92-94.3%) and B. dorsalis (7.1%). Combination of protein with metyleugenol attracted four species i.e. B*. zonata* 81.1%, *B. dorsalis* 10.2%, *B. cucurbitae* 1.7 and *M. pardilina* 7.9%.

Synergistic effect of methyl eugenol and cue-lure combination on different species of fruit flies

Methyl eugenol and cue–lure were mixed with each other @ 0, 25, 50, 75 and 100% to see their effect on catch of different species of fruit flies. Maximum number of 11 flies per trap was captured in 1:1 combination followed by 9 adults in 1: 3 combinations. Pure methyl and cue-lure attracted 3 and 6 flies/trap, respectively. Cue-lure attracted males of melon fly, *B. cucurbitae*, while traps of Methyl eugenol attracted males of two species, *B. zonata* and *B. dorsalis*. Combination of two lures, attracted 3 species i.e. B. cucurbitae, *B. zonata* and *B. dorsalis*. The relative abundance of species showed that B. cucurbitae was the dominant species. Its percentage ranged between 57 and 89 %.

Exploration of the fruit fly's parasitoids in Khyber Pakhtunkhwa (KPK)

Survey of fruit flies and their parasitoid's fauna from three host plants; guava, musk melon and pear in Haripur and Peshawar showed the presence of three fruit fly species i.e *Bactrocera cucurbitae* Coq., *B. dorsalis* Hend. and *B. zonata* Saund in the target sites. *B. dorsalis* . and *B. zonata* were recorded from Haripur and Peshawar on guava, while, *B. cucurbitae* was only present in Peshawar on musk melon. *B. zonata* and *B. dorsalis* were dominant in Peshawar and Haripur, respectively. Pear was found as the suitable host for *B. zonata* and *B. dorsalis* in Peshawar. Regarding the parasitoids; *Diachasmimorpha longicaudata* Ashm and *Trybliographa daci* Weld were found in Haripur and Peshawar, respectively.

Termite Control

Tunneling behavior of termite in chemically treated sand

Experiment was conducted to see the tunneling behavior of termites when blocked by treated sand barrier. Results showed that termites were totally repelled and no tunnels were made when barrier of sand had 400 and 200 ppm of Chlorpyrifos, 6.25 ppm of Cadusafos and 50 ppm of agenda. Termites tunneled up to 2.90 cm in sand treated with 25 ppm of Chlorpyrifos. At lower concentrations (3.125 ppm) of

Cadusafos and 6.25 ppm of Agenda cumulative tunnel length was 11.20 cm and 9.56 cm, respectively.

Mortality in termite specie *Heterotermes indicola* caused by different concentrations of insecticides at different intervals of times

Experiments were conducted to see the effect of different concentrations of insecticides against *Heterotermes indicola* at different intervals of time after application. Five concentrations of Chlorpyrifos, Cadusafos and Agenda were tested. Results showed that mortality was 90% and 82% after 8 hours when Chlorpyrifos was applied @ 400 and 200 ppm, respectively as compared to Cadusafos in which mortality was 29% and 24% at same concentration and same interval of time. Chlorpyrifos caused 100% mortality after 24 hours of treatment whereas in Cadusafos maximum 35 % mortality was recorded. Mortality was nil in Agenda treatment after 8 hours but it was 50% after 48 hours. So Chloropyrifos was found to be more lethal in given time and tested concentrations whereas Agenda acted as slow acting toxicant.

Slow acting toxicant bait for termite control

When exposed to different concentrations of Fipronil, a very high mortality rate was observed for doses above 1 ppm. ELT 90 (Effective lethal dose to kill 90% of the termites) values ranged from 2 to 6 d for 5 to 50 ppm. Projected ELT 90 value was protracted for 1 ppm (11 d) while less than 5 d for 5-30 ppm. At concentration range of 1-20 ppm, no significant difference was observed between the consumption of treated and untreated substrate while at 30 and 50 ppm, termite preferred to feed on untreated substrate only. Probit analysis of dose response data for Imidacloprid showed that a dose of 100 ppm took 12 to 27 days to inflict 90% mortality after the termites got a chance to feed on the treated substrate while ELT 90 for 500 ppm varied from 6 to 10 d. Studies on horizontal transfer of Imidacloprid showed that a concentration of 100 ppm did not produce a high recipient mortality (<30%) when confined with the donor for 10 d, however, for concentration range of 200-5000 ppm, significantly higher mortalities were observed in untreated termites (recipients) confined with treated workers. Studies on trail-following behavior of termite workers treated with different concentrations of Spinosad showed that treatment with the lowest concentration (1ppm) increased the trail following speed even compared with the untreated control but with the increase in exposure concentration, worker's speed slowed down. Delineation studies at an infested building in Mardan revealed a colony of termites having eight foraging points with a spread of 1.5 to 21 m. Using the Lincoln index, the colony population was estimated to be around 0.72 million workers.

Honey Bee Management

Impact of honey bee foragers as pollinators on oilseed brassica grain yield

A research trial on impact of honey bee as pollinator on the yield of oilseed brassica crop was carried out. The results showed that plots under caged condition gave minimum grain yield of 2.75 kg.plot^{-1} while plots without cages for free pollination of bees gave maximum yield of 7.32 kg.plot^{-1}. The data indicates that plots kept open for bee's pollination enhanced crop yield. More demonstration plots on farmer's field on bee's pollination services will be conducted to create awareness and utilization of the beneficial insects for the well beings of farming community.

Multiplication of bee population in the colony

Daughter colonies were produced from existing mother colonies and properly maintained for further brood development and colony maintenance. Twenty extra bee colonies were produced and are maintained for research trials.

Raising of fresh queens in bee colonies

Twenty five (25) new queens were produced and introduced into separate colonies for replacement old queens. The new queens are performing well in brood development.

Medical Entomology

Effect of eggs storage and drying on developmental attributes of anopheles

Anopheles arabiansis eggs were collected over white filter paper in plastic bowls lined with black cloth on insides and wet sponge at the bottom. Eggs were dried over a 400 microns cloth in a specially designed apparatus by passing a gentle flow of air and adjusting fan speed and time to the level so that all the eggs dried and clumping was not seen. The effect of drying, storage condition of wet, dry, bulk and storage temperature at 10°C, 15°C and 20°C was investigated up to 10 days storage time for hatchability on *An. arabiensis* eggs. Larval duration, success to adult emergence and flight

performance of resulting adults were measured as quality parameters. Post dry and storage hatch rate was determined from count on hatched and unhatched eggs under a stereo microscope and confirmed by counting the free swimming larvae in the rearing medium. Hatch rate from eggs dried at 1.0 $m.s^{-1}$ or 1.80 $m.s^{-1}$ was the same as in control (82%) except that more time was required for drying at wind speed of 1.0 m/s. Eggs dried earlier in 13-15 minutes at 2.5 m/s wind speed but hatch rate was very low (64%) as compared to control. Eggs stored at 20°C, 75% ± 5 RH in bulk in a 1.5 ml aerated graduated vial performed better than when eggs were stored in wet or dry condition at 10°C or 15°C. No significant change in percent hatch, larval duration and survival was recorded up to 8 days storage period in bulk at 20°C. No clear indication of reduction in flight performance of irradiated and un-irradiated males was seen until 9 days post storage period at egg stage.

Larvicidal activity of some local oils against mosquito larvae

The recent epidemic of dengue throughout the country has necessitated area-wide integrated control strategies including use of larvacides, adulticides and sterile insect techniques (SIT). The crude oil of neem, gamama, eucalyptus, and cinamon were tested against fourth instars larvae of *Culex quinquefasciatus*. The larval mortality was observed after 24 and 48 hours exposure. Most of the oils showed mortality in the range of 200-600 ul of the oil. Experiments are in progress to find out the LC 50 and LC 90% mortality.

Integrated Management of Stone /Fruit Insect Pests

Evaluation of different synthetic insecticides against peach flat-headed borer in plum orchard

Field efficacy of different synthetic insecticides i.e., Cyren, Tenakil, Thiodan, Triazophos including Control @ 50 $ml.10l^{-1}$ of each were applied against peach flat-headed borer on trunks of plum trees. Maximum infestation (15.65 gum $points.m^{-2}$) was recorded in the control treatment followed by Triazophos (5.87), Tenekil (3.20), Thiodan (2.15) and Cyren (0.80), respectively. Cyren was found very effective as compared to other insecticides against Peach flat-headed borer causing gummosis in the month of October.

Evaluation of different synthetic insecticides in bordeaux mixture against peach flat-headed borer in plum orchard

Efficacy of Bordeaux mixture in combination with different pesticides i.e., Timer 1.9EC (Emamectin benzoate), Steward 150SC (Indoxacarb), Coragen (Rynaxypyr) @ 2.5 $ml.l^{-1}$, Neem oil (*Azadirachta indica*) and Winterhort 861$g.l^{-1}$ @ 10 $ml.l^{-1}$ and Cyren (Chlorpyrifos) @ 7.5 $ml.l^{-1}$ were applied against peach flat-headed borer on plum tree's trunks. Maximum infestation (7.41 gum $points.m^{-2}$) was recorded in the control treatment followed by Timer (7.00), Steward, (5.95); Coragen (5.59), Neem oil (3.40), Winterhort (1.59) and no infestation was recorded in Cyren. Cyren was found very effective in combination with Bordeaux mixture as compared to other insecticides in the month of January.

Monitoring of adult emergence timings of peach flat-headed borer in plum orchard

Monitoring of emergence timings of adult peach flat-headed borer is a pre-requisite for pesticidal spray in plum orchard. Adult trapping of peach flat-headed borer was done by covering 10 trunks/branches of trees with plastic strips trapper in plum orchard during 2011. Data were taken on weekly basis throughout the year. Results showed that beetle's emergence started in the month of April-May (5.0) and June-July (8.0) and no adult was captured in plastic strip trapper in the months of September-October.

FOOD SCIENCE DIVISION

The over all focus of the R&D in 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 radiation 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. Healthy foods and healthy food habits are promoted through awareness programs.

Food Irradiation & Microbiology

A comparative study of bioaccumulation of some essential and toxic metals in human blood in industrially contaminated area and relatively less polluted area

Heavy metals were analyzed in blood samples collected from different age group subjects: children (1-12 years), adolescent (12-18 years), adults (18-45 years) and old people (above 45 and 55 years for males and females, respectively) from polluted and relatively less polluted areas. The gender and age-wise distribution of trace metals in the blood of the subjects showed that overall concentration of metals in the subjects from the polluted area was higher than the control. However, their concentrations were found within the safe limits and may not pose any risk. Random distribution of trace metal concentrations was noticed in the blood of males and females subjects. Significant differences in concentrations were observed for Cu, Zn and Mn in the blood samples from two areas as well as between different age groups. It can be concluded from this study that consumption of contaminated food crops, meat and milk significantly increased the concentration of trace metals in human blood as compared to the control area, indicating that these food chains may be one of the major pathways of exposure and sources of contamination of human blood with metals. Moreover, Cu, Zn and Mn concentrations were significantly higher ($p < 0.05$) in the blood samples collected from the polluted area as compared to control area. Similar trends were also observed between the different age groups within the same area. Overall metal concentrations in males were higher as compared to females which may be due to diet habits and body mass along with other factors. Old age people had accumulated higher concentrations of trace metals as compared to younger ones due to slow accumulation of the metals in their bodies.

