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## Scientific Cultivation of Sweet Flag (*Achorus calamus* L.) under Wetland Ecosystem of North Bihar

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### **Abstract**

Sweet flag (*Achorus calamus* L.), is one of the most important aquatic medicinal plants grown in India. It is an important crop of family Achoraceae but recently placed in family Araceae. Average sweet flag production is 1.6 ton of rhizome (dry) acre<sup>-1</sup> annually in India. Nowadays, it is being used in medicine for alleviating rheumatic pain and illness and used as an aphrodisiac as it contains some important amino acids and flavonoid compound. The essential oil of *A. calamus* was found to be effective against storage pest and root knot nematode larvae. With the recent agro techniques a fertilizer dose of N:P:K @ 45:15:30 kg acre<sup>-1</sup> and FYM @ 2-3.0 t acre<sup>-1</sup> resulting in higher yield. Spraying of ZnSO<sub>4</sub> 2-3% at the young stage significantly increased the rhizome production. The maximum fresh yield is of 40.0 Q acre<sup>-1</sup> fresh and cleaned rhizome was obtained from Tumkur-1 cultivar, which was introduced from Karnataka. Dry rhizome yield is 16.0 Q acre<sup>-1</sup> resulting in i.e., B:C ratio of 1.63:1 under the wetland ecosystem of North Bihar.

### **Introduction**

It is a superb medicinal plant used in several Ayurvedic formulations in India from ancient times. This plant is under cultivated conditions in different states of south India. It has been found that about 70.0 percent of total cultivated area belongs to Karnataka. The total production of sweet flag in the country is 5725 Q annum<sup>-1</sup> from about 120.0 ha (Lokesh, 2004). The sun dried rhizomes of sweet flag contain 1.85 percent of calamus oil. The leaves are scented and contain numbers of volatiles in addition to calamus oil about 0.1 percent. The rhizome has an aromatic odor and contains several sesquiterpenes and asrones. It is a fair source of protein 15.0% but the presence of phenolics and trypsin inhibitors render it unfavorable for consumption in fresh. Therefore a suitable thermal processing method is required to have different processed food products. It has been found that tetraploid and triploid cultivar contains higher amounts of calamus oil than usual diploid. Occasionally sweet flags have been used as edible plants. The people of Indiana (USA) roasted the rhizome and took it as vegetables. The rhizome was also candied as a confection by European and American colonists. Up until the Second World War sweet flag was employed in North America to flavour the food products, tonics and tooth powders as scented ingredients. In recent years, the fragrant oil of the sweet flag has been used in perfumes' industry. The fragrant leaves are used as a repellent of insect and pest storage products (Kumar *et al.*, 2000).

### **Soil and Climate**

Sweet flag thrives well in almost all types of submerged and swampy with shallow depth of water. The warm humid climate with waterlogged soil is the best habitat

for sweet flag growth. It was found that soil rich in organic matter/ organic carbon responds positively to higher rhizome yield. Incorporation of sufficient organic matter as FYM or green manure resulted in better water holding capacity and more rhizome production. For green manuring, *Sesbania* spp. can be grown in April during 1<sup>st</sup> Nor-Webster and subsequently buried to field by ploughing during 1<sup>st</sup> monsoon shower.

## Cultivar

### Bach Selection-1

It is collected from BAU campus Ranchi Jharkhand. It is vigorous cultivar having less *tillering*, which causes maximum yield up to 10.0 Q dry rhizome acre<sup>-1</sup>. It is also well adapted to the subtropical and sub humid climate of Mithilanchal of north Bihar.

### Bach Selection-2

It is a semi domesticated sweet flag, collected from Pithoria areas of Jharkhand. This cultivar is dwarf *i.e.*, plant having less height and yield than Bach Selection-1.

### Tumkur-1

The best variety is from Tumkur district of Karnataka. It is high yielding cultivar produces 16.0 Q dry rhizome acre<sup>-1</sup> as compared to traditional Bach Selection-1 (10.0 Q acre<sup>-1</sup>) (Figure 1 & 2).

## Field Preparation

During the month of March, ploughing of the field is done for solarization of the soil and destruction of soil borne insects and pests too. Fields are puddled after incorporating sufficient FYM/ green leaf manure like *Sesbania* leaf (*Sesbania aculeata*) or karanz leaf (*Pongamia piñata* Pierre.) to facilitate impounding as much water in the rhizosphere. Best planting season for Mithilanchal area is the first fortnight of June. After planting 5 cm water depth is maintained to well settle the rhizome below the soil. After two months 10 cm water depth is maintained. With assured irrigation the crop can be planted in March and harvested in February (next year).

## Planting Materials and Planting Distance

Best planting material is the rhizome of the previous crop and the size of the rhizome is generally 5-8 cm long. Sweet flags can be propagated by seed also. Live shoot ends that are growing horizontally under the ground can be taken from the current season crop. For vigorous and improved cultivar planting distance is 45 cm × 30 cm while for wild type and semi wild type cultivar should have planting distance of 30 cm × 30 cm.

