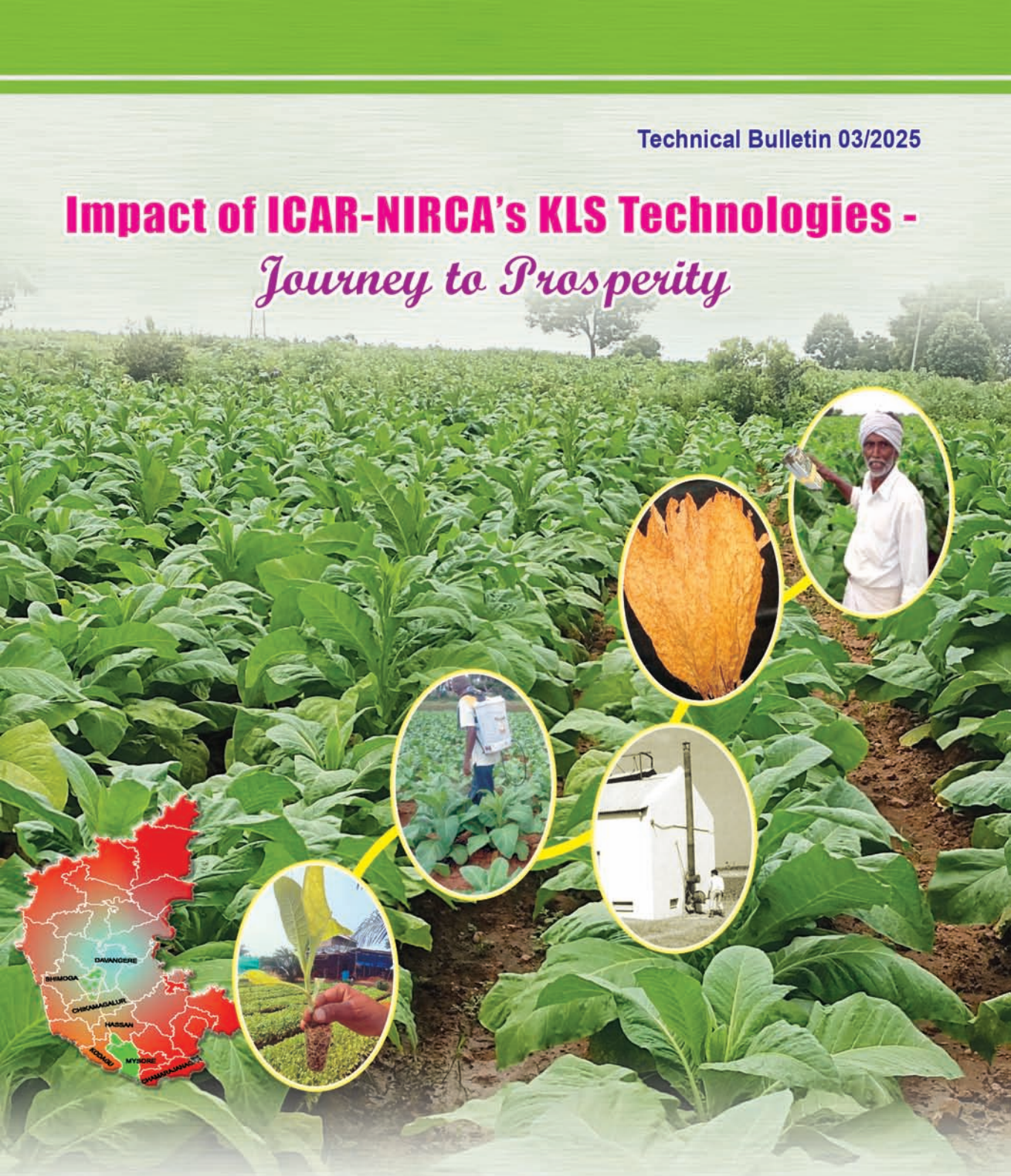
Technical Bulletin 03/2025

Impact of ICAR-NIRCA's KLS Technologies - *Journey to Prosperity*



ICAR-NATIONAL INSTITUTE FOR RESEARCH ON COMMERCIAL AGRICULTURE
(Formerly ICAR-CENTRAL TOBACCO RESEARCH INSTITUTE)
RAJAHMUNDRY-533 105, A.P., INDIA

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Impact of ICAR-NIRCA's KLS Technologies - *Journey to Prosperity*

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Impact of ICAR-NIRCA's KLS Technologies - Journey to Prosperity

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Preface

Flue-Cured Virginia (FCV) tobacco grown on the light soils of Karnataka (KLS) holds a distinguished position in the global tobacco industry. Known regionally as "Mysore Style," KLS tobacco is highly valued in international markets for its distinctive quality. The cropping area spans approximately 70,000 hectares distributed across about 1,000 villages, with cultivation primarily in Mysore (85%) and Hassan (15%) districts. The crop yields around 85 million kilograms annually and generates approximately ` 23,375 crore in revenue. Roughly 70% of KLS tobacco is exported, reflecting strong global demand.

Organized research on FCV tobacco in Karnataka commenced in 1957 with the establishment of the ICAR-CTRI Research Station at Hunsur, Mysore, under the former Central Tobacco Research Institute, Rajahmundry (Andhra Pradesh). That institute is now rechristened as the ICAR-National Institute for Research on Commercial Agriculture (NIRCA). The station's mandate is to advance research on FCV tobacco, with emphasis on crop improvement, production and protection. A multidisciplinary team of scientists has developed region-specific technologies and varieties, which are disseminated to KLS farmers through collaborations with the Tobacco Board, Ministry of Commerce. Dissemination activities include field-level workshops, training programs, On-Farm Trials (OFTs), and Farmer Field Schools.

This publication compiles the success stories of impactful technologies that have significantly enhanced the socio-economic status of KLS farmers. It aims to serve as a valuable resource for tobacco farmers and other stakeholders. I commend the authors for their contribution.

Date : 15th September, 2025

(M. SHESHU MADHAV)
DIRECTOR

CONTENTS

SWARNA: Powdery Mildew Resistant Variety for KLS

Introduction

In Karnataka, Flue-Cured Virginia (FCV) tobacco is grown as a rainfed crop on light soils during the *kharif* season. Since its introduction to the region, several exotic cultivars—Harrison Special, Virginia Gold, Super Gold, followed by Hicks, Delcrest, NC95, and Kutsaga 51—were grown in the absence of suitable local cultivars. FCV Special was the first variety released in the 1960s for the Karnataka Light Soil (KLS) region. However, the aforementioned exotic varieties exhibited suboptimal yield levels and leaf quality and showed susceptibility to powdery mildew, threatening the crop's sustainability. To address this issue, ICAR-CTRI RS, Hunsur initiated a targeted FCV tobacco varietal development program for KLS and developed the variety Swarna, which combined high yield with powdery mildew resistance. Swarna was released for farmers' use in the KLS during 1986.

Nature of the problem

Low yield and powdery mildew susceptibility were major constraints in the heavy-rainfall regions of Mysore and the neighboring Coorg districts. Early-season infections caused stunted plant growth, and severe infections led to premature senescence, wilting and leaf drop, reducing both the quantity and quality of harvestable leaves. Infected leaves acquired a scorched or brownish appearance, particularly after curing, and the blemished, discolored leaves diminished commercial value.

Technology details

Swarna was developed by crossing Kanakaprabha and Koufan, followed by pedigree selection at ICAR-CTRI RS, Hunsur. It is a dark-cast, high-yielding FCV variety with an estimated yield potential of approximately 1,450 kg ha^{-1} and 20–22 curable leaves. Swarna is resistant to powdery mildew and exhibits field tolerance to black shank.

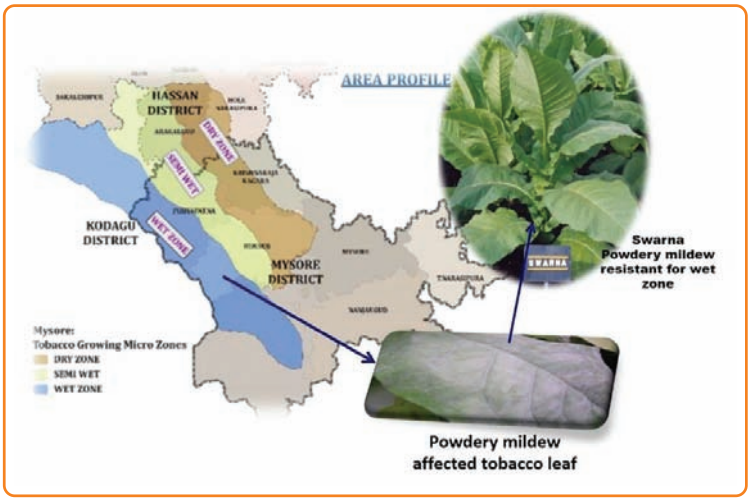
Recommendation

Given its dark-cast phenotype and high yield, Swarna was released for commercial cultivation in 1986 for powdery mildew–endemic areas of the KLS within the high-rainfall zone.

