

## Effect of Sweet Flag (*Acoru scalamus* L.) Rhizome Treatment on Growth Parameters in Field bean (*Lablab purpureus* L.)

B. MEGHA<sup>1</sup>, P. VENKAPPA<sup>2</sup>, R. SIDDARAJU<sup>3</sup>, T. ONKARAPPA<sup>4</sup> AND USHA RAVINDRA<sup>5</sup>

<sup>1,2&3</sup>Department of Seed Science and Technology, <sup>4</sup>AICRP on Soyabean, ZARS,

<sup>5</sup>Department of Food Science and Nutrition, College of Agriculture, UAS, GKVK, Bengaluru - 560 065

e-Mail : meghasavaraj72@gmail.com

### AUTHORS CONTRIBUTION

B. MEGHA :

Conceptualization, design, manuscript writing, curation, tabulation of results and data analysis

P. VENKAPPA :

Conceptualization, design, supervision, manuscript editing and guidance

R. SIDDARAJU :

Critical feedback, design, supervision, manuscript editing and guidance

T. ONKARAPPA &

USHA RAVINDRA :

Supervision and helped to shape the research

### Corresponding Author :

B. MEGHA

Received : October 2025

Accepted : December 2025

### ABSTRACT

A field experiment was conducted to identify the best treatment concentration of sweet flag (*Acorus calamus*) rhizome for the enhancement of growth parameters in field bean (*Lablab purpureus* L.) at Research Institute of Organic Farming, UAS Bangalore, GKVK, Karnataka. The experiment consisted of eight treatments an untreated control (T<sub>1</sub>), sweet flag rhizome powder at 5g/kg (T<sub>2</sub>), 10g/kg (T<sub>3</sub>) 15g/kg (T<sub>4</sub>), Sweet flag rhizome oil at 2.5ml/kg (T<sub>5</sub>), 5ml/kg (T<sub>6</sub>), 7.5ml/kg (T<sub>7</sub>) along with a chemical control spinosad at 0.04ml/kg (T<sub>8</sub>). All the treatments were arranged in a randomized complete block design with three replications. Among the treatments, (T<sub>4</sub>) rhizome powder at 15g/kg recorded the highest growth parameters, with field emergence (98.9 %), plant stand (96.3), number of branches per plant (5.79), days to 50 per cent flowering (44.5) and days to maturity (96.2) followed by sweet flag rhizome powder at 10g/kg (T<sub>3</sub>). Plant height was the highest in T<sub>4</sub> at all stages (20.1 cm at 30 DAS, 63.0 cm at 60 DAS and 64.6 cm at maturity) followed by sweet flag rhizome oil at 7.5ml/kg (T<sub>7</sub>). The superior performance of T<sub>3</sub> and T<sub>4</sub> may be attributed to the bioactive properties of sweet flag rhizome in reducing pest and disease incidence in the field, thereby promoting better crop growth and development. These results highlight the potential of sweet flag rhizome formulations, especially in powder form at higher concentrations, as sustainable and eco-friendly alternatives to chemical seed treatments for improving growth and productivity in field bean cultivation.

**Keywords :** Sweet flag rhizome, Growth parameters, Field bean, Seed treatment

FIELD bean is considered as one of the oldest vegetable legumes cultivated worldwide, particularly across tropical regions of India, Africa and Southeast Asia. It is an annual, herbaceous and warm-season crop believed to have originated in India (Sandeep *et al.*, 2024). In addition to its use as a pulse and vegetable, it is grown for multiple other purposes, including green manure, hay, silage and as a cover crop for erosion control and weed suppression. The crop is mainly cultivated in the peninsular regions of India, where its adaptability to

various agro-ecological conditions makes it a reliable choice for small and marginal farmers. It also contributes to soil improvement by enhancing nitrogen levels and breaking soil compaction.

India holds the distinction of being the largest pulse-producing country and contributing significantly to global food security. The country accounts for approximately 25 per cent of global pulse production and nearly 32 per cent of the world's pulse-growing area. Karnataka is a major pulse-growing

state in India and plays a crucial role in the country's overall pulse output. It contributes nearly 90 per cent to both the total area under pulse cultivation and production at the national level. In India, Karnataka has major area under field bean cultivation accounting about 80 per cent of total country's area. In Karnataka, field bean is grown in an area of 0.52 lakh ha and production of 0.28 lakh tonne of grain (Anonymous, 2023). It requires high temperatures to grow (18-30 °C). Prominent pulse-growing districts in Karnataka include Bangalore, Kolar, Mysore, Hassan, Dharwad, Belgaum and Bidar, where favourable agro-climatic conditions and traditional cropping practices support their cultivation.

Among the diverse range of pulses cultivated in India, field bean (*Lablab purpureus* L.) holds particular importance in Karnataka and other southern states due to its multipurpose utility. It belongs to the family Fabaceae and sub-family Faboideae. The crop is known by several regional and local names, such as hyacinth bean, dolichos bean, Indian bean, avare, bonavist bean and (val) in Maharashtra. Field bean is primarily a self-pollinated legume and is cultivated both for its edible green pods, which are consumed as a vegetable and for its mature dry seeds, which serve as a protein-rich pulse (Bai *et al.*, 2020). The crop is culturally and economically significant, especially in rainfed farming systems.

The nutritional composition of field bean makes it highly valuable in vegetarian diets. The green pods and dry grains are rich in essential nutrients, including carbohydrates (6.7g), proteins (3.8g), fats (0.7g) and minerals (0.9g). Moreover, they are abundant in magnesium (34.0g), calcium (210mg), phosphorus (68.0mg), iron (1.7mg), potassium (74.0mg) and vitamins A and C. These nutritional qualities make it a wholesome food, particularly in rural households. The amino acid profile is well balanced with lysine content reaching up to 6.1 per cent. The total protein content ranges from 18.3 per cent to 31.6 per cent, making it a significant source of plant-based protein (Thamburaj and Narendra Singh, 2003). Its use is not limited to human consumption alone but also extends to animal feed and traditional medicine.

Among all inputs used in agriculture, seed is the most critical for ensuring good crop establishment and yield. High-quality seed leads to better germination, achieving maximum plant population, uniform stand and higher resilience to stress. However, seed quality can deteriorate rapidly due to poor storage conditions. In pulses, approximately 30-40 per cent of seed damage and viability loss occurs at post-harvest, primarily due to the infestation of storage pests like bruchids (*Callosobruchus* spp.) along with fungal contamination and nutrient imbalances (Paikaray *et al.*, 2022). Therefore, developing effective low-cost and environmentally friendly seed storage techniques is essential to ensure seed viability and vigour until the next planting season, especially in rainfed areas where seed replacement rate is low.