Development of irradiated foods for immunocompromised patients and other specific target groups

The research work was conducted under IAEA CRP awarded to NIFA in June 2010. Recipes of five different types of meals (sprouted mungbean with chicken, sprouted mungbean with liver, sprouted kidney beans with chicken, garden pea with chicken and bottle gourd with chicken) were prepared in the light of nutritional recommended daily allowances (RDA). The ingredients of the meals were analyzed for their nutritional and microbiological contents. The meals were prepared, packed in Tetrapack pouches, treated with irradiation doses of 6, 8 and 10 kGy gamma rays. For the present study, the treated samples were tested for their storage stability up to 3 months at ambient temperature. The samples were analyzed chemically for peroxide value, anisidine value, ascorbic acid and microbiologically for total bacterial counts, total coliform counts, Salmonella, Staphylo-coccus aureus and Listeria monocytogenes at 0 day and fortnightly for extended period of 3 months storage at ambient conditions.

Results indicated that there was slight increase in POV during successive storage of 3 months in all the diet samples. It was observed that there was no difference among the radiation doses. The anisidine value of fresh oil and those recovered from 5 meals samples was determined at 0 and up to 3 months storage. The initial AV of fresh sunflower oil was 1.7 and increased to 3.6 with irradiation doses and storage period. Ascorbic acid content of the diets were adjusted to 15 $mg.(100.g)^{-1}$ by adding herbal materials in the diet formulations. Ascorbic acid contents of the diets were analyzed initially and subsequently at the extended storage of 3 months. It was observed that both irradiation and storage period drastically affected the ascorbic acid content. Maximum decrease in ascorbic acid content was noted in the 10 kGy irradiated diets while minimal decrease was observed in 6 kGy treated diets.

The irradiated diet samples packed in polyethylene and tetrapack pouches were

analyzed for total bacterial counts, total coliform counts, Salmonella, *Staphylococcus aureus* and *Listeria monocytogenes* at 0 day and fortnightly during the 3 months storage at ambient conditions. It was observed that polyethylene pouches could not retained the microbiological quality of diets, and was discarded from the lot of experiment. All the diet samples packed in Tetrapack pouches were found free from the above mentioned microbes irrespective of irradiation doses up to the tested period of 3 months. The diets prepared for immune-compromised patients were subjected to a panel of judges to rate the sensory parameters (appearance, color, Taste, and flavor), using a 10 points hedonic scale. No major differences were noted in the fresh and 3 months stored meal samples.

Effect of gamma irradiation on the extraction yields, selected phytoconstituents and free radical scavenging properties of selected medicinal plants

Five plants were selected for the present study. Selected plant parts were washed with tap water to remove soil particles and other debris. The parts were dried in oven at 55°C till constant weight. The dried materials were then ground to mesh size 30 and subjected to radiation doses of 4, 8, 12, 16 and 20 kGy. Unirradiated controls were kept in each case. The treated and control samples were analyzed for extraction yields, DPPH activity, alkaloids, tannin, steroids, flavonoids etc. using standard methods.

The results of the study showed that gamma irradiation increased the dry weight yields in methanol, water and acetone extracts of the tested plant materials Generally the increase in dry weight of the extracts was parallel to increase in radiation doses. Maximum extraction yield for all the three solvents were noted for 20 kGy treated samples. The biologically active phytoconstituents were also affected by radiation doses. Generally the irradiated plant samples showed comparatively higher flavonoid, tannin and steroid contents, that increased with the increase in radiation doses. Alklaoidal contents were not unaffected by gamma radiation up to 20 kGy. The DPPH scavenging activity is expressed as EC50 ($\mu g.ml^{-1}$). The low EC50 value is indicative of high DPPH scavenging activity. The control samples showed relatively high EC50 values. The scavenging activity increased with increase in radiation Maximum activity was found for 20 kGy treated samples for all the plants. Our results showed that gamma irradiation treatment increased certain beneficial properties in plant samples in addition to microbial decontamination.

Microbial and biochemical studies of irradiated nuts (almond and peanut) stored at different temperature

The effect of combination treatment to extend shelf life of dry nuts stored at different temperatures was studied Microbial load has been found to grow on almond during marketing. Different treatments with respect to irradiation doses and packaging were tested to extend the shelf life of whole nuts and their products. So the project was planned to determine the fungal infestation percentage, total fungal counts and biochemical changes such as moisture %, free fatty acid % and oxidative rancidity ($meq.kg^{-1}$) of the irradiated samples (5 kGy) incubated at different temperatures.

The TFC/fungal infestation % showed counts ranged from 1.7×10^1 to 4.6×10^4 for almond while in peanut it was 2.5×10^2 – 6.9×10^4 in control samples stored at room temperature. In irradiated samples the range was 1.0×10^1 – 6.4×10^3 for almond while in peanuts the counts range was 2.0×10^1 -3.9×10^3 , respectively. The % infestation was 20.0 to 32.0 for almond, 22.0 to 29.0 for peanut in control samples at room temperature while for the radiated samples, the % counts were 5.0 to 8.0 % peanut and 6.0 to 7.0 almond sample stored at room temperature. The data showed that moisture content of the sample increased 7.62 to 7.70% in (control) almond sample and 7.66 – 7.79 in peanuts and 7.62 -7.64 (almond) and 7.64 - 7.74 (peanut) in Irradiated samples with successive storage time. Per oxide value increased slightly with storage time and temperature in control sample the per oxide value range was 2.8 -9.8 in almond while in peanuts its range was 2.9- 9.9 $meq.kg^{-1}$ with the passage of time respectively. In irradiated it becomes 2.8 to 9.8 $meq.kg^{-1}$ in peanuts samples. in almond samples, it 2.6 to 9.6 respectively.

It was also observed from the data that free fatty acids increased slightly with storage time, temperature and irradiation. Free fatty acid showed 6.69 - 7.26 % increase in almond, while in peanuts 6.49 - 7.60 in control samples. While in irradiated it becomes 4.59 to 6.30 % in peanuts while in almond it becomes 4.90 to 5.90 %. The combination treatment indicated improvement in overall quality and hence the acceptability of proper packed dry nuts during storage to maintain their nutritional quality and extended its shelf life up to 1 year safe storage and fit for human consumption.

Pesticide Residues in foods of plant origin

Vegetable samples were collected from different vegetable markets viz. Itwar bazaar and two whole-sale markets of Peshawar. The vegetable samples included okra, brinjal, bitter gourd and squashes. Vegetable samples were subjected to QuEChERS extraction and cleanup methods for pesticide residue. The QuEChERS extraction and cleanup method was validated for multiclass, multiresidue analysis. The method was able to extract residues at low levels. The limit detection of different pesticides ranged from 1.0 – 3.4 μg.kg^{-1}. All the compounds included in this study showed a linear response ($R^2 \geq 0.95$) to GC-ECD analysis at calibration range from 0.6 - 300 μg.kg^{-1}. The extracts produced by the QuEChERS were used for the analysis of organochlorine, organophosphate, carbamate and pyrethroid residues by GC-ECD. All the vegetable samples (100%) were found contaminated with pesticide residues and majority (63%) of them exceeded maximum residue limits (MRL). Majority of the okra samples (75%) exceeded MRL followed by bitter gourd (67%), squashes (58%) and bringal (50%) (Fig. 1). Vegetable samples were predominantly contaminated with cypermethrin followed by endosulfan and dimathoate.

Bioremediation potential of white rot fungi

Study was conducted to compare the efficacy of two strains, one each of Agaricus bisporus and Pleurotus ostreatus for elimination of α-endosulfan and β-endosulfan in bioassay. Potato dextrose agar medium (PDA) was spiked @ 100 μg.ml-1 with technical grade endosulfan reference standard containing 70% α-endosulfan & 30% β-endosulfan in 50 ml flasks.

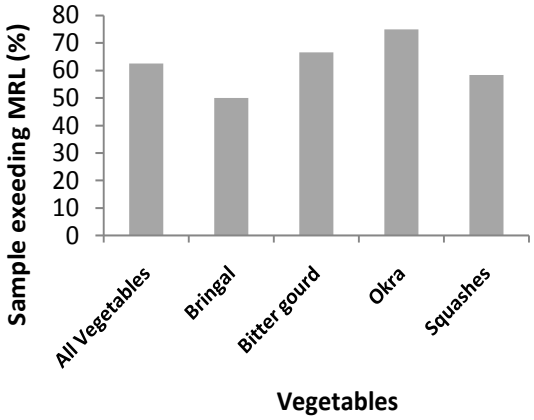

Figure 1. Status of pesticide residues in vegetables collected from vegetable markets of Peshawar.

The spiked PDA media were inoculated with plugs from fresh cultures of Agaricus bisporus and Pleurotus ostreatus. The flasks were incubated at 25±2°C in darkness. Aliquot of PDA was analyzed for endosulfan residues at regular intervals by gas chromatography with flame ionization detector (GC-FID). For GC-FID analysis an aliquot (1ml) was drawn from each treatment and extracted with 2ml of acetonitlie by liquid-liquid extraction. The acetonitrile extracts were subjected to cleanup by liquid-liquid portioning on n-hexane.

A. bisporus was more effective in eliminating the endosulfan residues than P. ostreatus. Residues of a-endosulfan and b-endosulfan declined by 75% and 82% by A. bisporus and 58% and 44% respectively in P. ostreatus treated spiked PDA medium. The pesticide disappearance data was subjected to zero, first, second and third-order t models of chemical disappearance kinetics.. The data showed goodness-of-fit for zero-order model R = k(A)0. The rate constant (k) for biodegradation of α-endosulfan and β-endosulfan by Agaricus bisporus using zero-order kinetics was 2.19 and 1.007, respectively and the rate constant for biodegradation of α-endosulfan and β-endosulfan by Pleurotus ostreatus using zero-order kinetics was 1.899 and 0.656, respectively (Fig. 2).