Impact

Swarna occupied more than 75% of the powdery mildew–endemic areas (approximately 9,000 ha) in the Periyapatna, Kushalnagar, and H.D. Kote taluks, where varieties such as FCV Special, Harrison Special, and Virginia Gold could not be cultivated. The adoption of Swarna reduced the need for fungicidal applications, thereby increasing net farm income through reduced

input costs, higher yields, and improved ecological sustainability. Impact assessment indicates that adoption of the CTRI-recommended Swarna in these zones increased annual revenue by 2.5 crores.



Farmers Feedback

"I had cultivated FCV Special for many years, but escalating powdery mildew incidence severely affected both quantity and quality of tobacco. After learning about Swarna from ICAR-CTRI RS, Hunsur, via a fellow farmer, I switched to Swarna. I was impressed by its resistance to powdery mildew, which enabled better disease management and higher cured leaf yield with more bright-grade tobacco, thereby increasing my net farm income. The reduced need for fungicides also lowered my production costs".

Sri K.N. Shivanna
Village - Kallahalli
TBGR No. 61118134

BHAVYA – Black Shank Resistant FCV Tobacco Variety

Introduction

Initial breeding efforts to replace exotic lines led to the release of FCV Special and Swarna for the light soils of Karnataka. However, the yield levels of these varieties were inadequate to meet rising export demand, and new biotic challenges—such as soil-borne pathogens including root-knot nematodes and black shank—emerged. There was thus an urgent need for a variety tolerant to biotic stresses while maintaining high productivity to ensure long-term crop sustainability. At ICAR-CTRI RS, Hunsur, this need guided the development and release of the variety Bhavya in 1988.

Nature of the problem

Low FCV tobacco productivity, coupled with susceptibility to soil-borne pathogens (black shank and root-knot nematodes), threatened the sustainability of tobacco production in the Karnataka Light Soil (KLS) zone.

Technology intervention

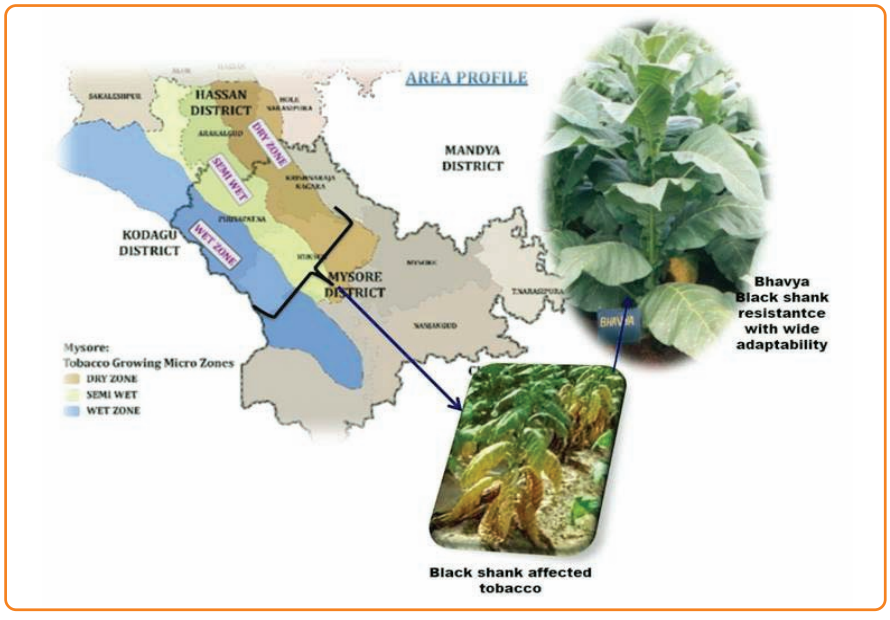
Bhavya is a medium-cast, high-yielding FCV tobacco variety developed through pedigree breeding from the cross (Virginia 145 × FCV Special) × mutant of FCV Special. It exhibits resistance to black shank and tolerance to root-knot nematodes and frog-eye spot, and it tolerates initial moisture stress. Bhavya produces 22–24 curable leaves, corresponding to an average yield of approximately 1,800 kg ha^{-1}. The cured leaf is bright lemon to orange in color, with a medium-bodied, grainy texture and reduced spotting.

Recommendation

Bhavya was released in 1988 and recommended for cultivation in areas with assured rainfall and in regions prone to black shank within the KLS.

Impact

Bhavya, as a high-yielding variety with higher production of bright-grade leaf and resistance to black shank, became widely adopted and gradually replaced other varieties. By 1998, about 92% of the FCV tobacco area in the region (~ 50,600 ha) was planted with Bhavya, out of a total FCV area of 55,000 ha. This shift increased the overall productivity of FCV tobacco in KLS from 905 kg ha^{-1} to 954 kg ha^{-1}, contributing an estimated additional revenue of ₹ 77.90 crore per year to FCV tobacco growers over a 15-year period.



Farmers Feedback

"I previously cultivated FCV Special for many years, with an annual cured-leaf yield of about 1,200 kg. After adopting Bhavya, I achieved around 1,500 kg from the same area, with ~60% of the leaves in the bright grade. In addition, I saved on plant-protection chemicals needed to control black shank and root-knot nematodes. I am very satisfied with Bhavya, particularly for its bright golden-yellow leaf that commands a better market price".

Sri Govindegowda
Village - Kirsodlu
TBGR No.2329072

KANCHAN : High yielding dark cast FCV Tobacco Variety for high rainfall areas of KLS

Introduction

The Karnataka Light Soil (KLS) FCV tobacco has long been regarded as a premium product, celebrated for its distinctive quality and often described in international markets as "Mysore style." Shifts in consumer preferences in importing countries led to an increased demand for FCV tobacco grown in KLS. Consequently, ICAR-CTRI RS, Hunsur redirected its breeding focus from resistance breeding towards yield enhancement to meet this rising demand. This direction culminated in the identification of Kanchan, a high-yielding variety released for KLS, particularly in medium- to high-rainfall zones, to sustain the growing export demand.

Nature of problem

There was a requirement for a variety that combined higher yield with high quality and disease resistance/tolerance to enhance productivity in KLS, especially in regions with heavy rainfall.

Technology details

Kanchan is a high-yielding, dark-cast FCV tobacco variety developed by pure-line selection from an exotic cultivar. It is a green-cast variety with a semi-open plant habit and short internodes. The variety produces 18–20 curable leaves, with long, narrow leaves and a wavy lamina. The cured leaf is bright lemon to orange in color, thick-bodied, optimally spotted, pliable, and possessing a superior aroma. Kanchan yields more than 2,000 kg ha^{-1} of cured leaf, with around 70% bright grades, and is suitable for assured and heavy rainfall areas, as leaf maturity is slower with extended intervals between picks and is not hampered by physiological immaturity. It responds well to nitrogen, requiring a minimum of 60 kg N ha^{-1}. It is resistant to black shank and tolerant to root-knot nematodes.

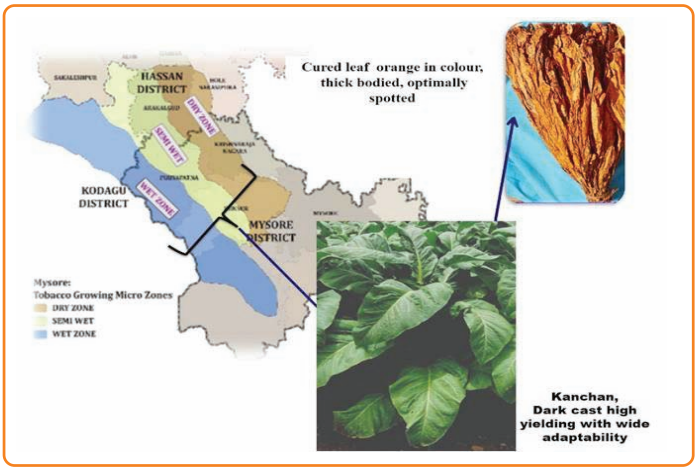
Recommendation

Kanchan, a semi-flavorful variety resistant to black shank and tolerant to root-knot nematodes, was released in 1999 for cultivation in assured heavy-rainfall areas of KLS.

