# NIFA


# ANNUAL REPORT 2024

**NUCLEAR INSTITUTE FOR FOOD & AGRICULTURE (NIFA)**
**PESHAWAR**

# NIFA Annual Report

## 2024


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# PREFACE

As a developing nation, Pakistan faces a significant challenge with food insecurity, exacerbated by rapid climate change, land and water resource degradation, and increasing food demands to meet domestic needs. This issue is particularly critical in Khyber Pakhtunkhwa, where up to 80% of the population is engaged in agriculture or related industries. The national food security is projected to become increasingly vulnerable due to the escalating effects of climate change in the coming years. Addressing these concerns necessitates a comprehensive and strategic approach, with active involvement from all relevant stakeholders. To enhance the performance of the agricultural sector amid changing climate conditions, adopting a forward-looking strategy in research and innovation is imperative.

The Nuclear Institute for Food and Agriculture (NIFA) is leading in addressing the challenges faced by the farming community in Khyber Pakhtunkhwa. Through an integrated approach, NIFA focuses on the development and implementation of climate-resilient crop varieties, advanced technology packages, and climate-smart farming practices aimed at improving the efficiency of water and fertilizer use. The institute also emphasizes integrated pest management and value addition to agricultural produce.

NIFA is engaged in applied research to address both current and emerging challenges within the agricultural sector of the province, leveraging conventional and nuclear techniques. The institute is committed to enhancing food security and ensuring food safety through innovative research and development (R&D), utilizing nuclear and other modern technologies in the fields of food and agriculture. The key activities and findings from the applied research conducted by NIFA scientists are detailed in the following sections of this report.

# HIGHLIGHTS

## PLANT BREEDING AND GENETICS DIVISION

In the wheat irrigated line CT-18062 ranked 8th in Khyber Pakhtunkhwa (4381 kg ha$^{-1}$) and 9th in Pakistan (2023-24 NUWYT), with a 4.8% yield increase over Arooj-22. It also secured 2nd position in Khyber Pakhtunkhwa (3835 kg ha$^{-1}$), surpassing Akbar-19 by 4.8%. Similarly, CIBW-2 excelled in 11th KPWYT, ranking 4th with 6104 kg ha$^{-1}$ (6.3% above the high-yielding check) and showed strong yellow rust resistance (RRI 8.83). CIBW-2 performed well nationally with yellow rust resistance (RRI 8.51). Additionally, five genotypes (CTES-141, CTES-136, CTES-107, CTES-114, and CIBW-5) underwent evaluation in the 12th KPWYT (2023-24). Notably, CTES-107 yielded 3496.7 kg ha$^{-1}$, securing 2nd position with a 16.8% advantage over Khyber-23 among 80 genotypes on 12 locations all over the province. NIFA candidate varieties, NRL 1901 and NRL 1908 were subjected for 1st year mandatory evaluation in National Uniform Wheat Yield Trials (NUWYT- Rainfed) at different sites in the country. NIFA candidate line NRL 1901 ranked 2nd (3604 kg ha$^{-1}$) on Khyber Pakhtunkhwa basis and 3rd (3812 kg ha$^{-1}$) on Pakistan basis. The candidate line NRL 1901 was declared resistant to both yellow and leaf rust (CDRI 2024).

A new mustard mutant candidate variety NIFA Raya-T24 (MM-31-5) was recommended by the Variety Evaluation Committee (VEC) on oilseed crops in its meeting held on 09-10-2024 at PARC, Islamabad for approval to the Provincial Seed Council. In the National Uniform Rapeseed Yield Trial four rapeseed mutants/ recombinants RM-1-5, RR-016-49, RR-016-101, and RR-016-30 were evaluated across diverse locations. Among these, RM-1-5 demonstrated superior seed yield performance, achieving an average yield of 1274 kg ha$^{-1}$, slightly surpassing the control variety, Super Canola, which had an average yield of 1270 kg ha$^{-1}$ across sixteen locations. In a multi-location adaptation yield trial conducted at four locations in KP, a total of 13 rapeseed recombinant/ mutants and 04 mustard recombinants were evaluated for their seed yield performance. The results of the three locations demonstrated that among the rapeseed mutants/ recombinants, RR-15-1-33/18 and RM-20-5-41/18 yielded 5% to 8% more than the check variety Super Canola

(2384 kg ha$^{-1}$) and mustard recombinants MR-15-3-35/18 and MR-2-5 achieved seed yields that were 14% to 20% higher than the check variety Super Raya (1970 kg ha$^{-1}$).

Green-seeded mungbean candidate variety 'NIFA Mung-24' was recommended by the VEC on pulses in its meeting held on 16-04-2024 at PARC, Islamabad for approval to the KP Seed Council. First-year DUS study of 02 black-seeded mungbean candidate lines (NBM-5-3-6, and NBM-5-3-10) was carried-out by Federal Seed Certification & Registration Department (FSC&RD) in kharif-2023. Seventy-seven advanced green-seeded recombinants and mutants were evaluated for yield and yield related traits in 04 sets of replicated yield trials in kharif 2023. A total of 14 genotypes produced statistically significant average higher seed yield of 1007-1656 kg ha$^{-1}$ against average seed yield of check varieties NIFA Mung-19 (903 kg ha$^{-1}$) and AZRI Mung-21 (1137 kg ha$^{-1}$). Mungbean National Uniform Yield Trial (Mungbean-NUYT) comprising of 21 entries was planted at NIFA in kharif 23. Two out of 20 black-seeded mungbean genotypes produced statistically significant higher seed yield (1541 and 1576 kg ha$^{-1}$) against seed yield of check variety NIFA Mung Spinghar-21 (1356 kg ha$^{-1}$).

In case of kidney bean, Distinctness Uniformity & Stability (DUS) of candidate line NKB-Kenya was carried-out by FSC&RD in spring-2024. In adaptation yield trial conducted at three locations in Kurram, NKB-Kenya produced a statistically significant higher average seed yield of 1809 kg ha-1 against the average seed yield of check variety NIFA Lobia Red-22 (1672 kg ha$^{-1}$). In a replicated yield trial conducted at NIFA in spring 2024, five genotypes produced statistically significant higher seed yield of 1834-1932 kg ha-1 compared with check variety NIFA Lobia Red-22 (1747 kg ha$^{-1}$).

A two-year mandatory DUS study of a promising okra candidate line 'NBL-1' was completed. The line demonstrated its unique characteristics and consistent performance. This thorough evaluation process confirmed that NBL-1 exhibits distinct traits that differentiate it from other existing varieties, including dark green fruit and improved yield potential. Its uniform growth pattern and stable performance across different environments further confirmed its viability for commercial cultivation.

Peach mutants and exotic/ local selection were evaluated for yield and fruit characters in the field. Zincle-4 is a visually appealing red nectarine with a high Total Soluble Solids

(TSS) value of 10.0 and matures early, ready for harvest in the third week of April. The fruit is large, aromatic, and has a high TSS brix of 11.0. Similarly Plum local germplasm and mutants were evaluated for morphological and fruit characters in the orchard. 02 mutant plants in 30 Gy treatment have initiated flowering but could not reach to maturity.

**FOOD AND NUTRITION DIVISION**

The primary objective of this division is to carry out R&D to minimize post-harvest losses of fruits and vegetables, value addition of foods, and ensure food safety through nuclear and other advanced techniques. The division provides analytical services to industry and R&D organizations and also coordinates with academia and communities for human resource development. In the Food Engineering and Irradiation Group, the development of a hybrid solar drier was undertaken in ALP funded project. Fabrication of the dryer has been completed. It features a drying chamber covered with corrugated metal sheets and glass with a capacity for 100 kg of fresh fruits and vegetables. The water heating is achieved through 26 two-inch diameter pipes installed in the roof under the glass. Maximum water temperature of 80°C was recorded in these pipes, while the drying chamber itself achieved 70°C. A 600-liter water tank for hot water storage is provided on the floor of the chamber. Preliminary drying experiments showed that honeydew melon moisture was reduced from 93% to 7% in three days, and moisture in bitter gourd from 77.8% to 7% moisture in two days. Low Energy Electron Beam (LEEB) technology is being used for food packaging, while low-energy X-rays are used for treating spices and dry fruits essential for Pakistan's exports. In this study, peanuts were irradiated with Co-60 gamma rays and low-energy X-rays at doses of 3, 5, and 7 kGy, demonstrating that a 5 kGy dose effectively extended shelf life for seven months without significant changes in essential fatty acids. Additionally, experiments with cakes showed that a 4 kGy irradiation dose maintained sensory qualities and prevented spoilage for up to 21 days without added preservatives. This approach enhances the safety of bakery products by reducing pathogens and the need for chemical preservatives.

Food and Environmental Safety Group (FES) is working on the optimization of cultivation technology of edible mushrooms as nutritive and safe food through R&D. Training workshops are conducted for mushroom popularization as a cottage industry among

farmers/ growers in Pakistan particularly Khyber Pakhtunkhwa (KP) including Newly Merged Tribal Districts (NMTDs). To enhance the testing capabilities of the Food Testing Laboratory, analytical methods were optimized for the determination of key honey quality parameters, including Hydroxymethylfurfural (HMF), flavonoids, pH, reducing sugar content, acidity, metals (Ca, Na, K etc.), phenol, density, protein, and ash. Additionally, an indigenous apparatus based on the Rankine Titration method for the determination of sulfur dioxide in preserved foods was designed and tested on food samples.

Micronutrient deficiency is a major concern in Pakistan, prompting a governmental initiative for salt iodization and the development of rapid test kits by the Food Nutrition Group to assess added iodine presence in salt. Recent experiments demonstrated that the NIFA Iodine Rapid Test Kit remained stable in detecting iodine concentrations under various storage conditions for one year. Additionally, trials for rapid test kit for the qualitative analysis of added zinc in wheat flour were conducted. Various chemical compounds were evaluated to identify the most effective reagents for kit development; however, all tested compounds yielded negative results due to the masking effects of intrinsic and extrinsic interfering agents. Furthermore, a series of experiments focused on optimizing methods for the lab-scale production of potassium iodate ($KIO_3$). The final results indicated an optimum molar concentration of 4M for maximum yield (49%), an ideal crystallization temperature of 50°C for maximum yield (51.14%), and an optimal reaction time of 25 minutes for the highest yield (58.46%).

## SOIL AND ENVIRONMENTAL SCIENCES DIVISION

The natural resources (soil, water and nutrients) use efficiency and crop productivity are influenced by climate change. Agricultural production is mostly affected by the severity and pace of climate change in developing countries and faces bigger repercussions. Adoption of climate smart agricultural practices devised by the scientists of Soil & Environmental Sciences Division (S&ESD) are among the strategies to combat the negative impacts of climate change on natural resources use efficiency, using conventional as well as nuclear and isotopic techniques. The key project themes of divisional research include climate-smart agriculture, vertical farming, zinc biofortification, integrated nutrient & water management, bio-fertilizer development and organic farming.

Under the zinc biofortification project, findings from the hydroponics study depicted that the Zn efficiency of the wheat genotypes under study ranged from 25 to 76% and two genotypes were identified as the most Zn-efficient ones. The tunnel farming technology for bitter gourd and melon was optimized and it was found that the highest marketable bitter gourd yield was achieved by the application of NPK @ 45-45-50 kg $ha^{-1}$ at 30 days intervals and that of melon by applying NPK @ 20-20-25 kg $ha^{-1}$ at 15 days intervals.

The findings from the long-term field trial on comparative assessment of chemical and organic farming systems depicted that organic farming systems enhanced soil productivity without compromising the yield of wheat and potato to a greater extent. Several nutrient-dense materials were analyzed for their exploitation in the value addition of compost and compost tea. The potential materials were further utilized to improve the nutritive value of compost and compost tea. The baseline information from these studies may lead to the development of nutrient-enriched fertilizer products. Research work on soil microbiology has also been initiated to identify suitable microbial strains for the development of a microbial consortium-based product.

## PLANT PROTECTION DIVISION

The Plant Protection Division (PPD) leads innovative research aimed at mitigating the impact of economically significant insect pests, crop diseases, and vectors of human diseases. Focusing on eco-friendly control measures, PPD seeks to reduce dependence on traditional pesticides. Tomato fruit worms and wheat aphids cause major damage to tomatoes and wheat. Biological control using Trichocard (*Trichogramma* pupae 1,000/ card) effectively reduced tomato fruit worm infestations. In lab conditions, the fungi *Nomuraea rileyi* and *Beauveria bassiana* showed high mortality and egg-hatching inhibition for fruit worms. A chickpea flour-based diet was the best for rearing tomato fruit worms, surpassing natural okra and maize flour diets. Radiation treatment (200 Gy) induced sub-sterility, while 250 Gy caused complete sterility in male moths. Garlic and orange peel extracts (5%) effectively controlled wheat aphids. Host plant resistance identified 11 resistant wheat genotypes from 189 studied.

Clove extract (5-10%) proved to be effective in termite control, inhibiting trail-following and reducing tunneling by over 95%. Clove extract's toxicity was comparable to the

synthetic termiticide, Fipronil at higher concentrations. In bait development, termite aggregation was highest toward used poplar wood (58%) and crushed termites (69%). Lufenuron (51 ppm) killed termites in 6 days without repellent effects, and field trials showed reduced termite activity with baits containing toxin. Fruit fly research showed that a guava juice, brewer's yeast, and ammonium acetate mixture (12:4:3) attracted various *Bactrocera* species, with ripe guava and banana identified as the most attractive hosts for *B. zonata*. A yeast-based solid diet improved adult rearing of *B. dorsalis*. Bakkayen extract (5%) effectively managed peach fruit flies. Under phytosanitary project, Gamma irradiation (200 GY) decreased egg hatch rates and larval survival in *H. armigera*.

In wheat pathology, five pathotypes of *Puccinia striiformis* f. sp *tritici* and seven yellow rust resistance genes were identified. The fungicide Tilit proved effective against yellow rust, and 1,203 wheat genotypes were screened for disease resistance. For dengue control through Sterile Insect Technique (SIT), 25 *Aedes* iso-male families were developed and tested for developing Genetic Sexing Strains in Pakistan, with two showing resistances to 40°C.

## PLANT BREEDING AND GENETICS DIVISION

### Wheat Irrigated

### Results of NUWYT & KPWYT (2023-24)

Recent yield trials demonstrated exceptional performance of NIFA's wheat genotypes, CT-18062 ranked 8th in Khyber Pakhtunkhwa (4381 kg $ha^{-1}$) and 9th in Pakistan (2023-24 NUWYT), with a 4.8% yield increase over Arooj-22. It also secured 2nd position in Khyber Pakhtunkhwa (3835 kg $ha^{-1}$), surpassing Akbar-19 by 4.8%. Similarly, CIBW-2 excelled in 11th KPWYT, ranking 4th with 6104 kg $ha^{-1}$ (6.3% above the high-yielding check) and showed strong yellow rust resistance (RRI 8.83). CIBW-2 also performed well nationally, with robust yellow rust resistance (RRI 8.51). Additionally, five genotypes (CTES-141, CTES-136, CTES-107, CTES-114, and CIBW-5) underwent evaluation in the 12th KPWYT (2023-24). Notably, CTES-107 yielded 3496.7 kg $ha^{-1}$, securing 2nd position with a 16.8% advantage over Khyber-23 among 80 genotypes in 12 locations all over the province.


**Field view of NIFA's Wheat Candidate Line CT-18062**

### Maintenance of NIFA-released wheat varieties and multiplication of advance lines:

Since its inception, NIFA has developed and released several improved wheat varieties (Fakhr-e-Sarhad, NIFA Bathoor-08, NIFA Aman-17, and NIFA NIJAT-23) to cater to the growing seed demands of government organizations, seed companies, and farmers in irrigated areas of Khyber Pakhtunkhwa. To ensure the continued quality of these varieties, NIFA maintains rigorous varietal purity protocols. In this regard, the institute undertook seed purification and multiplication efforts for NIFA NIJAT and NIFA Aman during the current season. Specifically, 84 blocks and 170 progeny rows of NIFA NIJAT, along with 67 blocks and 113 rows of NIFA Aman, were planted at the institute's experimental farm. Rows and blocks with off-type plants were eliminated, while desirable ones were harvested,

threshed, and prepared for quality seed production in the upcoming 2024-25 cropping season.

To ensure timely availability, seeds of NIFA NIJAT, NIFA Aman, and advanced lines from the previous year's National Uniform Wheat Yield Trials (NUWYT) and Khyber Pakhtunkhwa Wheat Yield Trials (KPWYT) underwent limited-scale multiplication.

**NIFA Awaz-2019 Demonstration plot planted on Mr. Asghar Ali field at Wazir Garhi, District Nowshera**

**Evaluation of candidate wheat lines in NUWYT and KPWYT under irrigated conditions:**

Country-wide field evaluations of candidate wheat varieties in the National Uniform Yield Trials (NUWYT) under irrigated conditions bridge the gap between genetic improvement and real-world production environments. Following outstanding performance in the Khyber Pakhtunkhwa Wheat Yield Trial (KPWYT) and NUWYT, two promising genotypes, CTES-107 and CTES-114, have been selected for 1st year mandatory evaluation in the National Yield Trial (NUYT).

Multi-location testing and zonal trials are essential for developing new wheat genotypes with broad adaptability and identifying suitable candidates for National Uniform Yield Trials (NUYT). Following exceptional yield and disease resistance performance in the 2023-24 Micro Plot Test (MPT), five high-performing wheat genotypes (CT-19047, CT-19071, CT-19242, CTES-111, and CTES-141) have been selected for evaluation in the 13th Khyber Pakhtunkhwa Wheat Yield Trial (KPWYT) during 2024-25.

**Evaluation in DUS**

Two elite genotypes, CT-18062 and CIBW-2 from NUWYT, underwent DUS trials to assess distinctness, uniformity, and stability.

**NWDSN Results**

Twenty advanced lines were submitted to the National Wheat Disease Screening Nursery (NWDSN) at NARC, Islamabad,

for disease evaluation. We received satisfactory results.

### Evaluation of Genotypes in AYTS

Forty-four genotypes were evaluated in two Advanced Yield Trials (AYTs), including checks NIFA NIJAT-23, NIFA Aman-17, and Zarghoon-21. Sixteen high-performing genotypes (yielding 4444-6222 kg $ha^{-1}$) were selected for further evaluation.

### PYTS

Sixty promising genotypes were tested in three Preliminary Yield Trials (PYTs), including checks NIFA NIJAT-23, NIFA Aman-17, and Zarghoon-21. Thirteen genotypes (yielding 4944-7055 kg $ha^{-1}$) showed significantly higher yields and disease resistance.

### Disease Screening Nursery

One hundred twenty-five genotypes from NUWYT, KPWYT, MPT, AYTs, and PYTs (2023-24) were evaluated for disease reaction against yellow rust, leaf rust, and loose smut using Morocco as a disease spreader.

### Observation Nursery

Sixty-seven wheat lines were assessed, and twenty-seven top-performing lines were selected for further testing based on yield and disease response.

