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Insights into the composition of lotus rhizome

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Abstract
Nelumbo nucifera Gaertn. (Nymphaeaceae) known as sacred lotus, is a very unique ornamental plant having multiple medicinal properties. The proximate analysis of rhizome were analysed and the results include moisture (72.14%), starch (10.05), carbohydrates (16.03g), protein (2.6g), fat (0.1g), fibre (3.2g), vitamin C (38mg), calcium (40mg), iron (1.07mg), phosphorus (58mg), potassium (450mg). Major chemical constituents that are present in methanol extract of rhizome were analysed through cold maceration method by High Resolution Mass Spectrometry (HR-LCMS) techniques. The compounds include: Betulinic acid, Rutin, Isoquercetin, 2R - aminohexadecanoic acid, Phytosphingosine, Sphinganine, Phorbol, Ginkgolide B, Tetrahydroxy- 2,6- dimethyl anthroquinone, Pseudouridine, p – Hydroxyphenobarbital, Fluoroacetate, Isoamyl nitrite, Metronidazole, Napthaldehyde, Acetoin. The results showed that bioactive compounds identified by HR-LCMS from rhizome of *Nelumbo nucifera* have revealed a very good potential to be explored as food supplements or even pharmaceutical products to improve human health.

Keywords: *Nelumbo nucifera*, HR-LCMS, rhizome, nutrient composition, therapeutic property, bioactive compounds

Introduction
Identification and isolation of active phytocompounds is the preliminary step in designing plant based drugs. Plant extracts and bioactive compounds isolated from medicinal plants are used for antibacterial, antifungal and antiviral therapy (Pawar and Nazreen, 2018). Moreover, a quarter of the allopathic medications are based on compounds isolated from natural products. With increase in drug recalls resulting from severe side effects, the pharmaceutical industry also is interested in finding new drugs from natural sources with fewer or no side-effects. Recently, these traditional medicines are receiving more scientific support which helps in not only authenticating the use of these medicines for treatment but also understanding the mechanism of action of these drugs (Fernandes and Banu, 2012).

Lotus (*Nelumbo nucifera* Gaertn.) produces highly valued flowers and rhizome which is an underutilised vegetable. In addition, leaves, seeds, stems and other parts are edible and have many medicinal properties (Mukherjee *et al*., 2009) [21]. This plant is naturally seen as well as grown throughout the tropics. It has economic value where rhizomes are popular because of its crispness, attractive white colour and abundant nutrients. They can be eaten either as cooked or raw form and are rich in health promoting compounds such as alkaloids, lipids, flavonols, carotenes, aporphine, nuciferine, phospholipids, flavonoids, xanthophylls, and minerals (Li *et al.*, 2017) [15].

Lotus belongs to the *Nelumbolaceae* family and the genus *Nelumbo*. There are only 2 species in this genus: *Nelumbo nucifera* with pink, red or white flowers, distributed in Asia and Oceania, and *Nelumbo lutea* with yellow flowers, distributed in North and South America (Man *et al*., 2012) [17].

Contents of fresh rhizome is described to have 81.42g water, 66kcal energy, 0.07g fat, 0.52g sugars, 1.58g protein, 3.1g fibre, 26mg calcium, 78mg phosphorus, 363mg potassium, 0.9mg iron The vitamins thiamine (0.12mg/100 g), riboflavin (0.01 mg/100 g), niacin (0.30mg/100 g) and ascorbic acid (27.4 mg/100 g) are also present in the rhizomes (Sheikh 2014) [31].

The lotus rhizomes are rich in minerals and are consumed as health foods. It has profuse starch grains throughout the tissue. Fresh rhizome contains 31.2% starch, which shows no characteristic taste or odour (Fatima *et al*., 2018) [6]. Mukherjee *et al*. (1997) found that the methanol extract of the rhizome contained a steroidal triterpenoid – betulinic acid.

Zhao *et al.* (2014) identified the compounds astragaline, rutin, isoquercetin, nuciferine, dauricine, isoliensinine, and neferine. Lotus rhizome contains high levels of polysaccharides. Jiang *et al.* (2011) [12] isolated two antioxidant micro-molecular components (gallocatechin, catechin) and an antioxidant macromolecular component LB2 from lotus rhizome.

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Short communication

Evaluation of *Piper longum* L. hybrids under different shade levels

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Abstract

Four promising hybrids along with female parent and Viswam variety were evaluated for growth and yield under open, twenty five percent and fifty percent shade levels. Among the hybrids, PI 9, PI 63 and PI 140 recorded higher plant height, number of laterals, number of spikes, fresh and dry spike yield per plant which were on par but significantly higher than the present popular variety "Viswam" released by the Kerala Agricultural University. The hybrid PI 63 was found to be the most promising hybrid followed by PI 9 under open condition. At 25 per cent shade, hybrid PI 140 produced higher fresh and dry spike yield per plant. However, at 50 per cent shade, Pl 9 produced maximum spike yield. Yield was higher at lower shade level (zero per cent) compared to higher (25 per cent and 50 per cent).