Impact

As a dark-cast variety with slow maturity and high yields, Kanchan gained rapid popularity and expanded across nearly the entire FCV tobacco area in KLS, eventually replacing most earlier varieties. It reached peak adoption in 2007–08, occupying more than 95% of the KLS FCV tobacco area. Farmers could achieve yields of up to 2,500 kg ha^{-1} in heavy rainfall zones, lifting the regional average productivity from 954 kg ha^{-1} to 1,200 kg ha^{-1} under normal seasons. Even after 25 years, Kanchan maintained demand alongside newer varieties and hybrids due to its ability to deliver reasonably good quality yields in all weather conditions. Adoption of

Kanchan across most of KLS contributed to a substantial uplift in FCV tobacco productivity and an estimated additional revenue of ₹155 crores per annum for growers in the region.



Farmers Feedback

"I was provided with the Kanchan variety for trial by ICAR-CTRI RS, Hunsur in 1999. I initially planted it on three acres and was astonished by the yield, around 3,000 kg, compared with about 1,500 kg from the same land previously. Since then, I have grown only Kanchan and consistently achieved higher yields and farm income".

Sri Umesha
Village - UG Halli
Hunsur Taluk

RATHNA - FCV Tobacco Variety for semi-dry to dry zones of KLS

Introduction

FCV tobacco grown in the Karnataka Light Soils (KLS) region is globally known as "Mysore Style" tobacco and is classified as a quality-neutral filler. Over 80% of the tobacco produced is exported, serving a wide range of international markets. In the early years, several exotic cultivars were used to meet export requirements. To achieve the desired qualities for exports—such as light to medium body, bright lemon to orange color, proper ripeness with spotting, good pliability, and open grain structure—the variety *Rathna* was developed at ICAR-CTRI RS, Hunsur. Rathna, a light-cast and drought-tolerant variety, was evolved through mutation breeding of FCV Special.

Nature of the problem

To develop an improved variety suited to the dry and semi-dry zones of KLS that meets the required quality standards.

Technology details

Rathna is a high-yielding FCV tobacco variety developed at Hunsur through mutation breeding of FCV Special. It is a light-cast type with an open plant habit and medium internodes, producing about 20 curable leaves that are long, broad and acuminate-tipped. The cured leaves are ripe, thin to medium-bodied, pliable, and display a deep lemon to orange color with uniform spotting, characteristic of the traditional "Mysore style." Rathna records an average cured leaf yield of 2,000 kg ha^{-1}, with over 80% in the first-quality grade, and possesses field resistance to black shank. In the semi-dry and dry zones, Rathna is a superior alternative to Bhavya, as it yields well-spotted, pliable cured leaves even under moisture-deficit conditions.

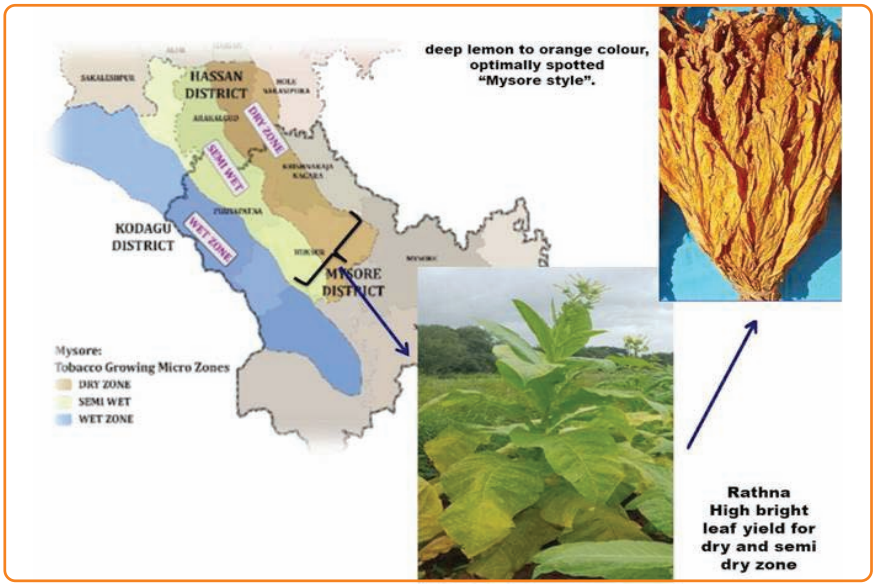
Recommendation

Rathna, a high-yielding light-cast variety with field resistance to black shank, was released in 2001 for commercial cultivation in the medium- and low-rainfall areas of KLS.

Impact

In the low and medium rainfall zones, FCV tobacco growers adopted the variety Rathna for its ability to produce higher bright-grade yields compared to the ruling cultivar Bhavya. By 2003, Rathna accounted for nearly 15% of the total FCV area and covered about 90% (9,450 ha) of the low- and medium-rainfall regions. During a five-year adoption period, the farmers realized an additional revenue of ₹ 39.82 crores as a result of productivity enhancement from 954 kg ha^{-1} to 1157 kg ha^{-1}. However, with the emergence of the high-yielding variety Kanchan, the

area under Rathna cultivation gradually declined. Nevertheless, Rathna continues to serve as an important parental line in breeding programs focused on improving yield potential and leaf quality.



Farmers Feedback

"I cultivated the variety Rathna for four consecutive years on about five acres. Before its adoption, I was growing Bhavya, which yielded around 2,400 kg of bright-grade tobacco from a total of 4,000 kg. After switching to Rathna, the bright-grade yield increased to 3,200 kg, which significantly increased the average price and improved my net returns".

Sri Shathisha
Village - Agrahara
TBGR No.2301088

FCH 222: A high yielding Fusarium Wilt Resistant FCV Tobacco Variety

Introduction

In the transitional zone of the Karnataka Light Soils (KLS), Flue-Cured Virginia (FCV) tobacco is grown as a rainfed crop which is valued for its export quality. Fungal diseases have long threatened the crop, and while resistant varieties have kept black shank under control, Fusarium wilt (*Fusarium oxysporum* f.sp. *nicotianae*) has emerged as a major problem. The disease affects about 7.5% of the 69,049 ha of FCV tobacco in KLS, particularly in medium and high rainfall areas, impacting villages such as Abbur, Kachuvinahally, Neralakupe, Marur, Kebakoplu and Harave. To address this, ICAR–CTRI RS, Hunsur developed and released FCH 222, a Fusarium wilt–resistant variety. Along with resistance, it offers higher yields and superior leaf quality, especially in the dry and semi-dry regions of KLS.

Nature of the problem

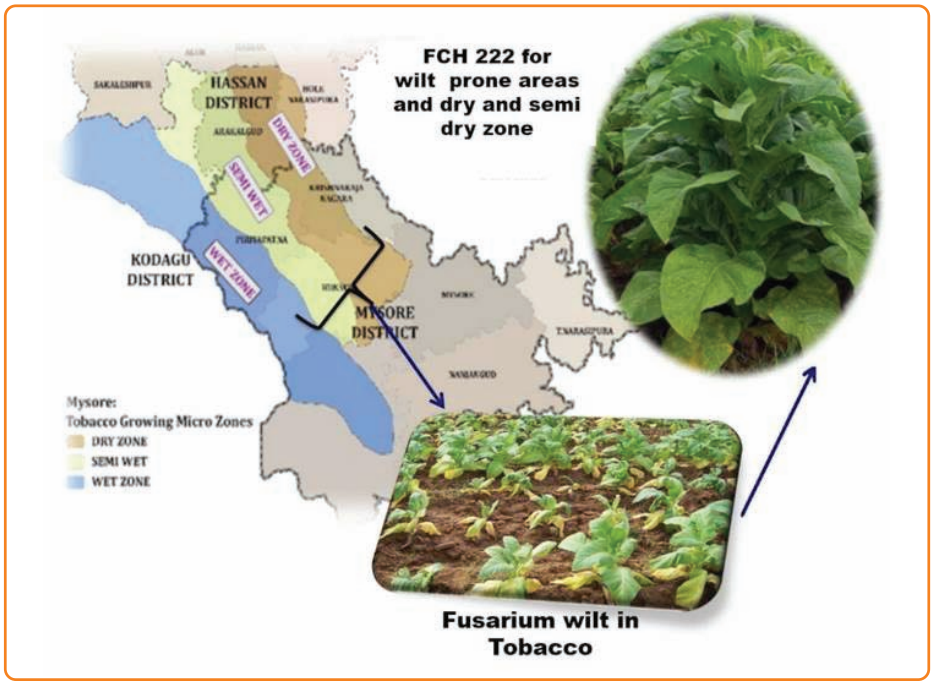
Over the years, Fusarium wilt has caused increasing yield and quality losses in FCV tobacco due to the continuous cultivation of susceptible varieties like Kanchan and CH 3. In areas such as Hunsur, Periyapatna and Chilkunda, growers faced avoidable yield losses of about 9%. With no effective chemical control or crop rotation options available, research was focused on identifying resistant sources and developing a Fusarium wilt–resistant variety suited for the KLS region.