### Segregating Populations

i. Seventy-nine diverse genotypes were planted, yielding seeds from twenty-three successful cross combinations for the $F_1$ generation.
ii. $F_1$ generation consisting of ten cross combinations was harvested and will be raised as $F_2$ in the next season.
iii. Fakr-e-Sarhad's $M_1$ generation (200 Gy of Gamma rays) was harvested and will be raised as $M_2$ in the next season.
iv. Twenty-three desirable recombinants exhibiting disease resistance and desirable traits were selected from five cross-combinations of $F_2$ populations.

### Demonstration Plots and Seed Multiplication on Farmer's Fields

Demonstration plots on farmers' fields play a vital role in promoting new crop varieties and providing easy access to quality seeds. In 2022-2023, 400 kg of NIFA Aman, NIFA NIJAT-23, CTHN-172114, and CT-18062 seeds were distributed to two farmers in Charsadda and Bannu districts free of charge, with

the understanding that the harvested seeds would be shared with neighboring farmers.

**Seed Production Outcome**

Reports from the farmers revealed that the two plots yielded 4550 kg of seeds, which will be available for cultivation among the farmers in 2024-25.

**Wheat rainfed**

**Early Generation Seed Production**:

Consistent efforts are being made by NIFA rainfed wheat breeders to develop improved cultivars coupled with potential wheat germplasm helping in boosting farm productivity and ensuring food security in the country. The research activities along with the desired goals are summarized as under:

**Seed Production**

A total of 20,150 kg quality seed of NIFA wheat varieties Fakhre NIFA 2023, NIFA NIJAT-2023, NIFA Awaz 2019, NIFA Aman 2017, and NIFA Lalma 2013 was produced and field certified by FSC&RD for fast proliferation through active involvement of public / private entrepreneurs in Khyber Pakhtunkhwa. Final certification by FSC&RD officials is in progress.

| Variety | Seed Class | Quantity (Kg) |
|---|---|---|
| Fakhre NIFA 2023 | Pre-Basic | 7100 |
| NIFA NIJAT 2023 | Pre-Basic | 5800 |
| NIFA Awaz 2019 | Pre-Basic | 3600 |
| NIFA Aman 2017 | Pre-Basic | 1600 |
| NIFA Lalma 2013 | Pre-Basic | 2050 |
| | **Total** | **20150** |

**NIFA wheat varieties popularization/ demonstration**

Demonstration plots on farmer's fields play an important role in varietal proliferation and helping the farming community with easy access to quality seed. During Rabi 2023-24, 950 kg seed of wheat varieties NIFA Lalma 2013, NIFA Awaz 2019, Fakhre NIFA 2023 and NIFA NIJAT 2023 were provided to farmers in different districts of Khyber Pakhtunkhwa for quick proliferation of wheat varieties. The seed was provided free of cost with an undertaking that the produced seed would be provided to the neighboring farmers.

**Performance of wheat genotypes in various yield trials under rainfed conditions**

Twelve (12) promising genotypes including Fakhre NIFA 2023 and Tarnab Gandum I as standard checks were

assessed for grain yield, yield components and disease resistance in advanced yield trial at the institute. Based on grain yield and disease resistance 05 promising genotypes were selected. NRL 2225 produced the highest mean grain yield of 6222 kgha$^{-1}$ followed by NRL 2239 (6037 kgha$^{-1}$) The grain yield of selected genotypes in Advanced yield trial was in the range of 5185 kg ha$^{-1}$ to 6222 kg ha$^{-1}$.

Thirty-six newly selected genotypes were tested for grain yield, disease resistance, and other agronomic traits in 03 Preliminary Yield Trials under moisture stress conditions at the institute. Wheat varieties Fakhre NIFA 2023 and Tarnab Rahbar were included as standard checks in each trial. On the basis of high yield & disease resistance, a total of 17 genotypes were selected from these trials. The grain yield of selected genotypes in these preliminary yield trials ranged from 5139 kg ha$^{-1}$ to 7315 kg ha$^{-1}$.

The relative effects of environment, genotypes and their interaction on grain yield and agronomic attributes were assayed using 80 promising bread wheat genotypes grown in replicated trials in the plains, southern parts and northern part of Khyber Pakhtunkhwa. Wheat varieties Pirsabak 21 and Khyber 23 were used as grand checks. The trails were conducted with standard cultural practices with no irrigation. NIFA six elite wheat lines (NRL 2122, NRL 2112, NRL 2101, NRL 2123, NBL 1701 and NBL 2024) were among the contested genotypes. NRL 2122 ranked 7$^{th}$ under rainfed conditions by producing grain yield of 3352kg ha$^{-1}$.

NIFA candidate varieties, NRL 1901 and NRL 1908 were subjected for 1$^{st}$ year mandatory evaluation in National Uniform Wheat Yield Trials (NUWYT-Rainfed) at different sites in the country. NIFA candidate line NRL 1901 ranked 2$^{nd}$ (3604 kg ha$^{-1}$) on Khyber Pakhtunkhwa basis and 3$^{rd}$ (3812 kg ha$^{-1}$) on Pakistan basis. The candidate line NRL 1901 was declared resistant to both yellow and leaf rust (CDRI 2024).

**Evaluation of segregation material and creation of genetic variability for desired traits**

Continued raising of different segregating populations achieved through gene pyramiding and single gene mutation is the most important breeding strategy that ultimately results in the availability of homozygous

genotypes. A crossing block consisting of 30 genotypes was planted on three different dates for acquiring floral synchrony among early and late flowering parents.

Based on transfer of genes for disease resistance and other economically important traits to otherwise well adapted cultivars/ genotypes, fresh crosses among different wheat cultivars/ genotypes were carried out. $F_1$ generation comprised of 17 different cross combinations were raised. Each cross combination was planted in 02 rows with 2.5 m length and having 25 plants per row. Seed of the $F_1$ population was harvested, bulked and stored after proper labeling. In $F_2$ generation 04 cross combinations having about 1500-2000 plants per cross were space planted. Based on field performance 73 desirable plants were selected and threshed individually. $F_3$ generation of 11 cross combinations was raised in the field for isolating desirable plants. Eighty (80) best progenies were selected. In $F_4$ generation (02 cross combinations) nine (09) progenies were selected.

**Breeder Nucleus Seed production of NIFA rainfed varieties**

Consistent efforts were made by the NIFA wheat breeders to maintain seed purity and to produce Breeder Nucleus Seed by growing progeny blocks / rows of these varieties on the available land at the institute. In total 300 progeny blocks and 300 progeny rows were grown for Fakhre NIFA 2023, NIFA Awaz 2019 and NIFA Lalma 2013. After regular observations 255 progeny blocks and 225 progeny rows were selected and the rest were discarded. A total of 700 kg breeder nucleus seed of NIFA rainfed wheat varieties Fakhre NIFA 2023, NIFA Awaz 2019 and NIFA Lalma 2013 was produced. These cultivars showed resistance to prevailing yellow and leaf rust races. The BNS seed will be used for the production of pre-basic seed in the coming Rabi season (2024-25).

**Oil Seed Brassica**

**Recommendation of a new mustard mutant candidate variety**

A new high seed yielding (3300 kg $ha^{-1}$) mustard mutant candidate variety “NIFA Raya-T24” was recommended by the Variety Evaluation Committee (VEC) on

09-10-2024 at PARC Islamabad, for approval to the Provincial Seed Council.

**New candidate mustard mutant variety NIFA Raya-T24.**

**Evaluation of Oilseed Brassica Mutants/ Recombinants in Various Yield Trials**

**Rapeseed/Mustard Adaptability Trials**

In the National Uniform Rapeseed Yield Trial (2023-24), four rapeseed mutants/ recombinants RM-1-5, RR-016-49, RR-016-101, and RR-016-30 were evaluated across diverse locations. Among these, RM-1-5 demonstrated superior seed yield performance, achieving an average yield of 1274 kg $ha^{-1}$, slightly surpassing the control variety, Super Canola, which had an average yield of 1270 kg $ha^{-1}$ across sixteen locations. The other mutants/ recombinants, while not exceeding the control in terms of seed yield, showed notable attributes in oil content and canola quality, indicating potential value beyond seed yield alone.

In a multi-location adaptation yield trial conducted at four locations in KP (NIFA Peshawar, ARS Buner, AZRC D.I. Khan, and BARS Kohat), a total of 13 rapeseed recombinant/mutants ( RM-6-10, RM-10-24, RR-6-4-14/18, RR-15-1-33/18, RR-18-1-48/18, RM-6-3-11/18, RM-7-4-13/18, RM-9-1-16/18, RM-9-2-17/18, RM-9-3-18/18, RM-14-5-34/18, RM-20-5-41/18 and RM-23-5-48/18) and 4 mustard recombinants (MR-2-5, MR-57-1-82/18, MR-21-3-65/18 and MR-15-3-35/18) were evaluated for their seed yield performance. The results of the three locations demonstrated that among the rapeseed mutants/ recombinants, RR-15-1-33/18 and RM-20-5-41/18 yielded 5% to 8% more than the check variety Super Canola (2384 kg $ha^{-1}$) and mustard recombinants MR-15-3-35/18 and MR-2-5 achieved seed yields that were 14% to 20% higher than the check variety Super Raya (1970 kg $ha^{-1}$). These findings highlight the improved performance of these advanced lines, making them promising candidates for further development and potential commercial release.

**Evaluation of promising lines in Seed Yield Trials at NIFA**

At the NIFA breeding station, a comprehensive evaluation of rapeseed and mustard advanced lines was conducted through six sets of Advanced Yield Trials (AYTs) and four sets of Preliminary Yield Trials (PYTs).

**Advanced Yield Trials (AYTs)**

**Rapeseed:** Twenty-six advanced lines were tested, with thirteen genotypes significantly outperforming the check variety, Super Canola. These high-performing genotypes achieved yields ranging from 1999 kg $ha^{-1}$ to 3124 kg $ha^{-1}$.

- **Mustard:** Among four mustard lines evaluated, MM-34-13 significantly surpassed the check variety Super Raya, producing a yield of 2457 kg $ha^{-1}$.
- **Preliminary Yield Trials (PYTs)**
- **Rapeseed:** Out of twenty-one genotypes tested, six produced numerically higher seed yields compared to the check variety Super Canola. Three of these genotypes significantly exceeded the check, with yields ranging from 2083 to 2894 kg $ha^{-1}$.
- **Mustard:** Among the four mustard lines tested, the mutant MM-1-17-18 achieved a notable yield of 2269 kg $ha^{-1}$, outperforming the check variety Super Raya. Two other mustard mutants also yielded higher than the check.
- The promising rapeseed and mustard mutants/ recombinants showing superior performance will be further assessed in the next series of higher-level trials.

**Generating genetic variability and advancement of breeding materials**

Improving the selection choices for desirable ideotypes, creating variability, and advancement of breeding materials is vital for effective and productive breeding programs. This involves progressing genetic stocks ($F_1$ – $F_5$, $M_1$ – $M_5$) through successive generations to stabilize desired traits. Using gamma radiation to induce mutation, one genotype was treated at 1 kGy and 430 new crosses were attempted in seven combinations to study and harness genetic variability for significant advancement in developing high yielding and climate smart new varieties.

**Seed production & varietal maintenance**

To ensure high seed yield and quality, maintaining varietal purity through careful production and certification process is essential. Breeder Nucleus Seed was produced through raising 20 progeny rows and progeny blocks of each six brassicas varieties, and having private companies to produce certified seeds, the overall quality and reliability of the seed supply was upheld. True to type progeny blocks were selected on the basis of varietal characteristics. A total of 30 & 40 kg Pre-basic Seed (P.B.S.) of NIFA Sarson-T20 and newly developed NIFA Sarson-T23, respectively was produced and certified by FSC&RD.

**Commercial Seed Production by Private Companies**

***Seed Quantities Produced**:*

- Tarnab Seeds: 1700 kg
- Gala Seeds: 1800 kg
- Broad Way Seeds: 1800 kg

These companies produced certified class seeds of NIFA Sarson-T20, ensuring that the seeds distributed to farmers are of high quality and true to type.

**Distinctive, Uniformity & Stability Studies (DUS):**

Second year DUS of rapeseed recombinant (RR-8-2) was executed at NIFA, Peshawar in collaboration with FSC&RD, Regional Office- Peshawar.

**Income Generation:**

The oilseed group has generated income under the following heads:

| | |
|---|---|
| Variety Seeds: | Rs= 42,000/- |
| Varietal grain: | Rs= 163,200/- |
| Oilseed quality analysis: | Rs= 5,160/- |
| | **RS=210,360/-** |

**PULSES**

**Mungbean**

**Recommendation of new mungbean candidate variety**

New green-seeded high yielding (2100 kg $ha^{-1}$) mungbean candidate variety “NIFA Mung-24” was recommended to KP Seed Council by the Variety Evaluation Committee (VEC) on 16-04-2024 at PARC Islamabad.

**Evaluation of mungbean advanced lines in various yield trials**

A total of 19 green-seeded recombinants and mutants along with 02 check varieties NIFA Mung-19 and AZRI Mung-21 were evaluated for yield and yield components in Advanced Lines Yield Trials (ALYT) in kharif 2023 at NIIFA. Out of these, 03 genotypes produced statistically significant ($p \leq 0.05$) higher seed yields of 1424 to 1458 kg $ha^{-1}$ against seed yield of high-yielding check variety AZRI Mung-21 (1250 kg $ha^{-1}$). Fifty-eight green-seeded recombinants from 08 different cross-combinations (6601 x Ramzan, NFM-5-36-24 x NFM-5-63-18, NM98 x NFM-5-36-24, V2802 x Ramzan, VC1482C x NM92, NM98 x NM92, Sona Mung x NM-2011 and ML-5 x Song Mung) were evaluated for yield and yield related traits in 03 sets of Preliminary Yield Trials (PYTs) along with 02 check varieties i.e. NIFA Mung-2019 and AZRI Mung-21 in kharif 2023 at NIFA. Of these, 11 recombinants produced statistically significant ($p \leq 0.05$) higher seed yield of 1007 to 1656 kg $ha^{-1}$ as compared to average seed yield of NIFA Mung-19 (903 kg $ha^{-1}$) and AZRI Mung-21 (1002 kg $ha^{-1}$). National Mungbean Uniform Yield Trial comprising of 21 entries was planted at NIFA in kharif 2023, and the results were sent to National Coordinator (Food Legumes), PARC, Islamabad.

In case of breeding black-seeded mungbean, 20 black-seeded genotypes were evaluated in PYT at NIFA in kharif 2023 of which 02 genotypes i.e. NBM-5-3-6 and NBM-5-3-10 produced significant higher seed yield of 1541 and 1576 kg $ha^{-1}$ against check variety NIFA Mung Spinghar-21 (1358 kg $ha^{-1}$).

Adaptability yield trial comprising of 08 green-seeded recombinants derived from 03 cross-combinations i.e. NFM-5-36-24 × NFM-5-63-18, NM-98 × NFM-5-36-24 and V2802 × Ramzan along with 02 checks NIFA Mung-19 and AZRI Mung-21 was conducted at ARS, Karak in kharif 2023 for testing wider adaptability of yield and related traits of these lines. Of these, 04 genotypes produced statistically significant ($p \leq 0.05$) higher yield of 1219 – 1282 kg $ha^{-1}$ as compared to highest check i.e. NIFA Mung-19 (1105 kg $ha^{-1}$). Similarly, the same genotypes were evaluated in adaptability yield trial conducted at AZRC D.I. Khan. The same four genotypes produced statistically significant ($p \leq 0.05$)

higher yield of 1283 to 1306 kg $ha^{-1}$ as compared to highest check i.e. AZRI Mung-21 (1146 kg $ha^{-1}$).

**Evaluation of mungbean segregating material**

Early generation segregating material ($F_2$/ $M_2$ generation) comprising of 07 different cross-combinations i.e. NIFA Mung-19 x NIFA Mung Spinghar-21 (70 single plants), NIFA Mung Spinghar-21 x NIFA Mung-19 (50 single plants), NIFA Mung-19 x NBM-5-3-6 (81 single plants) and NBM-5-3-6 x NIFA Mung-19 (69 single plants), NIFA Mung-19 x NBM-5-3-8 (31 single plants), NBM-5-3-8 x NIFA Mung-19 (23 single plants), Jumbo mung x NIFA Mung Spinghar-21 (19 single plants) were evaluated for yield and related traits at NIFA in kharif 2023. Based on seed color, better plant type, MYMV resistance and high per plant grain yield, a total of 219 single plants were selected for evaluation in next season. Similarly, ($F_3$/ $M_3$ generation) comprising of 11 different cross-combinations i.e. NBM-2-14-4-1 × MPP-15024 (32 single plants), NBM-2-2-4-5 × NFM-19 (138 single plants), NFM-19 × NBM-2-2-4-5 (152 single plants), MPP-15024 × NBM-5-3-4 (98 single plants), NBM-2-14-4-5 × NFM-19 (20 single plants) and MPP-15024 × NBM-2-14-4-1 (11 single plants), NBM-2-2-4-8 x Azri Mung-18 (36 single plants), NBM-2-14-4-1 x NFM-19 (16 single plants), NFM-19 x NBM-2-14-4-5 (12 single plants), NBM-5-3-4 x MPP-15024 (79 single plants) and NBM-5-3-4 x NFM-19 (12 single plants) were evaluated for yield and related traits at NIFA in kharif 2023. Based on seed color, better plant type, MYMV resistance and high per plant grain yield, a total of 215 single plants were selected for evaluation in next season. Similarly, 165 single plants from 04 cross-combinations (Ramzan × NBM-2-14-4-6, NBM-2-14-4-6 × Ramzan, NBM-2-14-4-6 × NFM-19 and NBM-2-14-4-6 × V2817) were evaluated in $F_4$/$M_4$ generation. A total of 94 single progenies were individually selected cross combination wise. In case of creation of new genetic variability 05 new cross combinations were attempted in Kharif-2023.

In case of quality seed production, 230 kg of pre-basic seeds of NIFA mungbean green and black-seeded varieties i.e. Ramzan, NIFA Mung-17, NIFA Mung-19, NIFA Mung Spinghar-21 and NIFA Mung Sikaram-21 was produced in 2023-24.

**New candidate mungbean variety NIFA Mung-24 recommended for approval as variety by Variety Evaluation Committee (VEC) in meeting held on April 16, 2024**

**Spot Examination of mungbean candidate variety NIFA Mung-2024 on August 6, 2024 at NIFA farm**

## Kidney bean

### Evaluation of kidney bean genotypes in adaptation yield trials

In kharif 2024, 04 kidney bean genotypes along with 02 check varieties i.e. NIFA Lobia Red-22 and NIFA Lobia Yellow-22 were evaluated for yield and yield components in Replicated Yield Trial at NIFA at three locations in Kurram. Of these, 01 genotype i.e. NKB-Kenya, produced statistically significant ($p \leq 0.05$) higher average seed yield of 1809 kg $ha^{-1}$ compared with highest check NIFA Lobia Red-22 (1672 kg $ha^{-1}$). Replicated yield trails comprising of 12 genotypes including three check varieties i.e. NIFA Lobia Red-22, Swat Red and Himalaya-1 was planted at NIFA during spring 2024. Five genotypes (NKB-Kenya, NKB-21-1 and NKB-21-2, NKB-22-2 and NKB-22-5) produced statistically significant ($p \leq 0.05$) higher seed yield ranging from 1834 to 1932 kg $ha^{-1}$ against the highest yield check i.e. NIFA Lobia Red-22 (1747 kg $ha^{-1}$). NIFA Lobia Red-22 and NIFA Lobia yellow-22 were evaluated using multiple sowing dates at 10 days' interval started from 20 January, 2023. The study has completed and it was observed that March 01 to March 10 was the most optimum time for sowing kidney bean in spring season.