Keywords: *Piper longum*, Promising hybrids, Shade level, Yield.

Piper longum L., commonly known as long pepper, belongs to family Piperaceae. The species has originated in South Asia. *Piper longum* is an important medicinal plant used in more than 320 ayurvedic preparations. Inspite of the importance so far. As a part of a KSCSTE funded project, hybrids of *Piper longum* were developed and in the preliminary evaluation trials, four hybrids were found promising. In the present study an attempt was made to evaluate these hybrids under different shade levels for growth and yield.

The experimental material included four promising hybrids of *Piper longum* viz., Pl 9, Pl 63, Pl 140, Pl

This experiment was conducted at Vellanikkara during 2015-2017. Four promising hybrids along with female parent and Viswam were evaluated for growth and yield under three different shade levels such as zero per cent, twenty five per cent and fifty per cent. The experiment was laid out in CRD with 18 treatments and four replications. Rooted cuttings were transplanted into pots at three to four leaf stage in June. Observations were recorded on plant height, number of primary branches per plant, time taken for production of first lateral, number of laterals per plant, season of flowering and fruit set, number

Observations were recorded since from the time of planting and continued for a period of one year.

The four promising hybrids of long pepper were catalogued based on the descriptor developed for *Piper nigrum* by IPGRI (1995) with suitable modifications. Observations on morphological characters like leaf shape, leaf color, spike orientation, spike shape, immature spike color and

for cataloguing.

All the accessions studied had leaves with elliptic-lanceolate shape on their plagiotropic shoots. Leaf lamina was mostly cordate on their orthotropic shoots and only Pl 141 was ovate-lanceolate. Leaf color was varying from light green to dark green.

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How Mechanical Bund Formation Affects the Shear Strength of Bunds: A Study in Paddy Wetlands

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Mechanical bund formation, Shear strength, Paddy wetlands

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A B S T R A C T

Bund formation is an important field preparation operation in rice cultivation. Presently, this operation is done manually. A low cost, tractor drawn bund forming and strengthening implement for paddy wetlands has been developed. Shear strength of the bunds formed is one of the parameters for assessing effectiveness of bunds. Shear strength were measured for the bunds formed using the developed tractor drawn wetland bund formers and compared with the manual bunds formed at three locations. The medium bund former was seen to impart more strength to bunds formed at Pullazhi *kolepadavu*. At Kolothumpadam *kolepadavu*, the big bund former and the combination run provide strong bunds while at Athalur fields (non *kole*) the mechanical formers could be used to form new bunds only.

Introduction

Bund formation is a very important part of land preparation in paddy wetlands. *Kole* lands are a major rice growing tract in Kerala. They extend, almost parallel to the coastline, in an area of 13,632 ha, in the Thrissur and Malappuram districts of the State. The *kole* lands are located 0.5 m to 1.0 m below sea level and remain submerged under water for about six months of the year from May to October. The lands are very fertile as alluvial deposits are brought into this shallow basin, mainly by the Karuvannur river and Kecheri river, which then drain out into the Arabian sea. These lands have been put under paddy cultivation since long. Though the cultivation process is tedious here, the bumper yields (that are usually double the yield from the conventional paddy lands) prompt the farmers to cultivate rice here, every year. These large extents of paddy lands are crisscrossed by canals which divide the area into smaller blocks, called *kolepadavus* that ease the cultivation process. Each *padavu* has an average area ranging from 100 ha to 200 ha. The submerged fields are dewatered, mainly using the *petti* and *para*, starting by September, and the cultural practices for rice cultivation are then started. The fields have very soft soils at this juncture, as they have remained submerged for a long time. Further the soil comprises of alluvium coming with the river/ flood waters. Hence the properties of soil in the *kole* lands are very typical and unique (Johnkutty and Venugopal, 1993;

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A review on zinc and boron nutrition in rice

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Abstract
Micronutrients, though needed in smaller amounts, play a major role in the production and productivity of rice. Zn is the fourth most deficient nutrient element in Indian soils and its deficiency causes severe yield reduction in rice. Application of Zn either as foliar spray or soil application caused significant improvement in growth and yield attributes and yield of rice. Similar to that of Zn, B nutrition also caused significant improvement in growth and yield attributes and yield of rice. The review elaborates the effect of Zn and B nutrition on the growth, physiological parameters, yield attributes, yield and quality of rice.

Keywords: Growth attributes, Grain quality, Physiological parameters, Yield attributes, Yield

INTRODUCTION

Zinc (Zn) plays a major role in the growth and development of rice (Chaudhary *et al.*, 2007). Among the seventeen essential nutrient elements, Zn is the fourth most deficient nutrient element in Indian soils (Shukla and Behera, 2011). Zinc is one of the vital nutrients which is required for various biochemical and metabolic process in rice such as synthesis of cytochromes and nucleotides, auxin metabolism, production of chlorophyll, activation of several enzymes, membrane integrity, metabolism of carbohydrate, cell wall development, gene expression and respiration (IRRI, 2000; Broadley *et al.*, 2007).