Technology intervention

The Fusarium wilt–resistant variety FCH 222 was developed through hybridization between FCH 201 and Speight-G 33 (resistant donor) using the pedigree method. In wilt-sick plots, FCH 222 showed strong resistance with only 2.5% disease incidence, similar to Speight-G 33 (5.0%). Even in highly sick soils, disease incidence was only 20% compared to 90–95% in susceptible varieties like Kanchan and Bhavya. FCH 222 is a medium cast variety with 20–22 curable leaves that are light in color, moderately puckered, and show medium spangling at maturity. The cured leaf is ripe, medium-bodied, pliable, lemon to orange in color with optimum spotting, and has physical and chemical qualities comparable to the ruling variety Kanchan. Besides resistance, FCH 222 provides higher yields with superior leaf quality, especially in the dry and semi-dry regions of KLS where rainfall is low.

Recommendation

FCH-222 is a highly Fusarium wilt–resistant variety with an average yield potential of 3,000 kg ha^{-1} and 70% bright grades. Hence, it is recommended for the light soils of the southern transition zone of Karnataka, particularly in Fusarium wilt–endemic areas where FCV tobacco is grown under monsoon conditions.



Impact

Approximately 500 kg seed of FCH 222 developed by ICAR-CTRI RS, Hunsur, was distributed through the Tobacco Board, Ministry of Commerce, primarily to registered FCV tobacco growers in wilt-prone areas. Beyond effective Fusarium wilt disease management, the variety FCH 222 also enhanced bright-grade leaf production, leading to higher average prices for growers. The adoption of FCH 222 across 5,178 hectares in KLS resulted in a 9% yield increase due to Fusarium wilt management. Overall, the adoption of FCH 222 technology generated an additional annual revenue of approximately ₹14.7 crores for FCV tobacco growers in KLS.

HOSAKOPPALU - Sri Sannathammai Gowda

HARNEHALLY - Sri Mahadevappa

Farmers Feedback

"My field was badly affected by Fusarium wilt, and I lost more than 60% of plants every year resulting in a poor crop stand. After getting to know about the new variety, FCH 222, from ICAR–CTRI RS, Hunsur, I tried it and was happy to see a healthy crop. I achieved 2,490 kg ha^{-1} of cured leaf with over 75% bright grades. The crop was easy to manage, and I was satisfied with the topping at 20 leaves and the five-day harvesting interval".

Sri Mahadevappa
Village - Harinehally

Micro-sprinkler irrigation in nursery: Resource use efficient method

Introduction

FCV tobacco is grown under rainfed conditions in the Karnataka Light Soil (KLS) zone. Ensuring healthy, disease-free seedlings is a critical prerequisite for successful crops. Traditionally, seedlings are raised in seed beds and watered 5–6 times daily with rose cans, a process that requires substantial labor and is increasingly constrained by labor availability during peak nursery periods. To address these challenges, an efficient and economical watering method was sought. The micro-sprinkler irrigation system was developed and standardized for irrigating FCV tobacco nursery beds.

Nature of the problem

Frequent daily irrigations (5–6 per day) with water cans, combined with the inherently light-textured soils of KLS, result in low water and nutrient use efficiency. This situation motivated investigation into micro-sprinkler irrigation as a means to reduce labor costs and improve water and nutrient use efficiency in tobacco nurseries.

Technology intervention

Experiments were conducted to assess the effect of micro-sprinkler geometry on uniform coverage of nursery beds, seedling growth, number of transplantable seedlings, and labor requirements. Micro-sprinklers were evaluated against a control (manual watering with rose cans). Each lateral and micro-sprinkler system was laid out between beds 1 m wide; four sprinklers were required to irrigate two 1 m × 10 m beds. Optimal spacing was determined as follows: lateral spacing 2.5 m and inter-sprinkler spacing 2.5 m, at operating pressures of 1.25–1.5 kg cm^{-2}. Seedlings irrigated with micro-sprinklers showed higher root volume, weight and height, and a greater number of transplantable seedlings compared with rose cans.

Recommendation

Watering FCV tobacco nursery beds with micro-sprinklers is a viable alternative to manual watering with rose cans and is recommended for adoption by the KLS farming community.

Impact

- Micro-sprinkler irrigation in FCV tobacco nurseries increased transplantable seedlings by approximately 20% relative to conventional methods.
- Labor costs decreased by about ₹1,00,000 ha^{-1}.
- Water use at the nursery bed level decreased by ~24%, and total system water use declined by ~35% compared with the rose can method.
- The technology has been widely adopted by tobacco farmers in Karnataka.

Watering nursery beds with rose cans

Watering nursery beds using micro-sprinklers

Farmers Feedback

"The technology is easy to adopt, cost-effective and user-friendly, with adoption observed in at least 50% of farming households. Farmers appreciated reduced labor requirements and the practical benefits of the system".

Tray Nursery Seedling Production: Technology for healthy seedling production in KLS

Introduction

Successful FCV tobacco production under dryland conditions in the light soils of Karnataka depends on the availability of healthy, disease-free seedlings for timely planting in May. However, in conventional nurseries, seedlings are often affected by soil-borne pathogens such as root-knot nematode (*Meloidogyne incognita*), damping-off (*Pythium aphanidermatum*), soreshin (*Rhizoctonia solani*), leaf blight and black shank (*Phytophthora parasitica* var. *nicotianae*), and anthracnose (*Colletotrichum tabacum*). Such seedlings tend to be lanky, of poor quality, and heavily infected, resulting in gaps, uneven stands, and low yields when transplanted in the main field. To overcome these issues, research led to the development of a non-conventional method of raising FCV tobacco seedlings in polystyrene trays filled with well-decomposed coir pith (coco-peat).

Nature of the problem

Conventional FCV tobacco seedlings are often prone to root-knot nematode and other soil-borne diseases, making them lanky, weak, and unfit for timely planting in the main field, which reduces profitability. In contrast, tray seedlings raised under soil-free conditions are healthy, free from diseases and nematodes, and serve as a boon to FCV tobacco growers.

Technology intervention

Unlike conventional nurseries, tobacco seedlings can be raised in poly trays, commonly called 'tray nurseries,' using soil-free organic media such as composted coir pith (cocopeat). This technology produces sturdy, disease-free seedlings suitable for early planting in May. The tray nursery method has been standardized and is being widely promoted in tobacco-growing regions by the Tobacco Board, Ministry of Commerce. Based on ICAR-CTRI recommendation, trays along with cocopeat media are supplied to registered growers in Karnataka on a credit basis. In this system, seedlings are raised in poly trays with 70–98 cells by transplanting 20–25 day-old healthy seedlings from conventional or solarized nurseries into the cocopeat medium, ensuring uniform and healthy planting material.

Recommendation

In tray nursery systems, 20–25 day-old healthy tobacco seedlings from solarized nursery beds are transplanted into plastic or polystyrene trays (70–98 cells) filled with sterile, soilless media such as cocopeat or vermiculite, and maintained under controlled conditions like polyhouses or shade nets. About 200 trays and 250 kg of cocopeat are required for raising tray seedlings for one hectare of FCV tobacco in KLS.

Impact

In Karnataka, trays and cocopeat are supplied to FCV growers through the Tobacco Board as per ICAR–CTRI recommendations. Tray nursery technology, being both eco-friendly and farmer-friendly, has been widely adopted across ~15,000 ha. Its adoption resulted in a 7% increase in cured leaf yield per farmer, along with reduced disease incidence—especially root-knot nematode—which improved bright grade yield and secured better market prices. Overall, this technology has helped farmers in Karnataka gain an additional annual revenue of about ₹ 30.06 crores.

Farmers Feedback

"I used to raise seedlings in traditional raised beds, but often struggled with timely planting due to the lack of healthy, disease-free seedlings. After adopting tray seedlings as recommended by ICAR-CTRI RS, Hunsur, I found this method highly effective for producing robust, nematode-free seedlings, even under water-scarce conditions. It reduces the need for fertilizers and pesticides, eliminates weeding, lowers labor, and ensures 100% crop establishment with uniform growth. Moreover, planting tray seedlings with compost has also improved the soil health".