### Evaluation of kidney bean segregating material

$F_1$/ $M_1$ generation derived from 02 cross-combinations i.e. NKB-BL-2 × Himalaya-1 (34 plants) and NKB-BL-2 (15 plants) was raised at NIFA in spring 2024. A total of 14 single plants were selected based on seed color, plant type and high per

plant grain yield. $F_2$/ $M_2$ derived from 04 different cross-combinations (NKB-BL-2 x NKB-Kurram local, NKB-BL-2 x NIFA Lobia Red-22, NIFA Lobia Red-22 x NKB-BL-2 and NIFA Lobia Yellow-22 x NKB-G-4495) was evaluated at NIFA in spring 2024 and a total of 29 single plants were selected on the basis of above-mentioned traits for further evaluation. Similarly, $F_3$/ $M_3$ generation derived from 03 different cross-combinations i.e. NIFA Lobia Red-22 × NKB-G-4729 (16 single plants), Himalaya-1 x NKB-Kenya (23 single plants) and NIFA Lobia yellow-22 × NIFA Lobia Red-22 (13 single plants) was raised at NIFA in spring 2024. Based on desired criteria, 27 single plants were selected from this generation. In case of induced mutation, $M_1$ generation of two parents (NKB-Kenya @50 Gy of γ rays and NKB-Kurram local @100 Gy of γ rays) was raised at NIFA in spring 2024. All $M_1$ plants were picked, threshed and bagged individually parent wise. $M_2$ generation of a parent Himalaya-1 irradiated @150 and 200 Gy of γ rays was evaluated at NIFA in spring 2024 and a total of 15 mutants were selected based on desired criteria. $M_3$ generation derived from NIFA Lobia Red-22 (75 Gy of γ rays) was evaluated in spring 2024. A total of 33 mutant plants were selected for traits under study.

**Evaluation of Kidney Bean Germplasm**

In spring 2024, sixty local and exotic genotypes as germplasm were evaluated for semi erect type plant growth, seed color and high yield to select suitable parent for use in hybridization and induced mutation. Based on desired criteria, of 10 genotypes were finally selected.

In case of quality seed production, 50 kg pre-basic seed of NIFA Lobia Red-22 and NIFA Lobia Yellow-22 was produced in 2023-24.

**Field view of kidney bean advanced line NKB-Kenya**

**Vegetable improvement**

Khyber Pakhtunkhwa province has significant potential for the production of a variety of vegetables, including okra, with a suitable acreage available for cultivation. However, the per unit yield of

okra remains low. To address this challenge, the proposed research program aims to enhance per acre yield of okra through conventional/ induced mutation breeding efforts. By focusing on the development of genotypes that are best suited to local growing conditions, the research program will prioritize traits such as short stature, medium-sized green fruits, prolonged fruiting ability, and resistance to diseases.

**Okra improvement for higher yield and other traits**

**Okra nursery screening**

The screening of 18 okra genotypes in the nursery was carried-out for yield potential and the other desirable traits, that is dark green fruit color etc. at NIFA Peshawar. This comprehensive assessment involved careful observation and data collection of various growth parameters, including plant height, fruit size, and overall productivity. The results showed that seven (07) okra genotypes exhibited not only robust growth but also produced high yields of dark green fruits and other economical traits, which are preferred in local markets.

**Evaluation of okra genotypes in PYT and AYT**

The evaluation of seven okra genotypes in the Preliminary Yield Trial (PYT) at NIFA Peshawar was carried out under local growing conditions. Each genotype was assessed for key attributes, including yield, fruit quality, and other agronomic traits. The trial was aimed to select genotypes that not only produce high yields but also exhibit traits favorable for market acceptance, such as size and color of the fruits. Preliminary results indicated two okra genotypes NOL-1 (110801) and NOL-12 (11671 kg $ha^{-1}$) showed better performance over other genotypes and local check (10219 kg $ha^{-1}$) for yield traits.

Two promising genotypes, NBL-1 and NBL-2, were selected for further evaluation in Adaptation Yield Trials (AYTs) across various locations, including the Agriculture Research Station (ARS) in Swabi, ARS Harichand in Charsadda, ARS Serai Naurang, Agriculture Research Institute (ARI), Mingora, Swat and farmers' fields in Bajaur during spring 2023 and 2024. Among these, NBL-1 demonstrated exceptional performance, exhibiting high yield (12000 to 18000 kg $ha^{-1}$), compact

stature, dark green fruits, prolonged fruiting ability and notable tolerance to diseases across all locations. Similarly, two years mandatory DUS completed of candidate line 'NBL-1' was carried-out by FSC&RD, Peshawar.

**Okra advance Line NBL-1 at NIFA**

**Creation of genetic variability for desired traits in okra**

Two genotypes were irradiated (200 Gy) and raised $M_1$ generation at NIFA farm. All $M_1$ plants were harvested, threshed and bagged individually for evaluation during next season. $M_2$ generation was evaluated at NIFA and 05 genotypes fulfilling the desired criteria (high yield and fruit quality) were selected.

**Horticulture**

**Improvement of Peaches for higher yield and quality**

Two exotic genotypes were assessed for their early blooming, fruit maturity, and short stature characteristics. Plawhite-5, a white-fleshed peach, is harvested 13-15 days before the Early Grand. Plawhite-5 has a semi-dwarf growth habit, is highly productive with a TSS value of 9-10, and features attractive fruit color and shape. Zincle-4 is a visually appealing red nectarine with a high TSS value of 10.0 and matures early, ready for harvest in the third week of April. The selection from the local peach orchard, based on fruit quality, was assessed at the NIFA orchard. The fruit is large, aromatic, and has a high TSS brix of 11.0. Initially, forty-five plants of four new genotypes were evaluated for growth parameters. Subsequently, twenty-nine mutant plants (Early Grand & Florida King) were assessed for earliness, short stature, and other characteristics.

**Effect of bio fumigations on Peach Replant Disorders**

A research study was conducted at the Nuclear Institute for Food and Agriculture Peshawar (NIFA) during the year 2023-24 to improve the germination and survival rates of peach nursery plants. Different bio-fumigants were applied to the soil for this purpose. The layout for the peach stone nursery was designed

as a Randomized Complete Block Design (RCBD) with four replications and treatments, as well as one control. The total experimental area was 5670 square feet, with 20 plots, each plot size being approximately 272 sq.ft. Different treatments of bio-fumigants were applied i.e., Mustard cake, poultry manure, neem cake, compost, and control. All bio-fumigants were applied before sowing the seed at the ratio of 5kg, 25kg, 5kg, and 25kg respectively. All culture practices such as irrigation, fertilizer, weeding etc. were kept uniform for all the treatments. Data were recorded on various parameters including seed germination percentage, plant height (cm), girth of seedling (mm), number of leaves, number of plants, number of branches, plant survival percentage, bud success percentage, buddling height (cm), number of leaves, number of branches, bud take success (%), buddling height (cm), number of leaves after budding, number of branches, root weight (g), root length (cm) and number of roots. The resulted data shows that the application of 5kg mustard bio-fumigants have best result over all other bio-fumigants applications in parameters i.e. germination of plants (62.74 %), plant height (77.85 cm), girth of seedlings (0.69 mm), number of leaves (313.60), survival of plants (61.58 %), number of branches (17.75), bud take success (81.97 %), weight of buddling plants height (36.50 cm), number of leaves after budding (22.60), number of branches (2.85), root weight (15.73 g), weight of plants (33.47 g), root length (11.10 cm) and number of roots (11.58). Therefore, it is significantly recommended that application of 5 kg mustard bio-fumigants before sowing of peach seed have best results in germination of seeds and survival percentage of peach stone nursery plants and budding plants which mitigate the effect of peach replant disorder disease in nursery field.

**Plum improvement for higher yield and better fruit quality**

**Evaluation of irradiated plum materials in orchard**

A total of 09 mutants in plum Fazli Manani irradiated with 20 and 30 Gy treatments were evaluated for blooming and fruiting characters. 02 mutant plants in 30 Gy treatment have initiated flowering but could not reach to maturity. Similarly in 20 Gy treatments no flowering was observed. The earliest sprouting 4-5 days was recorded in the

control plants as compared to irradiated material of 30 Gy treatment. Similarly lowest internode length of 1.7 cm was recorded in 30 Gy mutant plants as compared to control (150 cm and 2.0 cm). Internode length and seedling diameter were not much affected by 20 Gy doses and were at par with control.

**Evaluation of Local plum Germplasm:**

Fazli Manani: A total of 16 local selections of plum, Fazli Manani were evaluated for morphological and fruit characters in the orchard. 02-03 plants bear flowering but could not reach to maturity.

Santa Rosa: A total of 08 plants were evaluated in orchard for morphological and fruit charters. No flowers initiation was observed in all selections.

Red Beauty: A Total of 09 selections were evaluated in the orchard for morphological and fruit charters. No blooming was observed in all plants.

Blasting Star: Local selections of 02 plants were evaluated in the orchard for fruiting and other morphological characters. Since no flowering was observed in any plant, therefore no fruit character was evaluated.

## FOOD AND NUTRITION DIVISION

**Development of hybrid indirect-type solar dryer for fruits and vegetables**

Fabrication of the dryer has been completed as shown in the picture. The

**Complete Drying System (Drying Chamber and Solar Panels**

dryer consists of drying chamber with capacity of 100 Kg fresh fruits/ vegetables. Water tank installed inside the drying chamber for storing hot water up to 600 liters. There are 26, 2-inch diameter pipes (100 liters capacity) in the roof the drying chamber below the glass cover and exposed to sun light. Maximum temperature achieved for the water in the pipes was 80$^{o}$C while that of the drying chamber was 70$^{0}$C. Water temperature achieved in the storage tanks was 48$^{0}$C. In preliminary drying experiments, honey dew melon (cantaloupe) was dried from 93% to 7% moisture content in 3 days while bitter gourd was dried from 77.8 % content to 7 % moisture content 2 days.

**Adaptation of Low Energy Machine Generated Radiation Sources for Decontamination and Disinfestation of Food in Pakistan**

Low Energy Electron Beam (LEEB) technology is now commercially available for aseptic food packaging.


**Labelled Peanuts Kernels Samples and irradiation with low energy (X-rays).**

Additionally, low-energy X-ray units are being optimized for the treatment of

spices and dry fruits. As Pakistan exports dry fruits primarily to Gulf countries, radiation processing plays a crucial role in maintaining quality and meeting quarantine standards for food and agricultural products. In this study, peanuts were irradiated with Co-60 gamma rays and low-energy X-rays at doses of 3, 5, and 7 kGy. The quality parameter evaluated were sensory characteristics, physicochemical properties, microbial content, peroxide value, and fatty acid composition on day one and at three-month intervals during storage of seven months at 28°C ± 5°C. Key fatty acid compounds including Palmitic acid (control 5.85 ± 0.01, irradiated with X-rays with 5 kGy irradiation dose 6.45± 0.01, irradiated with gamma rays with 5 kGy irradiation dose 6.42 ± 0.01), Oleic acid (control 18.28 ± 0.01, irradiated with X-rays with 5 kGy irradiation dose 17.25 ± 0.02, irradiated with gamma rays with 5 kGy irradiation dose 17.03 ± 0.02) and Linolenic acid (control 63.27 ± 0.02, irradiated with X-rays with 5 kGy irradiation dose 62.46 ± 0.01, irradiated with gamma rays with 5 kGy irradiation dose 62.57 ± 0.03) were evaluated before and after irradiation. No significant variations were observed in the fatty acid profiles before and after irradiation. The study concludes that a 5 kGy irradiation dose effectively extended the shelf life of peanut samples up to seven months at ambient temperature (28°C ± 5°C), while preserving sensory attributes and nutritional quality, including key fatty acids such as Palmitic, Oleic, and Linolenic acids.

**Irradiation Effects on Bakery Products: A Focus on Cakes**

Irradiation offers a viable solution for enhancing shelf life and esuring safety of bakery products, particularly cakes by eliminating harmful pathogens and the need for chemical preservatives. Current project evaluated the feasibility of irradiating fruit cakes. Various doses of irradiation (2, 4, 6, and 8 kGy) were tested on both commercially available and homemade cakes to determine their effects on sensory attributes and storage life. Sensory analysis indicated that a 4 kGy dose resulted in no undesirable odor, scoring 7.1 for sensory evaluation, similar to non-irradiated controls (7.40), while higher doses led to detectable undesirable odors. Furthermore, the irradiated cakes (4 kGy) showed no signs of mold growth or spoilage up to 21 days,

maintaining quality comparable to non-irradiated samples. Thus, a 4 kGy dose was proven effective for extending the short-term storage life of preservative-free cakes, upto 21 days when packaged in zipper bags.

**Oyster mushroom yield enhancement, phytochemical analysis, commer-cialization and pharmacological evaluation of Ganoderma medicinal mushroom**

Pearl Oyster mushroom yield enhancement trial in different compost dimensions i.e. 12x17", 16x22" and 9x45" under Completely Randomized Designed (CRD) was evaluated. Pearl Oyster with compost dimension of 12x17˝ yielded best as improved cultivation technology having 52.9 % Biological Efficiency (BE).

NIFA optimized three Oyster species (Pearl, Grey and Pink) were analyzed for their quality or phytochemicals. Pear Oyster possessed highest % protein (18.1%) on dry basis. Pink Oyster had the lowest fat (1.37%), while highest % fiber (18.8%) was recorded in Grey oyster. Highest Sodium (16.4ppm) was recorded in Pearl Oyster while highest Potassium (98.2ppm) was recorded in Pink Oyster. Mushroom cultivation technology was commercialized through provision of mushroom spawn to growers, training of 70 farmers/ growers from 8 districts of Khyber Pakhtunkhwa (KP) through workshops, radio talks and national exhibitions. Furthermore, NIFA optimized Ganoderma medicinal mushroom was pharmacologically evaluated in the early experiments at the Department of Pharmacy, The University of Peshawar. Ganoderma was extracted in organic solvents (Ethanol, Chloroform, Ethyl acetate) and water. Ganoderma extract of 2ml exhibited anti-diabetic property through testing on Streptozotocin-induced diabetic rats.

**Strenthening of Food Testing Labortatory**

Sixteen (16) honey samples collected in 2021 and 2023 from different botanical origin including acacia (palosa) and Zizphus spina-christi (L.), locally known as Sidr were selected for optimization of procedures. Method for ten (10) physicochemical quality parameter including hydoxymethylfurfural (HMF), reducing sugar, pH, acidity, flavonoids (quercetin equivalent), phenols (gallic acid equivalent), ash etc. were optimized. The detail of the key quality

parameters along with test method and range are as under:

| S # | Parameter | Method | Results | Mean | Limits/ Normal Range |
|---|---|---|---|---|---|
| 1 | HMF (mg/kg) | UV-Vis Spectr. | 27.8 - 525.6 | 173.4 | <80 |
| 2 | Flavonoids (mg QE/kg) | -do- | 3.05 – 23.33 | 8.96 | NG |
| 3 | Phenol (mgGAEq/ kg) | -do- | 141.5-455 | 302.8 | 56 - 500 |
| 4 | pH | pH Meter | 3.47-5.30 | 4.23 | 3.1 – 6.1 |
| 5 | Acidity (meq/ kg) | Titration | 14.93 - 60.0 | 25.77 | 10 – 50 |
| 6 | R. Sugar (%) | Fehling's | 52.0 - 81.2 | 68.3 | 60 - 80 |
| 7 | Potassium K (ppm) | Flame photometer | 3.2–23.8 | 14.8 | NG |
| 8 | Sodium Na (ppm) | -do- | 0.8-17.4 | 9.7 | NG |
| 9 | Calcium Ca (ppm) | -do- | 6.3–19.8 | 9.8 | NG |
| 10 | Ash (%) | Direct Ignition | 0.038-1.24 | 0.57 | 0.02–1.5 |

None of the samples were found to be adulterant. However, the HMF values of 2021 sample were high indicating poor storage or overheating.

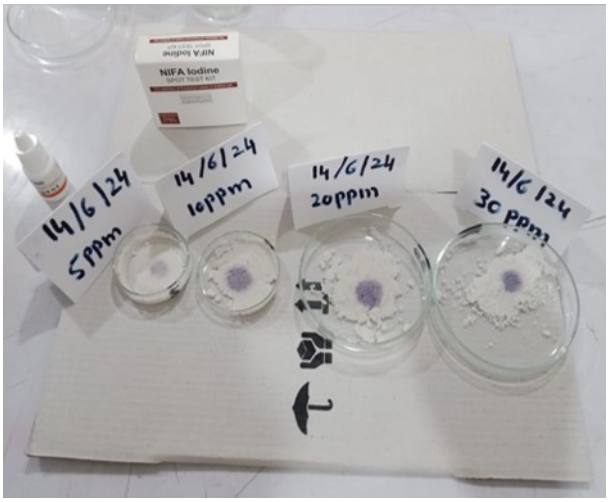
In addition, the laboratory is working on optimizing the Rankine method for the determination of sulfur dioxide. This involves developing of an indigenous titration apparatus that was rigorously tested for accuracy and repeatability. The focus is given to reduce the amount of nitrogen gas (carrier gas). Four samples of jams and squashes were used in three replicates however high standard deviation between replicates from 16.2 to 24.4 implies more work on air tightening of apparatus and reaction time.

**Development of an indigenous technology for rapid testing of added micro-nutrients in foods**

Micronutrient deficiency has become a serious issue in Pakistan, prompting the government to take action by launching a salt fortification program that adds iodine during processing. To help support this initiative, the Food & Nutrition Division has created rapid test kits to quickly assess the presence of added micronutrients in food. After thorough research and experiments, these iodine test kits have been validated for both sea salt and table salt.

This year, experiments were conducted to study the storage stability of Iodine Rapid Test Kits kept under different storage conditions over a one-year period. The iodine kits were tested at monthly intervals against added iodine concentrations of 5, 10, 20, and 30 ppm in salt. The findings showed that the NIFA Iodine Rapid Test Kit's color, a milky white, remained consistent at both room and refrigerated temperatures. The kit also performed well on both sea salt and rock salt, successfully detecting added iodine of different concentrations. The pH of the kit ranged from 2.61 to 2.68 when refrigerated and 2.61 to 2.72 at

room temperature, showing that the kit remained stable under both conditions over the year.