One such promising and eco-friendly seed preservation method is the use of botanicals, especially the rhizome of sweet flag (*Acorus calamus* L.). Sweet flag is a semi-aquatic perennial monocotyledonous herb with thick, branched and aromatic rhizomes. These rhizomes have been traditionally used in Indian medicine systems such as Ayurveda, Unani and Siddha for their medicinal and aromatic properties. The rhizomes are rich in essential oils such as  $\beta$ -asarone,  $\alpha$ -asarone, methyl eugenol, iso-methyl eugenol and camphor (Lokesh, 2004). These components are known for their diverse pharmacological properties including insecticidal, antifungal, antimicrobial, anti-oxidant, anti-inflammatory and repellent effects. Their presence offers great potential for sweet flag as a natural alternative to chemical pesticides and preservatives in seed treatment.

Traditionally, *Acorus calamus* has been widely used to treat a variety of ailments such as digestive disorders, bronchitis, skin diseases, colic pain, flatulence, rheumatism, fever and fatigue. The pharmacological activities of its essential oils, especially in repelling insects and protecting stored seeds, are being scientifically explored for agricultural applications. Its use in seed technology is a novel approach that bridges ancient herbal wisdom with modern agricultural science. Studies have shown that

sweet flag can be used effectively as a seed protectant, helping to prolong seed longevity, preserve vigour and reduce pest-related losses in storage, especially for pulse crops that are highly vulnerable.

In adoption of integrating traditional botanical knowledge with modern scientific methodologies this research aims to develop a dependable, affordable and eco-safe seed enhancement technology for field bean growing farmers. The approach will be particularly beneficial to small and marginal land holders in rainfed and resource-constrained regions of South India, where access to synthetic chemicals is limited. The outcome of this research is expected to contribute meaningfully towards improving field bean productivity, seed quality and post-harvest storage management in a sustainable manner. In Karnataka, where field bean is grown extensively as both an intercrop, sole crop under rainfed and irrigated conditions, there is a critical need for sustainable cost-effective seed storage solution. The increasing interest in botanical-based seed treatments offers a new avenue for utilizing *Acorus calamus* rhizome for enhancing growth parameters.



Sweet flag rhizome powder

## MATERIAL AND METHODS

Field bean seeds were subjected to six different treatments of sweet flag rhizome, one chemical seed treatments (spinosad) and untreated control, to study their effect on crop growth, seed yield and seed quality parameters. The treatments were imposed prior to sowing and the experiment was laid out in Randomized Complete Block Design (RCBD) with three replications (Plate 1.). The treated seeds were sown under uniform agronomic conditions at the Research Institute of Organic Farming (RIOF), UAS, GKVK, Bengaluru. The details of seed treatments and treatment structure are presented in Plate 2. The details are as follows:

### Treatment details:

- T<sub>1</sub> : Untreated Control
- T<sub>2</sub> : Sweet flag rhizome powder at 5g/kg
- T<sub>3</sub> : Sweet flag rhizome powder at 10g/kg
- T<sub>4</sub> : Sweet flag rhizome powder at 15g/kg
- T<sub>5</sub> : Sweet flag rhizome oil at 2.5ml/kg
- T<sub>6</sub> : Sweet flag rhizome oil at 5ml/kg
- T<sub>7</sub> : Sweet flag rhizome oil at 7.5ml/kg
- T<sub>8</sub> : Spinosad at 0.04ml/kg



Sweet flag rhizome oil



Spinosad



Treated seeds are ready for sowing

Plate 1 : Seed treatment materials used & treated seeds

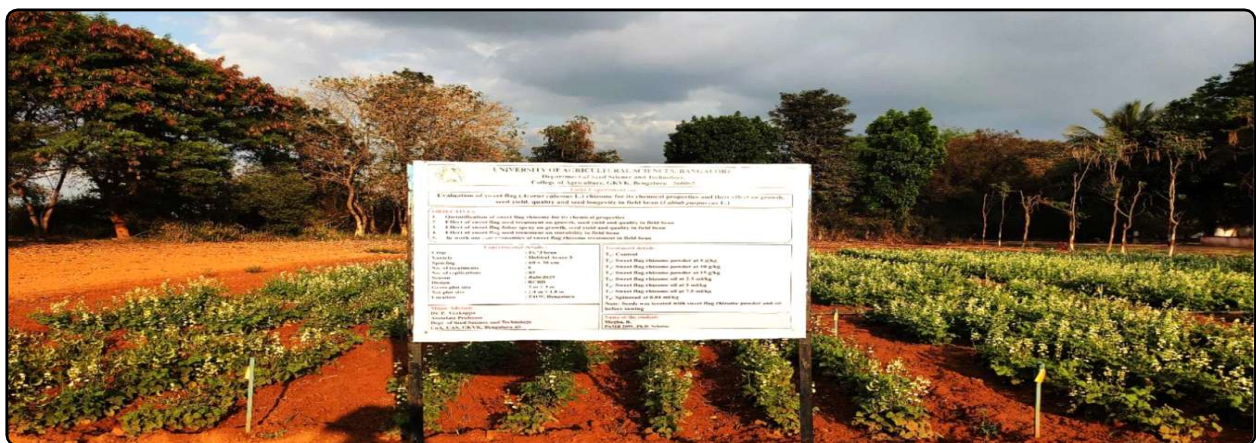


Plate 2 : General view of experiment

The field experiment was conducted during the *rabi* season, commencing in December 2024 and completed in April 2025. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The land was well ploughed and brought to a fine tilth by two to three harrowings followed by levelling, after which well-decomposed farmyard manure was applied uniformly to all the beds. Each plot measured 3m × 3m as a gross plot, while a net plot size of 2.4m × 1.8m was considered for recording yield observations, excluding the two border rows on each side. Prior to sowing, seeds were subjected to seven different treatments and one untreated control. A common irrigation was provided to all treatments before sowing to ensure uniform seed germination and an optimum plant stand under field conditions.