Cereals are more prone to Zn deficiency than legumes and resulted in substantial reduction in yield and quality (Cakmak *et al.*, 1999). Rehman *et al.* (2012) reported that Zn deficiency is considered to be the most important nutritional stresses limiting rice production in Asia. The main factors which affect the Zn availability to the plants are soil pH, concentration of Zn, Fe, Mn and P in soil solution, high organic matter and bicarbonate content, high Ca to Mg ratio, prolonged submergence and low redox potential.

Zinc deficiency in rice causes a deficiency disorder called Khaira disease. Seedling stage of the crop is highly prone to Zn deficiency. Leaves develop brown blotches and streaks, the streaks and blotches may fuse to cover the entire leaf, plants remain stunted and in severe case of deficiency the plant may die. Zinc deficiency decreases the tillering, increases the spikelet sterility and delay the crop maturity (IRRI, 2000). Slaton *et al.* (2001) reported that Zn deficient rice plant show poor root respiration especially in submerged soils.

The deficiency of boron (B) is spreading and it is most common in rice growing soils. Though it is required in small amounts but proved essential for plant growth. Boron is associated with one or more process of calcium utilization, cell division, flowering/fruiting, disease resistance, water relations and act as catalyst for several reactions (Spraque, 1951). It is also very much essential for the metabolism of carbohydrate, transport of sugars, synthesis of nucleotide, respiration and pollen viability (Dell and Huang, 1997). Deficiency of B affects the cell wall biosynthesis, phenol metabolism, structure and plasma membrane integrity. It does not affect enzyme activities since it is not an enzyme constituent and it is comparatively immobile in rice plants (Yu and Bell, 1998). The factors contribute to B deficiency in rice are drought, low pH, calcareous nature of the soil, leaching and fixation (Mengel and Kirby, 2001; Niaz *et al.*, 2002; Rashid and Rayan, 2004; Rashid *et al.*, 2005; Niaz *et al.*, 2007 and Rashid *et al.*, 2009). By correcting the deficiency, B has the potential to enhance the rice production and foliar application is an easy and effective way to resolve the B deficiency.

Effect of zinc fertilization on growth attributes of rice: Zinc fertilization had significant effect on growth attributes. Khan *et al.* (2002) indicated that application of 10 kg $ZnSO_4$ ha^{-1} produced tallest

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Effect of nutrient levels and schedule of nutrient application on the grain quality of upland rice intercropped in coconut

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Abstract:
Field experiment was conducted at Coconut Research Balaramapuram, during *Kharif* 2017 to study the effect of nutrient levels and schedule of application on the quality parameters of upland rice intercropped in coconut. The experiment was conducted in randomized block design (RBD) with four different nutrient levels and four different schedules of nutrient application. Quality parameters like crude protein and starch content were significantly influenced by nutrient levels. The crude protein content was found to increase with increase in N level, however starch content was found to increase up to 70 kg N and 35 kg K ha^{-1} and after that a decline in trend was observed. The highest crude protein content (8.38 per cent) was recorded with highest nutrient level, NPK @ 120:30:60 kg ha^{-1}. However, lower nutrient level, NPK @ 70:30:35 kg ha^{-1} recorded higher starch content (85.03 per cent). Among the schedule of nutrient application, N applied in three equal splits (15 days after sowing (DAS), active tillering and panicle initiation stage), P as basal and K in two equal splits (15 DAS and panicle initiation stage) along with foliar application of 0.2 per cent zinc sulphate and 0.04 per cent sodium borate at 45 DAS recorded the highest crude protein (7.50 per cent) and starch content (84.17 per cent). The study clearly indicated that the increased level of N and K increased the protein content due to the active role of N and K in protein synthesis. However, high rate of N application decreased the starch content. In addition to the application of NPK, foliar nutrition of zinc sulphate and sodium borate at 45 DAS considerably improved the quality of grain by increasing the starch and protein content.

Keywords: Crude protein content, Nutrient levels, Schedule of nutrient application, Starch content, Upland rice

INTRODUCTION

Rice is the oldest domesticated grain crop (10,000 years) and is the main energy source for more than 2.5 billion people. It provides 21 per cent of global human per capita energy and 15 per cent of per capita protein. Rice is cultivated in majority of the countries, with a total harvested area of about 160.75 million hectares, with an annual production of 488.23 Million metric tons (USDA, 2018). Considering its importance, the United Nations designated year, 2004 as the 'International Year of Rice'. Rice provides food for more than 65 per cent of the people living in India and is cultivated in an area of 433.88 lakh ha with an annual production of 104.32 m t and productivity of 2404 kg ha^{-1} (GOI, 2017).
Grain quality is of prime importance in rice production. Grain quality is controlled by genetic factors, environmental factors (temperature and light) and management practices (Mo, 1993; Zhou *et al.*, 1997; Bao and Zia, 2000). Among the management practices, nutrient management plays an important role. The yield and quality of upland rice can be enhanced by the application of adequate amount of nutrients at optimum level and at right time. Nitrogen, the primary nutrient element plays a pivotal role in rice production. It is the integral part of chlorophyll, amino acids and genetic material *i.e.* DNA and RNA and plays a significant role in enhancing the milling quality and protein content of rice grain (Nawaz *et al.*, 2017). For balanced fertilize use potassium is used along with nitrogen and phosphorus and the optimum NPK ratio for cereals is 2:1:1. Potassium plays an indis-

