PART-A) RESEARCH

I. TOBACCO RESEARCH STATION (TRS), MARDAN

1. BOTANY SECTION

A. PLANT BREEDING & GENETICS

TITLE NO. 1: DETAILED PROFILING/CHARACTERIZATION OF FCV GENE POOL AT THE MORPHOLOGICAL, PHYSIOLOGICAL, CHEMICAL, AND MOLECULAR LEVELS

Rationale

Screening and characterization of gene pool or available genetic resources is one of the most important prerequisites for initiating any breeding scheme and for achieving targeted traits in a resulting breeding line, hybrid, or a variety. Also, it's very important to know that the existing gene pool is genetically diverse as more diversity offers the combination of different traits and most of them can be helpful for their accumulation in breeding lines. Therefore, this experiment is designed to characterize the existing tobacco gene pool at the morphological, physiological, chemical, and molecular levels for availing the best and genetically diverse parental material for variety development. A list of gene pool varieties to be studied during this experiment is given in table 1.

Table 1: List of FCV gene pool varieties

S.No	Tobacco type	Name	Year of collection
1	FCV	SPT-G-227	-
2	FCV	NC-606	2017
3	FCV	SPT-G-234	2017
4	FCV	KHG-21	2017
5	FCV	K-51E	2017
6	FCV	SL-68	2017
7	FCV	KHG-21	2018
8	FCV	SPT-G-220	2018
9	FCV	RG-13	2018
10	FCV	SPT-G-117	2018
11	FCV	SL-168	2018

12	FCV	RG-17	2018
13	FCV	SPT-G-126	2018
14	FCV	OX-940	2018
15	FCV	KHG-26	2018

This experiment will be comprised of three years (2021-2023). Detail objectives for each year are given below:

I. 1st Year: Field characterization and seed multiplication

Some of the obsolete varieties in the FCV gene pool may possess the germination issue in the field while storing in the existing storage condition. To avoid any failure in this experiment, the first year will be devoted to seed multiplication and agro-chemical characterization of germinated varieties.

II. 2nd Year: Screening of varieties and pollen viability

During the 2nd year, detailed screening of all gene pool varieties will be performed for their agrochemical parameters. Also, pollen viability will be studied in all gene pool varieties to check the pollen vigour. Pollen in flowering plants is one of the most crucial tissues, which determines the fate of substantial developmental stages of the plant including pollination, fertilization, and seed development. Also, different varieties within the same genus have variable responses towards pollen viability. This becomes sometimes difficult during field crossing as different varieties have different pollen viability, which can lead to the loss of important pollen sources. Therefore, it is very important to characterize the available breeding germplasm for pollen viability so that a complete database before initiating any breeding scheme should be available and crossing can be planned accordingly. Therefore, the existing gene pool varieties will be assessed for their pollen viability by using an *in vitro* basic Brewbaker germination medium (Brewbaker and Kwack 1963a). The composition of this medium is given in table 2:

Table 2: Components of basic Brewbaker germination medium

Components	**(mg/L)**
Boric acid (H_3BO_3)	100
Calcium nitrate ($CaNo_3)_2.4H_2O$	300
Magnesium sulphate ($MgSO_4.7H_2O$)	200
Potassium nitrate (KNO_3)	100
Sucrose	10%
Polyethylene glycol 4000	-

However, modifications in this medium may be expected in case if it didn't work on available FCV varieties.

Time course experiment

To assess the viability a time course experiment will be followed in which pollen germination will be calculated at 0hr, 2hrs, 4hrs, and 6hrs. Pollen will be stored in a glass petri dish as a bulk sample at room temperature. Sub-sampling will be done from this stored pollen and data of germination % will be recorded by using the following formula:

$$\text{Germination\%} = \frac{\text{Number of germinated pollen grains} \times 100}{\text{Total number of pollen grains}}$$

III. 3rd Year: DNA profiling and finalizing the parental material

During 3rd year, the screened gene pool will be subjected to DNA profiling and genetic diversity will be assessed by using SSR (simple sequence repeats) markers. DNA of tobacco varieties will be extracted by following a CTAB method of DNA extraction as described in (Bansal et al. 2014) with little modifications. SSR primers for this study will depend on their availability and reproducibility on existing tobacco gene pool varieties.

TITLE NO. 2: EVALUATION OF FCV EXOTIC HYBRIDS UNDER AGRO-CLIMATIC CONDITIONS OF KPK

Importance

Unfortunately, the indigenous tobacco varieties of FCV tobacco don't meet the standards of the international tobacco market. Therefore, the tobacco industry is exporting hybrids from other tobacco-producing countries to gain the best price of tobacco leave and hence contributing to Pakistan's economy. However, before recommending any hybrid for general cultivation, it is very important to evaluate the exotic hybrids under the agro-climatic conditions of Pakistan. Therefore, this experiment will be laid out to check the performance physio-chemical performance of FCV exotic hybrids in the KPK region.

Plant material

Six FCV hybrids including RJR-603, RJR-602, RJR-213, RJR-217, RJR-215, RJR-902, and 2 checks (SPT-G-28 and K-399)

Experimental layout

Randomized Complete Block (RCB) with three replications having plant to plant and row to row distance of 2ft and 3ft, respectively

Parameters to be studied

1. Germination %
2. Days to flower initiation
3. Days to 50% flowering
4. Days to flower completion
5. Plant height (cm)
6. Leaf area (cm^2)
7. Internodal distance (cm)
8. Green weight (Kgs)
9. Green leaves Kg^{-1}
10. Cured weight (Kgs)
11. Cured leaves Kg^{-1}
12. Nicotine (%)
13. Reducing sugar (%)

Duration

This year was supposed to be the third year of this experiment but due to a hailstorm in previous cropping season, a crop was completely damaged. Therefore, it will be repeated again, and this year and it will be the 2nd year of this trial and if two years of data will be required then 2022 will be the concluding year for this experiment.

Statistical Analysis

The data for all the experiments, where required will be statistically analyzed by using a statistical package R (version 3.6.1) for the analysis of variance (ANOVA) and for post hoc analysis for significant pairwise comparison (Pinheiro et al. 2011).

TITLE NO. 3: EVALUATION OF RECOMBINANT HOMOZYGOUS LINES AS COMPARED TO STANDARD VARIETIES FOR DEVELOPMENT OF FCV VARIETIES

Importance

Deterioration and depletion of existing indigenous tobacco varieties is one of the pathetic situations for the tobacco industry of Pakistan. Therefore, it is very important to develop the FCV varieties and to broaden the genetic base of this important cash crop in order to achieve maximum gain from tobacco export. For this purpose, eight homozygous recombinant inbred lines have been developed from the locally made cross to develop an FCV variety/s for disease and drought resistance.

Filial generation

This year F_7 seed will be grown to get F_8 progeny. Due to last year's hailstorm the F_8 progeny was completely damaged therefore to avoid any generation missing, F_7 seed will be grown again for studying the required parameters.

Plant material

Eight homozygous recombinant inbred lines designated as E_1-E_8 and two checks ncluding SPT-G-28 and K-399

Focal Persons

Breeder: Dr. Qaizar Ahmed, Assistant Botanist and Breeding staff of Tobacco Research Station, Khangarhi, Mardan.

Experimental layout

Randomized Complete Block (RCB) with three replications having plant to plant and row to row distance of 2ft and 3ft, respectively,

Parameters to be studied

1. Germination %
2. Days to flower initiation
3. Days to 50% flowering
4. Days to flower completion
5. Plant height (cm)
6. Leaf area (cm^2)
7. Internodal distance (cm)
8. Green weight (Kgs)
9. Green leaves Kg^{-1}
10. Cured weight (Kgs)
11. Cured leaves Kg^{-1}
12. Yield (Kg/Hac)
13. Nicotine (%)
14. Reducing sugar (%)

General Activity: Seed Production Plot of FCV standard varieties

This activity by breeding section will be carried out to renew the seed of FCV standard varieties SPT-G-28 and K-399. Therefore, these two varieties will be grown in Buner and Hazro depending upon the land availability.

B. RUSTICA TRIALS

TITLE NO 1: RUSTICA VARIETAL EVALUATION TRIAL

Objective

To check the performance of 11 Rustica varieties under agro-climatic conditions of Mardan for various physiological parameters.

Plant Material

11 Rustica varieties viz; Rustica Swabi, Rustica-18, Rustica Bubak, Rustica 9 and Toba Tek Singh, Rustica-13, Rustica Rasool abad, Rustica-19, Rustica Jampur, Rustica Hazro, Rustica-14

Experimental Design

Randomized Complete Block Design with three replications having plant to plant and row to row distance of 30 and 45 cm, respectively.