#### **Growth Parameters:**

##### **Field Emergence (%)**

Field emergence was calculated by counting the number of seedlings that emerged in each plot. The observations were recorded 10<sup>th</sup> day after sowing and the results were expressed in percentage. The emergence percentage was computed using the following formula:

$$\text{Field emergence (\%)} = \frac{(\text{Number of seeds emerged})}{(\text{Total Number of seeds sown})} \times 100$$

##### **Plant Stand (No.)**

Plant stand was recorded on 20<sup>th</sup> day after sowing (DAS) in each plot by counting the total number of healthy plants established. The results were expressed as plant stand number.

##### **Plant Height(cm)**

Plant height was recorded at 30, 60 DAS and at maturity by measuring five randomly selected and tagged plants from the net plot area of each treatment and replication. The measurement was taken from the ground level to the tip of the main shoot using a meter scale. The mean height of the selected

five plants at each stage was calculated and expressed in centimeters (cm).

##### **Number of Branches Per Plant**

The total number of branches per plant was counted manually at the time of maturity from five randomly selected plants per treatment and replication. The average was calculated and expressed as number of branches per plant.

##### **Days to 50 per cent flowering**

Days to 50 per cent flowering was recorded by counting the number of days from sowing to the stage when 50 per cent of the plants in each plot had at least one fully opened flower. The result was expressed in days.

##### **Days to Maturity**

Days to maturity was recorded as the number of days taken from sowing until 75-80 per cent of the pods in each plot turned yellowish or dry indicating physiological maturity. The observation was taken on a plot basis and expressed in days.

##### **Statistical Analysis and Interpretation of Data**

In order to evaluate the comparative performance of various treatments, data was analyzed by using analysis of variance given by Fischer (1950). The collected research data were analyzed statistically by the method of Panse and Sukhatme (1967) wherever the results were significant, the critical difference (CD) was calculated at 5 per cent level of significance for field observations.

#### **RESULTS AND DISCUSSION**

##### **Field Emergence (%)**

The data on field emergence as influenced by various sweet flag rhizome powder and oil treatments along with a spinosad treatment under field conditions are presented in Table 1.

Field emergence showed significant variation across treatments with the highest (98.9 %) emergence in T<sub>3</sub> (sweet flag rhizome powder at 10 g/kg) followed

**TABLE 1**  
**Effect of sweet flag rhizome treatment**  
**on field emergence (%) in field bean**

Treatments	Field emergence (%)
T <sub>1</sub> : Untreated Control	83.6
T <sub>2</sub> : Sweet flag rhizome powder at 5g/kg	87.0
T <sub>3</sub> : Sweet flag rhizome powder at 10g/kg	98.9
T <sub>4</sub> : Sweet flag rhizome powder at 15g/kg	91.8
T <sub>5</sub> : Sweet flag rhizome oil at 2.5 ml/kg	85.6
T <sub>6</sub> : Sweet flag rhizome oil at 5 ml/kg	98.1
T <sub>7</sub> : Sweet flag rhizome oil at 7.5 ml/kg	88.3
T <sub>8</sub> : Spinosad at 0.04 ml/kg	85.8
Mean	89.9
S.Em.±	1.89
CD (P=0.05)	5.75
CV (%)	6.32
Significance	S

by T<sub>6</sub> (sweet flag rhizome oil at 5ml/kg) with 98.1 per cent. The lowest field emergence (83.6 %) was recorded in control (T<sub>1</sub>) indicating relatively poor seedling emergence and survival.

Findings of the study highlighted that, field emergence percentage registered a positive response to treatments with sweet flag rhizome powder at 10g/kg (T<sub>3</sub>), recording 15.3 per cent increase in field emergence as compared to the control indicating the beneficial role of bioactive compounds such as beta-asarone and methyl isoeugenol (Z and E), along with methyleugenol in promoting seedling vigour. Beta-asarone and methyl isoeugenol are known for their antifungal, insecticidal, antimicrobial and antioxidant properties, which can protect seeds and emerging seedlings from biotic and abiotic stresses, enhancing germination and early growth. These bioactivities likely contribute to better field emergence by reducing pathogen load and pest damage (Park *et al.*, 2003 and Lee *et al.*, 2004).

Similar results were obtained in the studies of Keerthika and Niranjana (2023), who reported that powder formulations of *Acorus calamus* rhizome

along with *Piper longum* significantly suppressed the cowpea weevil, improving seed survival and reducing progeny emergence under field conditions. Furthermore, this study concurs with the findings of Paneru and Shivakoti (2022), who found that sweet flag and similar botanicals reduced egg hatch and seed damage in pulse crops during field trials in pulses, thereby indirectly supporting higher field emergence. These findings affirm that treatments with bioactive-rich botanicals can enhance crop emergence by providing protection through their multifaceted antimicrobial, insecticidal and antioxidant properties.

In contrast, the control (untreated) plots exhibited the lowest field emergence (83.6%), likely due to greater vulnerability to soil-borne fungi and pathogens or insect pests that adversely impact seedling establishment. These results coincides with the findings of Abdel-Kader *et al.* (2011) and Lamichhane *et al.* (2022) in faba bean and pulses, who observed untreated plots often show poor emergence due to disease incidence and pests.

#### Plant Stand (No.)

The data on plant stand as influenced by different seed treatments under field conditions are presented in Table 2.

Plant stand was significantly influenced by seed treatments. The highest plant stand (96.3) was recorded with sweet flag rhizome powder at 10g/kg (T<sub>3</sub>) followed by (T<sub>6</sub>) sweet flag rhizome oil at 5ml/kg (95.8). The lowest plant stand (79.7) was recorded in the control (T<sub>1</sub>) showing comparatively poor seedling survival and establishment.