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Traditional knowledge on use of medicinal plants grown in homesteads as home remedies

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Abstract
The present paper is an attempt to explore the traditional knowledge nurtured by the farming community on medicinal plants. The study was conducted in Thrissur district of Kerala state. Thrissur has a long history in the use of medicinal plants and traditional medicine. Local people in the villages, especially the elderly, have useful information about health benefits and how to use these plants. Therefore, it seems that collecting and recording this information lead to the revival of traditional knowledge. A total of 62 species of medicinal plants and 45 ITKs were recorded in the study area. However, out of 62 species only 29 species are currently used for treating various illness and diseases. Further, 12 plants were used to cure more than one ailment, while 17 plants were mostly used for single therapeutic application. Traditional botanists and native people were also interviewed for identifying the medicinal plants and studying its uses.

Keywords: Indigenous traditional knowledge, ITK, medicinal plants, traditional knowledge, home remedies

1. Introduction
Medicinal plants are priceless gift of nature. From time immemorial they have been used as a source of medicine for treating human diseases. As per World Health Organization (WHO) [1] estimates, nearly 80 per cent of the population of developing countries depend on traditional medicines, mostly plant drugs, for their primary health care needs. It is estimated that 20,000 species of plants are being used for medicine in the third world countries [2].

In India, in traditional system of medicine it is estimated that about 8000 species of medicinal plants, herbs, shrubs, trees, climbers, orchids, grasses and tubers are used for medicinal purposes by millions of people across the country [3]. Even though there is a great advancement in the allopathic field of medicine, the medicinal plants are attracting the attention of the entire world in a much faster way. It has been reported that over 150 species of medicinal plants are either indigenous or naturalized to our state and are used in the Indian system of medicine like Ayurveda and Sidha [4].

The traditional wisdom and knowledge play an important role in contributing sustainable grass root innovation and the overall socio-economic development of communities. Researches show that the indigenous knowledge of medicinal plants has been decreasing at an alarming rate and many policies and development projects have collapsed because of failure to comprehend traditional knowledge and how this influences the way farmers manage available natural resources [5]. The knowledge of Ayurveda has led to the discovery of many potent bioactive agents in modern drug development [6],[7]. Still 75 per cent of total population relies on medicinal plants in the rural and remote areas by way of traditional systems of medicine. Large human population in developing countries is dependent on plant resources for healthcare because allopathic medicine can cure a wide range of diseases, but its high prices and occasional side-effects are causing many people to return to herbal medicines which tend to have fewer side effects [8].

There is an urgent need to document the traditional knowledge on medicinal and aromatic plants since this knowledge orally passes through generations and more vulnerable to be wiped out [9]. Kerala State is enormously graced with medicinal plants due to its diverse agro-climatic conditions. Medicinal plants constitute an important component of the plant resource spectrum of the state. Moreover, the state has a rich tradition in Ayurveda from very early period and contributed much to the development of this system of medicine. Out of 4600 flowering plants identified in Kerala, about 900 possess medicinal values.

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A parasporin from *Bacillus thuringiensis* native to Peninsular India induces apoptosis in cancer cells through intrinsic pathway

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Parasporins, a class of non-insecticidal crystal proteins of *Bacillus thuringiensis* (Bt) are being explored as promising anticancer agents due to their specific toxicity to cancer cells. The present study has identified 25 Bt isolates harbouring parasporin genes from Western Ghats region, the hotspot of biodiversity in India. Among these, the isolate, KAU 41 (Kerala Agricultural University isolate 41) contained non-hemolytic homogenous crystals showing specific cytotoxicity towards cancer cells. SDS-PAGE analysis of this crystal, isolated by aqueous biphasic separation, revealed a 31 kDa sized peptide. The N-terminal sequence deciphered in BLAST analysis showed homology to a hypothetical Bt protein. Upon proteolysis, a 29 kDa active peptide was generated which exhibited heterogenic cytotoxic spectrum on various cancer cells. HeLa cells were highly susceptible to this peptide with IC_{50} 1 μg/mL and showed characteristics of apoptosis. RT-qPCR analysis revealed the overexpression of *APAF1*, *caspase 3* and *9* by 14.9, 8 and 7.4 fold, respectively which indicates the activation of intrinsic pathway of apoptosis. However, at higher concentrations of peptide (>3 μg/mL), necrotic death was prominent. The results suggest that the 31 kDa protein from Bt isolate, KAU 41 is a parasporin that may have high therapeutic potential.