**Storage studies of Iodine Rapid Test Kit for one year**

**Development of rapid test kit for on-spot detection of added Zinc (Zn) in fortified wheat flour**

Conventional methods used for determination of zinc in wheat flour are time-consuming, costly and require huge capital investment. Therefore, development of a rapid, portable, economical and easy to use rapid test kit for qualitative detection of added zinc in wheat flour is required. During selection of reagents for kit development, a series of experiments was conducted. Wheat flour samples (fortified and unfortified) were collected from different flour mills, retailers & wholesaler shops, household consumers etc. Fortificant premix was obtained from Nutrition International (NI), Pakistan. Known concentrations of fortified samples (5, 10, 20 and 30 ppm) were prepared along with a blank sample (unfortified wheat flour). Different reagents ($R_1$, $R_2$ and $R_3$) were used in tandem against all procured samples to screen out the best performing reagent. $R_1$ developed purple color with fortified flour in acidic media in the presence of an indicator. But it also gave same color with unfortified samples as well which was due to the presence of intrinsic interfering metals (Ca, Mg, K etc.) found in wheat flour. Similarly, $R_2$ was tested against fortified & unfortified flour samples but same masking effect was observed due to inert elemental iron and extraneous iron ($Fe^{+3}$) present in the fortificant

premix. Interfering agent (iron) hided the end result (white precipitate formation) but at the same time produced blue spots on the surface of fortified samples. Development of blue spots on fortified flour showed encouraging signs for the up-gradation/ modification in NIFA Iron RTK as a sustainable alternate. In continuation of the experiments, reagent-$R_3$ was used to develop color producing strips to detect the presence or absence of zinc in wheat flour. Equal sized (5*8 inches) strips of whatman filter paper 42 were cut and dipped in reagent-3 solution. Flour samples were sprayed on these strips to observe the development of pink color indicating the presence of zinc in a sample. Unfortunately, same obstruction was observed from different agents (Sn, Cd, Co, Mg, K, Hg, Pb, Cr etc.) altering the end results and rendering $R_3$ unfeasible for further process.

**Selection of reagents for qualitative testing of zinc in fortified wheat flour**

**Method Optimization for Lab-Scale Production of Potassium Iodate ($KIO_3$)**

The level of household consumption of iodized salt in Pakistan surpasses 70%. Potassium iodate ($KIO_3$) is the primary fortificant used by the salt processing industry. However, due to import restrictions and escalating prices, there is a pressing need for a sustainable domestic solution. In this context, the current study was designed to develop and optimize a lab scale method for local production of low-cost analytical grade $KIO_3$ with reference to the standard method with some modifications. A series of trials was conducted with varying reaction parameters like reaction time, temperature & molar concentration of reactants to optimize the yield and absolute purity of end product. Different molar concentrations e.g. 1, 2, 3, 4, 6 & 8 were used during reaction and it was

found that no product was formulated till 3 molar concentration. Maximum yield (49%) of $KIO_3$ was obtained at 4 molar concentration. Similarly, reaction time was varied between 5 to 25 minutes with regular interval of 5 min. and it was observed that highest yield (58.46%) was achieved after 25 min. reaction time. In addition; crystallization temperature was also changed to get the optimized yield and results showed that crystallization temperature of $5^0$C produced optimum yield (51.14%).


**Method Optimization for Lab-Scale Production of Potassium Iodate ($KIO_3$)**

## SOIL AND ENVIRONMENTAL SCIENCES DIVISION

### Biofortification of zinc in wheat for balanced human nutrition

Hidden hunger is a global health crisis, driven in large part by poverty. More than 3 billion people around the world simply can't afford a diet of nourishing, diverse foods that provide enough essential vitamins and minerals (micronutrients). Staple crop biofortification is a practical, proven, demand-led response to hidden hunger. The agricultural strategy used to improve the nutritional value of crop plants is known as biofortification. Biofortification through agronomic approach (optimized fertilizer applications) is a feasible and cost-effective means of delivering micronutrients to populations that may have limited access to diverse diets and other micronutrient interventions and to enhance crop yield as well.

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

Seeds of ten wheat genotypes were surface sterilized and germinated on moist filter papers in petri dishes in an incubator at 20±1°C. Two seedlings of each germinated cultivar were transplanted into white thermopore sheets placed in stainless steel containers of 50 L capacity filled with 40 L of the chelate-buffered nutrient solutions having $Zn^{2+}$ activities of 2, 10, and 40 pM. Initially, plants were grown in solutions prepared with half strengths of all macro and micronutrients, except for zinc (Zn) and $K_3$HEDTA (which were at full strength) until day 10 following transplantation, and afterwards, full-strength solutions were used. The nutrient solutions were replaced with fresh mixtures on days 10, 15, 19, 24, 28 and 32 following transplantation. The pH values of the solutions were adjusted to 6.0±0.01 with 0.1 M HCl or 0.1 M KOH as required. Plants were harvested on the 35$^{th}$ day after transplantation. The tissue samples were then air dried on paper towels and later dried in a forced draught oven at 70±1 °C for 48 hours (until constant weight) and were analyzed for micronutrients and phosphorus (P) by standard procedures of analysis.

The impact of different $Zn^{2+}$ activity levels on the growth of wheat genotypes increased with the concentration of Zn in the medium. Zn efficiency of various wheat genotypes was assessed by

exploiting this variation in growth response. The Zn efficiency of genotypes under study ranged from 25 to 76%, CTES-107 being the most efficient and CIB-5 being the least. At a low Zn level (2 pM), the significantly (P≤0.05) higher dry biomass (21.36 g) was recorded for CTHRN-19101 and the minimum for CT-18062 (7.29 g). The genotype CTES-107 has accumulated maximum Zn (23.4 µg $g^{-1}$) at 2 pM $Zn^{2+}$ activity that was significantly (P≤0.05) higher than the rest of the genotypes under study, whereas the genotype CIB-5 has accumulated 13.5 µg $g^{-1}$ Zn. In general, roots accumulate higher nutrients than shoots.

**Improving off-season vegetable production under high & low tunnels through integrated nutrient management**

Natural resources (water, land) in Pakistan are overburdened and squeezing rapidly due to the increasing population. It is essential to utilize water and land more effectively in agriculture to meet the food and water needs of the growing population in the future. This situation demands tunnel farming with high-efficiency irrigation system, quality seeds, and a partly controlled environment as a reliable option to get optimum production and efficient utilization of irrigation water and fertilizers. The technology is not only cost-effective and ecologically viable but is highly suitable for small landholders. The growing of off-season vegetables in tunnels returns good quality and higher outcomes to fetch more income to the growers. Two studies were conducted on bitter gourd and musk melon during 2023-2024. The properly decomposed FYM (total NPK content 0.7-0.43-1.5% and total organic carbon 8.46%) @ 500 kg/ 250 $m^2$ was applied before transplanting nursery while NPK mineral fertilizer was applied after the establishment of the crop (30 days after transplanting) at different intervals. The results revealed that the maximum marketable bitter gourd yield (1272 kg/ 250 $m^2$), straw yield (122 kg/ 250 $m^2$), N, P & K uptake (10.5, 4.3 & 11.5 kg) and SPAD reading (76.89) were recorded in the treatment receiving NPK @ 45-45-50 kg $ha^{-1}$ as fertigation at 30 days interval. Meanwhile, the minimum bitter gourd yield (84 kg/ 250 $m^2$) was recorded in control (no NPK fertilizer applied).

The other study was conducted on the nutritional requirements of musk melon in

low tunnel. The results showed that melon yield and NPK uptake were found significant (P≤0.05) among the treatments. Maximum melon yield (1007 kg / 250 $m^2$) and highest NPK uptake (2.95, 1.89 & 4.48 kg / 250 $m^2$) were observed in treatment receiving 20-20-25 kg NPK $ha^{-1}$ at 15 days intervals.

**Monitoring the long-term impact of conversion to organic farming systems.**

The introduction of fertilizer-responsive wheat varieties has increased yield per unit area of land. This conventional farming approach involving intensive use of chemicals may not remain sustainable on account of problems arising from it. Conventional farming systems are responsible for environmental pollution, yield stagnancy, loss of biodiversity, poor soil health, etc. Many farmers are diverting from wheat to other crops due to less net returns from it, mainly because of the high cost of inputs (fertilizers and water). It may have repercussions for national food security as wheat is a key component of the food security mosaic in Pakistan. In this scenario, a viable option is to opt for other suitable farming approaches that may provide the farmers with good returns on a sustainable basis from wheat production. Organic farming systems offer a great prospect of providing good yield and improvement of soil fertility on a sustainable basis. Systematic research on the assessment of conventional (chemicals-based) and organic farming systems has not been carried out in long-term field experiments. The current project bridges this research gap through a long-term field trial.

Under this project, a long-term field trial was initiated in 2019-2020 and the study continued during 2023-2024. Wheat and potato yields were compared besides studying the impact of both farming systems on soil fertility parameters. Fertilizer requirements of test crops were met through chemical fertilizers under conventional farming and by the use of farmyard manure, compost and sesbania (green manuring crop) under organic farming systems.

Findings from last year's study depicted that wheat grain yield, water use efficiency, protein contents and uptake of nitrogen, phosphorus & potassium were statistically at par under conventional

and organic farming systems. Wheat grain yields of 6.5 and 4.1 t $ha^{-1}$ were reported under chemical and organic farming systems, respectively. Water use efficiency was found better under chemical (9.7 kg $ha^{-1}$ $mm^{-1}$) than organic farming systems (7 kg $ha^{-1}$ $mm^{-1}$). Protein contents were better under chemical (9.5%) than organic farming (9.2%). The uptake of nitrogen by wheat plants was higher under chemical (147 mg $plant^{-1}$) than organic farming systems (134 mg $plant^{-1}$). Phosphorus uptake exhibited a similar trend showing higher uptake under chemical (42 mg $plant^{-1}$) than organic farming systems (38 mg $plant^{-1}$). Relatively higher potassium uptake was observed under chemical (121mg $plant^{-1}$) than organic farming systems (106 mg $plant^{-1}$). Better potato tuber yield was recorded under chemical (9.4 t $ha^{-1}$) than organic farming systems (9.1 t $ha^{-1}$).

Data on the trial's parameters related to soil fertility (organic matter, organic carbon, nitrogen, phosphorus and potassium contents) revealed that soil fertility may be enhanced under organic farming systems. This soil fertility enhancement was achieved without compromising yield to a greater extent. The project is likely to develop recommendations and production technology packages for farmers of organic wheat and potato.

**Enrichment of agro-waste compost for nitrogen and phosphorus contents**

Intensive use of chemical fertilizers to improve crop yield would be unsustainable owing to ever-rising prices of chemical fertilizer products and environmental concerns. The situation demands to shift partially towards organic production that is constrained by the limited availability of good quality organic fertilizer products. Compost (a slow-release organic fertilizer, mainly prepared from agro-wastes) may serve as a partial substitute for intensively used chemical fertilizers besides improving the soil health and fertility status, leading to sustainable crop production. Compost products available in the local market are mostly developed from urban/ municipal wastes and may contain heavy metals and have low contents of essential plant nutrients, particularly nitrogen (1-2%) and phosphorus (0.3-0.5%). The current project aims at enhancing the nutritive value of NIFA agro-waste compost by exploiting naturally available sources of plant nutrition.

For this purpose, various potential sources of plant nutrition (including animal manure, poultry manure, rock phosphate, filter cake, mushroom spent, etc.) were analyzed in the laboratory for nitrogen (N) and phosphorous (P) contents. The findings of analytical work revealed that maximum N (2.04%) and P (18%) were found in filter cake and rock phosphate, respectively.

A composting trial was established at the composting facility of the institute, in which nutrient-dense materials were mixed with agro-wastes (green and dry) in various formulations to prepare the enriched compost. The mature composts were analyzed for N and P contents. Among the various formulations used for the preparation of enriched agro-wastes compost, maximum N (1.5%) was recorded when agro-wastes were enriched with animal manure, rock phosphate, filter cake, poultry manure & green soil (a microbial product). The highest P (1.9%) was found when agro-wastes were enriched with animal manure, rock phosphate, filter cake & poultry manure. The maximum microbial load (1.4 x $10^7$ cfu) was found in the compost enriched with animal manure, rock phosphate, and filter cake. The information obtained from the study may lead to the development of N and P-enriched slow-release organic fertilizer (compost) that may become available to be used by small-scale vegetables and nursery growers.

**Enrichment of compost tea for its nutritive value**

The current era emphasizing sustainability does not permit excessive chemical input and focuses on the conservation of land & environment. The situation demands to shift partially towards organic production that is constrained by the limited availability of good quality organic fertilizer products. One viable option would be to use compost tea (aqueous extracts of compost) as it has the potential to improve plant growth and yield by enhancing plant nutrient status and decreasing disease incidence. However, its use in Pakistan is not quite common on account of its low nutritive value, lack of indigenous research, and limited awareness amongst farmers. The current study addresses these issues through applied research on enhancing the nutritive value of compost tea for use by the farming community.

Various potential indigenously available sources of plant nutrition were collected and analyzed in the laboratory for their nutrient contents. Analytical results depicted that Green Garden Compost and rock phosphate had the highest values of nitrogen (2.3%) and P (18%). The selected nutrient-dense materials were then used in various formulations for the enrichment of compost tea. The enriched compost teas were analyzed in the laboratory for their nutritive value. The findings revealed that the highest values of N (742 ppm) and P (685 ppm) were recorded in compost teas enriched by using MIK Vermicompost and Green Garden Compost, respectively.

The findings of a field trial on potato depicted that Rhizobacterial application gave relatively higher potato tuber yield in organically than chemically managed plots (10.13 and 9.29 t $ha^{-1}$, respectively) and it was followed by the application of compost tea (9.83 and 8.97 t $ha^{-1}$, respectively). This study is likely to generate baseline data that may lead to the development of liquid fertilizer products. Its use may reduce the burden on farmers' pockets as it is an economical source of plant nutrition, eco-friendly and easy to formulate.

**Isolation, screening and biochemical characterization of different rhizobacterial strains for the development of effective microbial product**

Rhizobacteria are rhizosphere-colonizing microbes with the capability to fix atmospheric nitrogen, solubilize phosphorus & potassium, and release plant growth-regulating compounds like auxins. These microorganisms naturally enhance soil fertility, making them environmentally safe options for sustainable agriculture. Current products in the market often address only one or two aspects of soil fertility. In contrast, this project aims to develop a consortium of various rhizobacteria after conducting compatibility analyses, resulting in a comprehensive solution to multiple soil fertility challenges.

Under this project, initially bacterial strains were isolated from nodules of chickpea & berseem crops, the rhizosphere of wheat, maize & potato crops and from enriched compost teas. These isolates were characterized based on growth parameters (viable count & optical density) and biochemical properties (indole-3-acetic acid (IAA)

production, gram reaction, acid production & P-solubilization).

The results revealed that microbial strains from berseem showed significantly (P≤0.05) higher viable counts (2.56 × $10^7$ cfu) and optical density (2.55). IAA production was the highest (5.56 mg $L^{-1}$) in strains isolated from enriched compost tea. All strains were positive for acid production but negative for phosphorus solubilization. Strains isolated from the rhizosphere of wheat and potato were gram-positive, while the others were gram-negative.

A field trial was conducted to assess the efficacy of Green Soil product, compost tea and rhizobacteria on wheat crop under organic and inorganic conditions. The findings depicted that the highest grain (5.65 & 6.44 t $ha^{-1}$) and biomass yield (12.08 & 13.76 t $ha^{-1}$) were achieved by applying rhizobacterial strains in both organic and inorganic conditions, respectively. These preliminary findings suggest a potential of isolated strains for developing a microbial product that can enhance plant growth and yield.

**Organization of National Training Course on Climate Smart Agricultural Practices**

A National Training Course on "Climate Smart Agricultural Practices for Bridging Yield Gap of Major Crops Using Nuclear Science and Technology" was organized on December 9-13, 2024, under the auspices of the Pakistan Atomic Energy Commission (PAEC) and in collaboration with the International Atomic Energy Agency (IAEA). The course aimed at enhancing national capacity through human resource development in the peaceful application of advanced nuclear and isotopic techniques in soil, water & nutrient management. The event was planned under the Expert Mission activity of IAEA Comprehensive Technical Cooperation Project PAK5053 "Strengthening and enhancing national capabilities for the development of climate smart crops, improvement in animal productivity and management of soil, water and nutrient resources using nuclear and related techniques".

The course was attended by the participants (researchers, academia, extension officers, etc.) belonging to various federal and provincial

departments related to agriculture. Theoretical and practical sessions of course delivered by IAEA experts (both in person & virtual) covered aspects including climate smart agricultural practices, sustainable nutrient and water management strategies, assessment and mitigation of ammonia emissions, greenhouse gases measurement, biochar application, conservation agriculture, soil health improvement and carbon sequestration. Hands-on training was also imparted through practical demonstration of $15^{N}$ isotope application for the determination of nitrogen use efficiency at experimental farm of the institute. Dignitaries from PAEC HQs Islamabad, including DG (Agri & Biotech) and Member (Science) graced the inaugural and concluding sessions of the course, respectively. They lauded efforts of the entire team for successful conduction of course at critical juncture of time when climate change is adversely affecting agricultural productivity and sustainability of agro-food systems in the country and hoped that trainees will serve as master trainers to disseminate and apply the knowledge and skills gained from the national training course in their respective departments.

## PLANT PROTECTION DIVISION

### Biological Control

Bio-control technology offers an eco-friendly method to manage major insect pests. *Trichogramma chilonis* (Ishii) is a tiny egg parasitoid and a key bio-control agent that helps control lepidopterous pests. Insect pests like tomato fruit worms, *Helicoverpa armigera* (Hub.) and wheat aphids, *Schizaphis graminum* (Rodani) severely damage tomato and wheat crops. To address this, R&D focuses on sustainable techniques, including bio-control, entomo-pathogenic fungi, pheromone trapping and host plant resistance, reducing pesticide use and enhancing crop productivity.

### Evaluation of plant extracts against wheat aphids in vivo conditions

Various plant extracts (garlic, orange peel, neem, paneer dodi, and parthenium) were evaluated at 5, 10, and 20% concentrations against wheat aphids. Garlic and orange peel extracts showed high efficacy in reducing the aphid population up to 72% followed by neem (57%), paneer dodi (49%) and parthenium (28%) notably at 5% concentration. The results manifested that garlic and orange peel extracts could be used as alternatives to insecticides for controlling wheat aphids.

### Aphid resistance in wheat genotypes

A host plant resistance study was conducted on 189 wheat genotypes at NIFA farm. Results showed that 11 genotypes were found resistant; 27 (moderately resistant); 73 (weakly resistant); 43 (lowly susceptible); 20 (moderately susceptible) and 15 were found highly susceptible against wheat aphids.