In the current work, the plant stand responded favorably to treatments with 10g/kg of sweet flag rhizome powder (T<sub>3</sub>), which resulted in a 16.6 per cent increase in plant stand over the control. This suggests that bioactive compounds like  $\beta$ -asarone and methyl isoeugenol (Z and E isomers), as well as methyleugenol, are beneficial in promoting seedling vigour. Because of their well-known antifungal, insecticidal, antimicrobial and antioxidant qualities,  $\beta$ -asarone and methyl isoeugenol can shield seeds

**TABLE 2**  
**Effect of sweet flag rhizome treatment on plant stand (No.) in field bean**

Treatments	Plant stand (No.)
T <sub>1</sub> : UntreatedControl	79.7
T <sub>2</sub> : Sweet flag rhizome powder at 5 g/kg	86.0
T <sub>3</sub> : Sweet flag rhizome powder at 10 g/kg	96.3
T <sub>4</sub> : Sweet flag rhizome powder at 15 g/kg	90.0
T <sub>5</sub> : Sweet flag rhizome oil at 2.5 ml/kg	84.2
T <sub>6</sub> : Sweet flag rhizome oil at 5 ml/kg	95.8
T <sub>7</sub> : Sweet flag rhizome oil at 7.5 ml/kg	87.6
T <sub>8</sub> : Spinosad at 0.04 ml/kg	84.1
Mean	87.9
S.Em.±	2.00
CD (P=0.05)	6.07
CV (%)	6.83
Significance	S

and emerging seedlings from biotic and abiotic stressors, promoting germination and early growth by lowering pathogen load and pest damage, these bioactivities probably improve plant stand (Vaidya *et al.*, 2022 and Lal *et al.*, 2020).

The studies of Keerthika and Niranjana (2023) reported that powder formulations of *Piper longum* significantly suppressed the cowpea weevil, improving seed survival and reducing progeny emergence under field conditions. Likewise, these results are also align with findings of Ghasemi *et al.* (2020) that essential oils from *Thymus kotschyanus* containing thymol displayed strong antifungal and insecticidal activities, reducing pathogen pressure and promoting better seedling establishment in vegetable crops. These findings affirm that treatments with bioactive-rich botanicals can enhance crop emergence by providing protection through their multifaceted antimicrobial, insecticidal and antioxidant properties.

The lowest plant stand was observed in control (untreated) plots, likely resulting from heightened susceptibility to abiotic stresses, insect damage, seed and soil-borne diseases, which hindered seedling

establishment. These results corroborate with the findings of Lamichhane *et al.* (2022) and Abdel-Kader *et al.* (2011) in pulses and field bean who emphasized that untreated seeds suffer higher disease incidence and biotic stress, resulting in reduced plant stand and lower yield compared to treated seeds.

### Plant Height (cm)

The data on plant height as influenced by various sweet flag rhizome powder and oil treatments along with a spinosad treatment under field conditions are presented in Table 3 and Plate 3.

Plant height varied significantly among sweet flag rhizome treatments with the maximum recorded in T<sub>4</sub>- sweet flag rhizome powder at 15g/kg (20.1cm at 30 DAS, 63.0cm at 60 DAS and 64.6cm at maturity) followed by T<sub>7</sub>- sweet flag rhizome oil at 7.5ml/kg (19.5 cm at 30 DAS), T<sub>6</sub> - sweet flag rhizome oil

**TABLE 3**  
**Effect of sweet flag rhizome treatment on plant height (cm) in field bean**

Treatment	Plant height (cm)		
	30 DAS	60 DAS	Maturity
T <sub>1</sub>	14.2	47.1	47.8
T <sub>2</sub>	17.0	55.1	58.5
T <sub>3</sub>	18.0	61.3	62.3
T <sub>4</sub>	20.1	63.0	64.6
T <sub>5</sub>	19.4	60.5	63.4
T <sub>6</sub>	19.0	61.5	62.2
T <sub>7</sub>	19.5	61.0	63.6
T <sub>8</sub>	17.5	57.1	59.5
Mean	18.1	58.3	60.2
S.Em.±	0.54	1.73	1.85
CD (P=0.05)	1.65	5.25	5.60
CV (%)	9.01	8.90	9.20
Significance	S	S	S

Legend: T<sub>1</sub>: Untreated Control; T<sub>2</sub>: Sweet flag rhizome powder at 5 g/kg; T<sub>3</sub>: Sweet flag rhizome powder at 10 g/kg; T<sub>4</sub>: Sweet flag rhizome powder at 15 g/kg; T<sub>5</sub>: Sweet flag rhizome oil at 2.5 ml/kg; T<sub>6</sub>: Sweet flag rhizome oil at 5 ml/kg; T<sub>7</sub>: Sweet flag rhizome oil at 7.5 ml/kg; T<sub>8</sub>: Spinosad at 0.04 ml/kg