Sri Praveen
Village - Kothegala
TBGR No.62124339

High-density planting in KLS for stability amidst climate uncertainty

Introduction

FCV tobacco grown in KLS often suffers from unstable productivity and low-grade leaves due to erratic rainfall, recurring droughts, and poor soil fertility. In tobacco farming, leaves being the main economic part of the crop, the number of leaves per plant and the total leaf dry matter per unit area are key for higher productivity. In dry and drought-prone areas, high-density planting can be effective, providing early land coverage, more leaves per unit area with higher Leaf Area Index (LAI), and reduced soil evaporation.

Nature of the problem

FCV tobacco in KLS is grown under rainfed conditions during the monsoon, and its productivity largely depends on the amount and distribution of rainfall. Although normal rainfall is expected during the growth period, KLS often experiences cyclic droughts, particularly during the grand growth phase (third week of June to second week of July), leading to significant reductions in crop yield. Farmers in the region traditionally transplant FCV tobacco at standard spacing and rely heavily on seasonal rains, often facing failed seasons. High-density planting has emerged as a promising approach to improve productivity and make crops more resilient to unpredictable weather.

Technology intervention

Field demonstrations in the dry (K.R. Nagar and Hunsur) and semi-dry zones (Eastern Periyapatna and Eastern H.D. Kote) of the KLS region (Figure 1 & 2) showed that increasing plant density to 22,222 plants ha^{-1} using 90 x 50 cm spacing (inter-row x intra-row) increased cured leaf productivity by 11.9–12.8% compared to the conventional spacing of 100 x 55 cm (18,181 plants ha^{-1}). Cured leaf quality remained within the normal acceptable range and was not affected by the change in crop geometry. Farmers only incurred an additional 22% expenditure on seedlings compared to the traditional planting method.

Recommendation

High-density planting with 90 x 50 cm spacing, which increases plant density from 18,181 to 22,222 plants ha^{-1} is recommended by ICAR–CTRI RS, Hunsur for farmers in low and medium rainfall areas such as Hunsur, Chilkunda, and Ramnathpura.

Impact

The high-density planting technology of 22,222 plants ha^{-1} with reduced spacing of 90 x 50 cm was readily adopted by FCV tobacco farmers in the region. Of the 20,752 ha of FCV tobacco grown under low and medium rainfall conditions, 20% (4,150 ha) in areas prone to acute drought implemented this recommendation. By avoiding an estimated 10% yield loss due to drought, KLS growers gained an additional annual revenue of approximately ₹ 11.81 crores.

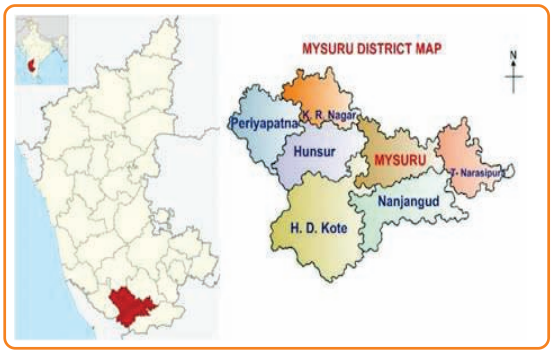


Figure 1: Mysuru district map of Karnataka

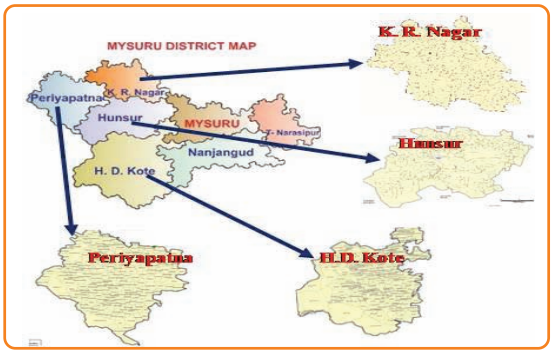


Figure 2: Map of dry and semi-dry zones in KLS

Farmers Feedback

"I regularly cultivated FCV tobacco in three acres under rainfed conditions in Hunsur, a low rainfall region. During droughts, especially from the last week of June to the second week of July, yields dropped significantly, causing heavy losses. After adopting high-density planting with 22,222 plants/ha as recommended by ICAR-CTRI scientists instead of 18,181 plants ha^{-1}, I gained about 50 kg extra per acre, earning additional income".

Sri Shivabasappa
Village - Kallahally
TBGR No.61118021

FCV tobacco quality enhancement through Nitrogen and Potassium foliar nutrition

Introduction

Flue-Cured Virginia (FCV) tobacco grown as a rainfed crop in Karnataka Light Soils is highly sensitive to nutrient imbalances. For achieving optimal yield and export-quality leaves, precise nutrient management is essential. Nitrogen and potassium, the major nutrients are particularly important, as they support higher cured leaf productivity, proper ripening, bright grade production, smoke chemistry and high burn rate. Research on foliar nutrition, particularly with potassium, has shown it to be effective in KLS, improving bright grade yield and enhancing disease resistance in tobacco plants.

Nature of the problem

Under optimal conditions, FCV tobacco can deplete 60–70 kg N and 80–100 kg K_2O per hectare. The light soils in Karnataka's tobacco-growing regions are low in organic matter and available nitrogen, though moderately rich in available potassium. Conventional fertilizer practices often result in nutrient losses through leaching, while uneven leaf maturity across the field causes harvesting and curing challenges. Poor uptake of nitrogen and potassium due to biotic and abiotic stresses leads to lower productivity, reduced bright grade yield, and immature or J-style tobacco, causing economic losses to FCV growers in the KLS region.

Technology intervention

Foliar application of nitrogen and potassium using potassium nitrate (1% solution, 13.5% N and 45% K_2O) in farmers' fields during crop growth phase at 45 and 55 days after transplanting increased leaf productivity by 9.3–11.2%. To promote foliar application of nitrogen and potassium in the region, large-scale field demonstrations were carried out, proving the practice highly successful. This targeted nutrient management not only boosted crop productivity but also improved profitability, producing leaves with optimal nicotine and sugar content that meet market standards for premium grades of FCV tobacco.

Recommendation

A foliar spray of N and K using potassium nitrate or a combination of ammonium sulphate and SOP at 2.5% concentration, applied twice at 45 and 55 days after transplanting, is recommended to improve cured leaf yield and increase bright grade production

Impact

Foliar nutrition with nitrogen and potassium has been a game-changer for KLS farmers, significantly improving the quality and marketability of FCV tobacco. The technology increased

bright-grade productivity by 9–11% and is widely adopted by over 25% of farmers across ~18,000 ha, resulting in better market prices with an ICBR of 1:6.51. Adoption of this practice has enabled KLS farmers to earn additional bright-grade yields and generate an extra annual revenue of around ₹ 11.8 crores.

Farmers Feedback

"I cultivate FCV tobacco on five acres. Light soil often led to nematode infections and potassium deficiency, resulting in more medium- and low-grade leaves, fetching lower market prices. Adopting the ICAR-CTRI recommendation, I applied nitrogen and potassium as foliar sprays using potassium nitrate (150 g per spray) at 45 and 55 DAT. The results were remarkable—potassium deficiency disappeared, bright-grade yield increased by 10%, and I received higher prices in the market".

Sri Chandrasekaraiah
Village - Marur
Hunsur Taluk

Boosting crop health with starter dose of Calcium Nitrate fertilization

Introduction

FCV tobacco farmers in Karnataka, growing the crop as a rainfed *kharif* crop, often face poor growth and premature leaf yellowing. This is mainly due to soils lacking calcium, nitrogen, and other essential nutrients, which directly impact crop growth and productivity. To address this, calcium nitrate (CN) fertilizer was evaluated and found effective in correcting calcium deficiency.

Nature of the problem

In FCV tobacco cultivation, calcium is an essential nutrient with high plant demand, similar to potassium, and its content in cured leaves typically ranges from 1.5 to 2.0%. Calcium strengthens cell walls, increases cell thickness, promotes better root development, and improves drought tolerance. It also protects against aluminum and manganese toxicity and enhances plant defenses against several fungal pathogens. By supplying a quick source of calcium and nitrogen, crops grow faster, withstand stress, and develop stronger, more robust structures.

Technology intervention

Applying a starter dose of calcium nitrate, which provides readily available calcium and nitrate nitrogen, greatly benefits seedling growth and development. This practice, widely used in many crops and vegetables, promotes early root development and overall plant vigor. Strong initial growth helps plants establish quickly and better withstand drought conditions.