Responsible Officers Rustica Botanist and Assistant Botanist

Location Tobacco Research Station, Khangarhi Mardan

Parameters to be studied

1. Germination %
2. Plant Height (cm)
3. No. of Leaves Plant^{-1}
4. Leaf Area (cm^2)
5. Internodal distance (cm)
6. Green Weight Plot^{-1}(Kg)
7. Green Leaf Kg^{-1}
8. Cured Weight Plot^{-1} (Kg)
9. Cured Leaf Kg^{-1}
10. Cured Yield hectare $^{-1}$ (Kg)
11. Nicotine %
12. Reducing Sugar %

RESULTS OF PREVIOUS YEARS WORK

Treatment	Yield (Kg/ha)	Nic%	R.S %	Treat.	Yield(Kg/ha)	Nic%	R.S %
R-Rasoolabad	4616	**3.35**	**5.2**	**R-Bubak**	5185	**3.55**	**5.5**
Rustica Hazro	3771	**3.27**	**5.0**	**R9**	4531	**3.31**	**5.2**
Rustica-19	**5816**	**3.42**	**5.3**	**R18**	4304	**3.19**	**5.4**
R-Jampur	5203	**3.29**	**5.4**	**R13**	5183	**3.64**	**5.3**
Rustica-14	4899	**3.31**	**5.2**	**Swabi**	**5595**	**3.66**	**5.4**

TITLE NO 2: RUSTICA TOPPING HEIGHT TRIAL

Introduction

Tobacco inflorescence is one of the dormant bud which reduces the yield and quality of the tobacco crop. Topping is an essential cultivating measure for tobacco, which shifts the plant from reproductive to vegetative phase. Topping and Desuckering are two most important methods in tobacco crop production, Suckers develop in tobacco plants from the shoots. The unwanted suckers grow with tobacco plants after topping and compete for food, light, moisture and space so nutrient and yield can be improved in these plants by practicing these techniques otherwise these nutrients will be consumed by inflorescence and suckers.

Topping stimulates root growth, the source of nicotine, which improves drought tolerance. In addition, topping and suckering of tobacco plant are used to improve growth, yield and quality of upper leaves, larger size and weight, increased alkaloid levels and cleanness from insects. The plant also stands firmer because of increased root growth and trimmed top. It stimulates the production of secondary plant products that accumulate in the leaves. These products give the cured leaf improved quality and smoking characteristics. Topping lowers the population of several insects that are attracted to the plant by the flowers due to alkaloid contents. Whenever the tobacco are topped late, there will be increase in the number of pre-topping suckers which must be removed to improve Morphology, Physiology, and Chemistry of a tobacco plant.

A field experiment will be carried out on the "comparative effect of topping height on yield and quality of Rustica tobacco" at the Tobacco Research Station, Khan Garhi, Mardan, using randomized complete block design replicated thrice. Treatments included (T1: 10 leaves, T_2 :12 leaves, T_3: 14 leaves) by sowing one conventional variety of Rustica 13, with following detail:

Variety Rustica-13

Treatments T_1: 10 leaves

T_2: 12 leaves

$T_{3:}$ 14 leaves

Design RCBD with three replications

Objective

- To set the optimum stage for topping for Rustica crop.
- To determine difference in yield and chemical properties of cured leaves due to varying the height of topping.

Person associated Rustica Botanist/Assistant Botanist

Parameters

1. Germination %
2. Plant Height (cm)
3. No. of Leaves $Plant^{-1}$
4. Leaf Area (cm^2)
5. Internodal distance (cm)
6. Green Weight $Plot^{-1}$(Kg)
7. Green Leaf Kg^{-1}
8. Cured Weight $Plot^{-1}$ (Kg)
9. Cured Leaf Kg^{-1}
10. Cured Yield hectare $^{-1}$ (Kg)
11. Nicotine %
12. Reducing Sugar %

LAST YEAR RESULTS TABLE

Treatments	Yield (kg/ha)	Nicotine (%)	Reducing Sugar Contents (%)
T_1 (10 leaves)	4912	**3.53**	**4.9**
T_2 (12 leaves)	5552	**3.45**	**5.1**
T_3 (14 leaves)	6320	**3.38**	**5.3**

The above table revealed that maximum yield was observed in T_3 (6320kg/ha) at one location (Tobacco Research Station, Mardan)

TITLE NO. 3: EFFECT OF DIFFERENT METHODS OF ZINC APPLICATION ON YIELD AND QUALITY OF TOBACCO

Zinc (Zn) is an essential micronutrient that plays fundamental roles in crop resistance against the drought stress by regulating various physiological and molecular mechanisms. Under drought stress, Zn application improves seed germination, plant water relations, cell membrane stability, osmolyte accumulation, stomatal regulation, water use efficiency and photosynthesis, thus resulting in significantly better plant performance. Moreover, Zn interacts with plant hormones, increases the expression of stress proteins and stimulates the antioxidant enzymes for counteracting drought effects.

Zinc is an indispensable micronutrient for crop growth, an important component of carbonic anhydrase and a stimulator of aldolase, which are involved in carbon metabolism. Zn is also an integral component of several biomolecules such as lipids, proteins and co-factor of auxins, and, therefore, it plays an important role in plant nucleic acid metabolism. Zn application has been proved beneficial in improving crop yield and quality, while its deficiency reduces yield and deteriorates crop quality.

Interactions occur between the micronutrients and some macronutrients. Phosphorus-Zn interactions i.e. Nitrogen-Zn, Macronutrient cations-Zn interaction (Macronutrient cations such as Ca, Mg and K inhibit the absorption of Zn by plants from solution.), Copper-Zn and Iron-Zn interaction, therefore zinc may increase availability of NPK to the plants.

By keeping in view the above significances, An experiment will be conducted to find out the response of various methods of Zn application on the final produce and quality of the tobacco variety K-399 and Rustica 14/Rustica 13.

Treatments

Five different application methods:

1. Soil application at (3 and 6 kg Zn ha $^{-1}$)
2. Foliar spray (2 and 4 kg Zn^{-1})
3. root dipping (2% and 5% Zn suspension for 24 hrs) at the time of transplantation
4. Seed priming 3 and 6 kg Zn for 24 hrs
5. Fertigation (3 and 6 kg Zn-1)
6. Control (without Zn)

Zn will be taken from ZnSO4 along with Nitrogen, Phosphorus and Potash in the form of compound fertilizer i.e. NPK (12:15:18).

Varieties Rustica-14 and FCV (K-399)

Design RCBD with three replications

Responsible Person Rustica Botanist/Assistant Botanist

Duration 3 years

Parameters:

1. Germination %
2. Germination rate
3. Plant Height (cm)
4. No. of Leaves Plant^{-1}
5. Leaf Area (cm^2)
6. Internodal distance (cm)
7. Green Weight Plot^{-1}(Kg)
8. Green Leaf Kg^{-1}
9. Cured Weight Plot^{-1} (Kg)
10. Cured Leaf Kg^{-1}
11. Cured Yield hectare $^{-1}$ (Kg)
12. Nicotine %
13. Reducing Sugar %
14. Zn concentration in leaf
15. Zn concentration in soil (before and after transplantation) and seed respectively
16. Length of plant (Nursery)
17. Leaf area (Nursery)

TITLE NO. 4: RUSTICA SEED PRODUCTION PLOT

In order to multiply the seed of Rustica standard variety Rustica 13 & Rustica 14 with maximum genetic purity, the seed production plot will be raised in Tobacco Research Station Mardan.

TITLE NO. 5: EFFECT OF DIFFERENT GROWTH REGULATORS BY OSMO-PRIMING ON THE YIELD AND QUALITY OF TOBACCO

Introduction

Seed priming is the controlled hydration process followed by re-drying that allows all metabolic activities before germination but prevents radical emergence. It is applied to minimize the germination period and enhance germination percentage. Seed priming is frequently used in the tobacco seed industry to increase seed germination rate and uniformity and to overcome temperature imposed dormancy. Seed priming is a germination enhancement technique used to modify physiological events during germination or early seedling growth. It allows the uptake of water to initiate the early events of germination, but the seed is allowed to dry before the radical begins to grow. The goals of priming are to increase the germination rate, increase germination percentages, allow germination over a broader range of environments, and improve seedling vigor, which would ultimately promote more uniform seedling emergence, higher yield, better drought tolerance & better growth of plants due to establishment of a good root system.

Objectives

i. To enhance germination percentage, germination rate and to overcome germination period in tobacco seeds.
ii. To check the response of primed tobacco seeds against unprimed seeds
iii. To set optimum dose of growth regulators on tobacco seeds for better germination
iv. To check the effect of osmopriming and growth regulator on yield and quality of tobacco

MATERIAL & METHODS:

Seed Material

Tobacco Seeds
KNO_3
$CaCl_2$

Methodology

The seeds of Speight-G-28/k-399 and rustica 14 will be used in this experiment. For osmopriming, Seeds of tobacco will be taken and after seed sterilization, the following pre-sowing seed treatments will be done:

- Untreated seeds (Control)
- Seed primed in 100 mM KNO_3 (12 hr)
- Seed primed in 100 mM $CaCl_2$ (12 hr)
- Seed primed in 100 mM KNO_3 (24 hr)
- Seed primed in 100 mM $CaCl_2$ (24hr)

The seed will be soaked in the above priming agents for 12 and 24 h respectively.

- **Fresh seeds will be sown** to gain uniform seedlings for transplantation and yield and quality of tobacco.

Parameters

1. Germination %
2. Germination rate
3. Allometry
4. Stand establishment
5. Seedling Vigor Index
6. Plant Height (cm)
7. No. of Leaves $Plant^{-1}$
8. Leaf Area (cm^2)
9. Internodal distance (cm)
10. Green Weight $Plot^{-1}$(Kg)
11. Days to germination
12. Green Leaf Kg^{-1}
13. Cured Weight $Plot^{-1}$ (Kg)
14. Cured Leaf Kg^{-1}
15. Cured Yield hectare $^{-1}$ (Kg)
16. Nicotine %
17. Reducing Sugar %

Possible Outcomes

On completion of this experiment there may be following possible outcomes:

1. Cost of production may be reduced by enhancing the germination percentage and reducing time between germination and seed sowing and at the end yield and quality may be increase as uniform and viable seeds leads to increase production.
2. To improve the tobacco cultivar against stress (drought, temperature) through osmopriming.