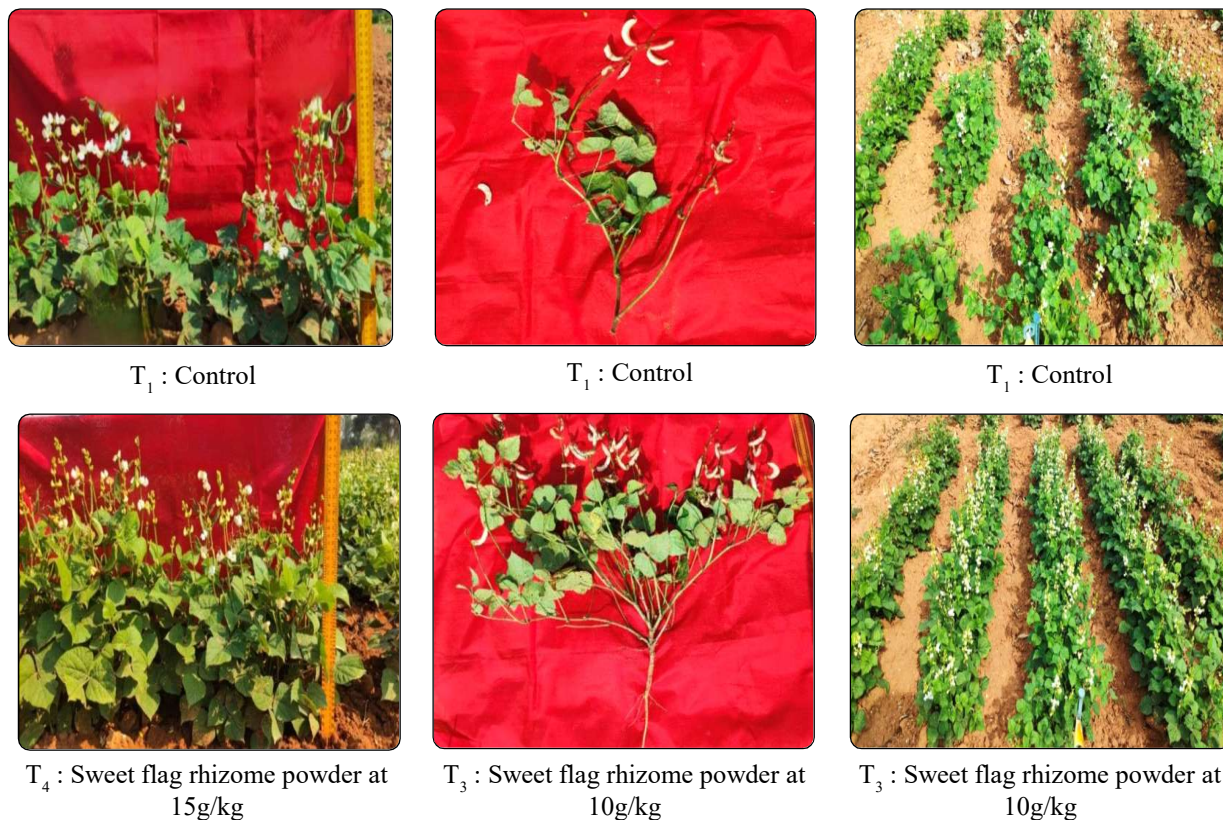


Plate 3 : Effect of sweet flag rhizome treatment on plant height, number of branches and days to 50 % flowering in field bean

at 5ml/kg (60.5cm at 60 DAS) and T<sub>7</sub> - sweet flag rhizome oil at 7.5ml/kg (63.4 cm at maturity). The control (T<sub>1</sub>) recorded the lowest plant height (14.2cm at 30 DAS, 47.1cm at 60 DAS and 47.8cm at maturity) indicating relatively poor vegetative growth under untreated conditions.

The findings revealed that, plant height responded favorably to treatments with sweet flag rhizome powder at 15g/kg (T<sub>4</sub>), which resulted in a 41.5, 33.8 and 35.15 per cent increase in plant height at 30 DAS, at 60 DAS and at maturity over the control. This suggests the usefulness of bioactive compounds like methyleugenol,  $\beta$ -asarone and methyl isoeugenol (Z and E). These substance's well-established antifungal, anti-insecticidal, antimicrobial, antioxidant and aromatic qualities probably lessen the stress caused by pathogens and pests, fostering stronger and better growth under field circumstances. According to Shalini *et al.* (2021),  $\beta$ -asarone has shown potent antifungal activity against plant

pathogens, assisting in the maintenance of a disease-free rhizosphere that promotes better nutrient uptake and seedling growth. They also emphasized the role that  $\beta$ -asarone boosts crop physiological activities. Moreover, methyl isoeugenol and methyleugenol enhance plant resilience by acting as natural insect repellents and antimicrobial agents, contributing to better stand establishment and growth in the field.

Supporting results were reported by Johnson *et al.* (2022) that extracts and oils from *Clausena austro indica* containing trans-anethole, exhibited potent insecticidal activities against pests such as *Sitophilus oryzae* and *Tribolium castaneum* in stored grain under field conditions, which supports better seedling protection and overall crop health. Furthermore, this study also corroborates the work of Bandara and Ranatunge (2020), who found that *Annona* seed-based aqueous botanical formulations effectively managed vegetable pests in field environments, reflecting the potential of botanicals

rich in antimicrobial and insecticidal compounds to enhance plant growth and yield. These findings affirm that botanicals like sweet flag, provide eco-friendly pest and pathogen control, which likely contributes to the improved plant height observed in the current study.

In the untreated control plots, plant height was the lowest, probably due to higher incidences of pest infestation, including pulse bruchids, leading to lower germination and stunted seedling development in the field. These results echo the results of Lamichhane *et al.* (2022) in pulses, that untreated seeds tend to suffer from higher pest infestation and poor growth, underscoring the significance of sweet flag rhizome-based seed treatments in enhancing pulse crop performance by bridging seed storage protection and field vigour.

#### Number of Branches Per Plant

The data on number of branches as influenced by various sweet flag rhizome powder and oil treatments along with a spinosad treatment under field conditions are presented in Table 4 and Plate 3.

**TABLE 4**  
**Effect of sweet flag rhizome treatment on number of branches/plant in field bean**

Treatments	Number of branches/plant
T <sub>1</sub> : Untreated Control	3.18
T <sub>2</sub> : Sweet flag rhizome powder at 5 g/kg	4.64
T <sub>3</sub> : Sweet flag rhizome powder at 10 g/kg	5.79
T <sub>4</sub> : Sweet flag rhizome powder at 15 g/kg	4.76
T <sub>5</sub> : Sweet flag rhizome oil at 2.5 ml/kg	4.68
T <sub>6</sub> : Sweet flag rhizome oil at 5 ml/kg	5.25
T <sub>7</sub> : Sweet flag rhizome oil at 7.5 ml/kg	4.52
T <sub>8</sub> : Spinosad at 0.04 ml/kg	5.09
Mean	4.74
S.Em.±	0.14
CD (P=0.05)	0.42
CV (%)	8.83
Significance	S

The number of branches showed significant variation across treatments with the highest (5.79) number recorded in sweet flag rhizome powder at 10g/kg (T<sub>3</sub>) and it is on par with (T<sub>6</sub>) sweet flag rhizome oil at 5ml/kg (5.25). The untreated control (T<sub>1</sub>) recorded the lowest number of branches (3.18) indicating relatively poor vegetative branching.

The number of branches in the present investigation responded favourably to treatments with sweet flag rhizome powder at 10g/kg (T<sub>3</sub>), which showed an 82.1 per cent increase in branches compared to the control. This implies the value of bioactive substances such as methyleugenol, methyl isoeugenol (Z and E) and β-asarone. Due to their well-known antifungal, insecticidal, antimicrobial, antioxidant and aromatic properties, these compounds reduce the pressure from pests and diseases, hence encouraging vegetative growth and healthy branch development. It has been demonstrated that β-asarone inhibits dangerous fungi like *Magnaporthe grisea* by altering the integrity of fungal membranes, shielding agricultural seedlings from infections in their early stages. These results align with those of Lee *et al.* (2004). Pinto *et al.* (2019) claim that methyl isoeugenol and methyleugenol both have insecticidal and antibacterial qualities that help improve physiological performance and biomass distribution to branches while reducing biotic stress on the crop.