## Integrated Nutrient Management

The crop must be well fertilized with NPK @ 45:15:25 kg acre<sup>-1</sup>. Higher dose (SSP) (P<sub>2</sub>O<sub>5</sub>) and muriate of potash (MOP) are needed to improve the quality of rhizome production *via* organic and inorganic nitrogen metabolism. All fertilizer can be placed as a basal dose but to get the maximum benefit of fertilizer efficiency, 2-3 split at two months intervals after 60 days of planting is more effective application. Soil of Mithilanchal is basic pH ranges from 6.8-7.5 and shows Zn deficiency symptoms through stunted growth by curling and bending of the leaves (Figure 3). This deficiency is usually corrected by spraying 2-3% ZnSO<sub>4</sub>. The algae population for the first six months can be checked by using CuSO<sub>4</sub> · 5H<sub>2</sub>O @ 4-5 kg acre<sup>-1</sup> as a single application at 3-4 month crop. To avoid deficiency of potash in use of at least 50 kg muriate of potash acre<sup>-1</sup> (a.i. 30 kg K<sub>2</sub>O) should be added in the soil (Figure 4). So the corrected fertilizer dose is N:P:K @ 45:15:30 kg acre<sup>-1</sup>. Moderate dose of FYM @ 2-3 t acre<sup>-1</sup> improves soil fertility.

## Harvesting

When the leaf tip becomes yellow to brown and color of flower/spathe turns brown indicate the time of maturity of the crop: rhizomes which come on near the surface and about 30-50 cm long are harvested for quality rhizome production. Harvesting time of the sweet flag in North Bihar is the next year in the month of Feb-March. For full maturity, the crop is ready for harvest within 9-10 months. After harvest crops are cut into pieces of 5-8 cm long and then sun dried for one day followed by beating and rubbing with an objective to remove scales and friable roots and inert materials adherence to rhizome.

## Yield

The average yield (dry rhizome) of this crop is 16.0 Q acre<sup>-1</sup> (Lokesh, 2004). With better horticultural practices and using suitable cultivar dry rhizome yield can be increased up to 20.0 Q acre<sup>-1</sup>. Fresh cleaned rhizome yield is maximum 40.0 Q acre<sup>-1</sup>.

## Diseases and Pest Management

### Leaf Spot (*Alternaria* spp.)

No major diseases or pests are found to attack this crop. At the late growing season *Alternaria* leaf spots are found discreetly or sporadically. This diseases can be best controlled by the application of carbendazim *i.e.*, Bavistin 1 g lit<sup>-1</sup> in the month of September.

### Weed Flora at North Bihar in Sweet Flag

Major weeds of the field of sweet flag are algae population, *Oxalis corniculata* and *Cyperus rotundus* and other common grasses. Manual weeding is needed up to six months before the plants block the rows in a thick cover.

### Economic Benefit

**E**conomic benefit of this crop is very good, having a B:C ratio of 1.63:1 or above as a mono crop in the Mithila regions of Bihar. Economics of the sweet flag under north Bihar is given below (Table 1). The productivity of fresh water sweet flag is 40.0 Q acre<sup>-1</sup> which was almost 1.63 times over the average productivity.

### Future Prospects

**T**he National Biodiversity act of India, 202, promotes cultivation of medicinal plants especially those endangered, to conserve the wild sources. Sweet flag is such crop which is in the red list to have protection with immediate effect. It is effectively grown in industrial waste

Table 1: Economics of sweet flag cultivation per acre/annum in waste and low land ecosystem of North Bihar (Traditional Cultivar)

Sl. No.	Items and Quantity	Total cost (Approx.)
1.	Planting material Rhizome-100 bundles (400-450 pieces/bundle )	Rs. 2,500.00
2.	Green leaf manure, Karanz or Sesbania 3 Tones/ha	Rs. 2,500.00
3.	FYM : Six Tones.	Rs. 3,000.00
4.	Fertilizer (NPK 45:15:30)	Rs. 4,000.00
5.	Labours Rs. 350.00 /day for intercultural operation and disease & pest control.	Rs. 5,000.00
6.	Extraction of ground water during winter & summer months/ cost of electricity	Rs. 3,000.00
7.	Ploughing and puddling for field preparation	Rs. 3,000.00
8.	Transportation cost for procuring and marketing (15 km)	Rs. 1,000.00
9.	Total Cost of Production	Rs. 24,000.00
10.	Gross Return 40.0 Q fresh yield. Dry Rhizome 16.0 Q (A class)	Rs. 64,000.00
11.	Net Return	Rs. 40,000.00
12.	B:C ratio (11-9)	1.63:1



Figure 1: Tumkur-1: Grown in Tumkur district of Karnataka



Figure 3: Tumkur-1 (RCM, Darbhanga, Bihar)



Figure 2: Tumkur-1: Grown in RCM, Darbhanga, Bihar



Figure 4: Zn deficiency: deformed leaves



Figure 5: K deficiency: drying of young leaves marginally

and used in bioremediation (Kumar *et al.*, 2000). It has been found that an improved variety Tumkur-1 introduced from Karnataka gave the more yield about 40.0 Q fresh and cleaned rhizome acre<sup>-1</sup> in RCM, Darbhanga, paving the way for 1.63 times more income to farmers.

## Conclusion

Sweet flag is a new crop in north Bihar. It can be cultivated as a companion crop with makhana at border of pond or field. It can be grown in neglected and abandoned marshy areas as a mono crop. Economic benefit of this crop is very good, having a B:C ratio of 1.63:1 or above as a mono crop. The productivity of sweet flag is 40.0 Q acre<sup>-1</sup> fresh rhizome which could earn about INR 64,000.00 where cost of cultivation is approximately INR 24,000.00.

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