TRIAL NO: 6: <u>STUDYING THE IMPACT OF GROWTH REGULATORS ON BREAKING DORMANCY OF FCV OBSOLETE VARIETIES</u>

Seed priming is a germination enhancement technique used to modify physiological events during germination or early seedling growth. It allows the uptake of water to initiate the early events of germination, but the seed is allowed to dry before the radical begins to grow.

Objectives

The goals of priming are to increase the germination rate, increase germination percentages, allow germination over a broader range of environments, and improve seedling vigor, which would ultimately promote more uniform seedling emergence, higher yield, better drought tolerance & better growth of plants due to establishment of a good root system.

Treatments

1. Untreated seeds (Control)
2. Seed primed in 100 mM Water (12 hr)
3. Seed primed in 100 mM Water (24 hr)
4. Seed primed in 100 mM KNO_3 (12 hr)
5. Seed primed in 100 mM KNO_3 (24 hr)
6. Seed primed in 100 mM $CaCl_2$ (12 hr)
7. Seed primed in 100 mM $CaCl_2$ (24hr)

Varieties

10 varieties from gene pool which germination was completely failed upon checking in vitro.

Duration One year

Responsible person Rustica Botanist and Assistant Botanist

Parameters:

- Germination %
- Germination rate
- Allometry
- Stand establishment
- Seedling Vigor Index
- No. of Leaves seedlings^{-1}

2. CHEMISTRY SECTION

TITLE NO. 1: <u>EVALUATION OF VARIOUS LEVELS OF NPK FERTILIZER ON FLUE CURED VIRGINIA TOBACCO FOR HIGH YIELD AND GRADE INDEX</u>

Importance

Tobacco belongs to family Solanaccae and genus Nicotiana. The widely cultivated species of Nicotiana are (*Nicotiana tabacum* L. and *Nicotiana rustica* L.). All over the world these species are cultivated as cash crop. The quality and yield of flue-cured tobacco (FCV) depends upon the soil texture, fertilization, depth of plough and nitrogen content of soil. The soils vary widely in physico-chemical properties and nutrients profile which considerably influences the type, grade and quality of FCV tobacco. Higher sugar and lower nicotine are obtained by the application of 60 and 70kg Nitrogen/Hectare (Chari *et al.* 1994).Nitrogen increases the vegetative growth of plants. Soil rich in Phosphorus content gave the highest cured leaf yield and quality of tobacco, if 112 kg N+112 kg P_2O_5 +112 kg K_2O/ha are applied. Potassium (K) balances the sugar-nicotine ratio and increases the yield and quality of tobacco (Hardter and Yuhong, 2000).

Objectives

- To study the effect of various formulations of NPK fertilizer on the yield and quality of Flue Cured Virginia tobacco.
- To evaluate the high yielding and best quality formulation for tobacco growers.

Persons associated Chemistry Section Tobacco Research Station, Mardan.

Duration 3 years.

- Year of Initiation: 2021-2022
- Year of completion: 2023-2024.
- This will be the 1st year of the research trial.

Economic impact

Finding out proper formulation of NPK fertilizer to FCV Tobacco for:

- Increase yield
- Improve quality and grade index

Detail work plan Design: Split-plot Design with three replications and six treatments.

S. No	Treatments Codes	Ratio	Kg/ha
		NPK	NPK
1.	T_0	12:12:18	60:60:90
2.	T_1	15:12:18	75:60:90
3.	T_2	17:12:18	85:60:90
4.	T_3	12:15:18	60:75:90
5.	T_4	12:17:18	60:85:90
6.	T_5	12:19:18	60:95:90
7.	T_6	12:17:15	60:85:75
8.	T_7	12:17:17	60:85:85
9.	T_8	12:17:19	60:85:95

Variety K-399/PVH2310.

Procedure

NPK recommended fertilizer 28gm/plant and other formulation doses will be made from straight fertilizers will be applied in split doses. Half dose will be applied in first week after transplantation and the remaining half dose will be applied after stress period (re-ridging). All recommended agronomic practices will be applied.

Parameters to be studied

- Plant Height (cm)
- Leaf Area (cm^2)
- No of Leaves/plant
- Green weight (kg/ha)
- Cured weight (kg/ha)
- Reducing Sugar (%)
- Nicotine (%)
- Grade index
- Cost benefit ratio of fertilizers

Requirements

Land, labour, fertilizer and pesticides etc. will be provided by Farm Manager, while soil and leaf analysis will be carried out at Chemistry laboratory of Tobacco Research Station, Mardan.

TITLE NO. 2: EFFICACY OF DIFFERENT PESTICIDES AND THEIR RESIDUAL EFFECT ON TOBACCO CROP

Importance

The use of insecticides and pesticides has increased during the past 3-4 decades and tobacco stakeholder's companies' also facing problem in export tobacco due pesticides residual effect. Pesticide residue refers to the pesticides that may remain on or in food after they are applied to harvesting. The maximum allowable levels of these residues are often stipulated by regulatory bodies in many countries. Each country adopts their agricultural policies and Maximum Residue Limits (MRL) and Acceptable Daily Intake (ADI).

Objectives

- To check the efficacy of pesticides (Insecticides, Herbicides & Fungicides)
- To check the residual effect of pesticides after 20 days of its application on green leaves and then after curing of FCV tobacco leaves

Economic impact

Finding out efficient and below MRLs of pesticide/weedicide/suckericide in FCV Tobacco for:

- Control of insects, pests and weeds
- To enhance tobacco export

Duration 3 years

- Year of Initiation: 2021-2022
- Year of completion: 2023-2024.
- This will be the 1st year of the research trial.

Variety K-399/PVH2310

Design RCBD design with 8 treatments and 4 replications

Treatments

T_1: Cypermethrin 10% EC

T_2: Lufenuron 5% EC

T_3: Emamectin Benzoate 1.9% EC

T_4: Pendimethalin 330% EC

T_5: Metolachlor 960% EC

T_6: Flumetralin 12.5% EC

T_7: Carbendazim 50% WP

T_8: Control

Methodology of Pesticides Application

All pesticide will be applied on crop as per recommended dose rate/procedure and then check the efficacy of used pesticides.

Methodology to Check Residual Effect

Above mentioned pesticides, weedicides and suckericides will be applied on tobacco crop to control insects/pests, weeds and suckers of tobacco. Recommended doses of pesticides, weedicides and suckericides will be applied in different stages, according to requirement and attack of insects/pests control. Green tobacco leaf samples will be analyzed for pesticides residues after 20 days of pesticides, weedicides and suckericides application. Similarly, residual effect of pesticides will be observed after curing on Gas Chromatograph. Collected samples will be shacked on shaker for 24 hours and then run on rotary evaporator to collect filtrate. Different methods (procedures) will be applied for each pesticide, weedicide and suckericide residues. Their MRLs will be checked and compared.

Agronomic and chemical parameters will also be checked by chemistry section. These parameters are given below as;

Parameters

1: Pesticides efficacy
2: Pesticides residual effects
3: Chemical analysis of leaf
   a. Nicotine contents (%)
   b. Reducing sugar (%)
4: Cured yield (kg/ha)

Requirements

Land, labor, fertilizer, and pesticides etc. will be provided by Farm manager, while leaf analysis (chemical, pesticides residues) will be carried out at Chemistry laboratory of Tobacco Research Station, Mardan.

TITLE NO. 3: SURVEY OF TOBACCO GROWING AREAS FOR EVALUATION OF SOIL PHYSICO-CHEMICAL COMPOSITION IN KHYBER PAKHTUNKHWA

Importance

Soil fertility plays an important role on the productivity of any crop. Soil test based fertilizer recommendation will help the farmers to optimize the resources and improve the productivity.

Objectives

- To update the soil survey report as carried out in 1984-85.
- To calculate the values of the test parameters of soil (Texture, pH, EC, organic matter, available nitrogen, phosphorous, potassium and chloride.
- To test and recommend fertilizer doses for different tobacco zones.

Persons associated

Chemistry Section Tobacco Research Station Khangarhi, Mardan

Economic impact

Finding proper physicochemical composition of tobacco growing areas soil and recommend fertilizer doses to:

- Update soil survey report of 1984-85
- Improve tobacco productivity
- Improve tobacco quality

Duration: 2 years.

- Year of Initiation: 2018-2019
- Year of completion: 2021-2022.
- This will be the 2nd year of the research trial.

Procedure

Soil samples will be collected from different tobacco cultivated zones and will be analyzed in Chemistry Section Tobacco Research Station Khan garhi, Mardan for various parameters. Soil survey report will be made and updated.

Name of Station/Locality

Tobacco Research Station Khangarhi, Mardan.