Recommendation

A starter application of calcium nitrate at 25 kg ha^{-1} before planting is recommended in the KLS region to promote a strong root system for efficient nutrient absorption.

Impact

Based on ICAR-CTRI RS, Hunsur recommendations, the Tobacco Board has included calcium nitrate in the modified fertilizer schedule for FCV tobacco growers in KLS. This technological intervention *i.e.* application at CN @ 25 kg ha^{-1} at planting has improved seedling establishment & growth, increased cured leaf yield, and enhanced bright-grade production by 7–11% across dry and semi-dry zones. Adopting this technology has helped the KLS farmers earn an additional annual revenue of ₹ 51.4 crores, with an ICBR of 1:3.9.

Farmers Feedback

"Following ICAR-CTRI RS, Hunsur's recommendation, I applied calcium nitrate (CN) at 25 kg ha^{-1}, supplied by the Tobacco Board, in my five-acre field. The results were remarkable—leaves that previously showed yellowing turned dark green, and incidences of leaf curl, stem borer, and wilt were much lower than the previous year. I earned additional profit due to higher yield, especially from increased bright-grade leaves. Since then, I have been regularly intending for supply of CN fertilizer to Tobacco Board, Mysuru".

Sri S. Jagadeesh
Bellarygowdanakopallu,
Pariyapatna Taluk

Integrated technology for managing Root-Knot-Fusarium Wilt disease complex

Introduction

Root-knot nematode (*Meloidogyne incognita*) is a major limiting factor in both the nursery and main field crop of FCV tobacco grown under rainfed conditions in the light soils of Karnataka. Conventional nurseries are especially prone to infection, resulting in poor-quality transplants and delays in planting. Infected seedlings often fail to establish, leading to uneven stands and reduced yields. Early infestation has a significant impact on both yield and quality. As a soil-borne pathogen, root-knot nematode interacts with other organisms in the soil, creating disease complexes that cause root decay and necrosis. In particular, it predisposes tobacco plants to wilt caused by *Fusarium oxysporum* f.sp. *nicotianae*, further compounding losses.

Chemical control options are neither cost-effective nor environmentally sustainable. In contrast, biological control using bio-agents has shown promise for managing root-knot nematodes in many crops, and thus offers a long-term, eco-friendly solution. Focused research efforts have led to the development of bio-rational strategies for managing the root-knot–wilt disease complex in FCV tobacco grown in the KLS region.

Nature of the problem

Root-knot nematodes (*Meloidogyne* spp.) are a serious constraint to FCV tobacco production in the KLS region, reducing transplantable seedlings in nurseries by up to 59% and causing main field yield losses of around 53%. Infected seedlings often remain stunted or collapse after transplanting, leaving field gaps and lowering productivity. The problem is further aggravated when nematodes interact with Fusarium wilt pathogens, creating a disease complex that results in severe crop losses for smallholder farmers, along with reduced income. While chemical nematicides such as carbofuran and dazomet are effective, their high cost and environmental risks limit their suitability. An integrated management strategy for the root-knot nematode–Fusarium wilt complex offers a sustainable alternative, improving yields while ensuring residue-free tobacco suitable for export markets.

Technology intervention

Focused research has led to the development of effective management strategies for the root-knot–Fusarium wilt disease complex. These strategies have been recommended to tobacco farmers as bio-rational and cost-effective solutions. The recommended practices are outlined below.

a) ***Growing sunnhemp or radish as rabi crop in FCV tobacco fields***

In the KLS region, FCV tobacco is grown during the *kharif* season, and the crops raised in the preceding *rabi* season play a key role in influencing nematode populations and the incidence of Fusarium wilt in the following tobacco crop. Research has identified radish and sunnhemp as suitable *rabi* crops for reducing root-knot disease in subsequent *kharif* tobacco. In farmers' fields, growing radish and sunnhemp before tobacco reduced root-knot nematode populations by 42.8% and 38.6%, respectively. The root-knot index (RKI) in the following *kharif* tobacco was lowered to 1.8 with radish and 2.0 with sunnhemp, compared to 3.3 in fallow fields. This resulted in higher economic returns for KLS tobacco growers, with an incremental cost-benefit ratio (ICBR) of 1:2.53 for radish and 1:2.34 for sunnhemp as preceding crops.

b) ***Recommendation of antagonists enriched FCV tobacco tray seedlings***

Effective delivery of antagonistic organisms into the main field is crucial for bio-rational management of root-knot nematodes and the associated disease complex in FCV tobacco. To address this, a cost-effective field methodology was developed for introducing nematode antagonists. The approach involves fortifying tray media (well-decomposed coir pith) with *Trichoderma viride* (2×10^6 spores g^{-1}) and *Paecilomyces lilacinus* (2×10^6 spores g^{-1}), each applied at 50 g per 1.2 kg of media, and covering the mixture with a polythene sheet. After incubating the media under shade for one week, it is filled into polystyrene trays for raising FCV tobacco seedlings. This ensures effective delivery of bio-agents into the main field through the transplanted seedlings. Field evaluation in the KLS region showed that this strategy increased cured leaf yield by 12.2%, reduced root-knot nematode incidence by 50.5%, and lowered wilt incidence by 33.3%.

c) ***Adoption of FCH 222, a fusarium wilt-resistant FCV tobacco cultivar***

Fusarium wilt, caused by *Fusarium oxysporum* f. sp. *nicotianae*, is a major endemic problem in FCV tobacco, affecting about 20,000–30,000 ha in the KLS region. In wilt-sick plots, the resistant line FCH-222 showed high level of resistance with only 2.5% disease incidence, comparable to the resistant donor Speight-G 33 (5.0%). It performed well under farmers' field conditions, recording a potential cured leaf yield of 2,241 kg ha^{-1}.

Recommendation

a) Grow radish or sunnhemp as preceding *rabi* crops to reduce root-knot disease in the following *kharif* tobacco crop.

b) Use microbial-enriched coco-peat media for raising seedlings. Prepare it by mixing well-decomposed coir pith with *Trichoderma viride* (2×10^6 spores g^{-1}) and *Paecilomyces lilacinus* (2×10^6 spores g^{-1}), each at 50 g per 1.2 kg of media. Cover the mixture with a polythene sheet, incubate for one week, and then use it in trays for seedling production.

c) Plant FCH-222, a Fusarium wilt-resistant FCV tobacco variety.

Besides the above, the other general recommended practices are:

- Carry out deep summer ploughing.
- Remove stubbles of previously infected crops.
- Keep fields weed-free, even in the off-season.
- Use only healthy, root-knot-free seedlings.
- Follow crop rotation with non-host crops such as ragi, maize, jowar, bajra, and sesame.

Impact

This integrated management technology for root-knot nematode and Fusarium wilt is recommended to KLS farmers as an eco-friendly and cost-effective solution. It is currently being adopted in about 42% of the affected areas—covering nearly 3,780 hectares across Hunsur, HD Kote, Periyapatna, KR Nagar and Ramnathpura—where the disease complex is a major problem. To support farmers, the Tobacco Board, Ministry of Commerce, supplies ICAR-CTRI–recommended coco-peat media enriched with antagonistic organisms and polystyrene trays. These inputs help growers raise healthy, disease-free seedlings for timely planting, ensuring effective and eco-friendly management while producing pesticide-residue-free FCV tobacco for sustained exports. Through the adoption of this technology, FCV tobacco farmers in the KLS region are saving 9–10% of otherwise avoidable yield losses (about 108 kg ha^{-1}), resulting in additional annual revenue of ₹ 10.98 crores.

Root-knot-fusarium-wilt disease complex in KLS

Farmers Feedback

"I have been cultivating FCV tobacco in ~9 acres. Year after year, my crop suffered from both root-knot nematode and Fusarium wilt. On the advice of ICAR-CTRI RS, Hunsur scientists, I adopted integrated disease management practices which helped me raise healthy, nematode-free seedlings for timely planting. I noticed healthier crop growth with no incidence of Fusarium wilt. My yield increased by about 60 kg per acre, and around 40% of the produce was bright grade leaves, which fetched a better market price and higher profits".