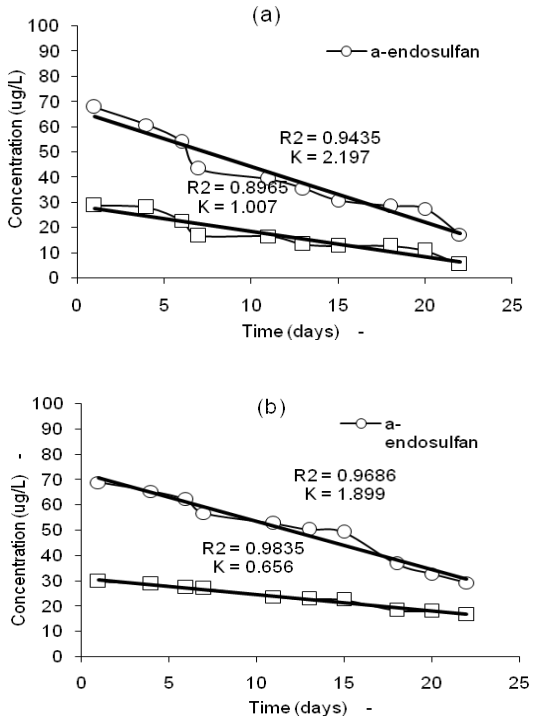

Figure 2: Biodegradation kinetics of α-ensoulfan and β-endosulfan by *Agaricus bisp*orus (a) and *Pleurotus ostearus* (b). (Rate constant (k) = ug/L^{-1}.day^{-1}).

The results indicate that both the fungal strains possess remediation potential for endosulfan isomers and the *Agaricus bisporus* is more efficient than *Pleurotus ostreatus*.

Food Engineering & Technology

Mushroom popularization and R & D for shelf life extension of oyster mushroom

Apart from conducting R&D on various aspects of mushroom cultivation, the main objective of mushroom program at NIFA is to popularize the developed technologies among both genders of farming communities. So for 3 training courses have been arranged this year. A total of 250 potential growers participated in these one day workshops, out of which 40 were women. To popularize the cultivation of mushroom in the country, it is very essential to work out technically and economically feasible techniques to overcome the problem of its short duration market life. In this respect, experiments were conducted on the shelf extension of oyster mushroom by applying the treatments of solar drying and gamma radiation. Different treatments in solar drying of mushrooms showed that the color of the controlled samples did not change after drying while the color of mushrooms which were sulphited and dried turned into some golden color. The samples which were blanched for 5 minutes turned black and blanching + sulphiting sample turned brown.

For oyster mushrooms, 4 different doses of gamma radiations were applied on the fruiting bodies of the mushrooms. (taken in replicate) i.e. 1, 2, 3 and 4 kGy, respectively. Results revealed that the 3 kGy dose increased shelf life of mushrooms up to one week at room temperature followed by dose of 2 kGy and 4 kGy that extended the market life to about 4 days, while 1 kGy dose so good as compared with controlled sample of mushroom i.e. 3 days.

Effect of processing and storage on antioxidant content/activity of fruits/ vegetables and their products

The objectives of this study was to standardize protocols for different apple products with maximum retention of antioxidant content and to document the effect of processing on total phenolics, flavonoides, ascorbic acid, proanthcyanidine and antioxidant activity.

Aqueous extract of different samples; T1 (fresh apple with skin), T2 (fresh apple without skin), T3 (apple chips), T4 (apple slices without skin preserved in sugar solution) and T5 (apple slices with skin presered in sugar solution) were prepared for quantification of the effect of processing on different antioxidant content. The total phenol content (catechin equivalent) of aqueous extract was 286.5367, 208.7156, 489.8, 202.4875 and 257.945 $mg.kg^{-1}$ for T1, T2, T3, T4 and T5 respectively. The total flavonoides (quercetin equivalent) ranged from 5.6 (T4) to 22.1 (T3) $mg.kg^{-1}$. The reducing power (ascorbic acid equivalent) of different apple products can be ordered as 2.51 (T3)>1.50 (T1)> 1.33 (T2)>1.20 (T5. 1.18 (T4) $mg.kg^{-1}$). The data revealed that the total phenol, total flavonoides and reducing power varied considerably for different processing conditions of apple products due to concentration in case of dried products and leaching of phtochemicals in case of preservation in sugar solution. Another most important reason for the antioxidants variations among apple products is that apple peels contain more antioxidant compoundsand may have higher antioxidant activity than the apple flesh.

Antioxidant content and anti oxidant activity of some common fruits

Reliable composition data on phenolics and assessment of their activity are essential for calculating dietary intake and for standardization of health promoting food products. The study included assay of water soluble total phenols ($mg.kg^{-1}$ of catechin), methanol extractable total phenol ($mg.kg^{-1}$ of catechin equivalent), water soluble total flavonoide ($mg.kg^{-1}$ of quercetin equivalent), methanol extractable total flavonoide ($mg.kg^{-1}$ of quercetin equivalent), water soluble flavonol ($mg.kg^{-1}$ of quercetin equivalent), proantho-cyanidine ($mg.kg^{-1}$ of catechin equivalent) and total reducing power ($mg.kg^{-1}$ of ascorbic acid equivalent) in commonly available fruits (apple, banana, persimmon, orange, kinnow and lemon) . The data revealed that persimmon fruit is richest source of water as well as methanol soluble phenolics (Fig.3) and flavonoide (Fig. 4) with maximum antioxidant activity ($mg.Kg^{-1}$ of ascorbic acid equivalent) among the studied fruits followed by apple. All the citrus fruits contained more methanol soluble phenolics as compared to water soluble phenolics (Fig.1).

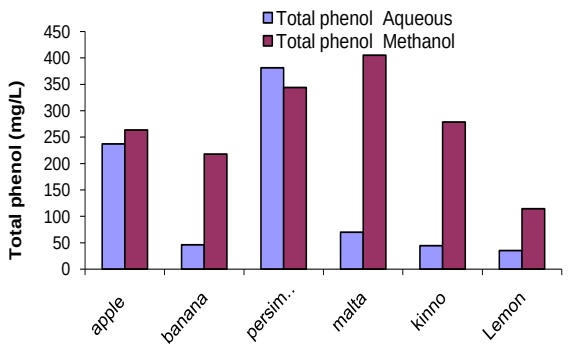

Figure 3: Water and methanol extractable total phenol (mg.kg^{-1} of + catechin equivalent)

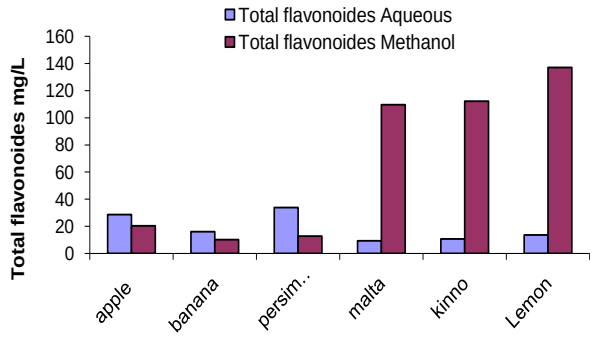

Figure 4: Water and methanol extractable total flavonoids (mg.kg^{-1} of quercetin equivalent)

Shelf life extension of plum fruit by use of different packaging materials during modified atmospheric storage

Plum fruit sealed packed in different colored (transparent, white and yellow) polyethylene was stored at ambient as well as refrigerated temperatures and studied for physical, chemical and sensory attributes at one week interval. Fruit weight loss increased over time but it was treatment dependent. By forty days fruit packed in any of the polyethylene packaging at refrigerated temperature lost weight from 0.3% to 0.5% of their fresh weight, whereas fruit packed kept at refrigerated temp without packaging material (control) lost nearly 6.0% of their fresh weight. Same pattern was observed in treatments at ambient temperature but fruits deteriorated after twenty days of storage. Fruit firmness and titratable acidity decreased with storage period. Universal hardness meter was used for firmness and results showed that values decreased minimum in T6 (transparent, refrigerated) from 4.16 to 3.1 while maximum was observed in To (no packaging, ambient temp) from 4.14 to 1.11. Titratable acidity ranged from 1.24 to 0.96 % during the storage period. Total soluble solids increased with storage and there was not much difference between different packaging materials. Loss in vitamin C and phenolic compounds was observed in all the treatments and minimum loss (18%) in vitamin C was recorded in the treatments kept at refrigerated temperature while maximum in T0 (control). Decay index data showed that fruits kept at ambient temperature deteriorated in twenty days while those kept at refrigerated temperature showed good quality and physiochemical attributes till forty days. Organoleptic evaluation and other quality attributes of plum fruit illustrated that treatment T6 (transparent, refrigerated) followed by T4 (white, refrigerated) performed better during storage. The creation of MAP by different packaging materials is a good approach to reduce plum weight loss and maintain the fruit flesh appearance at refrigerated storage periods up to 40 days.

Design and development of extrudate cutter for the single screw extruder

Specific objectives of this project were to i) develop a system that would cut the extrudates (extruded product) in proper length and ii) to install a water injection system for online addition of moisture into the ingredients. The extrudate cutter consisted of a 2 volt dc motor. Stainless steel blades were coupled to the motor shaft with the help of coupling tool. The shaft was provided for the cutter forward and backward movement in order to adjust the blade's distance from the die of extruder. For controlling the length of cut, a speed regulator has been installed. The cutter was tested for the rapeseed extrudates at different speeds and with different number of blades. The results show that the cutting range of rotary cutter was 0.5 to 9.2 inches.

Canning of fruits and vegetables

Fresh ripe tomatoes were washed and dipped first in boiling water for 1 minute and then in cold water. The peel was removed by hand. One-third of the tomatoes were crushed and passed through a fine pulper to separate the seed and skin from the pulp. The pulp was then concentrated to 24 % solids through slow heating. One-third were canned as diced and the remaining one third were canned as whole tomatoes. The TSS, pH and vitamin C content of the fresh tomato were 5%, 4.23 and 58.2 mg per 100 g, respectively. The TSS, pH and vitamin C content for the blanched tomatoes and freshly made paste were 5, 4.32, 16.5, and 24, 4.29 and 46.5, respectively. The cans were stored at room temperature. The products retained their original color, taste and appearance during the 10 month storage. No microbial growth was

observed. Fungal growth started in the cans within three days after opening.

Food Nutrition

Radiation decontamination of poultry feed – biochemical effects on feed

Present research was carried out to study the influence of gamma irradiation on the microbial load and biochemical quality of poultry feed. The feed samples, 3 commercial brands of poultry feed for broiler (No.14) and 3 for layer (feed No.12) were obtained from local poultry market. Samples were packed in polyethylene bags and directly transported to the institute. Each of the feed samples mentioned above were packed in 3 plastic jars, making a total of 18 jars. One of the three jars for each sample was kept as untreated control; the second was irradiated at 5 and the third at 10 kGy dose of gamma rays. The irradiated and un-irradiated (control) samples were kept at ambient room conditions for subsequent analysis. Feed samples were analyzed in triplicate for various microbial and biochemical parameters.