Table: Survey of Tobacco Growing Areas for Evaluation of Soil Physico-chemical Composition in Khyber Pakhtunkhwa

District	Area	pH	Electrical Conductivity (dSm^{-1})	Organic Matter%	Nitrogen %	Available Phosphorus P_2O_5 ppm	Available Potash K_2O ppm	Texture
Mardan	*Shergrh*	7.6-8.2	0.31-0.53	0.27-0.61	0.04-0.10	5.40-12.48	58.00-120.00	Silt/silt Loam
	Takht Bhai	7.7-8.3	0.35-0.62	0.17-0.72	0.03-0.12	6.32-13.00	50.00-105.00	Silt/silt Loam
	Khan garhi	7.9-8.3	0.41-0.56	0.20-0.56	0.03-0.09	6.00-12.46	52.00-85.00	Silt/silt Loam
Charsada	*Mandani*	7.6-8.3	0.34-0.64	0.37-0.78	0.06-0.12	7.53-12.50	45.00-135.00	Silt/silt Loam
	Sardheri	7.7-8.2	0.44-0.67	0.28-0.69	0.04-0.11	8.23-13.97	67.00-140.00	Silt/silt Loam
Swabi	*Yar Hussain*	7.7-8.4	0.31-0.71	0.17-0.73	0.03-012	5.12-11.23	42.00-76.00	Silt/silt Loam
	Charbagh	7.5-8.1	0.26-0.72	0.27-0.84	0.04-0.13	4.56-10.44	48.00-95.00	Silt/silt Loam
	Chota Lahor	7.8-8.2	0.15-0.54	0.40-0.92	0.06-0.15	5.62-11.73	50.00-115.00	Silt/silt Loam
Buner	*Chamla*	7.0-7.9	0.30-0.67	0.34-0.83	0.05-0.14	6.00-13.40	70.00-112.00	Loam/ Sandy Loam
Mansehra	*Baffa*	6.9-7.8	0.19-0.51	0.38-0.78	0.06-0.12	7.45-14.02	65.00-105.00	Loam/ SandyLoam

Table-4, showed that soil samples of the above areas of Mardan, Charsada, Swabi, Buner and Mansehra were analyzed for physico-chemical characteristics in 2018-19, while soil samples of some tobacco growing areas i.e Jamal Jarhi, Swat, Buner (Swari), Sharifabad, Mansehra etc. will be collected for analysis during 2020-21.

3. PLANT PROTECTION SECTION

A. PLANT PATHOLOGY

TITLE NO. 1: EVALUATION OF FUNGICIDES AGAINST SOIL-BORNE DISEASES OF TOBACCO SEED BED

Importance

Soil-borne diseases are those plant diseases caused by pathogens who inoculate the host by way of soil. Examples of such diseases are damping-off, root rot disease and black shank etc. Damping off is a major disease which effects seedlings and is caused by a fungus named as *Pythium*. Chemical control via fungicides is the quick response management strategy against onset of fungal diseases which reduces the incidence of disease below economic threshold level (ETL).

Objective

To test the efficacy of fungicides against soil born diseases under natural conditions.

Person Associated: Assistant Plant Pathologist

Duration: 3 years.

i. Year of initiation : 2021-2022

ii. Year of completion : 2023-2024

iii. This will be the 1st year of the trial.

Treatments

1. Fosetyl Aluminum
2. Pyraclostrobin
3. Iprodione
4. Control

Requirements

1. Land
2. Labor (manpower)
3. Fungicides

Parameter(s)

1. Disease incidence (%) will be recorded for each treatment.

Experimental Layout

- For this trial, Randomized Complete Block Design (RCBD) will be applied.
- Four replications will be done.

Detailed Work Plan

1. Above mentioned fungicides for soil born diseases will be collected and their solutions at recommended doses will be prepared.
2. Fungicides will be sprayed in diseased plot.
3. After one week of spray, disease incidence will be examined.

Economic Impact

This project will follow a curative approach and help to minimize the disease damage for tobacco growers. Moreover, it will also help to minimize the expenditure of chemical control with lesser number of sprays.

TITLE NO. 2: EVALUATION OF CANDIDATE FUNGICIDES AGAINST BROWN LEAF SPOT DISEASE OF TOBACCO

Importance

To test the new chemical product (candidate pesticide) is the pre-requisite for registration purpose. On the basis of results of field trials, these products are recommended by the research institutes for registration.

Objective

- To test the efficacy of candidate fungicide(s) against brown leaf spot disease under natural conditions

Person Associated: Assistant Plant Pathologist

Duration: 3 years.

i. Year of initiation : 2021-2022
ii. Year of completion : 2023-2024
iii. This will be the 1st year of the trial.

Treatments

1. Fosetyl Aluminum (Standard fungicide)
2. Metiram (Candidate fungicide)
3. Control

Requirements

1. Land
2. Labor (manpower)
3. Fungicides

Parameters

1. Disease incidence (%) will be recorded for each treatment.
2. Residual effect will also be examined in laboratory

Experimental Layout

For this trial, Randomized Complete Block Design (RCBD) will be applied.

- Four replications will be done.

Detailed Work Plan

1. Above mentioned fungicides for brown leaf spot disease will be collected and their solutions at recommended doses will be prepared.
2. Fungicides will be sprayed in diseased plot.
3. After one week of spray, disease incidence will be examined.

TITLE NO. 3: <u>EFFICACY OF RUSTICA PLANT EXTRACT AND NEEM EXTRACT FOR THE CONTROL OF APHIDS ON FCV TOBACCO CROP</u>

Importance

Chemicals have hazardous effects on environment especially on living organisms. Rustica powder is reported good to control many insects. In this trial Rustica Plant extract will be used to control aphids on FCV tobacco to find out its efficacy against aphids.

Objective

To control aphid attack on Tobacco using environment friendly biological control method

Person associated Rustica Botanist & Plant Pathologist

Treatments

1. Rustica Plant Extract (2 SS)
2. Rustica Plant Extract (SS)
3. Rustica Plant Extract (SS/42)
4. Neem Extract (2SS)
5. Neem Extract (SS)
6. Neem Extract (SS/2)
7. Amida Chloprid (Control)

(**2SS**= 2 times application of Standard Solution, **SS**= Standard Solution **SS/2**= 50 % of Standard solution)

Detailed Work Plan

FCV Tobacco variety will be used in RCBD and all the agronomic practices will be adopted. Rustica plant extract in the form of solution and in the form of water solution will be applied at different concentrations and one distilled water treatment will be applied as control to compare the efficacy of Rustica plant extract /Solution to control the Aphids.

Parameters

Disease incidence (%) will be recorded for each treatment.

B. ENTOMOLGY

TITLE NO. 1: PERFORMANCE OF DIFFERENT INSECTICIDES FOR THE CONTROL OF APHID

Importance

Myzus persicae cause damage to tobacco crop from sowing of nursery till crop maturity. As a result of vigor of the plant decrease, the leaves became curled up and deformed, chlorosis occurs and thus the leaves became vulnerable to the attack of the pathogen. The present research was, therefore, designed to determined relative efficacy of different chemical insecticides against *M. persicae*.

Variety K-399

Design

RCBD design with 3 treatments and 4 replications

Treatments

T_1: Acetamiprid 20% SP

T_2: Dinotefuran (Oshin) 20 SG

T_3: Control

Methodology

Data will be recorded as below mentioned detail

- Five plants will be selected randomly.
- Leaf from middle, bottom and top will be selected and count per leaf insect eggs, larvae and adults.

Insects will be count Before Insecticide application

- After 24 hours of Insecticide application
- After 48 hours of Insecticide application
- After 72 hours of Insecticide application

Objectives

- Comparison of new chemistry pesticides with acetamiprid for the control of Aphid

Persons associated

Plant Protection Section

Duration

This will be the 2nd year of this trial (2020-2023)

RESULTS OF PREVIOUS YEAR WORK

Sr. No.	**Treatments**	**Control % (2020-21)**
1	Acetamiprid 20% SP	**74.67**
2	Dinotefuran (Oshin) 20% SG	72.83
3	Control	**-**

4. PHYSIOLOGY SECTION

TITLE NO. 1: THE EFFECT OF DIFFERENT TRANSPLANTATION DATE ON TOBACCO CONVENTIONAL VARIETIES

Tobacco (*Nicotianatobacum* L.) is a cash crop not only in Khyber Pakhtunkhwa but also in Punjab, grown for cigarette production. Tobacco is one of the few plants entering into the world trade entirely on leaf basis and most commonly grown commercial non-food plant in the world (Yousafzai *et al*., 2007). Leaf is the major economic part of the crop, harvested for processing of cigarette industry. As a researcher our main purpose is to increase the yield and quality by following conventional practicesat low cost with high productivity through best technical services for farmers. Many factors are involved in boosting the required purpose of researcher for farmers, among them one is proper date of sowing of tobacco. The optimum time for transplanting of Tobacco to the field is usually recommended in early and mid-March, but due to weather fluctuation since last few years theses varieties are required to set the proper sowing date to get good yield and quality. It is obvious that climate change has a direct impact on tobacco Productivity.

Climate change is defined as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere"

Climate variability and change in the Globe also affects the sector of industry, health, politics, and social, economic. In agricultural sector, climate change affects not only on its resources, but also on its infrastructure, production system, and security. As a country that has a basic sector of agricultural, climate change has affected agricultural productivity .As delaying or even early transplanting decreased yield, returns, total alkaloids, hexane extracts, lamina weightand percent lamina. Delaying transplanting also increased the chlorophyll content of the leaf but had no effect on reducing sugars, and only reduced grade index late in the planting season. Enhancing tobacco farmer's resilience capacity is important. Moreover, lack accessibility to climate information unable tobacco farmers to predict the precise time to plant and harvest the tobacco.

For this purpose a field experiment was conducted to evaluate the optimum transplantation date in RCBD split plot design replicated thrice having four treatments with two conventional varieties.In previous two years research data, Visual differences in tobacco at different transplanting dates were clearly discernible inthe field throughout the growing season. Atharvest, part ofthese differences was a reflection of variation in the color of the leaf. The chlorophyll content of harvested green leaves was normally greater at the early transplanting than late. In summary delaying transplanting decreased yield as well as quality.