Sri Abhimanyu
Village - Tatekere

Novel Nematicidal Molecule - Fluopyrum 400 SC for management of Root-Knot Nematode

Introduction

Root-knot nematode (*Meloidogyne incognita*) is a major threat to FCV tobacco grown in the light soils of Karnataka, affecting both nursery and main field crops. Early-stage infection severely impacts yield and quality by causing root decay and necrosis, often in association with fungal and bacterial pathogens. Typical symptoms include multiple galls with egg masses on roots, stunted growth, premature yellowing of leaves resembling nitrogen deficiency, tip and marginal leaf drying ("rim firing") due to impaired nutrient uptake, especially potassium, and the characteristic uneven distribution of affected plants in the field. Nematodes can also form disease complexes with *Fusarium oxysporum* f.sp. *nicotianae* (causing Fusarium wilt) and *Phytophthora nicotianae* (causing black shank), resulting in significant yield and quality losses. Different chemicals were tested, and Fluopyrum 400 SC proved to be the most effective and easy-to-use option against root-knot nematode in both nursery and main field FCV tobacco in KLS.

Nature of the problem

Root-knot nematodes (*Meloidogyne* spp., particularly *M. incognita* and *M. javanica*) damage roots, hinder nutrient and water uptake, and predispose plants to other soil-borne pathogens, creating disease complexes. They cause significant economic losses in tobacco by reducing both yield and leaf quality. Though traditional fumigant nematicides are effective, they pose environmental and health risks. As a safer option, Fluopyrum 400 SC has emerged as an effective non-fumigant alternative, working well at low and economical doses.

Technology intervention

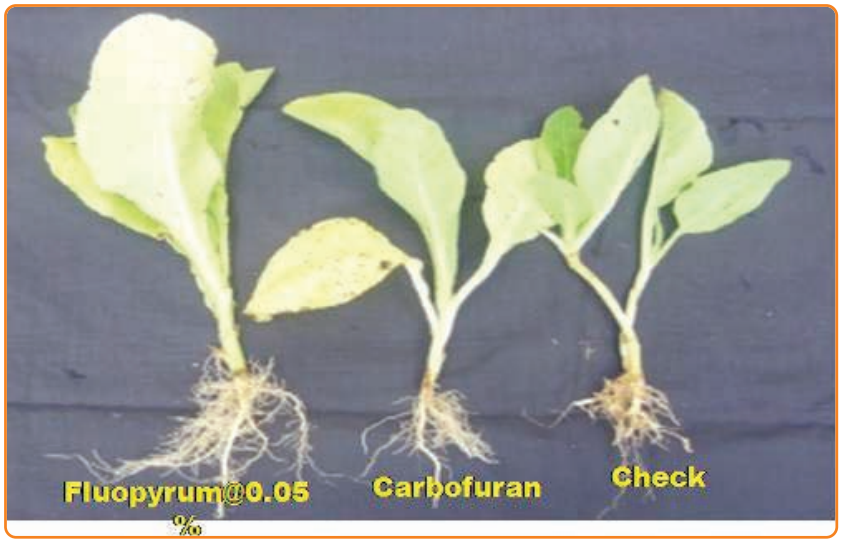
Novel nematicidal molecules—Fluopyrum 400 SC, Fluensulfone 2% G, and Carbosulfan—were evaluated at different doses against root-knot nematodes in FCV tobacco, with Carbofuran 3G as the chemical check under both nursery and main field conditions. Fluopyrum 400 SC, a succinate dehydrogenase inhibitor, disrupts nematode mitochondrial energy production, providing an effective and safer solution at economical dosage levels. In nursery trials, Fluopyrum 400 SC @ 0.05% reduced root-knot incidence (RKI 1.49 vs. 3.81 in untreated check), lowered nematode soil population by 44.2%, and increased root-knot-free transplantable seedlings by 25.1% compared to check. Fluopyrum is applied as a soil drench or through drip irrigation at planting or soon after transplanting. By inhibiting Complex II in the mitochondrial respiratory chain, it immobilizes and kills nematodes, effectively protecting roots from damage.

Recommendation

Fluopyrum 400 SC @ 0.05% is recommended for effective management of root-knot nematode (*Meloidogyne incognita*) in both nursery and main field FCV tobacco in KLS region.

Impact

The novel nematicide technology, being effective and user-friendly, was quickly adopted by farmers in root-knot nematode–affected areas, particularly Hunsur and Periyapatna in KLS. It is now used in both nurseries and main fields of FCV tobacco, covering about 1,000 acres. By preventing nearly 20% avoidable yield loss, farmers gained an additional annual revenue of around ₹ 2.5 crores. Its non-fumigant nature also reduces environmental risks, supporting sustainable farming practices.



Farmers Feedback

"I had severe root-knot nematode issues in both nursery and main field, which reduced yields and gave more low-grade leaves. Following the ICAR-CTRI recommendation, I applied Fluopyrum in both nursery and main field. To my delight, I raised healthy, nematode-free seedlings that ensured timely planting and set the stage for a successful crop. Further, drenching the main field with Fluopyrum @ 0.05% reduced root-knot incidence and doubled my bright grade yield, resulting in higher net returns".

Sri Krishnamurthy
Village - Seeguru
Periyapatna Taluk

Comprehensive Brown Spot Management Module in KLS FCV tobacco

Introduction

FCV tobacco is vulnerable to many diseases in both nursery and field stages. Since tobacco is harvested and sold as leaves, it is essential to ensure healthy leaf development in terms of size, physical quality, chemical composition, and freedom from disease damage. In the KLS region, where FCV tobacco is grown during the south-west monsoon under favorable conditions, fungal, bacterial and viral pathogens pose a constant threat, affecting production, yield and leaf quality. Brown spot, caused by the airborne fungus *Alternaria alternata*, is a major disease that severely reduces yield and quality in Karnataka tobacco.

Nature of the problem

Brown spot, caused by *Alternaria alternata* (Fries) Keissler, severely affects the quality and market value of FCV tobacco, where leaves are the primary product. In disease-prone areas, late-planted crops (June–July) are most affected, particularly during the initial primings, while early-planted crops (May–early June) usually experience minimal damage. The disease begins as small, water-soaked spots that quickly enlarge into circular brown lesions with concentric rings. These spots often merge, covering large leaf areas, making them ragged and unmarketable, sometimes forming central necrotic "shot-hole" lesions. Late in the season, sunken lesions may appear on stalks, petioles, suckers, flower petals and seed capsules. Disease severity is influenced by weather: over six hours of daily sunshine and daytime relative humidity below 60% favor outbreaks. Annual losses depend on the weather during crop growth and leaf development, resulting in significant reductions in yield, quality and chemical composition of FCV tobacco.

Technology intervention

Detailed studies at ICAR-CTRI RS, Hunsur, including work under an ICAR Adhoc Scheme, led to the development of a weather-based brown spot disease prediction model and a comprehensive management package for the region. Considering the harmful effects of chemical control, the focus has been on non-chemical approaches. Brown spot is a prime example where the concept of Integrated Pest Management (IPM) can be applied effectively.

Recommendation

The recommended comprehensive disease management program combines improved agronomic practices and phytosanitary measures.

- Use seeds only from authorized sources.
- Raise nurseries early (first half of March) and complete transplanting by May.
- Control root-knot in the nursery and plant only healthy, disease-free seedlings.
- Avoid soils with a history of root-knot or disease outbreaks.
- Remove and destroy all crop residues, including stalks and leaf trash.
- Avoid fields with a history of disease epiphytotics.
- Avoid heavy, humus-rich, or potassium-deficient soils in disease-prone areas.
- Monitor nitrogen levels and avoid over-application; apply potassium in two recommended splits.
- Keep fields and surrounding areas weed-free.
- Harvest leaves on time to prevent overripening.
- Increase harvest speed if disease begins to spread.
- Grow less susceptible varieties such as Kanchan in endemic areas.
- Apply chemical sprays only for late-planted crops or if other management practices are not fully implemented.
- For best results, apply a foliar spray of Propiconazole@ 0.1% at disease onset, followed by a second spray 15 days later.

Impact

The comprehensive brown spot management technology was recommended to FCV tobacco growers of Karnataka and it was widely adopted and being followed by at least 30 per cent of growers. Around 20,000 hectares of FCV tobacco growing regions are following the technology, mainly by planting early in May. Balanced K fertilization and need based nitrogen application is also strictly followed in these regions. By avoiding yield loss of around 5-6% due to brown spot disease (60 kg ha^{-1}), KLS farmers adopting the recommended technology realized an additional revenue of ₹6.71 crores annually.

Brown spot affected leaf

Farmers Feedback

"I follow the comprehensive brown spot management technology by planting early in May with root-knot-free seedlings and applying nutrients as recommended by ICAR-CTRI, including split doses of potassium. Using this approach every year helps me prevent brown spot disease, reduce low-grade leaves, and earn higher remunerative market prices".