Comparable findings were observed in the studies of Keerthika and Niranjana (2023) who reported that powder formulations of *Acorus calamus rhizome* along with *Piper longum* significantly suppressed the cowpea weevil, improving seed survival and reducing progeny emergence under field conditions. Additionally, these results corroborate with the findings of Paneru and Shivakoti (2022), that sweet flag and similar botanicals reduced egg hatch and seed damage in pulse crops during field trials, thereby indirectly supporting higher branching through better establishment and reduced pest stress. These results are further supported by the work of Xie *et al.* (2015), that essential oils of clove (*Syzygium aromaticum*) rich in eugenol and isoeugenol, exhibited antifungal and insecticidal

effects, enhancing crop stand and reducing yield losses. Furthermore, these results parallel to the observations of Tiwari *et al.* (2017) reported that intercropping with *Acoru scalamus* improved growth and yield attributes in rice, reinforcing the multi faceted benefits of this species in field conditions.

The control (untreated) plots exhibited the lowest number of branches, likely due to higher vulnerability to soil-borne fungi, insect pests and lack of protective bioactive compounds. Such untreated crops often suffer from reduced vigour, limited photosynthetic efficiency and restricted vegetative expansion and these results mirrors the findings of El-Mohamedy and El-Baky (2008), aligns with Iqbal *et al.* (2019) and echoes the results of Negi *et al.* (2021) in pulses.

### Days to 50 per cent Flowering

The data on days to 50 per cent flowering as influenced by various sweet flag rhizome powder and oil treatments along with a spinosad treatment under field conditions are presented in Table 5 and Plate 3.

Non-significant differences in days to 50 per cent flowering were recorded among different treatments.

TABLE 5

#### Effect of sweet flag rhizome treatment on days to 50 % flowering in field bean

Treatments	Days to 50 % flowering
T <sub>1</sub> : UntreatedControl	46.9
T <sub>2</sub> : Sweet flag rhizome powder at 5 g/kg	46.5
T <sub>3</sub> : Sweet flag rhizome powder at 10 g/kg	44.5
T <sub>4</sub> : Sweet flag rhizome powder at 15 g/kg	44.8
T <sub>5</sub> : Sweet flag rhizome oil at 2.5 ml/kg	46.7
T <sub>6</sub> : Sweet flag rhizome oil at 5 ml/kg	44.9
T <sub>7</sub> : Sweet flag rhizome oil at 7.5 ml/kg	45.7
T <sub>8</sub> : Spinosad at 0.04 ml/kg	45.9
Mean	45.7
S.Em.±	1.50
CD (P=0.05)	4.54
CV (%)	9.83
Significance	NS

Sweet flag rhizome powder at 10g/kg (T3) recorded the earliest flowering (44.5 days) followed by (T4) sweet flag rhizome powder at 15g/kg (44.8 days). The control (T1) was late to flower (46.9 days) indicating delayed reproductive development under untreated conditions.

The results of the experiment indicated that, the number of days to 50 per cent flowering responded favourably to treatments with 10g/kg of sweet flag rhizome powder (T3). This implies that methyleugenol, beta-asarone and methyl isoeugenol (Z and E) are bioactive substances that aid in accelerating blooming. By lowering biotic stress and changing defence systems, beta-asarone is said to enhance overall plant health and vigour in field settings. Flowering may be accelerated by this. The methyl isoeugenol has potent antibacterial and antioxidant qualities that shield plants from oxidative stress and fungal diseases. As a result, plants bloom earlier because they are less hampered by environmental stresses and disease. Same effects are also improved field emergence characteristics, these substances work together to produce an environment that is favourable for plant growth and development (Venkatesan *et al.*, 2019 and Schorr *et al.*, 2024).

Supporting results were obtained in the findings of Chandana *et al.* (2022) in turmeric (*Curcuma longa*), where organic manures and biofertilizers enhanced plant growth, reduced days to flowering and improved yield under field conditions. Likewise, these results are harmonious with the observations of Pandey and Gupta (2013) in sesame, demonstrated that the neem seed kernel extracts improved disease resistance and growth, which positively influenced flowering and emergence in agricultural field trials.

Conversely, the untreated control consistently exhibited the longest duration to reach 50 per cent flowering. These results are aligning with the findings of Bhoge *et al.* (2023) and Dhillon *et al.* (2021) that untreated plants are more vulnerable to pests and pathogens, which can delay reproductive development in pulse crops.

## Days to maturity

The data on days to maturity as influenced by various sweet flag rhizome powder and oil treatments along with a spinosad treatment under field conditions are presented in Table 6.

**TABLE 6**  
**Effect of sweet flag rhizome treatment on days to maturity in field bean**

Treatments	Days to maturity
T <sub>1</sub> : UntreatedControl	102.0
T <sub>2</sub> : Sweet flag rhizome powder at 5 g/kg	99.6
T <sub>3</sub> : Sweet flag rhizome powder at 10 g/kg	96.2
T <sub>4</sub> : Sweet flag rhizome powder at 15 g/kg	101.2
T <sub>5</sub> : Sweet flag rhizome oil at 2.5 ml/kg	98.5
T <sub>6</sub> : Sweet flag rhizome oil at 5 ml/kg	97.8
T <sub>7</sub> : Sweet flag rhizome oil at 7.5 ml/kg	100.9
T <sub>8</sub> : Spinosad at 0.04 ml/kg	97.0
Mean	99.1
S.Em.±	3.58
CD (P=0.05)	10.85
CV (%)	10.83
Significance	NS

Non-significant differences were recorded in the number of days to maturity among the treatments. The earliest maturity was noted in T<sub>3</sub>-sweet flag rhizome powder at 10g/kg (96.2 days) followed by T<sub>8</sub>- spinosad at 0.04ml /kg (97.0 days). The control (T<sub>1</sub>) was late in maturity (102.0 days) indicating delayed crop development under untreated conditions.

In the present investigation, T<sub>3</sub>- sweet flag rhizome powder at 10g/kg recorded the earliest days to maturity (96.2). This suggests that bioactive compounds like beta-asarone and methyl isoeugenol (Z and E), as well as methyleugenol are beneficial in speeding up crop maturation. By reducing biotic stressors, improving nutrient uptake and stimulating metabolic processes, beta-asarone is known to affect plant physiological health. This can increase overall vigour and stress tolerance, which will enable timely crop maturation

(Venkatesan *et al.*, 2019). Additionally, methyl isoeugenol and methyleugenol contribute to antimicrobial protection and antioxidative defense, reducing disease and environmental stress impacts and helping plants to reach maturity earlier and more uniformly (Schorr *et al.*, 2024).