Varieties

Following two varieties will be sown:

1. K 399
2. Spt-G28

Treatments

T_1: Last week of February

T_2: 15 March

T_3: 2nd week of April

T_4: Last week of April

$R_1V_1T_1$	$R_2V_1T_1$	$R_3V_1T_1$
$R_1V_1T_2$	$R_2V_1T_2$	$R_3V_1T_2$
$R_1V_1T_3$	$R_2V_1T_3$	$R_3V_1T_3$
$R_1V_1T_4$	$R_2V_1T_4$	$R_3V_1T_4$
$R_1V_2T_1$	$R_2V_2T_1$	$R_3V_2T_1$
$R_1V_2T_2$	$R_2V_2T_2$	$R_3V_2T_2$
$R_1V_2T_3$	$R_2V_2T_3$	$R_3V_2T_3$
$R_1V_2T_4$	$R_2V_2T_4$	$R_3V_2T_4$

Design

Spilt Plot design with three replications

Objective

- To check the response of different FCV varieties on variable transplantation dates.
- To set the optimum days for sowing for specific variety.

Person Associated

Assistant Physiologist

Parameters

1: Plant height (cm)
2: Leaf area (cm^2)
3: Green weight/plot (kg)
4: Cured weight/plot (kg)
5: No of green leaves/kg
6: No. cured leaves/kg
7: Chemical analysis of leaf
   a. Nicotine contents (%)
   b. Reducing sugar (%)
8: Total yield/ha (kg)

Duration

This will be the 3rd year of this trial

LAST YEAR RESULTS TABLE(2019-20)

Treatments	Yield(kg/ha)	Nicotine (%)	Reducing Sugar Contents (%)
V_1T_1	2862	2.80	13.43
V_1T_2	2526	2.44	14.06
V_1T_3	1636	2.47	14.43
V_1T_4	1140	2.78	12.77
V_2T_1	2380	2.62	14.61
V_2T_2	2974	2.32	13.84
V_2T_3	1496	2.77	14.43
V_2T_4	1240	2.92	13.83

The above table revealed that maximum yield was observed with V2T2 (Spt G-28 2974 kg/hac) transplanted on 22-03-2019

TITLE NO. 2. **DROUGHT TOLERANCE AMONG CONVENTIONAL FCV TOBACCO VERITIES AND DIFFERENT HOMOZYGOUS LINES**

Varieties

Following varieties and homozygous lines will be sown:

1 K-399
2 SPT-G-28
3 E-1
4 E-2
5 E-3
6 E-4
7 E-5
8 E-6
9 E-7
10 E-8

Design RCBD design with three replications

Importance

Tobacco is an agriculturally important Solanaceae crop and is one of the most studied plants as biological model system. Drought is one of the major constraints in crop production and affects 64% of the global land area. It is the most common cause of severe food shortage in developing countries. In order to improve drought responses in tobacco and other Solanaceae species, it is desirable to understand how these plants respond to drought stress at multiple levels in the plant. This allows a better understanding of primary and secondary metabolism and the interplay between transcriptional, posttranscriptional, translational and posttranslational regulation. However, there are few reports on metabolic changes in tobacco during drought stress and systems biology data that combine results from multiple different levels in the same samples appear to be lacking. Tobacco is a tropical crop in origin but it is grown in subtropical and temperate regions of the world.

The crop needs around 28°C as an optimum temperature for germination but it may germinates at a temperature ranging between 15°C to 35°C The crop cannot withstand frost and starts withering or wilting at a temperature above 35°C.Tobacco needs 50-100 cm rainfall which should be well distributed throughout growing period.Areas having a rainfall of more than 125 cm are not fit for tobacco production, whereas a rainfall of less than 75 cm results in production of leathery leaves having very high nicotine content in them.The leaves remain smaller and possess very poor burning quality.

In dry and hot season irrigation is done at the interval of 15 days . After first and second irrigation stress is necessary for the tobacco crop, in this condition the root and leaf well develop.

As above, Water Scarcitic a major issue in these days globally which also affect the agriculture sector very much in the crops yield as well as its quality. So, there is also a need in tobacco to introduce/establish a variety which has ability to grow in severe drought condition. Therefore the following trial is designed in RCBD with three replications having ten treatments to evaluate the level of drought tolerance among these lines and FCV varieties as well as to find out drought tolerant variety of tobacco.

Objective

- To check the level of drought tolerance among different available line and conventional FCV varieties.
- To check the effect of drought conditions on yield and chemical properties of tobacco.
- To find out drought tolerance variety of tobacco.

Person associated

Assistant Physiologist

Parameters

1: Plant height (cm)
2: Leaf area (cm^2)
3: Green weight/plot (kg)
4: Cured weight/plot (kg)
5: No of green leaves/kg
6: No. cured leaves/kg
7: Chemical analysis of leaf
    a. Nicotine contents (%)
    b. Reducing sugar (%)
8: Total yield/ha (kg)

Duration

This will be the 3rd year of trial

LAST YEAR RESULTS TABLE(2019-20)

Treatments	Yield (Kg/ha)	Nicotine Contents %	Reducing Sugar (%)
E1	2220	2.67	14.26
E2	2134	2.51	15.16
E3	2252	2.51	14.99
E4	2430	2.76	13.65
E5	1855	2.55	15.18
E6	2012	2.37	13.84
E7	2070	2.58	14.49
E8	2253	2.68	13.83
Spt G-28	2224	2.69	15.08
K-399	2320	2.60	16.04

Conclusion

The above table revealed that maximum yield was observed in E_4(2340 kg/ha) in somehow drought conditions.

5. AGRONOMY SECTION

TITLE NO. 1: EFFECT & COMPARISON OF MANUAL HOEING AND CHEMICAL WEEDICIDE CONTROL ON PRODUCTION OF TOBACCO (FCV)

Importance

Agriculture is the mainstay of Pakistan's economy. Its share in GDP is 24%. Tobacco production in Pakistan has long tradition and for many families it is the basic source of living. Tobacco makes a significant contribution in different sectors of the economy. Weeds compete with crop plants for nutrients, soil moisture, space and sunlight and hence reduce yield. Most of the weeds are more competitive than the crop plants. Reduction in tobacco yield has a direct correlation with weed competition. Generally, an increase in one kilogram of weed growth corresponds to a reduction in one kilogram of crop growth. Therefore, to find out the most suitable method of weed control is very important.

Objectives

- To evaluate the cost of production of different weed control methods
- To compare cured yield of FCV tobacco by adopting different weeds control methods

Persons associated: Agronomy Section, Tobacco Research Station, Mardan.

Duration: Three years.

i) Year of initiation: 2018 – 2019.
ii) Year of completion: 2021 – 2022.

This will be the 3rd year of the trial.

Economic impact

After finding the proper optimum/economical method of weed eradication as well as reduced labor cost and high FCV tobacco production, we will be able to produce export quality tobacco on low cost to contribute national economy.

Detailed Work Plan

The experiment would be conducted in RCB design with three replications.

Treatments

T_1: Control
T_2: Manual Hoeing (Three times in whole growing season)
T_3: Mechanical Hoeing (Two times)
T_4: Pre-Emergence Herbicide (STOMP 330 EC)
T_5: Post Emergence Herbicide (Topik 15WP)
T_6: Pre-Emergence Herbicide (STOMP 330 EC) in 1st irrigation after re-ridging

Sources

a. STOMP 330 EC + Topik 15WP
b. NPK

Variety Speight G-28.

Procedure

Hand hoeing will be done by labors. There will be 3 hand hoeing practices throughout the growing season at 15 DAT, 45 DAT and 75 DAT (days after transplanting). Mechanical hoeing will be done two times before re-ridging. Pre-emergence herbicide will be applied before the transplantation of seedling in the field. Topik 15 WP herbicide for narrow leaf weeds will be applied after transplanting at 15 DAT, 45 DAT and if possible at 75 DAT. Pre-emergence herbicide (1.5 liter/ha) will be applied in 1st irrigation after re-ridging. Recommended Fertilizer will be applied within a week after transplantation. All approved cultural practices and plant protection measures will be adopted.

Parameters to be studied

Yield data will be recorded and leaf samples will be analyzed for nicotine and reducing sugar.

Requirements

Land, labor, fertilizers and pesticides etc. will be provided by farm manager, while soil and leaf analysis will be carried out at chemistry laboratory of Tobacco Research Station, Mardan.

Parameters

1. Weed Density per m^2
2. Weed biomass gm per m^2
3. Plant height (cm)
4. Number of leaves per plant
5. Leaf Area (cm^2)
6. Cured weight per plot (kg)
7. Yield per hectare (kg)
8. Nicotine percentage (%)
9. Reducing sugar percentage (%)

SUMMARY OF THE PREVIOUS WORK

Title No. 1 Effect & Comparison of Manual Hoeing and Chemical Weedicide Control on Production of Tobacco (FCV):

Treatment	Weeds Density (m^{-2})	Weed Biomass ($gm.m^{-2}$)	Plant height (cm)	No of Leaves /plant	Leaf area (cm^2)	Cured Yield (kg/ha)	Nicotine %	R. Sugar %
Control	181	766.3	93	17	634.97	2243	2.03	11.58
Manual	76	130.5	106	20	714.08	2725	2.69	14.34
pre-emergence	111	185.8	105	19	740.27	2550	2.49	13.38
post emergence	126	276.1	102	18	662.11	2117	2.32	13.16
Mechanical Hoeing	67	121.2	106	21	674.55	2845	2.13	13.24
Pre-emergence after stress period	53	110.5	108	21	727.18	2749	2.45	12.16

Table-1, showed that minimum Weed Density $53m^{-2}$ and Weed Biomass $110.5gm/m^2$ was observed in pre-emergence weedicide application after stress period, followed by Mechanical Hoeing $67m^{-2}$ and $121.2gm/m^2$ and maximum value was observed in control $181m^{-2}$ and 766.3 gm/m^2. Similarly, maximum cured yield 2845kg/ha was observed in mechanical hoeing, followed by 2749 kg/ha in pre-emergence weedicide application after stress period and minimum cured yield 2117 kg/ha was observed in post-emergence weedicide application.