Keywords. Apoptosis; *Bacillus thuringiensis*; crystal protein; cytotoxicity; parasporins

1. Introduction

The Gram-positive soil bacterium, *Bacillus thuringiensis* (Bt) is a well-known insecticide, attributed by the presence of δ-endotoxin crystals which are lethal to certain types of insect larvae. It acts by creating pores in the intestinal duct leading to a drastic ion flux that disrupts and destroys the endothelial cells causing death of the insect larvae (Ibrahim *et al.* 2010). Studies have revealed that some of the proteins are non-insecticidal in nature and are more widely distributed than insecticidal ones (Ohba and Aizawa 1986). These non-insecticidal crystals have cytotoxic and non-hemolytic properties and are now classified as a unique family of proteins designated as 'parasporins' (Mizuki *et al.* 1999; Lee *et al.* 2000). Recently, the parasporins have received a tremendous attention in the field of cancer research due to their specific toxicity to cancer cells (Ohba *et al.* 2009).

Currently, a growing number of Bt strains and parasporin toxins are explored worldwide with varying levels of cytotoxicity and different types of mechanisms. Based on structure and the level of activity, the parasporins are categorized into six groups; PS1 to PS6 (Okumura 2010). Among these, parasporin 1 (Katayama *et al.* 2005), parasporin 2 (Kitada *et al.* 2006) including parasporin 2Aa and 2Ab (Hayakawa *et al.* 2007), parasporin 3 and 4 (Okumura *et al.* 2011) were studied in detail. The cytocidal effect of most of these proteins is considered to be receptor mediated, however diverse types of mechanisms of action have been described. Various reports suggest that the specific toxicity of parasporins towards transformed cells may be due to the over expression of its targeted receptor molecules than in normal cells. Thus, the protein recognizes and kills transformed cells specifically (Namba *et al.* 2003; Saitoh *et al.* 2006). The genetic diversity of Bt crystals is reported by the diverse plasmids and their conjugal transfer, recombination and some extrinsic factors like mutation, nutritional influences etc. This remarkable diversity among the Bt strains is, therefore, beneficial which enhances the scope of discovering novel toxins and urges for extensive exploration for more strains.

d Taxa | www.threatenedtaxa.org | 26 September 2018 | 10(10): 12350–12356

LATION STATUS OF THE GRIZZLED GIANT SQUIRREL *RATUFA MACROURA* (MAMMALIA: RODENTIA: SCIURIDAE) IN CHINNAR WILDLIFE SANCTUARY , INDIA

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Economics of Quality Silage Production as Influenced by Additives and Grass Types

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Abstract

A study was undertaken to assess the effect of different seasons, additives and grass types on the economics and quality of silage at College of Agriculture, Vellayani, Kerala during rabi 2015 and kharif 2016. Pooled analysis of the data over two seasons was done and perusal of the data showed that grass type had significant influence on crude protein and ether content of silage. Individual effect of additives was significant on ether extract of silage. Highest crude protein content was recorded in the silage prepared from BN hybrid + Jaggery 2% and it was on par with BN hybrid+ Urea 1% and BN hybrid+ Tapioca flour 1%. BN hybrid and guinea grass were equally remunerative for silage preparation.

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Aloe vera gel as a bio preservative for shelf life extension of mature green tomato

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Abstract: The effect of *Aloe vera* gel on the physiological parameters like physiological loss in weight, respiration rate and membrane integrity of mature green tomato were analyzed. The untreated tomato fruits (without *Aloe vera* gel coating) showed highest respiration rate which resulted in higher physiological loss in weight and least membrane integrity for a period of 24 days. In contrary the mature green tomato fruits dipped in 2% *Aloe vera* gel concentration for two minutes recorded the least Oxygen evolution and hence resulted a lower physiological loss in weight and higher membrane integrity for a period of 36 days. Hence the study revealed the use of *Aloe vera* gel as a bio preservative for the shelf life of mature green tomatoes.

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Comparative efficacy of herbicides against rock bulrush *Schoenoplectus juncoides* (Roxb.) Palla in wet-seeded rice

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ABSTRACT

Field experiment was conducted at the College of Agriculture, Vellayani during 2017- 2018 to assess the efficacies of pre-emergence, early post-emergence and post-emergence herbicides for managing rock bulrush *Schoenoplectus juncoides* (Roxb.) Palla, an emerging sedge weed in the lowland paddy fields of Kerala. A pre-emergence spray of bensulfuron-methyl + pretilachlor 60+ 600 g/ha at 4-7 days after sowing (DAS) was effective till 30 DAS with 93.3% reduction in weed count. At 45 and 60 DAS, lower weed density (2.09 and 3.15 no./m^2, respectively) and weed dry weight (0.13 and 1.83 g/m^2, respectively) were recorded for ethoxysulfuron 15 g/ha at 15 DAS *fb* HW at 40 DAS. Higher weed control efficiencies of 99.8% and 98.1% were obtained in plots treated with ethoxysulfuron 15 g/ha at 15 DAS *fb* HW at 40 DAS during critical stages of crop-weed competition (45 and 30DAS). Penoxsulam 22.5 g/ha at 15 DAS and ethoxysulfuron 15 g/ha at 15 DAS both *fb* HW at 40 DAS were on a par at 45 and 60 DAS in terms of weed control efficiency (99.1% and 97.9%, respectively. The weed removal of N, P and K (8.61, 3.13 and 10.95 kg/ha, respectively) were also lower with ethoxysulfuron 15 g/ha at 15 DAS *fb* HW at 40 DAS. The study revealed that rock bulrush could be effectively controlled by ethoxysulfuron 15 g/ha or penoxsulam 22.5 g/ha both at 15 DAS *fb* HW at 40 DAS.