Moisture, mineral matter (ash), crude protein, crude fat and crude fiber were determined. Nitrogen-free extract (NFE) was calculated by the difference method. Moisture, ash, protein, fat, crude fiber and NFE contents ranged from 8.3 to 10.9, 11.3 to 12.5, 16.5 to 21.7, 15.7 to 18.6, 10.6 to 13.9 and 26.5 to 33.9%, respectively. Per oxide value (POV), free fatty acid value (FFA), in-vitro protein digestibility (ivdp) and protein solubility, were significantly ($P<0.05$) increased by irradiation doses. However, irradiation treatments did not have a significant effect ($P<0.05$) on phytic acid content of feed brands. Result also showed that irradiation had no significant effect ($P<0.05$) on mineral contents. However, the treatment increased mineral (Fe and P) solubility. Irradiation eliminated almost all fungal and drastically reduced the bacterial load of the samples.

It was concluded that gamma irradiation (5 and 10 kGy) had significant effect on different quality parameter of poultry feed. Irradiation doses increased protein solubility, in-vitro protein digestibility, mineral solubility, per oxide value and free fatty acid value of different brands of poultry feed. Moreover, it is also concluded that gamma irradiation completely eliminated almost all fungal and drastically reduced the bacterial load of the feed samples.

Iodine Content of the salts produced in Pakistan

A joint project was undertaken in collaboration with Universal Salt Iodization (USI) programme of the ministry of Health Islamabad to conduct a survey of the table salts produced in Pakistan for level of iodization. A total of 278 salt processing units were sampled by the IDD / USI programme from across 39 districts giving 446 samples. The samples were analyzed for iodine contents at NIFA. The median value of Iodine in samples was 20 ppm (mean: 35, range 0-559). In order to be physiologically relevant, iodized salt must have at least 30 ppm of iodine. Results of the present study revealed that approximately 28% samples were in the 30-100ppm range and the rest were either below or above that range. Most of those falling out of this range were below 30ppm and only 8% were above 100ppm.

Fortification of commonly consumed edible oils with non conventional oil to upgrade their chemical and nutritional quality

The crude oil was extracted and refined. The test oil was blended @20, 40, 60, and 80% w/w with CO. Stability of blends was tested under various stressed conditions i.e. ambient, under fluorescent and sunlight for 8 weeks. The results regarding effect of different storage conditions on fortified samples are presented in Fig. 5. The peroxide value (POV)) is considered a quality indicator to measure the stability. The data indicated that maximum increase in POV was observed in samples stored under sunlight. Among all the blended samples, SMO:CO (60:40) blends exhibited greater stability under all the test conditions. The presence of high concentration of antioxidants and vitamins i.e. β-carotene and vitamin E as shown in Fig. 6 that play an important role in hindering the degradation of oils against excessive oxidation, radicals and active oxygen species, therefore, enhanced the oxidative stability of oils.

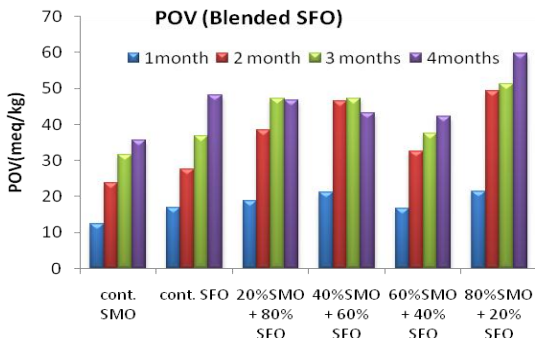

Figure 5. Peroxide value of blended and control samples

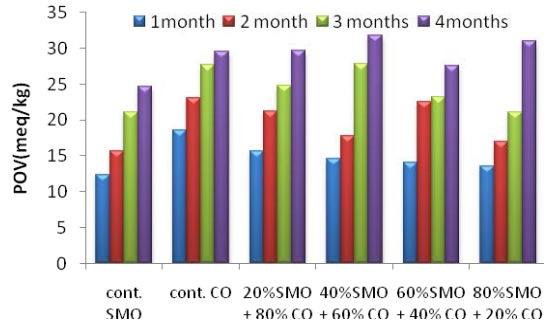

Figure 6. Effect of blending on vitamin concentration of CO

Evaluation of fatty acid profile of test blends was carried out using Gas Chromatographiv method. The results are presented in Fig. 7. The test oil was found low in saturated fatty acids and high in polyunsaturated fatty acids (Oleic 33.2% and Linoleic acid 45.5%), however, the canola oil contains oleic acid 35.1 and linoleic acid 15.4 Linolenic 7.3 and Erucic acid was 11.6%. The CO exhibited higher percentage of total unsaturated/total saturates (TU/TS) ratio (15.4) as compared to SMO (5.9), the lower ratio of TU/TS, greater the nutritional significance. Blending of CO with SMO showed that the degree of unsaturation increased progressively, by each increment of SMO. The maximum unsaturation was obtained with 60% SMO addition. Highest increase in linoleic acid was found in SMO:CO (60:40) blend, while higher concentration of linolenic acid was observed in SMO:CO (20:80) blend. The distinguished character of this study was reduction in Erucic acid from 11.6 to 2.8% in SMO:CO (60:40) blend which is an undesirable fatty acid with negative health effects and therefore, considered as anti nutritional factor.

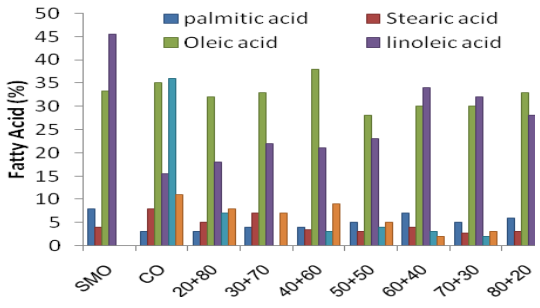

Figure 7. Fatty acid profile of blended and control samples

Among saturated fatty acids the stearic acid in this blend increased up to 3.1% which also take part in imparting stability to blend. Based on the results obtained, the extracted oil from milk thistle seeds was found rich in essential fatty acids, sterols, vitamin E and other natural antioxidants. Therefore, the test oil can be an attractive candidate for use in food preparation mixed with other vegetable oils or alone.

Overall results revealed that oil extracted from *Silybum marianum* seeds contains more than 50% polyunsaturated fatty acids of which 35-40% is α-linolenic acid (ALA ω3), an essential omega-3 fatty acid which is more stable than other essential fatty acids of this class. The execution of the study results in the production of innovative, economically viable blends, with maximum nutrition as well as desirable physico-chemical properties. Such information could be valuable in relation to formulation of food products containing high levels of n-3 PUFA from both plant and animal sources. The use of blended oil would decrease the health related problems, particularly liver, and heart ailments and would fulfill the body nutritional needs. Thus blending is a good choice to manufacture edible oils of good characteristics and ensure their quality. However, more study is required to exploit some other economical indigenous sources to improve the nutritional value of commonly consumed edible oils.

Supplementation of biscuit using barley and *Silybum marianum* flour

Barley and *Silybum marianum* were grown at NIFA experimental farm and the seeds were grinded to flour. Fine wheat flour was purchased from the local market. Wheat, *Silybum marianum* and barley flour were blended in the following ratios; A (100% wheat flour), B (70% wheat, 20% *Silybum marianum*, 10% barley flours), C (50% wheat, 30% *Silybum marianum*, 20% barley flours), D (30% wheat, 40% *Silybum marianum*, 30% barley flours) and E (10% wheat, 50% *Silybum marianum,* 40% barley flours). A known weight of sugar and ghee or oil was mixed thoroughly, and then composite flour and baking powder were slowly added. Ingredients were blended in a mixer and kneaded. The dough was then shaped into cookies and baked in laboratory oven at 180°C for 25 min; the cookies were allowed to cool down and stored in a polypropylene container. Proximate compositions i.e. protein, fiber, fat, ash and moisture contents of the formulations were analyzed using AOAC standard methods. Sensory attributes (color, texture, taste, odor and general acceptance) using five point hedonic scale involving trained judges were evaluated.

Sensory attributes

Results of sensory evaluation are as shown in Fig. 8. The sensory characteristics (texture, color, flavor) of sample B (70% wheat, 20% *Silybum marianum*, 10% barley), and C (50% wheat, 30% *Silybum marianum*, 20% barley) were most preferred as compared to other formulation. The overall acceptability of sample D (30% wheat, 40% *Silybum marianum*, 30% barley) and E (10% wheat, 50% *Silybum marianum*, 40% barley) showed differences in all parameters as compared to control (100 % wheat flour).

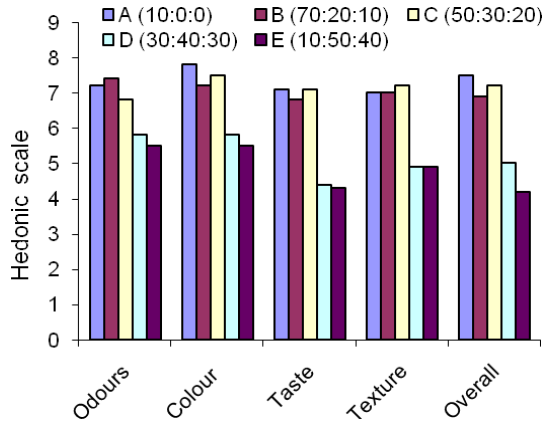

Figure 8. Sensory evaluation of fortified biscuits

The results of proximate composition of preferred formulations B and C are presented in Fig. 9. Moisture, protein, fiber, and mineral contents of these samples were found higher than the control. Adaptation of this technology will result in production of better protein and fiber enriched biscuit to the ever-increasing number of consumers.

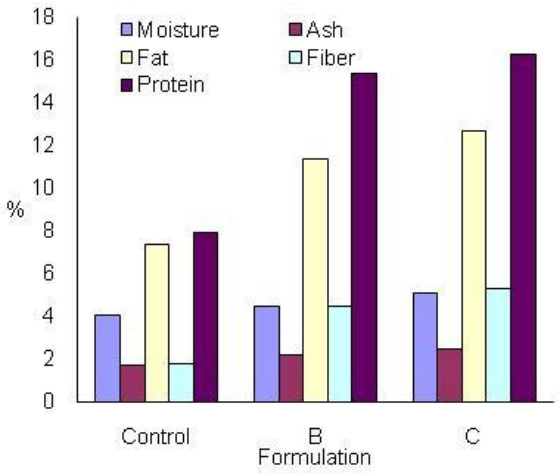

Figure 9. Proximate composition of fortified and control samples

Development and sensory evaluation of low cost weaning food formulations

Samples of wheat, whole green gram, chickpea and lentil were purchased from the local market. Germinated and ungerminated grains were dried at 60^{0}C, and ground into flour. Foods formulation was based on germinated cereal and roasted groundnut in the ratio of 75:25:25 with ungerminated wheat formulations as control. Developed products were evaluated for their acceptability by a panel of 10 judges and proximate composition. Results of sensory evaluation (Fig. 10) revealed nonsignificant differences for the appearance, color, and texture of various combinations. Kheer prepared from germinated wheat obtained highest scores, followed by lentil-supplemented and green gram supplemented diet.