TITLE NO. 2: EVALUATION OF ECONOMICAL AND BEST GROWTH CULTURE MEDIA FORTOBACCO SEEDLINGS IN SEEDLING TRAYS

Importance

It is undisputed that healthy growing seedlings are the basis of a good tobacco crop. To improve tobacco production is necessary good agricultural practice, which involves the implementation of new technologies for production of tobacco seedlings. Float Tray system technology of tobacco seedlings production is one of the key prerequisites for quality production. During the vegetation, a large number of factors have an impact on the tobacco that allow or interfere on the tobacco plant to express its biological and production potentials. Except the biological potential of the varieties, the largest influences have taken scientific farming methods and agro ecological conditions during the growing season. Tobacco growers must begin with production of healthy seedlings, in order to achieve good quality and high yield per unit area.

The high-quality seedlings are produced with Float Tray System technology, production which presents hydroponic system of growing tobacco seedlings on sterile substrate in medium with fertilizers and protection. The tobacco seedlings are quite uniform according to their morphological and biological characteristics, especially when tobacco has been transplanted on the field. Tobacco in the field depends on its well-developed root system and morphological uniformity in terms of its dimensions (Pearce & Palmer, 2005).The float system, besides being eco-friendly, is associated with many other benefits including a reduction in seedbed area and water requirement, more efficient use of fertilizers, and the production of superior robust seedlings that can better withstand harsh transplanting/Agro-climatic conditions.

Objectives

- To evaluate/comparison of different nutrients Medias in trays for better growth of tobacco seedlings
- To obtain healthy and weeds free Seedling for high yield
- To reduce the Cost of Production on Seed beds

Persons associated Agronomy Section, Tobacco Research Station, Mardan.

Duration Three years.

i. Year of initiation: 2019 – 2020.
ii. Year of completion: 2021 – 2022.

This will be the 3rd year of the trial.

Economic impact

Best economical media for tobacco seedling growth will be evaluated for the benefit of tobacco growers, which will reduce the Cost of production and obtaining high yield. Seedling without roots damage and soil ball will reduce the diseases attack on tobacco crop.

Detailed Work Plan

The experiment would be conducted in RCB design with four replications.

Treatments

T_1: Control: Normal Seed bed
T_2: Coco Peat
T_3: Slurry+ Soil: (50:50)
T_4: Slurry: 100%
T_5: Baggass ash+ Soil: (50:50)
T_6: Baggass ash+ Soil: (30:70)
T_7: Rice Hull

Variety Speight G-28

Procedure

Trial will be conducted in first week of December at time of nursery sowing. Bio-slurry will be analyzed for its nutrients profile. $CuSO_4$and Champion WP will be treated with treatments and trays will be prepared according to the ratio as mentioned above. Float bed will be prepared at suitable place. Water and $CuSO_4$ will be applied till germination of seedlings. After germination, Water will be removed from bed to avoid fungal attack on seedlings. Trays will be irrigated and fertilizer will be applied after 10 to 15 days till transplantation according to need of seedlings. The data will be recorded for below mentioned parameters.

Requirements

Land, labor, fertilizers and pesticides etc. will be provided by farm manager, while soil and bio-slurry analysis will be carried out at chemistry laboratory of Tobacco Research Station, Mardan.

Parameters

1. Diseases attack in trays
2. Weed density per ft^2
3. Weed biomass per ft^2
4. Germination percentage

SUMMARY OF THE PREVIOUS WORK

Table No. 1 Disease attack in trays:

Date	Normal Seedbed	Cocopeat	Baggas Ash	Baggas Ash+Soil	Slurry	Slurry+ Soil	Rice Hull
03-01-2021	Nil	Nil	Nil	Nil	Damping off	Nil	Nil
10-01-2021	-do-	-do-	-do-	-do-	Moderate	-do-	-do-
15-01-2021	-do-	-do-	-do-	-do-	-do-	-do-	-do-
22-01-2021	-do-	-do-	-do-	-do-	High	-do-	-do-
26-01-2021	-do-	-do-	-do-	-do-	-do-	-do-	-do-

Damping off disease was observed in Slurry applied in Nursery.

Table No. 2 Weed Density per ft^2:

Date	Normal Seedbed	Cocopeat	Baggas Ash	Baggas Ash+Soil	Slurry	Slurry+ Soil	Rice Hull
03-01-2021	5	0	0	0	0	0	0
10-01-2021	8	0	1	0	2	0	1
15-01-2021	10	0	2	0	2	1	1
22-01-2021	15	0	2	0	2	3	1
26-01-2021	15	0	2	0	2	3	1

Maximum weed density per ft^2 was recorded in normal seed bed followed by Slurry+Soil Nursery.

Table No. 3 Weed Biomass gm/ft^2:

Date	Normal Seedbed	Cocopeat	Baggas Ash	Baggas Ash+Soil	Slurry	Slurry+ Soil	Rice Hull
22-01-2021	1.5	0	0.02	0	0.01	0.03	0.02

Maximum weed biomass gm/ft^2 was recorded in normal seedbed followed slurry+Soil Nursury.

Table No. 1 Germination started on January 03, 2021:

Date	Normal Seedbed	Coco-peat	Baggas Ash	Baggas Ash+Soil	Slurry	Slurry+Soil	Rice Hull
03-01-2021	55%	50%	10%	20%	20%	40%	20%
10-01-2021	70%	70%	30%	50%	50%	45%	50%
15-01-2021	75%	73%	50%	70%	65%	50%	70%
22-01-2021	81%	81%	70%	81%	79%	63%	80%
26-01-2021 Refilling	Nil	100%	100%	100%	100%	100%	100%

From the above table, it is cleared that after 20days (03-01-2021) of seed sowing in different media's maximum germination 55% was recorded in normal seed bed followed by cocopeat, which was 50%. Above 80% germination was recorded in Normal Seedbed, Cocopeat, Baggas ash+ soil and Rice hull. Refilling was done in all Medias.

Table No. 2 Nursery growth:

Date	Normal Seedbed		Cocopeat		Baggas Ash		Baggas Ash +Soil		Slurry		Slurry+Soil		Rice Hull	
	Height Inches	No. of leaves	Height Inches	No. of leaves	Height Inches	No. of leaves	Height Inches	No. of leaves	Height Inches	No. of leaves	Height Inches	No. of leaves	Height Inches	No. of leaves
07-02-21	1	3	0	2	0	2	0	2	0	2	0	2	0	2
20-02-21	1.5	4	1	3	0.8	3	1	3	0.7	4	1	4	1.5	4
05-03-21	4	6	4	6	1.7	4	3	6	2.5	5	3	6	3.5	5
18-03-21	6	8	5	7	4	5	6	7	4.5	6	5	8	5	7

Table-2 showed that maximum height of 6 inches was recorded in Normal Seedbed followed by Cocopeat, Baggas ash+soil, Slurry+Soil and Rice Hull and minimum was noted in Baggas ash. Similarly, the maximum no of leaves i.e. 8 were recorded in Normal seed bed and Slurry+Soil and same no of leaves i.e., 7 leaves were recorded in Cocopeat, Baggas ash+Soil and Rice Hull.

II. TOBACCO RESEARCH SUB STATION (TRSS), MANSEHRA

1. CHEMISTRY SECTION

TITLE NO. 1: EFFECT OF DIFFERENT DOSES OF NITROGEN ON THE YIELD AND QUALITY OF FCV TOBACCO

Importance

Nitrogen is the most important element which effect the growth, development, yield and quality of FCV tobacco. Which its deficiency results in a) pale in yellow leaves

b) thin stem and stunted growth. So, it is imperative to find out an optimum and economical dose of nitrogen.

Objectives

To find out an optimum and economical dose of nitrogen fertilizer for the production and quality of FCV Tobacco.

Person Associated Chemist, TRSS Mansehra

Year of Initiation: 2021-22

Year of Completion: 2023-24

Economic Impact

To find out an optimum and economical dose of nitrogen fertilizer for the production and quality FCV Tobacco, will help the growers to save wasteful use of nitrogen and thus will be beneficial for the growers as well as country.

Detail Work Plan for the Year 2021-2022

A trial comprising of the following doses of nitrogen fertilizer along with 60 kg per hectare phosphorus and 100 kg per hectare potash will be conducted in randomized complete block design with four repeats.

The different treatments will be as follows.

S. No	Treatments Kg Per Hectare		
	N	P	K
T_1	60 (Control)	60 kg/ha	100 kg/ha
T_2	80 kg/ha	60 kg/ha	100 kg/ha
T_3	100 kg/ha	60 kg/ha	100 kg/ha
T_4	110 kg/ha	60 kg/ha	100 kg/ha
T_5	120 kg/ha	60 kg/ha	100 kg/ha

Source: Ammonium Sulphate (AS)
Single Super Phosphate (SSP)
Sulphate of Potash (SOP)

Variety: K-399

Parameters to be studied

Number of leaves per plant, leaf area, plant height, green weight, cured weight and yield data will be recorded. Leaf samples of FCV tobacco will be analyzed for nicotine and reducing sugar.