Parallel findings were reported in the findings of Karlina *et al.* (2024) in pulses, who reported that turmeric (*Curcuma longa*) rhizome extracts, rich in curcumin and essential oils, enhanced plant health through antifungal and antioxidant activities, leading to reduced days to maturity and improved yield. Furthermore, this study coincides the findings of Xi *et al.* (2022) in pulses, found that ginger (*Zingiber officinale*) rhizome extracts containing phenolic compounds and essential oils promoted growth and early maturation in field conditions through their antimicrobial and antioxidant effects. These findings affirm that aromatic, bioactive rhizome extracts can expedite plant developmental stages, which aligns well with the results of the current study regarding days to maturity.

By contrast, the untreated control plots exhibited the latest maturity (101.96 days), reflecting delayed crop development due to the absence of beneficial phytochemical effects. These results are in confirmity with the findings of Rani *et al.* (2020), Chandwani & Amaresan (2022) and Jadon *et al.* (2020), that untreated pulses often show delayed physiological processes and development under prevailing biotic and abiotic stresses.

The study revealed that sweet flag (*Acoruscalamus*) rhizome treatments significantly enhanced the growth performance of field bean under field conditions. Among the treatments, rhizome powder at 15g/kg (T<sub>3</sub>) proved most effective, followed by 10g/kg (T<sub>4</sub>), showing superiority in field emergence, plant height and overall vigour. The improvement may be attributed to the bioactive compounds present in the rhizome, which reduced pest and disease incidence. Hence, sweet flag rhizome formulations can be recommended as a sustainable and eco-friendly alternative to chemical seed treatments in field bean cultivation.

## REFERENCES

- ABDEL-KADER, M., EL-MOUGY, N. AND LASHIN, S., 2011, Essential oils and *Trichoderma harzianum* as an integrated control measure against faba bean root rot pathogens. *J. Plant Prot. Res.*, **51** (3).
- ANONYMOUS, 2023, Ministry of Agriculture, India, <http://www.agriwelfare.gov.in>.
- BAI, S. K., KULKARNI, L. R., KESHAVAREDDY, G., NAGARAJ, K. H. AND RANGANATH, S. C., 2020. Impact assessment of frontline demonstrations on field bean grown under rainfed and irrigated condition in Karnataka. *Mysore J. Agric. Sci.*, **54** (1).
- BANDARA, K. AND RANATUNGE, R., 2020, Aqueous botanical formulations from *Annona* seeds for management of selected vegetable pests. *Trop. Agric.*, **168** (2) : 52.
- BHOGE, R. S., PATIL, C. S. AND SHELAR, V. R., 2023, A review on bruchid management in pulses. *PharmaInnov. J.*, **12** (2) : 3141 - 3145.
- CHANDANA, M., PADMA, M., PRABHAKAR, B. N., JOSHI, V., MAHENDER, B., GOUTHAMI, P. AND SATHISH, G., 2022, Studies on effect of organic manures and biofertilizers on growth, yield and economics of turmeric (*Curcuma longa* L.) varieties. *Int. J. Agric. Sci.*, **11** (11) : 824 - 832.
- CHANDWANI, S. AND AMARESAN, N., 2022, Role of ACC deaminase producing bacteria for abiotic stress management and sustainable agriculture production. *Environ. Sci. Pollut. Res.*, **29** (16) : 22843 - 22859.
- DHILLON, G. S., GRETZINGER, M., BAARDA, L., LANGE, R., SINGH GILL, K., YAREMKO, V., HARDING, M.W. AND COLES, K., 2021, Effects of simulated hail damage and foliar-applied recovery treatments on growth and grain yield of wheat, field pea and dry bean crops. *Can. J. Plant Sci.*, **101** (5) : 758 - 769.
- EL-MOHAMEDY, R. S. R. AND ABD EL-BAKY, M. M. H., 2008, Evaluation of different types of seed treatment on control of root rot disease, improvement growth and yield quality of pea plant in *Nobaria province*. *Res. J. Agric. Biol. Sci.*, **4** (6) : 611 - 622.
- FISCHER, R. A., 1950, Statistical methods for research workers, biological monographs and manuals. No. V. Statistical methods for research workers. *Biological monographs and manuals*, (11th ed.).
- GHASEMI, G., ALIREZALU, A., GHOSTA, Y., JARRAHI, A., SAFAVI, S. A., ABBAS-MOHAMMADI, M., BARBA, F. J., MUNEKATA, P. E., DOMKNGUEZ, R. AND LORENZO, J. M., 2020, Composition, antifungal, phytotoxic and insecticidal activities of *Thymus kotschyanus* essential oil. *Molecules*, **25** (5) : 1152.
- IQBAL, J., YOUSAF, U., ZIA, S., ASGHER, A., AFZAL, R., ALI, M., SHEIKH, A. U. R. AND SHER, A., 2019, Pulses diseases 'important limiting factor in yield' and their managements. *Asian J. Res. Crop Sci.*, **3** (2) : 21 - 29.
- JADON, K. S., THIRUMALAISAMY, P. P. AND KUMAR, R., 2020, Major seed-borne diseases in important pulses: symptomatology, aetiology and economic importance. In: *Seed-borne Diseases of Agricultural Crops: Detection, Diagnosis & Management*. Springer, Singapore, **23** : 469 - 542.
- JOHNSON, A. J., VENUKUMAR, V., VARGHESE, T. S., VISWANATHAN, G., LEELADEVI, P. S., REMADEVI, R. K. S. AND BABY, S., 2022, Insecticidal properties of *Clausena austro indica* leaf essential oil and its major constituent, trans-anethole, against *Sitophilus oryzae* and *Tribolium castaneum*. *Ind. Crops Prod.*, **182** : 114854.
- KARLINA, L., SUWANDI, S., MUSLIM, A., DAMIRI, N., ROHIM, A. M. AND NEGARA, Z. P., 2024, Antifungal activity of turmeric rhizome extract against *Ganoderma boninense*. *J. Sci. Agric.*, **8** : 88 - 91.
- KEERTHIKA, S. AND NIRANJANA, R. F., 2023, The effectiveness of powdery formulations of long pepper (*Piper longum* L.) and sweet flag (*Acorus calamus* L.) to combat the cowpea weevil (*Callosobruchus maculatus* F.) on stored mung beans. *J. Dry Zone Agric.*, **9** (2) : 45 - 52.
- LAL, M., BARUAH, J., BEGUM, T. AND PANDEY, S. K., 2020, Identification of a novel myrcene and methyl iso-eugenol rich essential oil variant (Jor Lab L-11) of lemongrass (*Cymbopogon flexuosus* L.). *J. Essent. Oil Bear. Pl.*, **23** (4) : 660 - 668.