### Tomato fruit worm, *Helicoverpa armigera* (Hub.) rearing on artificial diets

Biological parameters of tomato fruit worms, *H. armigera* showed that the minimum larval period was recorded in chickpea flour based artificial diet i.e.,12 days followed by natural okra (16 days) and maize flour-based artificial diet (16 days). Minimum pupal period was recorded in chickpea flour artificial diet i.e., 9 days followed by natural okra (11 days) and maize flour artificial diet (12 days). Minimum moths emerged in the maize flour artificial diet i.e., 70% followed by chickpea flour artificial diet

(82%) and natural okra diet (85%). Minimum eggs were laid by female moths after feeding on maize flour artificial diet i.e., 357 nos. followed by a natural okra diet (443 nos.) and chickpea flour artificial diet (480 nos.). Fruit worm rearing on a chickpea flour-based artificial diet was found very effective with minimum larval-pupal period, high moths' emergence and fecundity rate as compared to natural okra and maize flour artificial diets.

**Optimization of irradiation doses for inducing male sterility in tomato fruit worm, *Helicoverpa armigera* (Hub.)**

The current study was conducted to determine the optimal irradiation dose for inducing male sterility of tomato fruit worm moths to control female moth's population in field cages. Male pupae of tomato fruit worm were irradiated at (200 & 250 Gy). Irradiation dose (200 Gy) induced sub-sterility in male fruit worm moths, leading to significantly reduced eggs production (13 eggs) and hatchability (18%) when mated with wild females. The sub-sterile males (200 Gy) produced complete sterility in the next generation. A higher dose of 250 Gy induced complete sterility in male moths, resulting in only 6 eggs laid by normal female moths, with none hatching. In contrast, mating between untreated (control) male and female moths produced up to 164 eggs, with a hatchability rate of 92%.

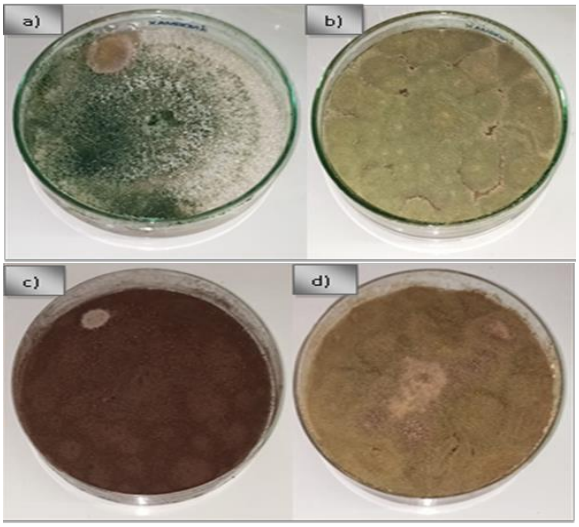
**Field efficacy of egg parasitoid, *Trichogramma chilonis* (Ishii) against eggs of tomato fruit worm**

*Trichogramma* wasps' efficiency was evaluated against tomato fruit worm infestation. Release of *Trichogramma* @ 1,000 wasps reduced fruit worm infestation upto 0.21 larvae/ plant followed by 800 wasps (0.23) and 500 wasps (0.24) as compared to control (0.31 larvae/ plant) in tomato crop. Tricho-card application @ 1,000 *Trichogramma* wasps proved effective against tomato fruit worm infestation which was significantly better than lower releases of *Trichogramma* populations.

**Evaluation of Entomo-pathogenic fungi strains against tomato fruit worm**

Entomo-pathogenic fungi isolated from various crops soils through Galleria bait technique. Entomopathogenic fungi including *Nomuraea rileyi*, *Aspergillus parasiticus*, *Aspergillus flavus* and

*Aspergillus niger* were evaluated against 3rd instar larvae of fruit worm in vitro conditions. Among these, *N. rileyi* confirmed the highest efficacy in controlling the larvae upto 89% followed by *A. parasiticus* and *A. flavus* (86%) and minimum was recorded in *A. niger* (70%). Entomo-pathogenic fungi *(N. rileyi*) was found best against fruit worm.




**(a). *Noumerea rileyi* (b). *Aspergillus flavus* (c). *A. niger* (d). *A. parasiticus.***

**Evaluation of Entomo-pathogenic fungi strains against tomato fruit worm, *Helicoverpa armigera* (Hub.)**

Entomopathogenic fungi based products (Racer & Pacer) were evaluated against the ovipositional preference of fruit worm on potted tomato plants. The fecundity and egg hatching parameters were studied during the experiment. The product 'Racer' containing *Beauveria bassiana* at $1x10^8$ spores/ml, resulted in the lowest fecundity (21 eggs) and egg hatch rate (50%) compared to the 'Pacer' product, with *Metarhizium anisopliae* at $1x10^8$ spores/ml, which showed fecundity of 22 eggs and a hatch rate of 70% against the fruit worm. In contrast, the control group recorded the highest fecundity (103 eggs) and egg hatch rate (86%).

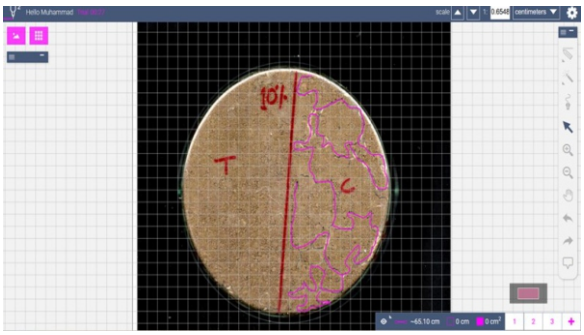
**Termites Management**

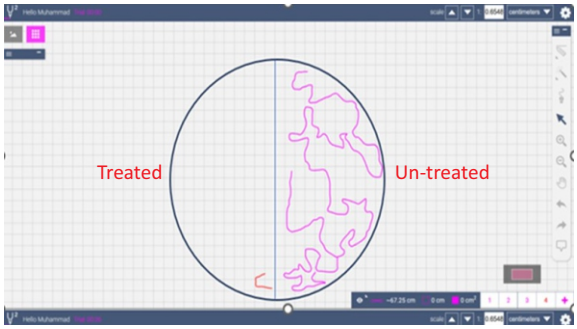
Subterranean termites are hard to control due to their concealed nature. Traditional methods rely on costly, harmful synthetic insecticides. Termite group aims to demonstrate plant extracts as eco-friendly alternatives, organic, cost-effective termite management with reduced environmental risks. Additionally, the group is exploring bait technology, a growing trend valued for its sustainability and ease of use.

**Exploitation of insecticidal properties of plants for termites' management**

Clove extract emerged as the most effective plant-based solution against termites in recent screenings. The impact of various concentrations of clove extract on key biological behaviors of termites, such as tunneling and trail following, was

thoroughly evaluated. The results revealed that clove extract at concentrations of 5% and 10% completely inhibited the trail-following behavior of subterranean termites, as demonstrated in experiments where termites failed to follow trails drawn with ink containing 2-phenoxyethanol. Furthermore, when the foraging arena was treated with a 10% clove extract, termite workers' tunneling activity in the soil was reduced to less than 5%. Notably, clove extract at concentrations exceeding 5% exhibited toxicity at par with Fipronil, one of the most effective synthetic termiticides in the market. These findings highlight the potential of clove extract to be further developed into a potent organic termiticide, offering a natural alternative to chemical treatments.

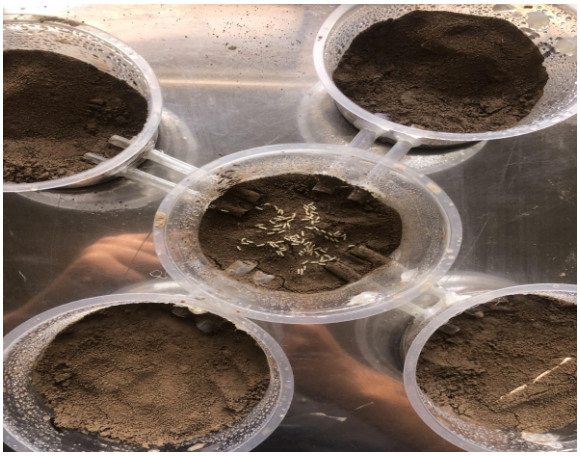




**Inhibition of termite tunneling in soil treated with clove-based formulations**

**Development of attractive bait matrix and toxin delivery foraging stations for termite control**

To improve the developed bait matrix, various cellulosic materials were assessed for termite attraction. Termites showed higher aggregation toward extract of used poplar wood (58%) and crushed extract of termite workers (69%) as compared to control while extracts of decaying wheat straw had no significant effect ($p \leq 0.05$). Similarly, applying guar gum to poplar wood sawdust increased termite aggregation to 53% as compared to 34% on untreated sawdust.



**Termite bait matrix preference trials in lab and indoor bait matrix application**

Five different concentrations of lufenuron were tested to determine the optimal concentration for incorporation into the bait matrix. The 50% lethal concentration (LC50) of lufenuron was observed at 51 ppm, with a lethal time (LT50) of 6 days, and no repellent effect was detected at this concentration. Laboratory trials showed that the bait matrix with the toxin was less attractive to termites (25%) compared to the toxin-free bait matrix (51%).

For field experiments, four active foraging points were established near the NIFA Officer Hostel, with an initial population estimate of 1,600 termite workers per trap counted biweekly.

Bait matrix with toxin was installed alongside toxin-free bait matrix and poplar wood at three active foraging stations. Termite activity was recorded as follows: an average of 1,100 termite workers and soldiers were found on poplar wood, 300 on the toxin-free bait matrix, and 120 on the bait matrix with toxin. Inside the buildings, termites were detected in only 2 out of 20 traps, with an average of 85 termites per trap.

In agricultural cropping area of NIFA, 50 termite detection stakes were installed at various locations, but no termite activity was found on any of the stakes.

**Fruit flies Management**

Fruit fly (Diptera: Tephritidae) is the major insect pest of horticultural crops, causing significant losses globally. Traditional pesticide-based control poses health risks, harms beneficial insects, pollutes the environment, and leads to pest resistance.

Fruit fly group research is focused on developing eco-friendly alternatives as part of Integrated Pest Management (IPM) systems, aiming to control fruit flies to minimize environmental and health issues due to use of toxic insecticides.

**Evaluation of guava juice-enriched protein hydrolysate bait formulations for enhanced fruit fly attraction**

Various guava-enriched protein hydrolysate-based formulations in combination with ammonium acetate were evaluated for their effectiveness in attracting fruit fly, *Bactrocera* species.

The specified concentrations of food baits were prepared by mixing them with 200 ml of water and were then placed in locally designed traps made from 1.5 L cold drink plastic bottles. These traps were installed at a height of approximately 2 m on trees within the guava orchard and were spaced at a suitable distance from each other. Among the various tested formulations, the blend consisting of guava juice, protein hydrolysate, and ammonium acetate at a ratio of 12:4:3 proved to be the most effective blend attracting a significantly higher population of both sexes of the three *Bactrocera* species, with an average weekly capture rate of 23, 33, and 12 flies/trap for *B. zonata*, *B. dorsalis* and *B. cucurbitae*, respectively and hence, the cumulative population of all the three species (52 flies/trap/week).

In comparison, a similar formulation with a slightly higher guava juice concentration (16 g:4 ml:3 g) attracted an average cumulative population of 38.4 flies/trap/week. These findings highlight the potential of the guava juice, protein hydrolysate, and ammonium acetate blend, particularly at the 12 g:4 ml:3 g concentration for managing multiple *Bactrocera* species.

**Species identification, sex separation, and total fruit fly count attracted toward the fruit fly bait**

**Assessing the attractiveness of guava juice and brewer's yeast-based food bait blends for fruit fly attraction**

Field trials were conducted to evaluate field attraction of various guava juice, brewer’s yeast and ammonium acetate used at various concentrations. Result

revealed that guava juice, brewer's yeast and ammonium acetate at a ratio of 16:4:3 attracted higher combined population of *B. zonata. B. dorsalis and B. cucurbitae* (85 flies/trap/week) followed by food blend of guava juice, brewer's yeast and ammonium acetate (at a ratio of 12:4:3, respectively) which attracted 58 flies/trap/week.

Notably, all tested food baits were more effective at attracting female flies compared to males. Overall, the guava juice and brewer's yeast-based food baits demonstrated superior performance relative to those based on protein hydrolysate, suggesting that this combination is more effective for attracting and managing *Bactrocera* species.

The study manifested that blend of guava juice, brewers' yeast and ammonium acetate (at ratio of 16:4:3) was highly effective in locally designed traps for mass trapping and population suppression of *Bactrocera* species in guava orchard and could further be optimized in order to further enhance their attraction towards fruit flies and developing a strong fruit fly attractant.

**Response of peach fruit fly *Bactrocera zonata* (Diptera: Tephritidae) towards different hosts at various stages of ripeness**

This study investigated how different ripeness stages of host fruits affect the ovipositional preference and offspring performance of the peach fruit fly, *Bactrocera zonata*. Firstly, the fruit fly preference was evaluated across various ripeness stages of guava, banana, peach, and mango followed by assessment of the most suitable host for optimal offspring performance by using these fruits at the same ripeness level (firm ripe). Results showed that fully ripe fruits were highly preferred, attracting more fruit flies, while green or unripe fruits were less attractive. Ripe guava and fully ripe banana showed superior biological parameters for *B. zonata* compared to peach and mango. In the follow-up experiment, guava was the most favored host, with the highest pupal recovery, adult emergence, and longevity, followed closely by banana. Bananas also showed the highest pupal weight and length, while mango was the least preferred. The study concluded that ripe and fully ripe fruits are more

susceptible to fruit fly infestation, with guava and banana being the most suitable hosts for large-scale laboratory production of *B. zonata*.

**Evaluation of protein-based artificial adult diets for successful rearing of Oriental fruit fly, *Bactrocera dorsalis***

Studies on adult diets revealed that *B. dorsalis* flies fed on solid diets exhibited significantly better growth and development compared to those on liquid diets. Among various diets tested, the yeast-based diet proved to be the most beneficial for the flies, resulting in the longest adult lifespan and the highest pupal production. Specifically, flies on the solid yeast diet lived up to 99 days, while those on the liquid yeast diet lived for 81 days. This diet also produced the highest number of pupae, with 701 pupae generated at a ratio of 1:1 concentration. In contrast, the casein-based diet led to the shortest adult lifespan and the lowest pupal production. Flies fed on the solid casein diet had a lifespan of 49 days, while those on the liquid casein diet lived for just 32 days. Additionally, the casein diet resulted in the lowest pupal production, with only 283 pupae recorded at a ratio of 1:3 concentration. These findings highlight the importance of diet composition in the growth and reproductive success of fruit flies with yeast-based solid diet as the most effective diet for large-scale production of *B. dorsalis.*

**Screening of various botanical extracts against peach fruit fly, *Bactrocera zonata* under laboratory conditions**

The laboratory study was conducted to assess various botanicals (at 5% concentrations) for their effectiveness against peach fruit fly, *B. zonata.* Results revealed that the Bakkayen extract demonstrated the highest percent non-preference rate (50%), whereas the Neem extract exhibited the lowest percent non-preference (38%). Garlic and Tobacco extracts showed intermediate non-preference towards fruit flies with value of 43% each in both cases. Regarding pupal mortality, Bakkayen resulted in the highest mortality rate of 73% and the longest pupal duration of 8 days. The control group, in contrast, had the lowest pupal mortality of 6% and the shortest pupal duration of 4 days. For adult mortality, Bakkayen also exhibited the highest rate of 50%, with an intermediate longevity of

9 days and a moderate number (22) of recovered pupae. The control group had the lowest mortality rate of 15%, the longest longevity of 33 days, and the highest number of recovered pupae at 61. These results suggest that Bakkayen is the most effective botanical for managing peach fruit flies, significantly impacting both pupal and adult stages, compared to the other botanicals tested.

**Investigating the effect of gamma irradiation in producing insect pests-free commodities for trade promotion**

Insect pests pose a significant threat to agricultural products, often spreading through trade and causing extensive damage to food production and international trade. Research is, therefore, being focused on irradiation as a phytosanitary treatment to eliminate quarantine insect pests. In this regard, the IAEA-funded project titled "Investigating the effect of gamma irradiation in the production of pest-free commodities for trade promotion in Pakistan and elsewhere" explores the use of gamma irradiation to produce pest-free agricultural commodities, enhancing both domestic and international trade while ensuring safer practices.

**Effects of artificial diets on development, survival and reproductive biology of the chickpea pod borer, *Helicoverpa armigera* (Hub.)**

The study reveals significant differences in the development and performance of *Helicoverpa armigera* across various artificial diets. Among the tested artificial diets, the chickpea flour-based diet emerged as the most effective diet, resulting in the shortest larval period of 13 days and the shortest pupal duration of 11 days. This was followed by the maize flour-based diet with a larval period of 15 days and a pupal duration of 12 days. In addition, the chickpea flour-based diet had the lowest larval mortality rate (10%), the highest adult emergence rate (90%), and the greatest fecundity, averaging 493 eggs per female. The male-to-female sex ratio was also the most balanced at (47:53). Regarding female longevity, the chickpea flour-based diet led with 13 days, followed by the maize flour-based diet (12 days). Cellulose powder-based diet appeared to show inferior biological parameters of *H.*

*armigera* compared to all artificial diets tested. Conversely, the cellulose powder-based diet showed the least favorable biological parameters, underperforming in all key aspects compared to the other artificial diets. Overall, the chickpea flour-based diet outperformed the others, providing the shortest developmental periods, lowest mortality, and highest adult emergence and reproductive success. It is thus highly recommended for maintaining lab-rearing of *H. armigera* for experimental purposes.

**Gamma irradiation effect on the developmental stages of chickpea pod borer, *Helicoverpa armigera* (Hub.)**

The present study was conducted to assess the radio-tolerance of field-collected eggs and larval stages of *H. armigera* by evaluating the effects of different doses of irradiation on their developmental stages. Samples of eggs and larvae at various stages were periodically collected from chickpea plants infested in the field and exposed to gamma irradiation doses of 50, 100, 150, and 200 Gy. Data on egg hatch rate, larval development, mortality, and F1 sterility were recorded. The results revealed that egg hatching was significantly affected, with a marked reduction observed at higher doses. A decrease in egg hatching was noted, from 50% at 50 Gy to only 12% at 200 Gy. Larval survival also declined as higher developmental stages of *H. armigera* were exposed to radiation, with survival rates decreasing from 77% to 32% at 50 Gy. A similar trend was observed across other stages and doses. Gamma radiation also impacted larval survival, with 72% of 2nd instar larvae surviving at 50 Gy compared to 48% at 200 Gy. Additionally, F1 sterility was observed at a dose of 150 Gy.