Requirements

Land, Labor and inputs will be provided by the Farm Manager TRSS Mansehra.

TITLE NO. 2: EVALUATION OF VARIOUS LEVELS OF NPK FERTILIZER ON FLUE CURED VIRGINIA TOBACCO FOR HIGH YIELD AND GRADE INDEX

Importance

Tobacco belongs to family Solanaccae and genus Nicotiana. The widely cultivated species of Nicotiana are (*Nicotiana tabacum* L. and *Nicotiana rustica* L.). All over the world these species are cultivated as cash crop. The quality and yield of flue-cured tobacco (FCV) depends upon the soil texture, fertilization, depth of plough and nitrogen content of soil. The soils vary widely in physico-chemical properties and nutrients profile which considerably influences the type, grade and quality of FCV tobacco. Higher sugar and lower nicotine are obtained by the application of 60 and 70kg Nitrogen/Hectare (Chari *et al.* 1994).Nitrogen increases the vegetative growth of plants. Soil rich in Phosphorus content gave the highest cured leaf yield and quality of tobacco, if 112 kg N+112 kg P_2O_5 +112 kg K_2O/ha are applied. Potassium (K) balances the sugar-nicotine ratio and increases the yield and quality of tobacco (Hardter and Yuhong, 2000).

Objectives

- To study the effect of various formulations of NPK fertilizer on the yield and quality of Flue Cured Virginia tobacco.
- To evaluate the high yielding and best quality formulation for tobacco growers.

Persons associated Chemistry Section Tobacco Research Station, Mardan.

Duration 3 years.

- Year of Initiation: 2021-2022
- Year of completion: 2023-2024.
- This will be the 1st year of the research trial.

Economic impact

Finding out proper formulation of NPK fertilizer to FCV Tobacco for:

- Increase yield
- Improve quality and grade index

Detail work plan Design: Split-plot Design with three replications and six treatments.

S. No	Treatments Codes	Ratio	Kg/ha
		NPK	NPK
1.	T_0	12:12:18	60:60:90
2.	T_1	15:12:18	75:60:90
3.	T_2	17:12:18	85:60:90
4.	T_3	12:15:18	60:75:90
5.	T_4	12:17:18	60:85:90
6.	T_5	12:19:18	60:95:90
7.	T_6	12:17:15	60:85:75
8.	T_7	12:17:17	60:85:85
9.	T_8	12:17:19	60:85:95

Variety K-399/PVH2310.

Procedure

NPK recommended fertilizer 28gm/plant and other formulation doses will be made from straight fertilizers will be applied in split doses. Half dose will be applied in first week after transplantation and the remaining half dose will be applied after stress period (re-ridging). All recommended agronomic practices will be applied.

Parameters to be studied

- Plant Height (cm)
- Leaf Area (cm^2)
- No of Leaves/plant
- Green weight (kg/ha)
- Cured weight (kg/ha)
- Reducing Sugar (%)
- Nicotine (%)
- Grade index
- Cost benefit ratio of fertilizers

Requirements

Land, labour, fertilizer and pesticides etc. will be provided by Farm Manager, while soil and leaf analysis will be carried out at Chemistry laboratory of Tobacco Research Station, Mardan.

2. BREEDING SECTION

TITLE NO. 1: FIELD EXAMINATION OF FCV HYBRIDS

Importance

Exotic genotypes will be grown as candidate varieties on the basis to check the performance for maximum yield production and good quality attributes. Plant introduction leads to introduce new genotypes in country through process of selection.

Objectives of the study

Hybrids of FCV Tobacco will be tested in Agro-ecological conditions of district Mansehra for examining the yield and quality attributes.

Hybrid varieties: **17x199, 17x202, RJR213, RJR217, RJR215, RJR901, NC938, K399, Spt.G.28**

Persons associated: Assistant Research Officer TRSS, Mansehra.

Year of experiment: 2021-22

Methodology: The experiment will be laid out in RCBD in three replications. Row to Row and Plant to Plant distance will be kept as per recommendation.

Characters to be studied:

1. Days to 50% flowering
2. Days to 90% maturity
3. Plant height (cm)
4. Leaf Area (cm^2)
5. Number of leaves $plant^{-1}$
6. Green leaves kg^{-1}
7. Cured leaves kg^{-1}
8. Yield $hectar^{-1}$
9. Nicotine content
10. Reducing sugar content

Requirements: Land, labour and fertilizer will be provided by the Farm Manager and all chemical analysis will be carried out by the Chemist, Tobacco Research Sub-Station, Mansehra.

RESULTS OF THE PREVIOUS YEARS WORK

Genotypes	Yield (kg ha^{-1}) 2020	Yield (kg ha^{-1}) 2021
17x199	647.4	3451.5
17x202	972.7	3234.5
RJR213	860.2	3441.9
RJR217	845.2	2822.7
RJR 215	827.3	2645.1
RJR 901	812.6	2924.3
NC938	1161.5	=
K399	967.3	=
SPT.G 28	1050	3820.9

TITLE NO. 2: **EVALUATION OF RECOMBINANT HOMOZYGOUS LINES AS COMPARE TO STANDARD VARIETIES FOR DEVELOPMENT OF FCV VARIETIES**

Importance

Locally made four crosses were led to F7 generation in 2015. Single plant election was made for vigorous growth, disease free and drought tolerant. The eight recombinant homozygous lines will be evaluated for candidate varieties.

Objectives

Development of our own local variety with higher yield, better quality and well adapted to local conditions.

Duration 2021-22 will be the 7^{th} year of trial.

Material Eight recombinant homozygous experimental lines Spt.G-28 and K-399.

Experimental Design Randomized Complete Block Design with three replications

Personnel Associated Assistant Research Officer, TRSS Mansehra

Parameter to be studied

1. Plan height after topping (cm)
2. Number of leaves $plant^{-1}$
3. Leaf area (cm^2)
4. Green weight $plot^{-1}$ (kg)
5. Cured weight $plot^{-1}$ (Kg)
6. No. of Green leaves per kg
7. No. of cured leaves per kg
8. Cured yield per hectare (kg)
9. Nicotine %
10. Reducing Sugars %.

Requirements

Land, labour and fertilizer will be provided by the Farm Manager and all chemical analysis will be carried out the Chemist, Tobacco Research Sub-Station, Mansehra.

RESULTS OF PREVIOUS YEAR WORK

Genotypes	Yield (kg/ha) 2021
E_1	2508.2
E_2	2466.6
E_3	2143.6
E_4	1853.1
E_5	1624.7
E_6	2313.4
E_7	1893.7
E_8	2019.3
E_9	2039.0
E_{10}	2085.0

3. AGRONOMY SECTION

TITLE NO. 1: EFFECTS OF DIFFERENT TRANSPLANTING DATES ON THE PRODUCTION OF FCV TOBACCO IN MANSEHRA REGION

Importance

Agriculture contributes 18.5% to country's GDP and provides 38.5% employment to national labour force. Tobacco adds a significant contribution in different sections of the economy. Its total income contribution to GDP is Rs.34 billion (4.75 of total GDP) in addition to foreign earnings Rs.587 million by cigarette manufactures. Climate has been changed and the raining pattern has been shifted forward in many regions. Climate change is affecting the cropping pattern of Pakistan & we are following the same old planting dates for our conventional crops. It is directly affecting production and ultimately the GDP of Pakistan. Therefore, it's a need of time to conduct research on the optimum transplanting dates of FCV tobacco according to the climate of the Mansehra region.

Objectives

To evaluate the effects of climate change on the FCV tobacco production in Mansehra region, so that the optimum transplanting time would be recommended for the local farmers.

Personnel associated

Farm Manager TRSS Mansehra.

Duration Three years

Year of initiation 2020-21

Year of completion 2022-2023

It will be the 2nd year of trial.

Economic impact

Once the optimum transplanting date of FCV tobacco with respect to its production and quality is achieved we may able to share this useful information with tobacco growers.

Experimental Design

The experiment will be conducted in RCBD with 04 replicates.

Treatments

T_1 : Control (normal transplanting date)

T_2 : Early transplanting (before 10 days)

T_3 ; Late transplanting (after 10 days)

T_4 ; Late transplanting (after 20 days)

Sources

a) N.P.K (12:12:18)

Variety/ genotype K-399 & Spt G-28

Parameters to be studied

1. Days to 50% flowering
2. Plant height (cm) after topping
3. No. leaves plant^{-1}
4. Leaf area (cm^2)
5. No. green leaves per kg
6. No. cured leaves per kg
7. Green weight plot^{-1}
8. Cured weight plot^{-1}
9. Nicotine %
10. Reducing sugars %
11. Cured yield Hectare^{-1}
12. Disease incidents
13. Insect attack

Requirements

Land, labour and fertilizer will be provided by the Farm Manager and all chemical analysis will be carried by the Chemist, Tobacco Research Sub-Station, Mansehra.