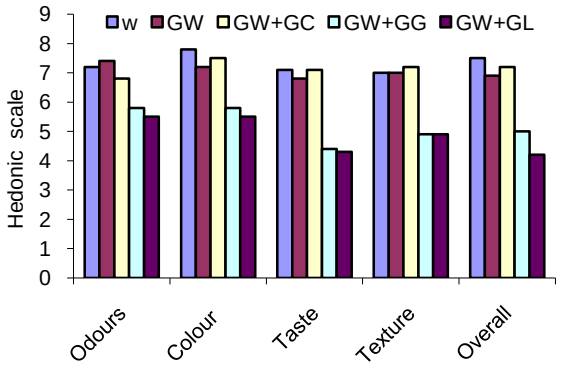

Figure 10. Sensory evaluation of different weaning diets

The proximate nutrient composition of diets and commercial formula as presented in Fig. 11 indicated that moisture, fiber, fat and energy values were higher in all the local diets than in commercial diet. Protein, fiber, minerals and vitamin contents were found higher in diets 2 and 3 than in commercial diet.

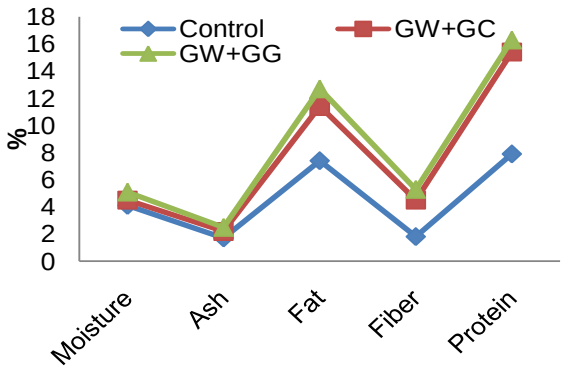

Figure 11. Proximate composition of weaning diets

SOIL SCIENCE DIVISION

Intensive cultivation, flooding irrigation, unbalanced fertilization and urbanization of cultivated land in the last few decades has led to the depletion of natural resources. Conservation and optimum utilization of available natural resources (soil, water and nutrients) is essential for sustaining and increasing agricultural productivity over the long term. The main aim of the soil science division is to improve nutrient and water use efficiency, and to conserve soil health/ fertility. The scientists are working on integrated management of nutrients for cereals/ vegetable crops and orchards. They also work on determining the nutritional requirements of NIFA candidate crop varieties, and development of quality compost and engineered fertilizer. In addition, help is extended to the breeding division in screening advanced wheat genotypes for high yield potential on low fertility soils.

Plant Nutrition

Enhancing stone fruits (peach, plum and apricot) orchards productivity through integrated nutrients (NPK) management

Six orchards two each of plum, peach and apricot of different farming communities are under trial in Peshawar and Nowshera districts of KPK Province. NPK and Farm Yard Manure were applied in different combinations along with control. Half nitrogen and all the phosphorus and potassium fertilizers were applied 0.5 meter away from tree trunk and between the drip lines after fruit picking in midsummer 2010 while the Farm Yard Manure was applied in dormant season. There were eight NPK treatments (T1 0-0-0, T2 0.75-0.5-0, T3 1.0-0.5-0, T4 0.5-0.5-0.5, T5 0.75-0.75-0.5, T6 1.0-0.75-0.5, T7 0.75-0.5-0.5+ FYM, T8 1.0-0.5-0.5 + FYM) with three replications and two trees per treatment. In this way 48 trees of uniform size, age and vigor were selected in each orchard (Total 288 trees in six orchards).

Leaf samples were collected in these orchards from each tree in midsummer (2010) from mid portion of current year extension growth. These samples were dried, ground and analyzed for NPK. Soil samples (two depths 0-15, 15-30 cm) were collected from all these orchards after fruit picking in midsummer. These samples were dried, ground and were analyzed for NPK, organic matter and various parameters.

Soil analysis

i. Peach orchards: Soil analysis (0-30 cm) indicated that the Soil Organic Matter (SOM) content was significantly improved compared to the previous year. The mean SOM content in the peach orchards ranged from 0.93 to 1.85 % with an overall average of 1.83%. The mean NPK of 0.1 %, 13.7 $mg.kg^{-1}$ and 135.8 $mg.kg^{-1}$ respectively, was found in the treatment that received NPK + Farm Yard Manure (FYM). The SOM in surface soil (0-15 cm) were higher compared to the lower depth (15-30 cm).

ii. Plum orchards: In plum orchard, the SOM contents also increased and the average value of two sites indicated that highest SOM (2.03%) was found in the treatment that received NPK + FYM. Like SOM, the NPK content in the soil of plum orchards were also improved in the same treatments.

iii. Apricot orchards: In apricot orchard the highest mean value of SOM of 1.94% and NPK content of 0.09 %, 13.8 $mg.kg^{-1}$,and 140 $mg.kg^{-1}$ respectively was found in the treatments received NPK + FYM.

Leaf analysis

Leaf analysis indicated that nutritional status of fruit trees improved with application of NPK and FYM and its contents were improved in all NPK treatments compared to control. Plum leaves had 2.33 %, N content, 0.28 % P value and 3.35 % K for the NPK + FYM treatment. In peach orchards the N concentration ranged from 1.95 to 2.70 %, the P concentration ranged from 0.2 to 0.3 % and K ranged from 2.3 to 3.1 %. Higher NPK concentration was found in the treatments that received NPK + FYM. Like plum and peach the NPK concentration in apricot orchards were also improved in all treatments compared to control. The N concentration in the leaves of apricot orchards ranged from 1.92 to 2.62% with a mean value of 2.54 % recorded in the treatments which received NPK + FYM.

Yield

The fruit yield data obtained during 2011 indicated that in peach, plum and apricot orchards the yield was almost double compared to previous year (2010). All the integrated nutrient management treatments improved the yield in all orchards and the balanced nutrition reduced the fruit drop which is a serious problem in deciduous orchards. The mean peach yield of Shakerpura and Daman Afghani ranged from 78.5 to 133.5 $kg.tree^{-1}$ while in case of apricot the yield range from 93.42 to 192 $kg.tree^{-1}$. In the plum orchard at NIFA, yield ranged from 50 to 150 $kg.tree^{-1}$.

In conclusion in all the above orchards (peach, plum and apricot) the yield and NPK content in the soil were improved through integrated nutrient management. FYM manure along with NPK improved the organic matter contents in the soil profile. The FYM manure along with NPK also improved the nutritional status of fruit trees and yield. The balanced nutrition improved fruit quality & increased productivity of these stone fruit orchards. It will also increase the life span of these orchards. High production will improve the socio-economic condition of farming communities and the surplus fruit will be a source of foreign exchange for the country. Soil fertility can be improved and maintained on sustainable basis. Final conclusion will be drawn after laboratory analysis at the completion of the project.

Effect of organic amendments and NPK fertilizer on yield, nutrient/water use efficiency and soil fertility in tomato-potato cropping system

Potato and tomato are the most popular vegetable crops in irrigated areas of Khyber Pakhtunkhwa. These crops are high nitrogen (N) feeder but fertilizer N utilization by these crops is too lower. The cultivated soils are deficient in organic matter (O.M) and essential nutrients. Among the essential plant nutrients, about 98 % of the soil nitrogen is stabilized in the organic matter. Organic matter slowly release the plant nutrients and thus contribute to efficient crop production and sustainable soil fertility. Addition of organic materials such as organic waste, crop residues and manure etc. to agricultural soil (with or without chemical fertilizers) is important for replenishing the annual C losses and for improving both the biological and chemical/physical properties of the soils. Keeping in view the importance of organic waste materials, a field experiment was started in March 2011 at research farm of NIFA with the objectives to investigate the effect of organic wastes i.e. Farm Yard Manure (FYM), Sugar Industry waste (Filter cake), Municipal Solid Waste (MSW), crop residue with and without NPK (mineral fertilizer) on yield, N-utilization, water use efficiency and its effect on soil available N-pool in soil. All organic wastes were analyzed for total organic carbon and nitrogen. All the wastes were applied @ 3 t C. ha^{-1} with full NPK (100-75-60) and half NPK. All wastes and full dose of PK + ½ N were applied before sowing and ½ N at earthing up time. A total eight tomato fruit pickings were collected. The data showed that organic wastes improved the yield significantly compared to control. The results further indicated that among wastes maximum yield was recorded in treatment which received sugar industry waste (filter cake). In overall filter cake with half NPK resulted in comparatively higher yield (9.2 $t.ha^{-1}$) than all other combination. These results showed that ½ NPK requirement of tomato crop can be fulfilled with application of filter cake @ 3 t $C.ha^{-1}$.

Effect of organic amendments and NPK fertilizer on yield, nutrient/water use efficiency and soil fertility in irrigated maize-wheat cropping system

A field experiment was carried out during 2010-11 at research farm of NIFA to study the effect of organic waste materials (farm yard manure (FYM), Sugar industry waste (Filter cake), Municipal Solid Waste (MSW), Crop residues and NPK mineral fertilizer on cereals yield, quality and soil fertility.

Before starting the experiment, organic solid wastes were analyzed for total organic carbon and total nitrogen. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. To study the effect of treatments on the soil water storage, neutron access tubes down to 90 cm in soil profile were installed in each treatment and probe reading recorded before and after irrigation.

Composite soil samples were collected from the experimental field for its various physico-chemical analyses. The soil particle size analysis indicated that soil had textural class of clay loam, alkaline in reaction, non-saline, low in OM and NPK. Wheat was sown on November 25, 2010. All organic wastes were applied @ 3 t $C.ha^{-1}$ with full NPK (120-90-60 $kg.ha^{-1}$) and half NPK. Known amount of water was applied in each irrigation and metrological observation was also recorded.

The results indicated that the applied organic wastes (except maize residues) produced biological yield of wheat statistically equal to full NPK mineral fertilizer treatment. In combination with NPK, these organic wastes further improved the yield by 8-15 %. Grain yield data indicated that maximum yield (4.84 $t.ha^{-1}$) was obtained by MSW + NPK full dose followed by Filter cake + NPK (4.80 $t.ha^{-1}$). Straw yield data showed that the MSW+NPK resulted into maximum straw yield (12.93 $t.ha^{-1}$) followed by Filter cake +NPK full dose (12.53 $t.ha^{-1}$).

Screening of advanced wheat genotypes for high yield and quality on low fertility soils

Application of fertilizers in maintaining soil fertility is a critical step for increasing wheat production, improving its nutritional status and quality. However, during the last decade, intensive cropping, unbalanced macronutrient fertilizer with low impurities of trace elements, inefficient micronutrient genotypes cultivation and flooding irrigation system has resulted in greater depletion of soil available micronutrients. The researcher recommended the application of micronutrients fertilizer along with macronutrient in major cropping system for sustainable soil fertility and crops production. However application of micronutrient fertilizers for correcting their deficiency is not a sustainable strategy due to economic, environmental and agronomic factor. It is essential to find a sustainable, economical and environment-friendly solution to micronutrients deficiency.