**Plant Pathology**

Crop diseases have a profound and far-reaching impact, spreading rapidly within a single season and often persisting across multiple growing cycles. These diseases result in substantial economic losses through reduced yields, costly chemical controls, and the continuous need to maintain disease resistance. Proactive management strategies are crucial to counter the threats posed by emerging pathotypes and virulence. Presented below are the research and development outcomes from the plant

pathology program for the reporting period:

**Current status and seasonal trends of airborne and vector-borne diseases**

Two hundred and twenty sentinel plots of a diverse collection of wheat genotypes were established at NIFA Peshawar, specifically curated for comprehensive epidemiological investigations concerning yellow rust, leaf rust, powdery mildew, and barley yellow dwarf. Throughout the study, five distinct temporal disease assessments of 220 sentinel plots were meticulously documented. Yellow rust manifested initially as sporadic flickering in the early season, and following the latent period, its progression was slow till the last assessment in April, exhibiting a mean disease severity ranging from <1 to 9%. This situation is quite different from the previous season in which the mean disease value reached 50% during the first week of April. However, during the current season, yellow rust was prevalent in 75% of the sentinel plots established at NIFA. Conversely, powdery mildew did not manifest throughout the season while leaf rust was prevalent in <1% of the plots. The aphid-borne barley yellow dwarf disease was prevalent in only 10 plots (5%), showcasing varying severity levels between 20-80%. This meticulous seasonal information plays a pivotal role in enhancing our understanding of various wheat diseases, aiding in the development of disease-resistant wheat varieties, and ultimately contributing to sustainable food security.

**Pathogen dynamics and the efficacy of all stage resistance genes**

Understanding *Puccinia striiformis* f. sp. *tritici* (*Pst*) virulences, detecting durable resistance sources, and the cultivation significance of all-stage *Pst* resistance genes are essential for effective rust management and promoting host resistance development and use. A comprehensive investigation into the temporal variability of natural *Pst* virulences and races throughout the growing season at NIFA Peshawar. Throughout the season at NIFA, five distinct *Pst* races: 0E0, 142E144, 143E128, 6E128, and 142E128, each presenting a range of 3-6 virulence factors were postulated. Encouragingly, critical yellow rust resistance genes, such as *Yr1*, *Yr25*, *Yr29*, *Yr35*, *Yr41*, *Yr53,* and *Yr64* were found resistant to highly resistant at NIFA, suggesting their

effectiveness in countering the prevailing *Pst* races. Understanding the temporal dynamics of *Pst* virulence and its interactions with host genes is pivotal for developing effective strategies to manage wheat yellow rust, ensuring sustainable wheat cultivation.

**Mitigating yellow rust through host resistance strategies**

**Durable resistance**

Mitigating the impact of yellow rust over 70% of the wheat landscape in the low-altitude districts of the KP Province, it is imperative to minimize the initial inoculum of *Pst* originating from both the source area (i.e., mid and high-altitude districts) and exotic territories. To attain this objective, a quantitative summary of disease intensity over time was carried out i.e. Area Under the Disease Progress Curve (AUDPC) to investigate a set of more than two hundred registered/ approved wheat cultivars under artificially induced *Pst* epidemic. The aim was to identify genotypes capable of reducing both allo and auto infections. The AUDPC values, ranging from 0 to 1170, were crucial indicators. Notably, 29 genotypes exhibited AUDPC values falling between 201-400, signifying a state of moderate resistance and potential for durability in combating rust progression. These genotypes are suggested for strategic deployment in the source area to effectively manage *Pst* and limit its spread, ultimately safeguarding wheat cultivation in the region.

**Impact of resistance levels on yellow rust and yield protection**

This two-year study investigated the impact of previously characterized yellow rust resistance levels of wheat cultivars. The cultivar groups included resistant(R): Fatehjang-16, Wardan-17, & Pasina17; moderately resistant (MR): Pakistan-2013, Boroloug-16 and Anaj-17; moderately susceptible (MS): Shafaq-2006, Galaxy-2013, Land race; and susceptible (S) “Morocco”. Three dependent parameters i.e. AUDPC, yield/ plot(g), and thousand kernel weight (g) were studied and analyzed over two years. Remarkable variability was observed in the measured parameters across these distinct resistance groups. Four resistance groups i.e R, MR, MS, and S means over years for AUDPC values were significantly less for R-group cultivars (i.e. Fatehjang-16: 50; Wardan-17: 26 and Pasina17: 68) in comparison with other groups while between years,

mean AUDPC value was significantly high during 2024 (i.e. 880) in comparison with 2023 (i.e. 349). Similarly, yield/ plot in grams of R-group cultivars i.e. Fatehjang-16: 1292g; Wardan-17: 1175g and Pasina17: 1300g were significantly high in comparison with other groups while between years, mean yield/plot was significantly high during 2023 (i.e. 1022 g) in comparison with 2024 (i.e. 965 g). Thousand kernel weight in grams of R-group cultivars i.e. Fatehjang-16: 33g; Wardan-17: 34g and Pasina17: 33g were significantly high in comparison with other groups while between years mean of 1000 kernel weight was significantly high during 2024 (i.e. 34 g) in comparison with 2024 (i.e. 28 g). These findings underscore the critical role of resistant cultivars in effectively managing yellow rust and enhancing both yield and kernel weight, emphasizing the potential for utilizing such cultivars to bolster wheat productivity and resilience against this detrimental disease.

**Evaluation of fungicides for yellow rust management and yield protection**

A comparative study was conducted over three years to assess the effectiveness of five fungicides including Tilit, Success, Redomil, Topsin-M, and Cymoxanil plus Mancozeb using the yellow rust susceptible variety "Morocco". Six replications of Morocco, each comprising 4-rows, arranged in a randomized complete block design for the five test fungicide treatments, adhering to the recommended doses along with untreated control. Three dependent parameters i.e. AUDPC, yield/plot(g), and 1000 kernel weight (g) were studied and analyzed over three years. Over the years AUDPC mean of the untreated control was significantly maximum (1239) while the significantly lowest value was recorded for Tilit (75). Statistically significant variability for AUDPC was recorded over the years. The highest AUDPC value was recorded during 2022 (984) which was followed by 2024(853) and 2023(421), respectively. Over the years mean of yield/plot(g) was (569 g) for Tilit which was significantly higher than the untreated control (489 g) while Tilit was statistically at par with Success, Redomil, Topsin-M, and Cymoxanil plus Mancozeb. Statistically significant variability for yield/ plot(g) was recorded over the years. The highest yield/ plot(g) was recorded during 2022 (818) which was followed by 2024 (425) and 2023 (350), respectively. Over the

years mean for 1000 Kernel weight (KW) was (35g) for Tilit which was significantly higher than the Topsin-M (33g) while Tilit was statistically at par with Success, Redomil, Cymoxanil plus Mancozeb, and untreated control. Significant variability for 1000 KW was recorded over the years. The highest 1000 KW was recorded during 2022 (40g) which was followed by 2024 (31g) and 2023 (30g), respectively.

**Fostering the advancement and promotion of disease-resistant wheat germplasm and varieties.**

Fostering the advancement and promotion of disease-resistant wheat germplasm and varieties are being done annually under a national program led by the Pakistan Agricultural Research Council (PARC), Islamabad involving 32 key national institutions including PAEC Agri & Biotec Institutes. During 2023-24, three distinct sets of wheat germplasm: the National Wheat Disease Screening Nursery (NWDSN), a set of candidate future varieties (National Uniform Wheat Yield Trial-Nursery), and a collection of released varieties totaling around 1203 were raised under artificially induced yellow rust epidemic conditions for accurate evaluation at NIFA. Meticulous disease data for each entry in these three sets was recorded throughout the growing season.

These invaluable insights will be collated and presented in the final country report by the PARC, Islamabad. This report will serve as a critical resource for national breeding programs, and provincial and federal seed councils, guiding the strategic release and recommendation of cultivars. This strategic approach is instrumental in averting potential epidemics of *Puccinia striiformis* f. sp. tritici (*Pst*) and ensuring the optimal cultivation of released cultivars, ultimately fortifying the wheat farming landscape.

**Pathogenic mycobiome of wheat seed**

A laboratory study was conducted using post-harvest seeds from 204 wheat varieties raised at NIFA Farm to assess the major pathogenic mycobiome relevant to wheat seed health. Major and economically important pathogenic components of wheat seed mycobiome include *Altemaia altennta* (Fr.) Keissler and *Tilletia indica* Mitra (=*Neovossia indica* (Mitra) Mundkur) which cause black point and karnal bunt diseases respectively.

Incidences of black point and karnal bunt of each variety underwent meticulous scrutiny, with a thousand seeds per variety manually examined for occurrences of black point and karnal bunt using a magnifying lens equipped with a built-in light source. The results indicated that the incidence of black point varied between <1 to 100% while karnal bunt incidence ranged between 0-20%. Black point incidence was recorded at >3% in 90% of the tested varieties while karnal bunt was not recorded in 81% of the tested varieties. Karnal bunt incidence of 38 varieties remained >0.20%. Threshold of black point caused by *A. altennta* (Fr.) Keissler for pre-basic seed is none; for basic seed is 0.05% and for certified seed is 3%. Similarly, the threshold for karnal bunt caused by *T. indica* Mitra for both pre-basic and basic seed is none while for certified seed is 0.20%.

Incidence rates recorded in the current study surpass the permissible thresholds, emphasizing the critical need for seed treatment employing appropriate fungicides. Ensuring such treatments is paramount to preventing and effectively managing these diseases, ultimately safeguarding the quality and yield of the wheat crop.

**Medical Entomology**

Dengue, a vector-borne disease, has become endemic in Pakistan. With no globally effective vaccine available, the primary strategy to mitigate its impact focuses on controlling the vector mosquitoes. However, excessive reliance on insecticides has resulted in health risks, entomological challenges, and environmental concerns.

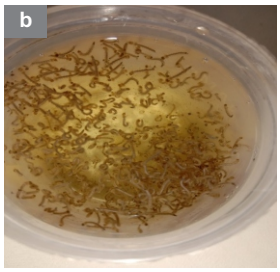
In response, research is now directed toward developing eco-friendly interventions and promoting an Integrated Vector Management (IVM) strategy. This approach combines conventional and innovative techniques to effectively curb the spread of dengue while minimizing environmental and public health impacts.

**Parthenium-based bio-pesticide and ovi-traps/ baits development for surveillance and mosquitoes' management**

Relying solely on synthetic insecticides to combat dengue mosquitoes has led to health and environmental concerns, as well as the emergence of insecticide resistance.

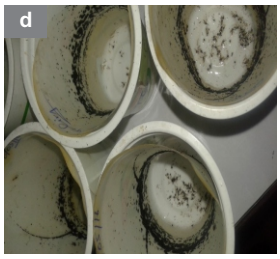
In response, there is a growing emphasis on sustainable, indigenous solutions like bio-pesticides and innovative trapping/ baiting methods. These efforts not only aim to provide effective mosquito control but also offer potential avenues for income generation, making them a holistic approach to addressing the challenges posed by deadly mosquitoes.


a. **Bio-Pesticide, dung cake formulation**




**b. Killing efficacy trial against dengue vector larvae**


**c. Indigenously designed Ovi-traps**




**d. Trapping of dengue vector eggs using Ovi-traps**

The selected bio-pesticide, proven effective in previous trials, was tested across diverse mosquito breeding habitats, including muddy/ sewage water, clean water, and rain/ tank water in both rural and urban settings. The bio-pesticide demonstrated high compatibility, with success rates ranging from 96% to 100% across all tested environments. Given these promising results, there is potential for large-scale testing in collaboration with health departments to further validate its effectiveness in field applications.

**Population dynamics of mosquitoes**

Mosquito traps serve as essential tools for surveillance, monitoring, and management of deadly mosquitoes. Data collected from July 2023 to June 2024 provided insights into mosquito population dynamics, revealing that *Aedes albopictus* was the dominant species, with its population peaking between July to November. The trap index also highlighted significant variations in the populations of other mosquito species, including *Culex* and *Aedes aegypti*. Regarding the use of traps as a management tool, bucket type large traps proved effective in capturing eggs, but were less successful in trapping adult mosquitoes, suggesting the need for design improvements to enhance their effectiveness as bait stations.

**Feasibility of Nano-particles for better formulation of parthenium-based bio-pesticide**

Initial studies indicate that incorporating silica nano-particles into the parthenium-based bio-pesticide formulation is not only feasible but also highly promising. This approach has the potential to significantly reduce the required dosage of the bio-pesticide, enhancing its efficiency. These lab-based experiments explored how nano-particles can optimize the formulation, paving the way for more effective and economical indigenous plant-based dengue control solutions in future.

**Hunt for naturally existing tsl mutation in *Aedes aegypti* and *Ae. albopictus* for the construction of a more robust Genetic Sex Strain (GSS) for SIT.**

Under the IAEA-CRP (44003), RC-No. 24085, eggs and larvae of *Aedes* species were collected from various climatic and topographic regions of Pakistan. From this wild collection, twenty iso-male families (one male and five females) were developed from the wild population of *Aedes* mosquitoes and subjected to thermal screening, leading to the identification of six potential iso-male families for developing tsl based genetic sexing strains.

These six potentially resistant families were then exposed to the same thermal regime, and two colonies were confirmed as resistant at 40°C for 5 hours. However, the exposure of other developmental stages, such as 4th instar larvae and pupae, to thermal screening did not yield significant results. Consequently, only 1$^{st}$ instar larvae were recommended for further tsl (temperature-sensitive lethal) screening.

**Enhancing the capacity and the utilization of the Sterile insect technique (SIT) for *Aedes* mosquito control**

Pakistan is actively participating in a Regional Asia project under the International Atomic Energy Agency (IAEA) umbrella, focusing on the Sterile Insect Technique (SIT) for *Aedes* mosquito control.

The IAEA's technical cooperation program is instrumental in building capacity within the country, encompassing key areas such as vector surveillance, scaling up mosquito rearing, and enhancing the production of

sterile males. This collaboration follows the IAEA's phased conditional approach (PCA), ensuring that SIT application is optimized before field application and effectively implemented step by step across the member Asian countries involved in the project.

**Increase in production capacity through improved blood feeding**

Female *Aedes* mosquitoes require vertebrate blood as a protein source for egg development and high fecundity, making a consistent and reliable blood source essential for rearing.

After evaluating various options, five different blood sources were optimized for *Aedes* mosquito production, offering flexibility based on availability. While the biological parameters varied slightly in efficiency across these sources, all fell within an acceptable range, ensuring that any of the five can be effectively used, depending on availability, to support large-scale mosquito-rearing efforts as per set requirements by IAEA.

**Semi-field tests of the competent sterile males**

In a Sterile Insect Technique (SIT) management program, the effectiveness depends on the ability of sterile males to successfully compete with wild males for mating. Ideally, these sterile males should outperform their wild counterparts to achieve effective population control. To evaluate this, sterile males irradiated with doses of 70-80 Gy were subjected to competition tests in a field cage. The results showed that the sterile males exhibited a higher competitive index (C), with values of 1.79 and 2.30 for 70 Gy and 80 Gy, respectively. A “C” value greater than 1 indicates that sterile males are more competitive than wild-type males. Additionally, the percent induced egg sterility (IES) was 100% for both irradiation doses, confirming their suitability for use in SIT applications.

# SOCIO-ECONOMIC IMPACT

## PLANT BREEDING AND GENETICS DIVISION

The development and dissemination of high-yielding, disease-resistant wheat varieties tailored for irrigated and rainfed areas have significantly improved crop productivity, with yields 5-10% higher than other wheat varieties. This enhancement will contribute substantially to improve the livelihoods of farming communities in the province. During 2023-24 a total of 20150 kg quality seed of NIFA wheat varieties i.e., Fakhre NIFA 2023, NIFA Nijat 2023, NIFA Awaz 2019, NIFA Aman 2017 and NIFA Lalma 2013 was produced which is sufficient to plant 403 acres of land. In Rapeseed the primary aim is to develop rapeseed varieties that offer higher seed yields. This increases the total production from the same area of land, enhancing farmers' income. By improving yields and resilience, the goal is to offer varieties that provide economic benefits to farmers, making rapeseed cultivation more profitable. NIFA Sarson-T20 and NIFA Sarson-T23 have demonstrated a 5-10% higher seed yield compared to other varieties in the KP region. This yield improvement translates to an increase in production per unit area. The higher seed yield over 100 kg per acre results in an additional income of Rs. 20,000-25,000 per acre for farmers. This additional income significantly enhances the economic viability of rapeseed cultivation. 230 Kg and 110 Kg Pre-basic seed of NIFA's mungbean and kidney bean varieties, respectively was sold to KP agriculture extension department and progressive growers through PSDP Pulses Project for further multiplication.

## FOOD AND NUTRITION DIVISION

The Food and Nutrition Division is making significant contributions to reducing malnutrition, thereby enhancing the health and productivity of the Pakistani population. NIFA has developed spot test kits that are used by organizations such as Nutrition International (NI), Iodine Global Network (IGN), Global Alliance for Improved Nutrition (GAIN), private mills, and regulatory bodies, NIFA supplied Vitamin A, iodine, and iron kits valued at Rs. 13.07 million for quality control and quality assurance purposes. The Division is also focused on developing preservation techniques and value addition for

fruits and vegetables, aiming to reduce postharvest losses through both conventional and nuclear methods. Training sessions have been conducted to help farmers and entrepreneurs adopt these technologies, improving their socioeconomic stability. In the fiscal year 2023-2024, limited-scale production of fruit products within the institute generated approximately Rs. 1.03 million. Additionally, NIFA provided irradiation services to gemstone traders, enhancing the value of gemstones such as topaz, kunzite, tourmaline, and quartz. NIFA earned nearly Rs. 1.39 million from these irradiation services, significantly benefiting gemstone traders, as the value of their gemstones can increase by three to four times through this process. Radiation services were also provided to R&D and academic organizations, further enhancing NIFA's reputation. The Food and Environmental Safety Group continued to deliver comprehensive analytical services for food and water testing, generating a total revenue of Rs. 0.18 million in 2024. The Food Microbiology Lab achieved ISO 17025-2017 Accreditation by Pakistan National Accreditation Council (PNAC), Islamabad on September 11, 2023. Furthermore, mushrooms and mushroom spawn worth Rs. 46,650 was sold out as part of NIFA's mushroom popularization program. Additionally, a radio talk was delivered on the Pashto program "Karkeela" of Radio Pakistan Peshawar, promoting these initiatives to a broader audience.

## SOIL AND ENVIRONMENTAL SCIENCES DIVISION

Soil and Environmental Sciences Division has optimized different water & nutrient management packages and production technologies for field and horticultural crops that are climate smart and cost-effective. These packages/ technologies are being popularized among the farming community through the training workshops and media talks. It has resulted in increasing the water and nutrient use efficiency at farm level, ultimately improving the overall farm productivity and net returns for the framers, leading towards uplifting the socio-economic conditions. Through the adoption of developed and deployed technologies by the farmers, the wheat yield has increased by 20-30% in addition to quality improvement. Socio-economic impact is more obvious in vegetables yield enhancement as it has increased up to 10 times through tunnel farming as compared with conventional farming.