RESULTS OF PREVIOUS YEAR WORK

Treatments	Yield (kg ha^{-1}) 2021
T_1	3295.2
T_2	3532.8
T_3	3501.4
T_4	3147.2
T_5	3658.3
T_6	3443.1
T_7	4178.4
T_8	2793.1

III. TOBACCO MODEL FARM (TMF), BUNER

TITLE NO. 1: EVALUATION OF RECOMBINANT HOMOZYGOUS LINES AS COMPARED TO STANDARD VARIETIES FOR DEVELOPMENT OF FCV VARIETIES

Importance

Deterioration and depletion of existing indigenous tobacco varieties is one of the pathetic situations for the tobacco industry of Pakistan. Therefore, it is very important to develop the FCV varieties and to broaden the genetic base of this important cash crop in order to achieve maximum gain from tobacco export. For this purpose, eight homozygous recomb inant inbred lines have been developed from the locally made cross to develop an FCV variety/s for disease and drought resistance.

Filial generation

This year F_7 seed will be grown to get F_8 progeny. Due to last year's hailstorm the F_8 progeny was completely damaged therefore to avoid any generation missing, F_7 seed will be grown again for studying the required parameters.

Plant material

Eight homozygous recombinant inbred lines designated as E_1-E_8 and two checks ncluding SPT-G-28 and K-399

Focal persons

Breeder: Dr. Qaizar Ahmed, Assistant Botanist and Breeding staff of Tobacco Research Station, Khangarhi, Mardan.

Experimental layout

Randomized Complete Block (RCB) with three replications having plant to plant and row to row distance of 2ft and 3ft, respectively,

Parameters to be studied

1. Germination %
2. Days to flower initiation
3. Days to 50% flowering
4. Days to flower completion
5. Plant height (cm)
6. Leaf area (cm^2)
7. Internodal distance (cm)
8. Green weight (Kgs)
9. Green leaves Kg^{-1}
10. Cured weight (Kgs)
11. Cured leaves Kg^{-1}
12. Yield (Kg/Hac)
13. Nicotine (%)
14. Reducing sugar (%)

General Activity: Seed Production Plot of FCV standard varieties

This activity by breeding section will be carried out to renew the seed of FCV standard varieties SPT-G-28 and K-399. Therefore, these two varieties will be grown in Buner and Hazro depending upon the land availability.

PREVIOUS HISTORY OF FCV VARIETAL TRIAL

Mean table of FCV Varietal Trial 2020-21

Treatments	*Plant Height cm sq*	*Leaf Area cm sq*	*Green leaf /kg*	*Green weight/plot (kg)*	*Cured leaf/kg*	*Cured weight/plot (kg)*	*Yield/Hect (kg)*	*Nic %*	*Reducing sugar %`*
CSC-447	*106*	*1043*	*38*	*33*	*236*	*6*	*2610*		
PVH-2310	*102*	*1010*	*51*	*27*	*242*	*4.7*	*2275*		
K-399	*104*	*1006*	*40*	*25*	*223*	*3.9*	*1820*		
Spt-G 28	*91*	*1001*	*45*	*24*	*245*	*3.6*	*1795*		

The above mean data show that CSC-447 gave maximum yield 2610-kg/Hect while minimum yield was recorded in *Spt-G-28 (1795-kg/Hect)*

IV. TOBACCO MEDEL FARM (TMF) HAZRO, ATTOCK

TITLE NO. 1: CUTWORM CONTROL TRIAL

Importance

Cutworm is among the major insect pest of Tobacco crop. Cutworm is the nocturnal insect and cut the whole Rustica Tobacco plant from basal portion. If not controlled on time, eats up the whole plant and leads to 100% failure of the plant. The efficacy of Jatara and Alpha cypermetrin for better control of cutworm will be studied with comparison to control plots.

Objective

To assess comparative efficacy of Jatara and Alpha cypermetrine for the control of Cutworm.

Person Associated FM/ ADO Hazro, Attock.

Year of initiation 2019-20

Probable year of completion 2021-2022

Economic Impact

The objective of the trial is to find out potential chemical for the control of cutworm. If this pest is controlled, quantity and quality of Rustica Tobacco will be improved and as a result will be beneficial for the growers and national economy.

SUMMARY OF PREVIOUS WORK

S.No.	Name Of Insecticide	Dose/Acre	Percentage
1.	Jatara 10% EC (Befinthrin)	450-500 ml/acre	8.7%
2.	Alpha Cypermetrin 10% EC	-do-	11.6%
3.	Control	---	17.4%

Detail Work Plan

Nursery for the trial will be raised at Tobacco Model Farm Hazro. The trial will be laid out in RCB Design with three repeats having inter and intra plant space of 45 cm and 30 cm. All other recommended cultural practices for tobacco will be followed.

Treatments

S. No	Name Of Insecticide	Dose/Acre
T_1	Jatara 10% EC (Befinthrin)	450-500 ml/acre
T_2	Alpha Cypermetrin 10% EC	-do-
T_3	Control	---

Variety R- Hazro

Parameters to be studied i. Total No. of plants

ii. No. of attacked plants

Requirements

Land, Labor, Fertilizer, Pesticides, Suckericides etc will be provided by Farm Manager/ADO

DEVELOPMENT PLAN

FCV Seed Production Plot

1. Varieties

i) K-399

ii) Speight G-28

2. Requirements

Land, Labor, Fertilizer, Pesticides, Suckericides etc will be provided by Farm Manager/ ADO.

PART-B) DEVELOPMENT PROGRAMME OF PAKISTAN TOBACCO BOARD 2021-22

Development staff of Pakistan Tobacco Board plays a vital role to educate the growers about the latest technology and growing techniques required to improve quality and yield of tobacco crop. Well planned and well managed programmes i.e. workshops and field days are arranged annually to master tobacco growers to produce tobacco crop in order to meet national and international requirements.

Apart from this, At least 10 Corner meetings would be arranged in each tobacco growing area by concerned ADOs to disseminate technical assistance at all stage of tobacco crop i.e. from Seedbed preparation to Curing.

The development staff also strives to explore new areas for cultivation of FCV and DAC in all the four Provinces:

PARTICULARS		NO. OF PLOTS TO BE LAID BY PTB KP	
		FCV	WP
1	Model nursery	40	6
2	Model Plots	40	1

The tobacco Companies will lay out model nurseries / plots as detailed below;

S.NO	NAME OF COMPANY	SUPERVISED PRODUCTION PLOTS
		FCV
1	Pakistan Tobacco Company	300
2	Phillip Morris Pakistan (Ltd)	300
3	Soveniour Tobacco Company	5
4	Walton Tobacco Company	5
5	Sarhad Cigarette Industry	5
6	Khyber Tobacco Company	30

The following schedule will be observed for inspection/monitoring and evaluation of plots to be laid out by the Board/Tobacco companies.

i- Lying out of model nurseries from 1st December to end of December.
ii- Submission of lists to the Board from 1st January to 31st January with full particulars.
iii- Lying out of model plots from 1st March to the end of March.
iv- Submission of lists to the Board 1st fortnight of April.
v- Inspection: The senior officers of the Board will inspect the model plots at various stages of crop development.
vi- The ADOs shall inspect the model plots laid out by tobacco companies in the areas of their jurisdiction and shall furnish report to the Board in the relevant columns of the crop monitoring proforma on weekly basis.
vii- The ADOs and Depot Managers of Tobacco Companies shall cooperate with each other in the development activities.
viii- ADOs and Field Assistants submit their tour programme on monthly basis of their respective areas.
ix- Field assistant will submit daily reports on the Board prescribed proformas to Head Office, Assistant Director (Dev) and one copy with himself for the record. (The format of proforma is given below);

S. No	Name of grower	Address	Contact No.	Type of tobacco FCV / Rustica	No. of Barn	Crop condition	Recommendations	Remarks

1. **TOBACCO WORKSHOPS**

Tobacco workshops will be arranged in various provinces of the country in coordination with tobacco companies to apprise the tobacco growers about the targeted demands of tobacco companies for the crop 2022. The tobacco growers will also be advised for sowing of only Recommended Varieties (RVs).

2. **FIELD DAYS**

To disseminate the latest technology amongst the tobacco growers of the country, field days will be organized in various tobacco growing areas. Efforts will be made to arrange these field days at the sites of model nurseries / plots at appropriate stage of nursery and tobacco crop development.

3. **TOBACCO CROP SURVEY**

The field staff of the Board and tobacco companies will carry out the survey of various type of tobacco crop for assessment purpose and furnish reports to the Board.

4. **CROP MONITORING REPORTS**

Crop monitoring reports will be supplied by ADOs to the Board on weekly basis in respect of their area.

5. **SURVEY OF TOBACCO BARNS**

Efforts will be continued to have proper record of tobacco barns operating in different tobacco growing areas.

6. **DISSEMINATION OF TECHNICAL KNOWLEDGE**

To disseminate latest technical knowledge, leaflets / hand bills will be prepared for distribution among the tobacco growers covering all aspects of quality tobacco production. The handouts will be circulated through press.

The field staff of the Board and tobacco companies will continue efforts for popularizing the use of suckericides. The merits of topping/desuckering and harvesting of mature / ripe leaf will also be communicated to tobacco growers.

7. **STREAMLINING OF FERTILIZER AND PESTICIDES**

With the purpose of arranging recommended fertilizers, pesticides for tobacco growers and ensuring their supply in different tobacco growing areas, meeting with concerned companies will be organized. These companies will also be requested to educate growers for use of recommended fertilizer and safe use of pesticides on tobacco crop.

8. **MEETINGS OF ASSISTANT DEVELOPMENT OFFICERS WITH DIRECTOR (R&D) AND ASSISTANT DIRECTOR (DEVELOPMENT)**

To discuss the tobacco crop situation and related problems, meetings of ADOs will be convened during the crop season at appropriate timings.

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