One of the efficient and sustainable solutions is the development of micronutrient-efficient plant genotypes that can be grown more efficiently on micronutrient deficient soil which would reduce fertilizer inputs and protect the environment. Keeping in view the importance of wheat crop in food security of the country and role of micronutrient in yield and quality improvement, a pot experiment was carried out to identify micronutrient-efficient wheat genotypes that can be grown more efficiently on micronutrient deficient soil and to reduce micronutrients fertilizer inputs cost of wheat crop and to protect the environment. Three irrigated advanced wheat genotypes (CT-03457, CT-04192, and NIFA-V15) were obtained from the Plant Breeding & Genetic Division of NIFA and were sown on November 15, 2010 at research farm of NIFA. These lines were screened under control moisture condition for response to Zn and B. The nutrient levels detail was as follow:1. Control, 2. Zn, 3. B, 4. NPK, 5. NPK + Zn, 6. NPK + B. The experiment was conducted in RCB design (factorial) and was replicated three times. The crop was harvested at maturity and data was recorded on yield and yield components. The grain and straw samples were analyzed for macro and micronutrients. Micronutrient efficiency was calculated as the ratio of yield (shoot dry matter or grain yield) produced under micronutrient deficiency (control) to yield produced with micronutrient fertilization (treatment),

Experiment was harvested on May 31, 2011.The yield data showed that CT-03457 and NIFA-V15 were found zinc and boron efficient wheat genotypes. These genotypes are recommended to plant breeding and genetic division for further testing to release the Zn and B efficient wheat variety for low fertility soils of KPK.

Effect of foliar application of urea, humic acid and micronutrients on potato crop

Field experiment was conducted during 2010-11 at research farm of NIFA to study the influence of foliar feeding on potato crop. The foliar applied nutrients were urea, humic acid, Zn, and B, which were applied alone and in combination with full and half NPK. There were eight treatments; 1. Control, 2. Full NPK soil App, 3. ½ NPK + H.A (0.03 %), 4. ½ NPK + urea (0.5%), 5. ½ NPK + Zn, 6. ½ NPK + B, 7. ½ NPK + Zn+ B, 8. ½ NPK + Zn+ B+ H.A (0.03 %). Potato variety CV. Aror was sown in RCB design with three replications in plot measuring 4 x 4.8 m^2. Distance between rows was 80 cm. Potato tuber samples were analyzed for total N and P uptake. The nutrients were sprayed at vegetative, flowering, tuber formation and ripening stages. The experiment was harvested at physiological maturity in December 2010. Result showed that maximum tuber yield (15.3 $t.ha^{-1}$) was obtained in treatment where half NPK + Zn + B+ H.A (0.03%) were applied followed by the treatment where half NPK + H.A (0.03%) was applied (14.43 $t.ha^{-1}$). The percent increase in yield of these treatments over full dose of NPK was 22% and 16%, respectively. Highest N-uptake (168.95 $kg.ha^{-1}$) and P-uptake (83.52 $kg.ha^{-1}$) were obtained in treatment where half NPK+ Zn + B+ HA (0.03%) were applied followed by the treatment where half NPK + H.A (0.03%) were applied. Economic analysis of the experiment showed that maximum value cost ratio of (5.12) was in the treatment where half NPK+ Zn + B+ H.A (0.03%) were applied.

Effect of various level of NPK on yield of advanced wheat lines evaluated at NIFA

NPK requirements of advanced wheat lines (CT-04192 and NIFA-V15) developed at NIFA were determined in a field experiment during rabi 2010-2011.The experiment was a factorial combinations of three 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) making 13 treatments per replicate including control. Plot size was five square meters with six lines in each plot. Row to row to distance was 30 cm. Experiment was sown in Nov 2010 and harvested on physiological maturity in June 2011. The data showed that maximum grain yield of (5000 kg ha^{-1}) of wheat line CT-04192 was found where NPK was applied at rate of 70-60-30 $kg.ha^{-1}$,

respectively. In case of NIFA-V15 maximum grain yield of (4833 kg.ha^{-1}) was found where NPK was applied at the rate of 140-60-0 kg ha^{-1}, respectively. Among these lines CT-04192 at lower level of NPK (70-60-30 kg.ha^{-1}) produced similar to that recorded at recommended level of NPK (140-90-60 kg.ha^{-1}) under NIFA experimental research station soil.

Effect of boron application on oil seed brassica yield and quality

The experiment was conducted at NIFA experimental farm. Three advanced varieties/lines (two varieties Durr-e-NIFA, Abasin-95 and an advanced line NH-975/2-4) developed at NIFA were tested. The experiment was laid out according to split plot design, keeping varieties/lines in main plot and B levels in sub plot. Recommended row to row distance for sowing and other cultural practices were followed. Basal doses of DAP was applied as per recommendation at the time of sowing. The treatments of boron were applied as foliar spray on the crop in three split doses at vegetative growth, flowering and pod formation stages. The treatments were: T1. Control (0.0 g.B.ha^{-1}), T2. 100 g.B.ha^{-1}, T3. 400 g.B.ha^{-1}, T4. 700 g.B.ha^{-1}, T5.1000 g.B.ha^{-1} , T6.1300 g.B.ha^{-1}, T7. 1600 g. B.ha^{-1}.

Plant height data was recorded at the time of maturity before harvesting. The results of mean height shows that the plant height increased with the increase in boron application up-to T4 (700 g.B.ha^{-1}) and then decreased with the increase of boron level. The trial was harvested in April and after drying biological and grain yields were recorded.

The results of grain yield showed that all B applied treatments increased yield over control. Maximum yield was observed in Durr-e-NIFA where grain yield increased 15.8% over control that received boron @ 700 g ha-1 followed by Abasin-95 (15.7% over control in the same treatment. While in advanced line NH-975/2-4, 24.1% increase in grain yield over control was recorded in treatment which received B @ 1000 g.ha^{-1}. There was no significant change in the other qualitative parameters such as oil content, protein, GSL, moisture, oleic acid, lenolenic acid and erucic acid.

Soil Biology & Biochemistry

Effect of agro-waste compost (ordinary and value added) levels on vegetables

Vegetable Pea: A field experiment was conducted in October 2010 to study the beneficial (fertilizing) effect of value added and ordinary compost alone and with half NPK on the yield and quality of vegetable pea (Local cultivar Early Tarnab). Nine treatments i.e. i) control, ii) NPK recommended dose, iii) 50% NPK, iv) 1% value added compost, v)1% ordinary compost, vi) 0.5% value added compost vii) 0.5% ordinary compost, viii) 0.5% value added compost + ½ NPK and ix) 0.5% ordinary compost + ½ NPK, were replicated four times in RCB design. The plot size was 11 m^2. The compost was applied to the respective plots one week before sowing. Seeds were sown at field capacity condition with a plant to plant distance of six inches on ridges The data revealed that maximum pod yield (5.8 t.ha^{-1}) was recorded in treatment receiving 0.5 % value added compost alone followed by treatment receiving 0.5% ordinary compost (5.3 t.ha^{-1}) compared to control (3.2 t.ha^{-1}). The increase over control was 79.7 and 64.2 %, respectively. Maximum number of pods (1546 per plot) were in treatment receiving 0.5 percent value added compost along with half NPK followed by treatment receiving 0.5% ordinary compost (1380 plot^{-1}) compared to control (791.3 plot^{-1}). The increase over control was 94.4% and 74.4%, respectively. Maximum single pod weight of 4.7 g.pod^{-1} was recorded in treatment receiving 0.5% value added compost compared to control (4.49 g.pod^{-1}) the increase over control in pod size was 4.7%.

Tomato: To see the fertilizing effect of value added and ordinary compost alone and along with half NPK on the yield and quality of tomato (cultivar Shamla), a field experiment was conducted in March 2011. Seven treatments were replicated four times in RCB design. The treatments were i) control, ii) Full NPK (recommended dose), iii) Half NPK, iv) 1% value added compost, v) 1% ordinary compost, vi) ½ NPK + 0.5% value added compost and vii) ½ NPK + 0.5% ordinary compost. The plot size was 15 m^2 and compost was applied/mixed in the concerned plots before transplanting of tomato seedling. The plant to plant distance was 30 cm. Data was recorded on tomato fruit yield (kg.plot^{-1}), number of tomatoes per plot, tomato size (single tomato weight) and plant biomass (kg.plot^{-1}) at harvesting. The study revealed that highest tomato fruit yield was recorded in treatment receiving 1% value added compost (25.3 t.ha^{-1}) followed by full NPK (22.6 t.ha^{-1}) and 1% ordinary compost (22.4 t.ha^{-1}) compared to control (14.7 t.ha^{-1}). The increase over control was 72.7, 54 and 52.7 %, respectively. Highest plant biomass yield was recorded in treatment that received 1 % ordinary compost (7.4 t.ha^{-1}) followed by 1% value added compost (6.75 t.ha^{-1}) as compared to control (3.5 t.ha^{-1}). The %

increase over control was 114 and 95%, respectively.

Effect of commercial and NIFA compost with and without N application on wheat yield

A field experiment on the effect of commercial compost and NIFA compost with and without N application on the yield parameters of wheat was conducted in rabbi season 2010-2011. NIFA wheat variety NIFA-Batoor-08 was used as test crop with plot size of 16 m^2. There were 6 treatments with 4 replications in RCB Design. The treatments were i) control, ii) NPK (full dose), iii) 625 kg commercial compost + 125 kg urea ha^{-1} iv) 625 kg NIFA compost + 125 kg $ureaha^{-1}$, v) 625 kg commercial compost alone vi) 625 kg NIFA compost alone and vii) 125 kg $urea.ha^{-1}$. Maximum biomass yield (14.37 $t.ha^{-1}$), highest number of tillers per plant (12.3) and maximum plant height (95 cm) were recorded in treatment receiving recommended dose of NPK. The increase over control was 18%, 11.3%, and 16%, respectively. Maximum grain yield of 5.8 $t.ha^{-1}$ was also recorded in case of recommended NPK followed by NIFA compost with125 kg $urea.ha^{-1}$ (5.25 $t.ha^{-1}$). However, maximum 1000 grain weight (36.5 g) was recorded in treatment receiving 625 kg commercial compost + 125 kg $urea.ha^{-1}$ as compared to control (33.3 g).