## PLANT PROTECTION DIVISION

Crop diseases and pests represent a substantial economic burden, leading to decreased agricultural productivity, increased expenditure on chemical control measures, and the necessity for comprehensive resistance management programs. In Khyber Pakhtunkhwa, key wheat diseases-including yellow rust, leaf rust, powdery mildew, and various blights have caused yield losses exceeding 1% across multiple production zones. The national wheat improvement sub-program on rust resistance at NIFA contributed in the development of more than 100 wheat varieties. Additionally, rust resistance at NIFA contributes annual to the tune of 12.3 million AUD to rust control value in Pakistan. Advancements in biological control (biocontrol) strategies are actively being developed, utilizing natural antagonists such as parasitoids, entomopathogenic fungi, and plant-based extracts. For instance, garlic and orange peel extracts have demonstrated efficacy in reducing aphid populations in wheat fields, while certain wheat genotypes have shown varying degrees of resistance to aphid infestations.

Concurrently, sustainable pest control methods have made significant progress in addressing major agricultural threats. Eco-friendly approaches, such as the deployment of traps for fruit fly management, have achieved a 25% reduction in fruit fly populations. Similarly, organic solutions, such as clove extract, are being employed for the management of subterranean termites, which are responsible for 10-20% of damage to crops and forestry, with performance metrics comparable to those of synthetic pesticides. Research into phytosanitary treatments, bio-pesticides, and mosquitoes traps-particularly in the context of dengue vector control-demonstrates considerable potential to reduce public health expenditures and enhance agricultural productivity. These initiatives also support the standardization of phytosanitary protocols, facilitating both domestic agricultural sustainability and expanded access to international markets.

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# FUNDED RESEARCH PROJECTS

| Sr. # | Project Title | Project Duration | Total Funds | Principal Investigator | Funding Agency |
|---|---|---|---|---|---|
| 1 | Promoting research for productivity enhancement in pulses (Country-wide umbrella project, NIFA, Peshawar as a sub-component). | 2019-25 | 24.446 M | Dr. Gul Sanat Shah, CS/ Director | PARC-PSDP |
| 2 | Strategies for mitigating postharvest losses in fruits and vegetables through various processing and storage techniques and analytical optimization. | 2024-27 | 10 M | Dr. Maazullah Khan, DCE/ Head FND | PAEC |
| 3 | Genetic improvement of field (wheat, oilseed brassica and pulses) and horticultural (peach/plum and okra) crops for high grain//fruit yield and resilience to changing climate. | -do- | 10 M | Dr. Roshan Zamir, DCS/ Head PB GD | |
| 4 | Development of biocontrol technology for sustainable management of agricultural insect pests/ diseases and vector of human importance | 2024-27 | 10 M | Mr. M. Zahid, DCS/ PPD | PAEC |
| 5 | Development and deployment of climate smart technology packages and fertilizer products for enhancing crop and soil productivity | 2024-27 | 10 M | Dr. Amir Raza, PS/ S& ESD | PAEC |
| 6 | Strengthening and Enhancing National Capabilities for the Development of Climate Smart Crops, Improvement in Animal Productivity and Management of Soil, Water and Nutrient Resources Using Nuclear and Related Techniques | 2022-25 | 89 M | Dr. Amir Raza, PS (NIFA Counterpart) | IAEA TC |
| 7 | Genetic improvement of oilseed brassicas through induced mutations and hybridization techniques | 2023-25 | 3.0 M | Mr. Hafiz Munir Ahmed, PS | PARC-ALP. |

| Sr. # | Project Title | Project Duration | Total Funds | Principal Investigator | Funding Agency |
|---|---|---|---|---|---|
| 8 | Breeding of okra (*Abelmoschus esculentus* L.) for high-yielding genotypes development through induced mutations and breeding techniques | 2023-25 | 2.0 M | Dr Syed Tariq Shah, PS | PARC-ALP. |
| 9 | Sustainable approaches for effective control of peach stone replant disorders | 2022-25 | 2.8 M | Mr. Shahid A. Khalil, PS | PSF |
| 10 | Evaluation and deployment of multiple stress-tolerant biofortified wheat germplasm in Khyber Pakhtunkhwa | 2023-24 | 0.83 M | Dr. Faroopq-I-Azam, PS | AIP |
| 11 | Adaptation of Low Energy Machine Generated Radiation Sources for Surface Decontamination and Disinfestation of Food in Pakistan | 2021-26 | 9.17 M | Mr. Alamgeer Khan, PS | IAEA |
| 12 | Development of a hybrid indirect-type solar dryer for drying of fruits and vegetables | 2022-25 | 3.261 | Dr. Maazullah Khan, DCE | ALP/ PARC |
| 13 | Production of Black Soldier Fly, *Hermetia illucens* larvae as sustainable proteinaceous food for the poultry industry. | 2023-26. | 2.257 M | Ms. Noor Fatima, JS. | PSF |
| 14 | Development of Local attractive Bait matrix and toxin delivery foraging stations for the control of Pakistani subterranean termites. | 2024-27. | 2.298 M | M. Irfan, SS | PSF |
| 15 | Hunt for naturally existing tsl mutation in *Aedes aegypti* and *Ae. albopictus* for the construction of a more robust genetic sex strain for SIT. | 2020-25. | 5.20 M | Dr. Muhammad Misbah ul Haq, PS | IAEA RC-24085. |
| 16 | Investigating the effect of gamma irradiation in the production of pest-free commodities for trade promotion. | 2022-28. | 12.52 M | Dr. M. Hamayoon Khan, PS | IAEA RC-24975. |
| 17 | Enhancing the capacity and the utilization of the Sterile insect technique for Aedes mosquito control. | 2022-26. | – | Dr. Gul Zamin Khan, DCS | IAEA RAS-5095 |

# EVENTS/TRAININGS ORGANIZED

| S. #. | Title | Date | Name of Organizers |
|---|---|---|---|
| 1. | Training on titration method for Lab Technicians by Nutritional International (NI) at NIFA Peshawar | 20.02.2024 | Dr. Zahid Mehmood, PS<br>Tauqeer Ahmad, JS,<br>Aurangzeb Khan, ARO |
| 2. | Use of Electron Beam & X-rays Technology in Industry and Qualitative Analysis of Added Micronutrients in Foods | 28.02.2024 | Dr. Zahid Mehmood, PS<br>Alamgeer Khan, PS |
| 3. | Workshop on "Popularization of eco-friendly insect pest control technologies". | 09.05.2024. | Dr. M. Misbah Ulhaq, PS<br>Dr. M. Hamayoon, PS |
| 4. | Workshop on "Solar Drying of Fruits and Vegetables" | 04.06.2024 | Dr. Maazullah Khan, DCE<br>M. Asim Irshad, JS |
| 5. | Workshop on "management strategies for the insect pests of medical importance". | 24.09.2024. | Dr. Inamullah Khan, DCS<br>Dr. Gul Zamin Khan, DCS |
| 6. | 55th QMS requirement and Implementation Course. | 23-24.9.24 | Mr. Raufullah, MR ISO |
| 7. | 29th QMS Training Course for Staff Members | 25.09.2024 | Mr. Raufullah, MR ISO |
| 8. | 39th Postgraduate Training Couse on "The Use of Nuclear and other Techniques in Food & Agricultural Research" | 14.10.2024<br>18.10.2024 | Dr. Muhammad Amin, PS<br>Dr. Haroon Shahzad, JS |
| 9. | National Training Course on "Climate Smart Agricultural Practices for Bridging Yield Gap of Major Crops Using Nuclear Science and Technology" | 09.12.2024<br>13.12.2024 | Dr. Amir Raza, PS<br>Mr. Parvez Khan, PS |
| 10. | Workshop on "Mushroom Farming Popularization as Cottage Industry" | 19.12.2024 | Dr. Muhammad Ibrahim, PS |

# EVENTS/TRAININGS ATTENDED

| S# | Title | Period | Place | Scientist Name(s) |
|---|---|---|---|---|
| 1. | Appraisal process for selection of community infrastructure projects (Online) | 21-23.2.24 | PARD, Peshawar | Mr. M. Irfan, SS<br>Mr. M. Usman Khalique, JS |
| 2. | New Public Management (Online) | 27-29.2.24 | PARD, Peshawar | Mr. M. Zahid, DCS |
| 3. | Environmental impact assessment on developmental projects (Online) | 04-6.3.24 | PARD, Peshawar | Dr. Gul Zamin Khan, DCS |
| 4. | Project Proposal Development & Implementation (Online) | 17-19.4.24 | PARD Peshawar | Dr. M. Irfaq Khan, PS<br>Dr. M. Amin, PS<br>Dr. Salman Ahmad, PS<br>Mr. Khurshid Ahmad, SS<br>Mr. M. Asim Irshad, JS<br>Mr. Tauqeer Ahmad, JS<br>Dr. Haroon Shahzad, JS |
| 5. | Molecular and genomic techniques applied in mutation breeding | 20.5.24 - 16.8.24 | IAEA, Vienna, Austria | Mr. Shahzad Ahmad, JS |
| 6. | Income generation opportunities for rural youth (Online) | 20-22.5.24 | PARD, Peshawar | Dr. Gul Zamin Khan, DCS |
| 7. | Office Procedure and Management | 29-31.5.24 | PARD, Peshawar | Mr. Muhammad Zahid, DCS<br>Dr. Gul Zamin Khan, DCS.<br>Dr. Amir Raza, PS<br>Dr. Iqbal Saeed, PS<br>Dr. S. T. Shah, PS<br>Mr. Shahzada Asif Ali, SS<br>Mr. M. Asim Irshad, JS<br>Mr. Tauqeer Ahmad, JS |
| 8. | Natural disaster and its impact on economic growth (Online) | 24-26.6.24 | PARD, Peshawar | Mr. M. Zahid, DCS |
| 9. | Applications of nuclear techniques in industry | 25.6.24 | NIFA, Peshawar | Mr. Shahzada Asif Ali, SS;<br>Mr. M. Usman Khalique, JS<br>Mr. Dr. Haroon Shahzad, JS |
| 10. | IAEA Regional Training Course (RTC) on Quality Assurance and Quality Control for Gamma Dosimetry Applications | 24-28.6.24 | Quezon City, Philippines | Mr. Alamgeer Khan, PS |
| 11. | Climate Change and Its Impacts on Economy of Pakistan (Online) | 2-4.7.24 | PARD, Peshawar | Mr. Yasir Anwar, PS;<br>Mr. Zahid Ali, PS |

| S# | Title | Period | Place | Scientist Name(s) |
|---|---|---|---|---|
| 12. | Office procedure and management in public sector (Online) | 4-7.07.24 | PARD, Peshawar | Mr. Muhammad Zahid, DCS<br>Dr. Gul Zamin Khan, DCS |
| 13. | Hospitality Management | 23-24.7.24 | PARD, Peshawar | Mr. M. Asim Irshad, JS |
| 14. | Essential IT Skills for Government Officials (Online) | 20-22.8.24 | PARD, Peshawar | Dr. M. Amin, PS<br>Dr. S. Tariq Shah, PS<br>Mr. Khushid Ahmad, SS<br>Mr. Usman Khalique, JS<br>Mr. Tauqeer Ahmad, JS<br>Mr. M. Asim Irshad, JS |
| 15. | Project Cycle Management (Online) | 10-12.9.24 | PARD, Peshawar | Dr. Zahid Mehmood, PS |
| 16. | 55th QMS Requirement & Implementation Course - ISO Based | 23-24.9.24 | NIFA, Peshawar | Mr. Yasir Anwar, PS |
| 17. | 29th QMS Course for staff | 25.9.24 | NIFA, Peshawar | Mr. Shahzada Asif Ali, SS |
| 18. | Hand-On Training on Analytical Techniques | 24-26.9.24 | PINSTECH, Islamabad | Dr. Haroon Shahzad, JS |
| 19. | Result Based Monitoring and Evaluation of Developmental Projects (Online) | 2-4.10.24 | PARD, Peshawar | Mr. Tauqeer Ahmad, JS |
| 20. | IAEA Regional Training Course on “Quality Assurance and Quality Control for Electron Beam Dosimetry” | 7-11.10.24 | Hoi Chi Minh City, Vietnam | Mr. M. Zubair Shah, PE |
| 21. | Annual Wheat Planning and Review Meeting | 10-11.10.24 | NARC, Islamabad | Dr. M. Irfaq Khan, PS<br>Dr. Salman Ahmad, PS |
| 22. | Regional training course on “Collection of entomological baseline data and data management tools for SIT project for mosquito control under IAEA RAS 5095” | 14-18.10.24 | Quezon City, Philippine | Mr. Muhammad Irfan, SS |
| 23. | CIMMYT partnership Event | 21-22.10.24 | Marriot Hotel Islamabad | Dr. Farooq-I Azam, PS |
| 24. | Officers Placement Course IV | 21-22.10.24 | PAEC, Islamabad | Dr. M. Misbah ul haq, PS<br>Dr. Zahid Mehmood, PS |

| S# | Title | Period | Place | Scientist Name(s) |
|---|---|---|---|---|
| 25. | Filing Income Tax Return through IRIS 2.0 (Online) | 29-31.10.24 | PARD Peshawar | Dr. Haroon Shahzad, JS<br>Mr. Mushtaq Ali, RA |
| 26. | Ethical Leadership and Decision Making (Online) | 5-7.11.24 | PARD Peshawar | Dr. Amir Raza, PS |
| 27. | Training Workshop on Integrated Nuclear and Complementary Approaches to Understanding the Nexus between Water and Nutrient Use Efficiency, Nutrition Security, and Food Safety for Dryland Crops in a Changing Climate (Online) | 26.11.24<br>03.12.24 | IAEA/ NIFA | Dr. Haroon Shahzad, JS |
| 28. | 3rd Research Coordination Meeting (RCM) under coordinated research project D44003 on "Generic approach for the development of genetic sexing strains for SIT application" (Research contract no. 24085) | 9-13.12.24 | Vienna, Austria | Dr. M. Misbah ul haq, PS |
| 29. | 3rd Research Coordination Meeting (RCM) under coordinated research project D44003 on "Novel Irradiation Technology for Phytosanitary Treatment of Food Commodities and Promotion of Trade" (Research contract no. 24975) | 9-13.12.24 | Vienna, Austria | Dr. Muhammad Hamayoon Khan, PS |
| 30. | National Training Course on "Climate Smart Agricultural Practices for Bridging Yield Gap of Major Crops Using Nuclear Science and Technology" | 9-13.12.24 | NIFA, Peshawar | Mr. Shahzada Asif Ali, SS<br>Dr. Haroon Shahzad, JS |
| 31. | Data processing skills (Online) | 10-13.12.24 | PARD Peshawar | Mr. Usman Khalique, JS |

# DETAILED LIST OF OFFICERS

| Name | Designation |
|---|---|
| Dr. Gul Sanat Shah, Ph.D. Botany | Director/CS |
| **I. PLANT BREEDNG & GENETICS DIVISION** | |
| Dr. Roshan Zamir, Ph.D. Horticulture | Head/DCS |
| Mr. Hafiz Munir Ahmad, M.Sc. (Hons.) Genetics & Breeding | PS |
| Dr. Muhammad Irfaq Khan, Ph.D. Biology | PS |
| Dr. Farooq-i-Azam, Ph.D. Genetics & Breeding | PS |
| Dr. Syed Tariq Shah, Ph.D. Crop Genetics & Breeding | PS |
| Dr. Iqbal Saeed, Ph.D. Crop Genetics & Breeding | PS |
| Dr. Salman Ahmad, Ph.D. Genetics & Breeding | PS |
| Dr. Akhtar Ali, Ph.D. Breeding & Genetics | SS |
| Mr. Shahzad Ahmad, M.Sc. (Hons.) Plant Breeding & Genetics | JS |
| **II. FOOD & NUTRITION DIVISION** | |
| Dr. Maazullah Khan, Ph.D. Agricultural/Food Engineering | Head/DCE |
| Dr. Zahid Mehmood, Ph.D. Food Science and Technology | PS |
| Dr. Muhammad Ibrahim, Ph.D. Plant Pathology | PS |
| Mr. Alamgeer Khan, M.S. Medical Physics | PS |
| Mr. Khurshid Ahmad, M.Phil. Chemistry | SS |
| Mr. Tauqeer Ahmad, M.Sc. (Hons.) Food Science | JS |
| Mr. Muhammad Asim Irshad, M.Sc. (Hons.) Food Science | JS |
| Mr. Nisar Ahmad, M. Phil Chemistry | ARO |
| Mr. Aurang Zeb Khan, M. Sc Chemistry | ARO |

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|---|---|
| Mr. Arshad Ali, M. Phil Chemistry | ARO |
| Mr Waseem Jan, DAE Chemical | ATO |
| **III. SOIL AND ENVIRONMENTAL SCIENCES DIVISION** | |
| Dr. Muhammad Imtiaz, Ph.D. Soil Science | Head / DCS |
| Dr. Syed Azam Shah, Ph.D. Agronomy | DCS |
| Dr. Amir Raza, Ph.D. Natural Resources & Life Sciences | PS |
| Mr. Parvez Khan, M.Sc. (Hons.) Soil Science | PS |
| Mr. Zahid Ali, M.Sc. (Hons.) Soil Science | PS |
| Mr. Yasir Anwar, MS (Nuclear Engineering) | PS |
| Mr. Shahzada Asif Ali, M.Sc. (Hons.) Agronomy | SS |
| Dr. Haroon Shahzad, Ph.D. Soil Science | JS |
| **IV. PLANT PROTECTION DIVISION** | |
| Dr. Syed Jawad Ahmad Shah, Ph.D. Plant Pathology | Head/DCS |
| Mr. Muhammad Zahid, M.Sc. (Hons.) Entomology | DCS |
| Dr. Gul Zamin Khan, Ph.D. Entomology | DCS |
| Dr. M. Misbah ul Haq, Ph.D. Entomology | PS |
| Dr. Muhammad Hamayoon Khan, Ph.D. Entomology | PS |
| Mr. Muhammad Salman, M.Sc. (Hons.) Entomology | SS |
| Mr. Muhammad Arfan, M.Sc. (Hons.) Entomology | SS |
| Mr. Usman Khaliq, M.Sc. (Hons.) Entomology | JS |
| Mrs. Noor Fatima, M.Sc. (Hons.) Entomology | JS-On attachment at PAEC HQ |
| **V. TECHNICAL SERVICE DIVISION** | |
| Mr. Muhammad Zubair Shah, M.S. Chemical Engineering | Head / PE |
| Mr. Abdul Khaliq, M.Sc. Computer Science | PS |
| Mr. Asif Murad, B.Sc. Engineering | PE |

| | |
|---|---|
| Mr. Jahangir Khan, M.S. Engineering | SE |
| Mr. Qadeer Ahmed, MS Computer Science | SS |
| **VI. ADMINISTRATION & ACCOUNTS** | |
| Mr. Sardar Khalid Khan, B. Sc | Sr. Admin Officer |
| Syed Muhammad Abdullah, MBA | Admin Officer |
| Mr. Muhammad Jamil, MBA (Finance) and M.Sc., Economics | Pr. Account Officer |
| Mr. Raufullah, M.L.I.Sc. | Pr. Librarian |