- LAMICHHANE, J. R., CORRALES, D. C. AND SOLTANI, E., 2022, Biological seed treatments promote crop establishment and yield: A global meta-analysis. *Agron. Sustain. Dev.*, **42** (3) : 45.
- LEE, J. Y., KIM, S. H., KIM, J. H., KIM, J. Y. AND KIM, K. H., 2004, Antifungal activity of  $\alpha$ -asarone from rhizomes of *Acorus gramineus*. *J. Agric. Food Chem.*, **52** (4) : 776 - 780.
- LEE, J. Y., LEE, J. Y., YUN, B. S. AND HWANG, B. K., 2004, Antifungal activity of  $\beta$ -asarone isolated from *Acorus gramineus* rhizomes against plant pathogenic fungi. *J. Agric. Food Chem.*, **52** (8) : 2244 - 2250.
- LOKESH, G. B., 2004, Sweet flag (*Acorus calamus*) Cultivation and economics aspects. *Indian J. Nat. Prod. Res.*, **3** (1) : 19 - 21.
- NEGI, S., BHARAT, N. K. AND KUMAR, M., 2021, Effect of seed biopriming with indigenous PGPR, *Rhizobia* and *Trichoderma* sp. on growth, seed yield and incidence of diseases in french bean (*Phaseolus vulgaris* L.). *Legume Res.*, **44** (5) : 593 - 601.
- PAIKARAY, S. S., SATAPATHY, S. N. AND SAHOO, B. K., 2022, Estimation of yield loss due to pulse beetle, *Callosobruchus chinensis* (L.) on different mung bean cultivars. *J. Pharm. Innov.*, **11** (3) : 924 - 927.
- PANDEY, N. AND GUPTA, B., 2013, The impact of foliar boron sprays on reproductive biology and seed quality of black gram. *J. Trace Elem. Med. Biol.*, **27** (1) : 58 - 64.
- PANERU, B. AND SHIVAKOTI, G., 2022, Effect of botanicals on pulse beetle management and seed quality in field conditions. *Int. J. Pest Manage.*, **68** (4) : 290 - 298.
- PANSE, V. G. AND SUKHATME, P. U., 1967, Statistical Methods for Agricultural Workers. ICAR, New Delhi.
- PARK, I. K., CHOI, D. H. AND KIM, S. I., 2003, Insecticidal activity of  $\beta$ -asarone from *Acorus* species against stored-product insects. *J. Asia-Pac. Entomol.*, **6** (2) : 125 - 129.
- PINTO, S. M. L., RIVERA, Y., HERRERA SANDOVAL, L. V., LIZARAZO, J. C., RINCÓN, J. J. AND VARGAS MÉNDEZ, L. Y., 2019, Semisynthetic eugenol derivatives as antifungal agents against dermatophytes of the genus *Trichophyton*. *J. Med. Microbiol.*, **68** (7) : 1109 - 1117.
- RANI, A., DEVI, P., JHA, U. C., SHARMA, K. D., SIDDIQUE, K. H. AND NAYYAR, H., 2020, Developing climate-resilient chickpea involving physiological and molecular approaches with a focus on temperature and drought stresses. *Front. Plant Sci.*, **10** : 1759.
- SANDEEP, V., JAYARAMAIAH, R., NAVI, L. AND UMASHANKER, N., 2024, Influence of planting geometry and nutrient levels on growth, yield, economics and nutrient uptake of field bean. *Mysore J. Agric. Sci.*, **58** (4).
- SCHORR, R. R., BALLESTEROS GARCIA, M. J., PETERMANN, D., MOREIRA, R. R., SALES MAIA, B. H., MARQUES, F. A. AND MAY-DE MIO, L. L., 2024, Eugenol, isoeugenol, thymol, carvacrol and ester derivatives as an ecofriendly option to control *Glomerella* leaf spot and bitter rot on apple. *Plants*, **13** (22) : 3196.
- SHALINI, K., CHANDEL, S. R., ATRI, S., GULERIA, S., BHARDWAJ, I. AND ROLTA, R., 2021, The therapeutic properties and applications of *Acorus calamus* (sweet flag): A review. *Asian J. Microbiol. Biotechnol. Environ. Sci.*, **23** (1) : 122 - 136.
- THAMBURAJ, S. AND NARENDRA SINGH, 2003, *Vegetables, Tuber Crops and Spices*. Directorate of Information and Publication of Agriculture, ICAR, **2** (4) : 214 - 216.
- TIWARI, R. K. S. AND CHANDRA, K. K., 2017, Intercropping of sweet flag (*Acorus calamus* L.) with early and late maturing cultivars of rice (*Oryza sativa* L.). *Afr. J. Agric. Res.*, **12** (20) : 1713 - 1726.
- VAIDYA, V., BHANDARY, V., QURESHI, F. AND DARBAR, H., 2022, Mycorrhiza! A potential natural booster to the phytoconstituent ( $\beta$ -asarone) of *Acorus calamus*. **2** : 1 - 3.

VENKATESAN, R. A., KARUPPIAH, P. S., ARUMUGAM, G. AND BALAMUTHU, K., 2019,  $\beta$ -Asarone exhibits antifungal activity by inhibiting ergosterol biosynthesis in *Aspergillusniger* ATCC 16888. *Proc. Natl. Acad. Sci. India Sect. B Biol. Sci.*, **89** : 173 - 184.

XI, K. Y., XIONG, S. J., LI, G., GUO, C. Q., ZHOU, J., MA, J. W., YIN, J. L., LIU, Y. Q. AND ZHU, Y. X., 2022, Antifungal activity of ginger rhizome extract against *Fusarium solani*. *Horticulturae*, **8** : 983.

XIE, Y., YANG, Z., CAO, D., RONG, F., DING, H. AND ZHANG, D., 2015, Antitermitic and antifungal activities of eugenol and its congeners from the flower buds of *Syzygium aromaticum* (clove). *Ind. Crops Prod.*, **77** : 780 - 786.