Wet seeded rice is infested with a composite weed flora comprising of grasses, sedges and broad-leaved weeds. Among the three weed groups, sedges pose a greater threat to rice (Satapathy *et al.* 2017) as they are usually perennial with underlying propagules that help in tiding over unfavourable climatic conditions. Rock bulrush *Schoenoplectus juncoides* (Roxb.) Palla, a sedge weed belonging to Cyperaceae, problematic in the Asian countries has recently invaded the paddy fields of Kerala. *Schoenoplectus juncoides* has been documented to occur globally in direct seeded lowland rice. IRRI (2017) included *S. juncoides* as one among the twelve most troublesome weeds in the rice fields of South and South-East Asia. Rock bulrush, annual / perennial sedge with hollow stem was found to grow copiously in the lowland paddy field, field bunds, and associated water channels. The weed was observed to grow to a height of 66.76 cm at maturity, vigorously tillering with an average tiller production of 19.6 tillers/plant and fibrous roots growing to a mean depth of 17.76 cm with a dry weight of 0.99 g/plant and average biomass production of 0.96 t/ha (Umkhulzum 2018).

Uncontrolled weeds reduce the grain yield by 61% in wet-direct seeded rice (Maity and Mukerjee 2008). Though manual weeding is the farmer's practice, it cannot be inculcated as an effective strategy for managing rock bulrush, especially in wet-seeded broadcasted paddy owing to the failure in removing the underground weed propagules. The use of herbicides can maintain the weed below its economic threshold limits, but continuous use of herbicides can induce resistance in weeds. Shultana *et al.* (2016) observed integrated use of pre-or post-emergence herbicides in conjunction with hand weeding as a better weed management strategy in wet- seeded rice. Use of new generation herbicides is an attractive option for weed management due to lower application rates and lower mammalian toxicity. In the present investigation, application of pre-emergence, early-post emergence and post-emergence herbicides followed by hand weeding, were tested for their effectiveness in controlling *S. juncoides* in wet- seeded rice.

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Short Communication

Weed management in cabbage (*Brassica oleracea* var. *capitata* L.)

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Abstract

A field experiment was conducted during 2017-18 at Centre for Hi-tech Horticulture and Precision Farming, Vellanikkara, Thrissur to assess the efficacy of different weed management technologies involving both chemical and non-chemical methods in cabbage. The experiment was laid out in randomized block design with eight treatments and three replications. Among the different treatments, mulching with silver-black polythene alone maintained a weed free condition and resulted in superior yield characters such as head length, head breadth and gross and net head weight. Yield of 16.83 t/ha could be realized under polythene mulching. Pre emergence application of pendimethalin 1.5 kg ha^{-1} plus manual weeding at 30 DAP gave the next best result in terms of yield and weed control efficiency. Stale seed bed followed by glyphosate application plus manual weeding at 30 DAP, hand weeding twice at 25 and 50 DAP and pre emergence application of oxyfluorfen 0.2 kg ha^{-1} plus manual weeding at 30 DAP gave comparable per hectare yields of 8.53, 7.90 and 7.44 tonnes respectively. High density planting plus manual weeding at 30 DAP and coconut frond mulching gave lower yields as a result of lower weed control efficiency.

Keywords: Cabbage, Coconut frond mulch, Oxyfluorfen, Pendimethalin, Polythene mulch, Stale seed bed, Weed management.

Cabbage is an important cool season annual vegetable crop belonging to the family Brassicaceae. In Kerala its cultivation was restricted to the hill tracts of Idukki and Wayanad districts till recently. With the introduction of tropical varieties and hybrids by the Kerala Agricultural University, cultivation of the crop has spread to the plains also (Narayanankutty et al., 2012). The heavy manurial and frequent irrigation requirements of this crop create conducive conditions for germination and growth of weeds, which reduce cabbage yield by 45-80 per cent (Chadha, 2001). Taking these factors into consideration, the present experiment was conducted to assess the efficacy of different weed management technologies involving both chemical and non-chemical methods on weed control efficiency and yield of cabbage.