Sri Sidaraju
Village - Keriyur
Hunsur Taluk

Integrated Barn Technology for reducing wood fuel usage in Curing

Introduction

Among the various types of tobacco grown worldwide, cigarette tobacco is distinct in that it undergoes flue curing—a controlled drying process carried out inside a barn. In Karnataka, Flue-Cured Virginia (FCV) tobacco is a major commercial crop cultivated over approximately 70,000 to 80,000 hectares in light soil regions. Firewood is the most commonly used fuel for this curing process, where heat is applied gradually to remove moisture from freshly harvested green leaves. However, the long-term availability of firewood for FCV tobacco curing in Karnataka Light Soils (KLS) is a growing concern. This has highlighted the need for research aimed at reducing firewood consumption in the curing process.

Nature of the problem

In FCV tobacco cultivation in the Karnataka Light Soil (KLS) region, the curing process accounts for over 25% of the total production cost. Adopting energy-saving methods can reduce the use of fuel, conserve natural resources, and significantly lower production expenses for farmers. To support this, ICAR-CTRI has developed and introduced several energy-efficient curing techniques.

Technology intervention

***Ventury Furnace*:** A modified ventury furnace, tested in collaboration with M/s ITC-ILTD Division under farmer conditions, improves combustion by ensuring adequate oxygen supply. Ash collection in a pit prevents soot deposition in flues, enhancing heat transfer. In curing trials at Hunsur, a 16'×16'×16' barn with a ventury furnace used 4.3 kg wood per kg of cured leaf, saving 15% fuel compared to a conventional furnace.

***Roof Insulation with Paddy Straw*:** Insulating the tiled roof of a 16'×16'×16' barn with paddy straw during flue curing reduces heat loss, especially during the rainy season. Fuel use dropped to 3.4 kg wood per kg of cured leaf, a 21% reduction compared to a non-insulated barn.

***Modified Flue System*:** Conventional barns use a central cast-iron pipe and G.I. ducts, which limit heat transfer and cause heat loss. ICAR-CTRI, in collaboration with M/s TIDE, Bangalore, developed a new flue system using a brick arch duct supported by hollow tile blocks with air vents, plus spun concrete pipes and corrugated flues, increasing surface area by 60%. Studies at Hunsur showed a mean fuel use of 3.5 kg wood per kg cured leaf, a 25% saving over the conventional 4.6 kg. Fifteen farmer barn trials confirmed a 24% saving in wood fuel.

***Turbo Ventilators*:** Traditional barns rely on natural convection, which is inefficient. Installing a turbo ventilator at the barn roof outlet provides forced convection, ensuring uniform heat

distribution. Equipped with a flap for adjustable venting during different curing stages, the ventilator achieved approximately 27% wood fuel savings in farmers' fields.

An integrated barn combining a low-profile design, ventury furnace, paddy straw roof insulation, modified flue system, and turbo-ventilator was tested at ICAR-CTRI RS, Hunsur. Fuel use ranged from 2.2 to 2.8 kg wood per kg cured leaf, averaging 2.4 kg, compared to 5 kg in a conventional 16'×16'×16' barn without energy-saving features. The high efficiency of the integrated barn comes from better wood combustion, reduced heat loss, improved heat circulation, and enhanced thermal retention. With a 51% fuel saving over conventional barns, this integrated system can significantly reduce wood consumption for flue curing of tobacco in Karnataka.

Recommendation

An integrated barn with a low-profile design, ventury furnace, paddy straw roof insulation, modified flue system, and turbo-ventilator is recommended for FCV tobacco curing in KLS to reduce firewood consumption.

Impact

The Integrated Barn Technology, developed and evaluated at ICAR-CTRI, is being recommended to FCV tobacco growers in Karnataka through the Tobacco Board, Mysore, Ministry of Commerce. Currently, it has been adopted by 40% of KLS farmers (around 20,000 farmers), providing an additional annual benefit of ₹ 10 crores by saving approximately 8% (₹ 5,000) on cultivation costs per farmer. Beyond the financial gains, incorporating these energy-saving modifications in all existing barns is expected to substantially reduce total fuel requirements for flue curing, thereby minimizing dependence on wood for curing FCV tobacco in the KLS region.

Ventury Furnace

Barn Ceiling insulation with Paddy Straw

Insulated Model Barn

Turbo ventilator fitted Barn

Farmers Feedback

"I implemented all the energy-saving technologies recommended by CTRI and modified my 13'×13'×13' barn. This helped me save 15% on cultivation costs and increased my bright-grade tobacco yield, which earned a higher price in the market due to better heat circulation in the barn".

Sri Dinesh
Village - Kirsodlu
TBGR No. 2329054

Integrated Farming System (IFS) for rainfed ecosystem of Southern Transitional Zone of Karnataka

Introduction

FCV tobacco is the main commercial crop in Mysore and Hassan districts, covering over 95% of cultivation, followed by cotton, maize, finger millet, and pulses. Red sandy loams and sandy clay loams, with slightly acidic to neutral pH and good drainage, are well-suited for growing most arable and horticultural crops.

Nature of the problem

Most farmers in the region are small and marginal, with land holdings of one to two hectares. Despite favorable soils, climate, and bimodal rainfall that allow diversified cropping, farmers largely practice monocropping, with cattle rearing as the only secondary activity. The farm's production potential is underutilized due to limited use of scientific soil and crop management, poor resource recycling, and lack of optimal cropping systems. Undulating topography, inadequate soil and water conservation, absence of agroforestry and subsidiary enterprises, along with unpredictable monsoons and market fluctuations, further limit sustainable farm and animal productivity and reduce the stability of farm income in this rainfed region.

Technology intervention

Considering the available resources and socio-economic conditions, an Integrated Farming System (IFS) model was developed and demonstrated at ICAR-CTRI Research Farm, Hunsur, from 2005 to 2010 on a one-acre area. The model integrates agroforestry, ideal cropping systems, and subsidiary enterprises to sustainably increase farm productivity and income. The one-acre area is divided into five blocks of 0.2 acre each to accommodate the different components of the system.

Components of IFS

Agri-Horticulture System (0.2 acre): Dryland fruit trees such as mango, sapota, tamarind, and pomegranate are planted, with short-duration intercrops like pulses (greengram, black gram, cowpea, horse gram) and castor grown in the spaces between the trees. This system works well on low- to medium-fertility soils.

Silvi-Pasture System (0.2 acre): Non-timber trees like eucalyptus and casuarina are planted at 1.5 m × 1.5 m, while timber species like neem and acacia are planted at 7 m × 7 m. Between the trees, short forage crops-*Styloxanthus hamata* and Co-3 grass-are grown for dairy animals and goats. The system has very low input and operational costs, requires no tillage, and can

be used on poor or marginal soils. While trees have a long gestation period, the forage crops provide multi-cut fodder, reducing milk and meat production costs.

Cropping Systems (0.4 acre): Both food and commercial crops were grown using recommended agronomic practices along with integrated nutrient and pest management. Intercrops included hybrid maize + cowpea (1:1) and pigeonpea + groundnut (2:8), along with sole crops of finger millet and hybrid cotton. In the *rabi* season, field bean and horse gram were grown to utilize north-east monsoon rains, increase cropping intensity, and maintain soil fertility. Crop residues were recycled to produce quality FYM and vermicompost. Growing multiple crops helps reduce risks from extreme weather, pests and diseases, and market fluctuations.

Subsidiary Enterprises (0.2 acre): Vegetables such as tomato, brinjal, chilli, and greens were grown alongside perennial crops like coconut, mango, papaya, banana, moringa and curry leaf. This system supported the family's nutritional needs and provided additional income. It emphasizes tree-based farming integrated with crops and livestock to conserve resources, recycle farm inputs, mitigate drought, and sustain long-term farm productivity.

Recommendation

About 60–70% of the total revenue from the model came from subsidiary components, highlighting the importance of an Integrated Farming System (IFS) for sustaining the livelihoods of small and marginal farmers in the rainfed Southern Transitional Zone of Karnataka. Agroforestry components like horticulture and silvi-pasture are expected to further increase income and stabilize farm earnings in the coming years. Therefore, a one-acre IFS—comprising 0.2 acre agri-horticulture, 0.2 acre silvi-pasture, 0.4 acre cropping systems, and 0.2 acre subsidiary enterprises—is recommended to FCV tobacco farmers in KLS region.

Impact

The one-acre IFS model was demonstrated to around 1,000 farmers in Karnataka. A few farmers implemented this technology on their land and secured consistent income regardless of weather conditions.

Agri-Horticulture System

Cropping Systems

Farmers Feedback

"Farmers observed that the IFS model developed at ICAR-CTRI RS, Hunsur is both economically viable and environmentally sustainable, and can be easily adopted by small rainfed farmers".

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