Effect of foliar application of humic acid on the yield and quality of vegetables

Onion: To see the effect of foliar application of humic acid alone and in combination with NPK, a field experiment was conducted at NIFA field using onion (a local cultivar) as a test crop. Number of treatments was six with three replicates in RCB design. The treatments were; i) control, ii) Full dose of NPK, iii) 0.01% humic acid , iv) 0.05% humic acid, v) half NPK+0.01% humic acid and vi) half NPK +0.05 % humic acid. Plot size was 24 m^2 and numbers of ridges per plot were three. The results revealed that maximum onion bulb yield of 17.6 $t.ha^{-1}$ was recorded in treatment receiving 100% NPK fertilization, followed by treatment receiving ½ NPK + 0.05% humic acid (15.8 $t.ha^{-1}$) as compared to control (11.4 $t.ha^{-1}$). The % increase over control was 55.7% and 39.8% respectively.

Vegetable Pea: A pot experiment was conducted to study the effect of different humic acids on the growth and yield parameters of vegetable pea. Eight $kg.pot^{-1}$ soil was taken and 10 $seed.pot^{-1}$ were sown. After thinning 3 plants per pot were maintained. The treatments were i) control, ii) peat based humic acid and iii) commercial humic acid. The humic acid was applied through foliar application of 0.05% concentration. The parameters studied were no. of pods per plants, pods yield number of grains/pods, grains weight and plant height. The data showed that maximum number of pods (4.3. $plant^{-1}$), pods yield 8.5 $g.plant^{-1}$, pod length (5.7 cm), number of $grains.pod^{-1}$ (5.4), grain weight (4.7 $g.pot^{-1}$) and plant height (53.3 cm) were recorded in treatment receiving peat base humic acid. Their increase over control was 65%, 82%, 29%, 34%, 75.8% and 49.7%, respectively.

SOCIO-ECONOMIC IMPACT

Plant Breeding and Genetics Division

NIFA Crop Varieties

NIFA crop varieties are being grown in all districts of Khyber Pakhtunkhwa (KPK). During 2011, 10.8 tons BNS & Pre-basic seed of NIFA wheat varieties was produced and distributed to provincial agricultural department, seed companies and farming community. The total seed of NIFA wheat varieties duly certified by FSC & RD can cover 4600 ha and may fetch return of approximately Rs. 737.6 millions. Similarly, 170 Kg Breeder Nucleus Seed of rapeseed and mustard varieties of NIFA (Durr-e-NIFA, Abasin-95, and NIFA Raya) was produced. The average yield of NIFA rapeseed and mustard varieties is 1500-1800 kg.ha-1 against the Khyber Pakhtunkhwa province average yield of 480 Kg.ha-1. Growers can obtain an additional income of more than Rs. 57,000/- per hectare from these high yielding varieties.

Plant Pathology

Breeding for disease resistance in wheat during 2011 in Khyber Pakhtunkhwa aimed at identifying effective genes, characterizing new sources of resistance, germplasm screening and enhancement of resistant sources. The impact includes protection of research investment, enhancement of selection efficiency, recognition of new pathotype introductions and support to development/deployment of rust resistant wheat germplasm and varieties.

Entomology Division

Fruit Fly management and Termite Control

Two-day farmers training workshops, one each on IPM of fruit flies and termite control technology were organized by entomology division in collaboration with provincial agricultural extension department during the year 2011. About 46 farmers from five districts of this province nominated by office of Director General Agric. Extension participated in each of the workshops. The training was a combination of specialized lectures and practical sessions covering mainly areas of developed eco-friendly control technology for fruit flies.

Honey Bee Management for Honey Production and Managed Pollination

During the past years, the inundating floods had adversely affected the honey bee cottage industry in KPK. To rebuild the destroyed bee industry, a training workshop was organized on “Honey Bee Management”. About 47 individuals including rural youth, farmers and extension workers of provincial agriculture department participated in the training workshop. The trainees were provided with basic skills required for honey bee management for livelihood and poverty reduction in the poor rural population.

Soil Science Division

Plant Nutrition Group

Imbalance application of mineral fertilizers is one major reason for low productivity in Pakistan. A package of integrated nutrient management practices and optimum and economic level of fertilizer for NIFA developed varieties of chickpea, rapeseed and wheat has been disseminated to the farmer’s through workshop/farmer’s days at their fields. Two workshops on “Balanced nutrition of deciduous fruit orchards” and one woekshop on tunnel farming were arranged to benefit the farming community.

Soil Biology and Biochemistry Group

The technology was demonstrated to the farming community at NIFA as well as at farmer’s field. A biogyeser was constructed by the farmer at his field for demonstration and his family use.

Food Science Division

Food Irradiation: On the basis of NIFA research, the 1st commercial food irradiator has successfully completed a business of Rs.10/- million during 2011. The trade is expected to increase in the coming years. During 2011, low radiation doses were provided to the samples, provided by various PAEC/Non-PAEC research organization and different Universities. Furthermore, An efficacy trial of the irradiated diets for immunocompromised patients was conducted in a joint study of NIFA and IRNUM. The prepared diets were served to neutropenic patients and their blood profile was assed for any improvement.

Mushroom Cultivation: During 2011, about 550 farmers were trained including 80 women. Seven new farmers have started their commercial farms in the vicinity of Peshawar while 65 women of Charsadda district have adopted this technology as kitchen gardening in their respective houses.

Food Products: The group organized 9 technical trainings on “Food Preservation” for Field Assistants, house wives, farmers and stakeholder and additionally trained 8 students for their internship programme. Under the public /private partnership activities on food products, 700 kg of tomato pulp was prepared @ Rs.10/Kg with the aim of starting small scale business by the stake holder. A one day workshop on “Canning of Fruits and Vegetables” was organized in order to introduce this technology to the potential entrepreneurs in collaboration with SMEDA. Thirty four participants from various districts of Khyber Pukhtoonkhwa and Khyber Agency attended the workshop.

Iodine Kit: Iodine Rapid Test Kit (RTK) for spot testing of iodine contents in table salt was developed. More than 16,000 kits @ 62/- per kit were provided for use at national level. Under the countrywide survey, more than 1500 salt samples collected from salt crushers from all over the country were evaluated for iodine contents.

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FUNDED RESEARCH PROJECTS

Title of the Project	Duration	Allocation (Rs. in millions)	Principal Investigator
Screening of sugarcane (*Saccharum officinarum* L.) germplasm and use of induced mutation/callus culture for frost tolerance, high cane and sugar yield. ALP/PARC No. CS-188.	2008-2011	2.853	Mr. Roshan Zamir, PS
Pak-US Wheat Productivity Enhancement initiative. PAK-US.	2011-2013	US $ 113,572	Mr. Tila Muhammad, CS
Development of Wheat Mutants for Higher Yield and Improved Efficiency of Water and Nitrogen Use. IAEA.	2011-2014	Euro 9,000 (annually)	Mr. Abdul Jabbar Khan, DCS
Enhancing stone fruits (peach, plum and apricot) productivity through integrated nutrient (NPK) management. ALP/PARC No. CS-306.	2008-2011	4.743	Mr. Syed Mahmood Shah, DCS
Development of slow acting toxicant bait for elimination of underground colonies of crop and building termites PSF/ NSLP.	2010-2013	2.400	Dr. Abid Farid, PS
Development of standardized mass rearing system for male Anopheles mosquitoes used in SIT program. IAEA.	2005-2011	Euro 35,000	Dr. Inamullah Khan, PS
Use of Iradiation as Phytosanitary Treatment for the Control of Citrus psyllids Diaphoronia citri and Scale Insects". IAEA.	2011-2012	Euro 10,000 (annually)	Dr. Inamullah Khan, PS
Bruchid resistance in Mungbean, PSF.	2011-2014	2.430	Mr. Alamzeb, PS
Integrated management of Peach Flat-headed borer, *Sphenoptera dadkhani* damaging trees of stone fruit orchards. PSF.	2011-2014	1.900	Mr. Muhammad Zahid, SS
Design and fabrication of a laboratory size screw extruder for conservation of agro-based materials into value added food and feed products. PSF.	2007-2011	0.657	Dr. Maazullah Khan PE
Development of processing method for pectin as value added product from citrus peel waste. PSF.	2007-2011	0.998	Mr. Amal Badshah PS

Irradiation for Enhanced Sanitary and Phytosanitary Treatment of Regional Products for Export. RCA/IAEA.	2009-2011		-	Dr. Ihsanullah DCS
Assessment of toxic metals in agricultural products and their relation with nutritional status in Pakistan. ALP/PARC No. CS-336	2008-2011		2.920	Dr. Ihsanullah, DCS
Development of package of technology for poultry feed irradiation in Pakistan. PSF.	2010-2013		2.834	Dr. Aurang Zeb, DCS
Development of irradiated foods for Immunocompromised patient and other potential target group. IAEA.	2010-2015	Euro	35,500	Dr. Anwar Ahmad, PS

SCIENTISTS /ADMINISTRATION

Officers		Staff	
Scientists	46	Technical	57
Administration/Accounts	6	Non Technical	67
Total Employees		176	

	Name	Designation
	Mr. Tila Mohammad	CS/Director
I.	PLANT BREEDNG & GENETICS DIVISION	
	Mr. Syed Anwar Shah, M.Sc. (Agric)	DCS/Head PBGD
	Mr. Abdul Jabbar Khan, M.Sc. (Botany)	DCS/Head TSD
	Mr. Iftikhar Ali, M.Sc. (Hons.) Agric.	DCS
	Dr. Syed Jawad Ahmad Shah, Ph.D. (Plant Pathology)	PS
	Mr. Roshan Zamir, M.Sc. (Hons.) Agric.	PS
	Dr. Gul Sanat Shah Khattak, Ph.D. (Botany)	PS
	Dr. Fazle Subhan, Ph.D. (Agronomy)	SS
	Dr. Muhammad Irfaq Khan, Ph.D. (Plant Breeding & Genetics)	SS
	Mr. Muhammad Amin, M.Sc. (Statistics)	SS
	Mr. Farooq-i-Azam, M.Sc. (Hons.) Agric.	SS
	Mr. Shahid Akbar, M.Sc. (Hons.) Agric.	SS
	Mr. Muhammad Ibrahim, M.Sc. (Hons.) Agric.	SS
	Mr. Iqbal Saeed, M.Sc. (Hons.) Agric.	JS
	Mr. Syed Tariq Shah, M.Sc. (Hons.) Agric.	JS
	Mr. Akhtar Ali, M.Sc. (Hons. Agric.)	ARO
II.	FOOD SCIENCE DIVISION	
	Dr. Ihsanullah, Ph.D. (Chemistry)	DCS/Head
	Mr. Fazal Mahmood, M.Sc. (Chemistry)	DCS
	Dr. Aurang Zeb, Ph.D. (Nutrition)	DCS
	Mrs. Nizakat Bibi, M. Phil. (Physical Chemistry)	PS
	Dr. Taufiq Ahmad, Ph.D. (Chemistry)	PS
	Dr. Shaheen Atta, Ph.D. (Chemistry)	PS
	Dr. Anwar Ahmad, Ph.D. (Radiation Chemistry)	PS
	Dr. Maazullah, Ph.D. (Agricultural Engineering)	PE
	Dr. Khanzadi Fatima Khattak, Ph.D. (Chemistry)	PS
	Mr. Misal Khan, M.Sc. (Hons.) Agric.	SS