The field experiment was carried out at Centre for Hi-tech Horticulture and Precision Farming, Vellanikkara, Thrissur during November 2017 to March 2018. The experiment was laid out in RBD with 8 treatments replicated thrice. The treatments were oxyfluorfen (0.20 kg ha^{-1}) (PE-Pre emergence) plus one hand weeding at 30 DAP, pendimethalin (1.50 kg ha^{-1}) (PE) plus one hand weeding at 30 DAP, high density planting (0.6m x 0.3m) plus one hand weeding at 25 DAP, mulching with coconut fronds, mulching with silver-black polythene (30 microns), stale seed bed followed by glyphosate application plus one hand weeding at 30 DAP, hand weeding at 25 and 50 DAP and an unweeded control. Net plot size was 6m × 2.4m. Twenty eight days old seedlings of cabbage variety NS 183 were transplanted at a spacing of 60cm x 60cm. Manures and fertilizers were applied according to the

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Calibration and Validation of Swat Model for Kunthipuzha Basin Using SUFI-2 Algorithm

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Keywords

SWAT, SUFI-2, NSE, R^2, p-factor, r-factor, Calibration and validation

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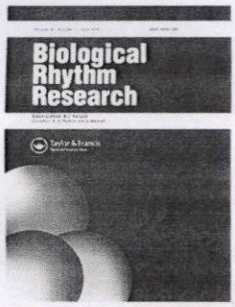
A B S T R A C T

Calibration and validation are the two important processes needed to perform for physically based distributed watershed models before their use for hydrologic calculations. The present study was conducted to calibrate the SWAT model for Kunthipuzha basin using SUFI-2 algorithm in SWAT-CUP package. SUFI-2 algorithm accounts for most sources of uncertainties and it is also easy to handle. By considering these advantages and based on recommendation of many researchers, Sequential Uncertainty Fitting procedure (SUFI-2) was selected in this study for sensitivity analysis, calibration and validation of the model. SUFI-2 also got provision for performing both type of sensitivity analysis such as one-at-a time and global sensitivity analysis. In this study, both one-at-a time and global sensitivity analysis was conducted. Calibration was done for a period of 7 years starting from 2000 to 2006, whereas, validation was done for a 3 year period starting from 2007 to 2009. The values of statistical indices such as NSE and R^2 were 0.81, 0.82 for calibration period and 0.73, 0.88 for validation period respectively which indicates the "very good" performance of the model in simulating hydrology. The p-factor and r- factor were 0.69 and 0.47 for calibration period, 0.57 and 0.51 for validation period respectively. SUFI-2 was found to be very convenient and easy to use than the other automatic calibration techniques.

Introduction

Model calibration is a process in which a generalized model is adjusted to represent the site specific process and conditions more realistically. Validation is the process of running a model with the parameters that were determined during calibration process with a data set which is not used for calibration. Validation should be carried out in order to build confidence whether the model represents the real system accurately or not. Calibration can be done either manually or by using auto calibration tools like SWAT-CUP. User's experience in modelling and recognizing parameters are the two main significant skills to achieve success in manual calibration. Whereas, automatic calibration requires only input files to be filled out once (Eckhardt and Arnold. 2001). SWAT CUP is a generic interface and stand-alone program developed for SWAT model calibration (Abbaspour *et al.*, 2007). SWAT CUP includes several techniques such as PSO, SUFI-2, GLUE,



Biological Rhythm Research

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Summer season induced heat stress impact on the expression patterns of different toll-like receptor genes in Malabari goats

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Forest laws, for whom, by whom? A concept mapping study of the Ecologically Fragile Lands Act, 2003 in Wayanad, Kerala, India

Jiss K. Varkey, S. Gopakumar, K. Vidyasagaran, Joy Mathew and A. V. Santhosh Kumar*

Kerala enacted the Kerala Forest (Vesting and Management of Ecologically Fragile Lands) Act, 2003 to conserve 'fragile ecosystems' lying contiguous to reserve forests. As this Act led to several litigations and conflicts, the current concept of Ecologically Fragile Lands (EFL) was concept mapped among the different stakeholders, including 'small and marginal' farmers in the context of Wayanad district, Kerala. Several dimensions of EFL, viz. 'Ecological', 'Situational', 'Socio-economic', 'Framework' and 'Better EFL' were developed and debated to evolve a more acceptable EFL concept. The study also accentuates the relevance of public participation in conceiving socially inclusive forest laws and policies.

Keywords: Concept mapping, ecologically fragile lands, participatory approaches, Wayanad, Western Ghats.

IN India, forests which occupy 21.54% of the total landed area remain a 'state' property[1]. After 1947, all 'privately owned' forests were 'vested' rooting on the 'doctrine of public trust'[2]. In 1976, the subject 'forest and wildlife' was shifted to the 'concurrent list' of the constitution. Kerala occupies only 1.18% of the land area of India, but has 29.1% under forest cover[3]. The per capita forest and tree cover of Kerala is 0.07 ha (ref. 1). Since its formation in 1956, Kerala has framed many forest laws, including the Kerala Forest Act, 1961, and more recently, the Kerala Forest (Regulation of Sawmills and other Wood Based Industrial Units) Rules, 2012. In the mid-2000s, the state Government promulgated 'The Kerala Forest (Vesting and Management of Ecologically Fragile Lands) Act, 2003' (hereafter referred to as EFL Act) and vested 'ecologically fragile lands (EFLs)'. This Act defined an EFL as 'any land lying contiguous to a legally defined forest predominantly supporting natural vegetation, or any land declared under section 4 of the EFL Act'[4]. The area under EFLs is 141.525 sq. km (ref. 3). The goal of the Government is to conserve and manage all 'privately owned lands having vegetation cover similar to that of forests and which lie contiguous to reserved forests', or to conserve biological diversity, even if that biodiversity is located in non-forest areas and is lying contiguous with the forests. In Kerala (density of population according to the 2011 census is 860 persons/sq. km), this new Act created multiple social ripples.