# PROMOTIONS/TRANSFERS/RETIREMENTS/APPOINTMENTS

## Promotions:

| S# | Name | From | To | On |
|---|---|---|---|---|
| 1. | Mr. Umar Javed | JE-II (Admin) | JE-I (Admin) | 28.05.2024 |
| 2. | Mr. Saeed Ullah | Sr. Asstt. (Admin) | Superintendent | 28.05.2024 |
| 3. | Mr. Sajjad Hassan | Sr. Asstt. (Admin) | Superintendent | 28.05.2024 |
| 4. | Mr. Muhammad Waseem Jan | Pr. Tech | Asstt. Technical Officer | 28.05.2024 |
| 5. | Mr. Ali Salman | Computer Operator | Sr. Computer Operator | 28.05.2024 |
| 6. | Mr. Zakirullah Jan | Scientific Assistant-I | Sr. Scientific Assistant | 28.05.2024 |
| 7. | Mr. M. Adeel Khattak | Scientific Assistant-I | Sr. Scientific Assistant | 28.05.2024 |
| 8. | Mr. Mushtaq Khan | Scientific Assistant-II | Scientific Assistant-I | 28.05.2024 |
| 9. | Mr. Nizam Shah | Scientific Assistant-II | Scientific Assistant-I | 28.05.2024 |
| 10. | Mr. Fazal e Deyan | Tech-II | Tech-I | 28.05.2024 |
| 11. | Mr. M. Athar Zia Siddiqui | Assistant (Admin) | Sr. Assistant (Admin) | 28.05.2024 |
| 12. | Mr. Waqas | Jr. Assistant-I (A/c) | Assistant (A/c) | 28.05.2024 |
| 13. | Mr. Ghulam Akbar | General Attdt-I | General Attdt | 28.05.2024 |
| 14. | Mr. Muhammad Imran | Driver-III | Driver-II | 28.05.2024 |
| 15. | Mr. Javed Khan | CooK-III | CooK-II | 28.05.2024 |
| 16. | Mr. Mir Ahmad | General Attdt-II | General Attdt-I | 28.05.2024 |
| 17. | Mr. Shaz Ali | General Attdt-II | General Attdt-I | 28.05.2024 |
| 18. | Mr. Shahid Zeb | General Attdt-II | General Attdt-I | 28.05.2024 |
| 19. | Mr. Amjad Abbas | General Attdt-II | General Attdt-I | 28.05.2024 |
| 20. | Mr. Ayub Masih | Sanitary Attdt -II | Sanitary Attdt -I | 28.05.2024 |

# TRANSFERS / POSTINGS

## Transfers / Postings:

| S. No. | Name | From | To | On |
|---|---|---|---|---|
| 1. | Mr. Waqas, Assistant (A/C) | DEUP-II, Kohat | NIFA, Peshawar | 17.01.2024 |
| 2. | Mr. Qadeer Ahmed, Sr. Scientist | KCI, Chashma | NIFA, Peshawar | 06.02.2024 |
| 3. | Mr. M. Naseer Khan, SSA | C-3, Chashma | NIFA, Peshawar | 06.02.2024 |
| 4. | Mr. Yasir Anwar, P.S | PINSTECH, Islamabad | NIFA, Peshawar | 04.03.2024 |
| 5. | Mr. Aamir Iqbal, SCO | DEUP-I, D.G. Khan | NIFA, Peshawar | 18.03.2024 |
| 6. | Syed Muhammad Abdullah, Admin Officer | MPB-2, Karak | NIFA, Peshawar | 13.05.2024 |
| 7. | Mr. Sajjad Hassan, Supdt. | NIFA, Peshawar | IRNUM, Peshawar | 02.08.2024 |
| 8. | Mr. Shahzad Mirza, Jr. Executive-I | MDP, Islamabad | NIFA, Peshawar | 15.08.2024 |
| 9. | Mr. Saeed Ullah Supdt. | NIFA, Peshawar | PAEC HQs. | 04.09.2024 |
| 10. | Mr. Umar Javed, Jr. Executive-I | NIFA, Peshawar | PAEC HQs. | 04.09.2024 |
| 11. | Mr. Kamran Rehmat, Sanitary Attdt-I | INOR, Abbottabad | NIFA, Peshawar | 09.09.2024 |
| 12. | Mr. Naseer Ahmad, Supdt. | ICCC, Islamabad | NIFA, Peshawar | 18.09.2024 |
| 13. | Mr. Shahid Akbar Khalil | NIFA, Peshawar | NIA, Tandojam | 29-11-2024 |

## Retirements:

| S. No. | Name | Date |
|---|---|---|
| 1. | Mr. Essa Khan, Pr. Scientific Assistant | 03.01.2024 |
| 2. | Mr. Robin Rouf, Sr. Sanitary Attendant | 16-02-2024 |
| 3. | Mr. Aurang Zeb, Pr. Scientific Assistant | 10-03-2024 |
| 4. | Mr. Arshullah, Sr. Assistant (Admin) | 15-04-2024 |
| 5. | Mr. Mukhtiar Ali, Pr. Scientist | 01-05-2024 |

| | | |
|---|---|---|
| 6. | Mr. Sadaqat Khan, Stenographer | 12-05-2024 |
| 7. | Mr. Ghaffar Ali, Research Associate | 09-06-2024 |
| 8. | Mr. Iqbal Gill, Sr. Sanitary Attdt | 03.07.2024 |
| 9. | Mr. Mukhtaj Gul, General Attdt | 04-07-2024 |
| 10. | Dr. Inamullah Khan, Dy. Chief Scientist | 20-07-2024 |
| 11. | Mr. Saif ur Rehman, Superintendent | 25-09-2024 |
| 12. | Dr. Muhammad Imtiaz, Dy. Chief Scientist | 20-10-2024 |
| 13. | Mr. Naseem Khan, Pr. Tech | 10-12-2024 |

**Appointment:** No appointment made due to ban on induction

# PICTORIAL VIEW OF SCIENTIFIC EVENTS/DEVELOPED TECHNOLOGIES

**One-Day Refresher Training on "Iodine Analysis for Lab Technicians Department of Health Khyber Pakhtunkhwa" held on February 20, 2024**

**One-Day Workshop on "Use of Electron Beam & X-rays Technology in Industry and Qualitative Analysis of Added Micronutrients in Foods" held on February 28, 2024**

**One-Day Training Workshop on "Popularization of Eco-Friendly Insect Pests Control Technologies" held on May 09, 2024**


**One-Day Workshop on "Solar Drying of Fruits and Vegetables" held on June 04, 2024**


**One-Day Seminar on "Applications of Nuclear Techniques in Industry" held on June 25, 2024**

**Awareness Seminar on "Plant Breeder's Rights (PBR)" held on July 31, 2024**

**Visit of Gilgit Baltistan for Enhancing wheat yield in Hitherto-neglected areas of Gilgit Baltistan (Phander Valley & Ghizer District) on August 17- 23, 2024**


**55th QMS requirement and Implementation Course-ISO Based held on September 23-24, 2024**


**29th QMS Training Course for Staff Members held on September 25, 2024**

**39th Postgraduate Training Course on "The use of Nuclear and Other Techniques in Food and Agricultural Research" held on October 14-18, 2024**


**Breast Cancer Awareness Seminar held on October 29, 2024**

**2nd Surveillance Certification audit of NIFA against ISO 9001:2015 QMS standard held on November 13-14, 2024**



**IAEA National Training Course on "Climate Smart Agricultural Practices for Bridging Yield Gap of Major Crops Using Nuclear Science and Technology" held on December 9-13, 2024**

**Workshop on "Mushroom Farming Popularization as Cottage Industry" held on December 19, 2024**

**Presenting cash Eidi to NIFA's Christian Employees on December 24, 2024**

# DAMAGES DUE TO HEAVY RAIN

**Damages due to heavy rain on August 8, 2024**

# MAY 2024 CELEBRATIONS

Dr. S.Tariq Shah, PS

Mr. Israr Khan, Foreman

Ghulam Akbar, General Attendant

# DEVELOPED FACILITIES & RECEIVED EQUIPMENT/IMPLEMENTS





**Upgradation of Analytical Facilities with Installation of Four New Lab Equipment (Double Beam Spectrophotometer, Flame Photometer, pH Meter, EC Meter) in S&ESD**

**Upgradation of Facilities with Installation of GC MS unit in FND**

# OFFICIAL VISITS


**Visit of Mr. Abid Burki, Director Audit, PAEC, HQs for NIFA Internal Audit Discussion from 30-01-2024**


**Civil Servant Officers of National Institute of Management (NIM) Peshawar visited NIFA on February 01, 2024**


**Visit of Sr. Director Admin PAEC HQ to NIFA on 13-02-2024**


**Laboratory Technicians of Nutritional International visited NIFA on February 20, 2024**

**Participants of Travelling Wheat Seminar visited NIFA Research Farm on March 05, 2024**


**Director LAD PAEC & Director Admin. PIEAS visited NIFA on May 22, 2024**

**Director (R&D) SPD Brig.(R) Ch. Nadeem Bashir Visited NIFA on June 28, 2024**

**Dr. Zahid Mukhtar DG (Agri. & Biotech.) PAEC visited NIFA on October 23, 2024**


**Senior Civil Officers of National Institute of Public Administration (NIPA) Peshawar visited NIFA on November 13, 2024**

# EDUCATIONAL TRIPS TO NIFA


**Students & Faculty's College of Home Economics, University of Peshawar visited on February 22, 2024**


**Students & Faculty's College of Home Economics, University of Peshawar visited on April 25, 2024**

**Students & Faculty's University of Poonch, Azad Jammu and Kashmir (AJK) visited on May 02, 2024**

**Students & Faculty's Women University, Mardan visited on May 29, 2024**

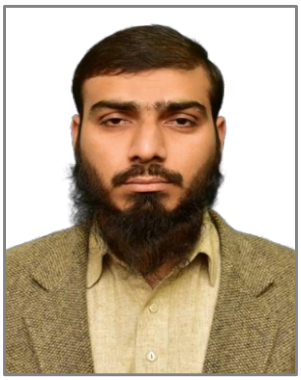
**Students & Faculty's Government Home Economics College, Nowshera on May 30, 2024**

# EXCURSION TRIPS


**Excursion trip of NIFA Employees to Naran Kaghan on August 05, 2024**

# TRANSFERS/POSTINGS

Transfer IN : **WELCOME**



Mr. Qadeer Ahmed, SS
From KCI
06-02-2024

Mr. Yasir Anwar, PS
From PINSTECH
04-03-2024

Mr. M. Naseer Khan, SSA
From C3
06-02-2024

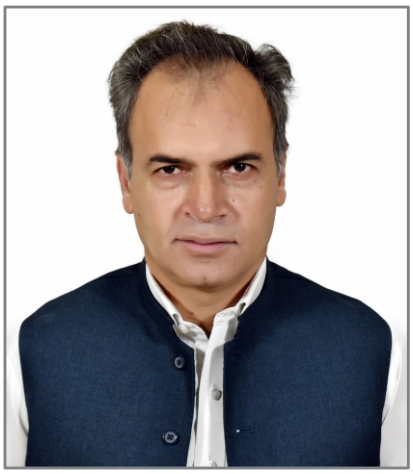
Mr. Aamir Iqbal, SCO
From DEUP-I
18-03-2024

Mr. Shahzad Mirza,
JE-I (Admin)
From MDP
06-02-2024

Mr. Kamran Rehmat,
Sanitary Attendant
From INOR Abbottabad
09-09-2024

Mr. Naseer Ahmad,
Supdt
From ICCC Islamabad
08-09-2024

Transfer OUT : **ALLAH HAFIZ**



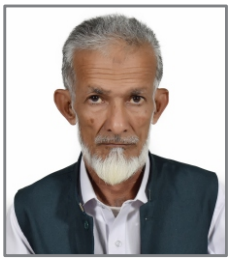
Mr. Sajjad Hassan, Supdt
To IRNUM Peshawar
02-08-2024

Mr. Saeed Ullah, Supdt
To PAEC HQ
04-09-2024

Mr. Umar Javed, JE-I (Admin)
To PAEC HQ
04-09-2024

Mr. Shahid Akbar Khalil, PS
To NIA Tandojam
29-11-2024

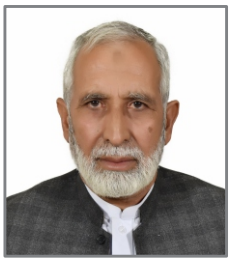
# RETIREMENTS / RELIEVING



Mr. Essa Khan,
Pr. Scientific Assistant
Retired on 03-01-2024

Mr. Robin Rauf,
Sr. Sanitary Attendant
Retired on 16-02-2024

Mr. Aurangzeb
Pr. Scientific Assistant
Retired on 10-03-2024



Mr. Arshullah
Sr. Assistant (Admin)
Retired on 15-04-2024

Mr. Mukhtiar Ali
Pr. Scientist
Retired on 01-05-2024

Mr. Sadaqat Khan
Stenographer
Retired on 12-05-2024

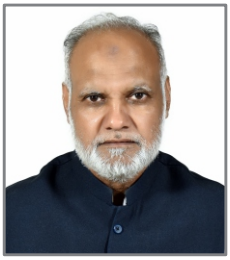
Mr. Ghaffar Ali
Research Associate
Retired on 09-06-2024

Mr. Iqbal Gill,
Sr. Sanitary Attdt.
Retired on 03-07-2024

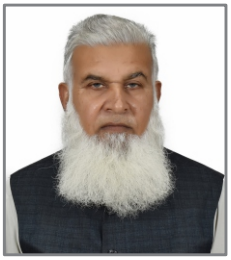
Mr. Mukhtaj Gul,
General Attdt-I
Retired on 04-07-2024

Dr. Inamullah Khan,
Deputy Chief Scientist
Retired on 20-07-2024

Mr. Saif-ur-Rehman,
Supdt.
Retired on 25-09-2024



Dr. Muhammad Imtiaz
Deputy Chief Scientist
Retired on 20-10-2024



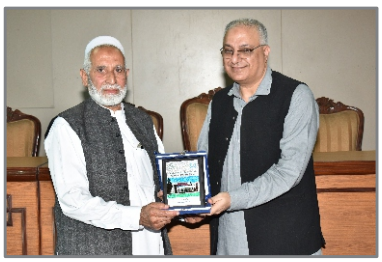
Mr. Naseem Khan
Pr. Technician
Retired on 10-12-2024

# FAREWELL ON RETIREMENT

Mr. Essa Khan
Pr. Scientific Assistant

Mr. Robin Rauf
Sr. Sanitary Attendant

Mr. Aurangzeb
Pr. Scientific Assistant

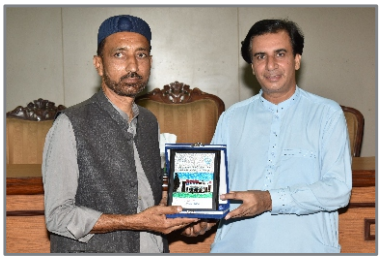


Mr. Arshullah
Sr. Assistant (Admin)

Mr. Mukhtiar Ali
Pr. Scientist

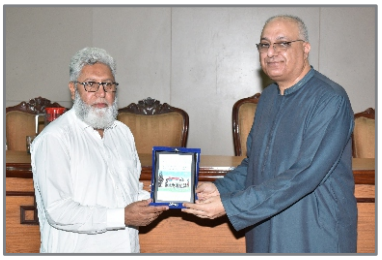
Mr. Sadaqat Khan
Stenographer

Mr. Ghaffar Ali
Research Associate



Mr. Iqbal Gill
Sr. Sanitary Attendant

Mr. Mukhtaj Gul
General Attendant



Dr. Inamullah Khan
Deputy Chief Scientist

Mr. Saif-ur-Rehman
Supdt

Dr. Muhammad Imtiaz
Deputy Chief Scientist


Mr. Naseem Khan
Pr. Tech

# SAD DEMISE OF NIFA EMPLOYEES


**Mr. Raza Khan (Ex SA-II) (27-02-2024)**

**Mr. Sher Ali (Ex SA-II) (16-03-2024)**

**Mr. Ibrar-ud-Din (Ex G.Attdt) (05-12-2024)**

# SCIENTIFIC EVENTS CALANDER 2025

## NUCLEAR INSTITUTE FOR FOOD AND AGRICULTURE (NIFA) PESHAWAR

**ISO 9001 : 2015 Certified**

### Scientific Events Calendar 2025

**February 25, 2025**

NIFA Farmer's Day

Organizers

| | |
|---|---|
| Dr. Roshan Zamir, DCS | 0301-8580109 |
| Dr. Syed Tariq Shah, PS | 0333-9169298 |
| | stariq81@yahoo.com |
| Dr. Salman Ahmad, PS | 0321, 5797387 |

**April 23, 2025**

Workshop on "Use of Electron Beam and X-rays Technology and Qualitative Analysis of Added Micronutrients in Foods"

Organizers

| | |
|---|---|
| Dr. Zahid Mahmood, PS | 0333-5033898 |
| | zahidnifa@gmail.com |
| Mr. Alamgeer Khan, PS | 0346-9322294 |

**May 21, 2025**

One-Day Workshop on "Application of Bio-control Techniques for the Management of Insect Pests of Vegetables"

Organizers

| | |
|---|---|
| Muhammad Zahid, DCS | 0332-9201361 |
| | zahidnifa200028@yahoo.com |
| Usman Khalique, JS | 0301-9401154 |

**July 16, 2025**

Workshop on "Balanced Application of Fertilizers for Enhancing Productivity"

Organizers

| | |
|---|---|
| Dr. Syed Azam Shah, DCS | 0346-9072113 |
| | azamsbpn3@gmail.com |
| Dr. Amir Raza, PS | 0324-5089725 |

**September 24, 2025**

One-Day Workshop on "Managing Fruit Flies, Termites and other Trade-Related Insect Pests"

Organizers

| | |
|---|---|
| Dr. M. Hamayoon Khan, PS | 0333-9227687 |
| | mhkhan170@gmail.com |
| Dr. M. Misbah ul Haq, PS | 0300-5511402 |

**October 13-17, 2025**

40th Postgraduate Training Course on "The Use of Nuclear and Other Techniques in Food and Agricultural Research"

Organizers

| | |
|---|---|
| Dr. Muhammad Amin, PS | 0333-9156518 |
| | aminkanju@gmail.com |
| Dr. Haroon Shahzad, JS | 0323-6038220 |

**November 18, 2025**

Management of Dengue Vectors/Mosquitoes Using Conventional and Advanced Nuclear Techniques

Organizers

| | |
|---|---|
| Dr Gul Zamin Khan, DCS | 0331-3811979 |
| | gulzaminkhan@yahoo.com |
| Dr. M. Misbah ul Haq, PS | 0300-5511402 |

**December 23, 2025**

Workshop on "Popularization of Solar Drying and Mushroom Farming"

Organizers

| | |
|---|---|
| Dr. Maazullah Khan, DCE | 0300-5834039 |
| | maaznifa@yahoo.com |
| Dr. Muhammad Ibrahim, PS | 0334-9180642 |

P.O. Box 446, Peshawar, 25000 Ph: 091-2964873 Fax: 091-2964059
E-mail: mails@nifa.org.pk
www.nifa.org.pk

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NIFA Raya-T24


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