	Dr. Azhar Rashid, Ph.D. (Biology)	SS
	Mrs. Tasnim Sharafat, M. Phil. (Microbiology)	SRO
	Mr. Zahid Mehmood, M.Sc. (Hons.) Agric.	SS
	Mr. Saeed Gul, B. Sc. (Chemistry)	ARO
	Mr. Tariq Nawaz, M. Sc. (Chemistry)	ARO
III.	Entomology DIVISION	
	Mr. Alam Zeb, M.Sc. (Hons.) Agric.	DCS/Head
	Dr. Abdus Sattar, PhD (Zoology)	DCS
	Mr. Amanullah Khan, M.Sc. (Zoology)	PS
	Dr. Abid Farid, Ph.D. (Entomology)	PS
	Mr. Muhammad Zahid, M.Sc. (Hons.) Agric.	SS
	Dr. Inamullah Khan, Ph.D. (Entomology)	SS
	Mr. Misbahul Haq, M.Sc. (Hons.) Agric.	SS
IV.	Soil Science DIVISION	
	Mr. Syed Mahmood Shah, M.Sc. (Agriculture)	DCS/Head
	Dr. Wisal Mohammad, Ph.D. (Soil and Envir. Science)	DCS
	Mr. Haider Khan, M.Sc. (Botany)	PS
	Dr. Syed Azam Shah, Ph.D. (Agronomy)	SS
	Mr. Zahid Ali, M.Sc. (Hons.) Agric.	SS
	Mr. Mukhtiar Ali, M.Sc. (Hons.) Agric.	SS
	Miss. Samreen Shahzadi, M.Sc. (Hons.) Agric.	SS
	Mr. Parvez Khan, M.Sc. (Hons.) Agric.	SS
V.	ADMINISTRATION & ACCOUNTS	
	Mr. Latif Zaman, B.Sc. MBA (HRM)	Pr. Admin Officer
	Mr. Muhammad Jamil, MBA	Accounts Officer
	Mr. Riaz Hussain, M.A.	Sr. Admin Officer
	Mr. Raufullah, M.L.I.Sc.	Librarian
	Mr. Rashid Nawaz, MA (English), MBA (HRM)	Jr. Executive (Admin)
	Mr. Wahid Gul, BA, LLB	Superintendent

Manpower position at NIFA

Officers	Number
CS	1
DCS	10
PS	11
PE	1
SS	17
JS	2
SRO	1
ARO	3
Administration	5
Account	1
Total	52

Staff	Number
Technical	
CSA	1
PSA	9
SSA	5
SA-I	8
SA-II	8
SA-III	8
SA-IV	3
Chief Tech	2
Pr. Tech	4
Sr. Tech	4
Tech-I	3
Jr. Comp. Operator	1
Tech-IV	1
Total Technical	57
Non Technical	67
Total	124

PROMOTIONS/TRANSFERS/RETIREMENT

Promotions

		From	To	On
1.	Mr. Tila Muhammad	DCS	CS	01-12-2011
2.	Mr. Alam Zeb	PS	DCS	01-12-2011
3	Mr. Iftikhar Ali	PS	DCS	01-12-2011
4.	Dr. Khanzadi Fatima Khattak	SS	PS	01-12-2011
5.	Mr. Zakirullah Jan	SA-III	SA-II	02-05-2011
6.	Mr. Nasar Khan	SA-IV	SA-III	02-05-2011
7.	Mr. Iqbal Gill	Sanitary Attdt-II	Sanitary Attdt-I	02-05-2011

Transfers/Posting

		From	To	On
1.	Mr. Mulk-e-Aman, Sec. Asstt.	CPC, DG Khan	NIFA, Peshawar	01-02-2011
2.	Mr. Israr Khan, Sr. Tech.	PINSTECH, Islamabad	NIFA, Peshawar	28-03-2011
3.	Mr. Parvez Khan, Sr. Scientist	NIA, Tandojam	NIFA, Peshawar	11-04-2011
4.	Mr. Muhammad Ejaz, Sec. Asstt.	SES, Islamabad	NIFA, Peshawar	13-06-2011
5.	Mr. Sarfaraz Khan, ASS	NIFA, Peshawar	INOR, Abbotabad	21-11-2011
6.	Mr. Muhammad Rafiq Khan, ASS	INOR, Abbotabad	NIFA, Peshawar	21-11-2011

Retirement

		Date
1.	Mr. Sher Ali, SA-II	28-5-2011
2	Mr. Rana Masih, Sanitary Attedt.-I	28-5-2011
4.	Mr. Dad Khan, Mali-1	01-7-2011
5.	Mr. Amal Badshah, PS	15-9-2011
6.	Mr. Mushk Alam, Sec. Asstt.	24-9-2011
7.	Mr. Alam Din	06-12-2011

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

EVENTS ORGANIZED

Nuclear Institute for Food and Agriculture - NIFA

Scientific Events Calendar 2011

Workshops | **Farmer's Day** | **Trainings** | **Symposia**

http://www.nifa.org.pk

January

27th January, 2011
One-day workshop on Mushroom Cultivation
Organizer: Food Science Division
Contact: Mr. Fazal Mahmood, DCS
Cell: 0301 8580108
E-mail: fazalmahmood@nifa.org.pk

February

9th and 15th February, 2011
One day workshop on Mushroom Cultivation
Organizer: Food Science Division
Contact: Mr. Fazal Mahmood, DCS
Cell: 0301 8580108
E-mail: fazalmahmood@nifa.org.pk

23 - 24 February, 2011
Two-day symposium on Iron Fortification of Wheat Flours in Pakistan
Organizer: Food Science Division
Contact: Dr. Aurang Zeb, DCS
Cell: 0333 9014498
Email: drzebkhattak@hotmail.com

March

16 - 17 March, 2011
Two-day Workshop on Agrowaste Composting & Biogeyser Technology
Organizer: Soil Science Division
Contact: Mr. Haider Khan, PS
Cell: 0334 9138064
E-mail: mails@nifa.org.pk

April

6th April, 2011
Farmers Day
Organizer: Plant Breeding & Genetics Division
Contact: S. Anwar Shah, DCS/Head
Cell: 0301 8580070
E-mail: sashah53@yahoo.com

27th Apr., 2011
Farmers' Workshop on Nutritional Management of Deciduous Stone Fruit Orchards
Organizer: Soil Science Division
Contact: S. M. Shah, DCS/Head
Cell: 0301 8580898
E-mail: mahmud_nifa@yahoo.co.in

May

11 - 12 May, 2011
Two-day training on Honey Bee Management
Organizer: Entomology Division
Contact: Mr. Alam Zeb, PS/Head
Cell: 0333 9407406
E-mail: mails@nifa.org.pk

June

8 - 9 June, 2011
Two-day Workshop on Preparation of Value-added Fruits and Vegetable Products
Organizer: Food Science Division
Contact: Mrs. Nizakat Bibi, PS
Dr. Shaheen Atta, PS
Ph: 091 2964060-2 (Ext) 221
E-mail: nizakatbibi@yahoo.co.uk

22nd June, 2011
One day training on Canning of Fruits and Vegetables
Organizer: Food Science Division
Contact: Dr. Maazullah Khan, PE
Cell: 0300 5834039
E-mail: maaz@nifa.org.pk

July

5 - 7 July, 2011
Three-day training on IPM Approaches for Insects of Agricultural Importance
Organizer: Entomology Division
Contact: Mr. Alam Zeb, PS/Head
Cell: 0333 9407406
E-mail: mails@nifa.org.pk

September

7 - 8 September, 2011
Two-day workshop on Edible Oil and Oilseeds Quality Assessment Techniques
Organizer: Plant Breeding & Genetics Division
Food Science Division
Contact: Mr. Iftikhar Ali, PS
Dr. Taufiq Ahmad, PS
Cell: 0333 9102990
E-mail: iali63@yahoo.com

12 - 23 September, 2011
28th Postgraduate training course on the Use of Nuclear and Other Advanced Techniques in Food and Agricultural Research
Organizer: NIFA
Contact: Ms. Samreen Shehzadi, SS
Cell: 0321 5774516
E-mail: sshehzadi11@hotmail.com

October

6 - 7 October, 2011
Two-day workshop on Disease transmitting Insects and their Control
Organizer: Entomology Division
Contact: Dr. Inamullah Khan, SS
Cell: 0334 9059180
E-mail: inamullah_nifa@yahoo.com

25 - 27 October, 2011
Three-Day International Symposium on Commercial Applications of Irradiation Technology for Food Safety, Security and Global Trade
Organizer: Food Science Division
Contact: Dr. Ihsanullah, DCS/Head
Cell: 0301 8580029
E-mail: ihsanullahdmifa@yahoo.com

November

21 - 25 November, 2011
One-Week training course on Modern Techniques in Food Testing
Organizer: Food Science Division
Contact: Mr. Fazal Mahmood, DCS
Cell: 0301 8580108
Email: fazalmahmood@nifa.org.pk

29 - 30 November, 2011
Two-day workshop on Phytosanitary Treatment of Herbal Materials/Products using Radiation Technology
Organizer: Food Science Division
Contact: Dr. K. Fatima Khattak, SS
Cell: 0334 9042823
E-mail: khattakkf@yahoo.com

December

12 - 24 December, 2011
17th Two-Week training course on Food Nutrition
Organizer: Food Science Division
Contact: Mr. Fazal Mahmood, DCS
Cell: 03018580108
Email: fazalmahmood@nifa.org.pk

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

NIFA in Pictures

New candidate variety " **NRL 0517**" (critical observations/expert discussion in the field)

Wheat variety "NIFA Barsat-10" at farmer's field

Desi Chickpea variety "NIFA-2005"

Sugarcane calliclones and mutants at tillering stage

Farmers workshop on "Integrated Nutrient Management" in deciduous fruits orchards

Field demonstration on application of fertilizers and water in deciduous orchards

High tunnel technology for growing of off season vergetables at NIFA

Training on biomass composting

Collection of mosquito larvae from the ponds (Sardyab Area)

Mosquito experiment in progress

Training workshop on honey beekeeping

Practical demonstration on honey extracting machine during training workshop

Development of iodine kit

Workshop on canning of tomatoes

Training on food product development

Preparation of mushroom compost

Sprouted kidney beans for preparation of diets for immunocomprmised patients

Organoleptic evaluation of diets for immunocomprmised patients

Visit of Member Science Dr. Badar Suleman to NIFA

NIFA Scientists along with Director

Plant Breeding and Genetic Division

Food Science Division

Entomology Division

Soil Science Division

Technical Services Division

Administration Section

Accounts Section

IT Cell

Director's Staff

Drivers

Field Staff at NIFA

ISO 9001 : 2008 Certified

NIFA

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