Wayanad district, Kerala, formed in 1980 (Figure 1) cradles the Western Ghats. It is predominantly a forested district (37% of the geographic area), which also houses a sizeable tribal (17.4%) and agrarian population (almost 60%). It has two territorial forest divisions (a forest division is an administrative unit in the Indian forestry establishment for managing territorial forests), apart from one wildlife division.

The livelihood of the indigenous people is predominantly land and forest-based[5]. Under the British rule, the indigenous sects practised shifting cultivation and collected forest produce for exchange[6]. It was the Britishers who later established a plantation economy. Wayanad forests later suffered intense 'internal colonization' by Syrian-Christian settlers from central Kerala[7]. Wayanad also attracted numerous impoverished settlers from erstwhile Travancore[6]. In 2012, the Kerala State Forest and Wildlife Department (KFD) notified 2688 ha land as EFL[8] in Wayanad Forest Division (FD), an action through which more than 350 'small and marginal' farmers faced the threat of being 'stripped' off their land rights at short notice[9]. They alleged that the Government 'notified and acquired' their legally owned farm lands in the name of 'EFLs' and usurped their only livelihood opportunity. Naturally, many legal and political tussles ensued. Farmers later filed review petitions for which final judgments are awaited[10].

Our field visits in Wayanad confirmed the limitations in actual field implementation and other socio-economic impacts of this new EFL Act. We noticed that this Act, in particular, impacted the 'small and marginal' farmers

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A REVIEW

Self-incompatibility: a pollination control mechanism in plants

■ Vijayakumar B. Narayanapur, B. Suma and J.S. Minimol

SUMMARY

Mode of pollination is very important in plant breeding because it determines the genetic constitution, nature of gene action, ease in pollination control and stability of varieties after release. There are several mechanisms that promote cross pollination, among these self-incompatibility (SI) is of special significance as it is used in hybrid seed production. SI is defined as the prevention of fusion of fertile (functional) male and female gametes of the same plant (Gowers, 1989). SI is a system where self-recognition and rejection is the rule that prevents inbreeding depression. Bateman (1952) classified self-incompatibility based on the interaction between pollen grains and pistil as complementary and oppositional system. Lewis (1954) has classified SI into homomorphic and heteromorphic systems. Homomorphic SI is again subdivided into gametophytic (determined by the genotype of gametes) and sporophytic (determined by the genotype of the plant) systems. Molecular studies after 1980's revealed that at least two genes within S-locus control the SI, among these one unit function as male and the other as female determinant. In Brassicaceae family, the determinant gene encodes a pollen ligand and its stigmatic receptor kinase and their interaction induces incompatible signaling within the stigma papilla cells. In the Solanaceae, Rosaceae, and Scrophulariaceae, the female determinant is ribonuclease and F-box protein, suggesting the involvement of RNA degradation and protein degradation within the system. In the Papaveraceae, the female determinant induces Ca^{2+} dependent signaling network that ultimately results in the death of incompatible pollen (Takayama and Isogai, 2005). Genes controlling the SI is multiallelic in nature and number of alleles varies depending upon the crop. Number of alleles reported are five in *Theobroma cacao* (Knight and Rogers, 1953), 30 in *Brassica campestris* (Singh, 2012), 32 alleles in *Raphanussativus* (Karron *et al.*, 1989). SI is commercially exploited for the production hybrid seeds. Pusa Hybrid-2, Snow Queen and Snow King hybrids of cauliflower, BRH-5, H-44 of cabbage and CCRP8 to CCRP15 (Minimol *et al.*, 2015a) of cocoa are some of the examples. Kucera *et al.* (2006) has compared the quality between SI and male sterility hybrids in cauliflower and it was found that SI hybrids are superior in their performance. Minimol *et al.* (2015b) emphasized the importance of polyclonal garden in cocoa for production of F_1 hybrid seeds by utilizing the self-incompatibility. Rego and Rego (2013) evaluated the efficiency of three methods of overcoming self-incompatibility in passion fruit and found fruit set of 16.67 and 10 per cent in bud and double pollination, respectively. The main limitations in exploiting SI is the maintenance of inbreds, however, it can be overcome by some temporary methods such as bud pollination, salt sprays and irradiation methods.

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Candidate molecular markers for monoecy in dioecious tree spice nutmeg (*Myristica fragrans* Houtt.) and analysis of genetic variability in a core collection

Nutmeg (*Myristica fragrans* Houtt.) is a major tree spice valued for its diverse uses in flavouring and pharmaceutical industry. Dioecious sex nature is the greatest bottleneck in its cultivation, and to avoid the male plants commercial orchards, propagation is necessitated through budding and grafting[1]. Previous attempts to develop molecular markers linked with the female sex form were differentially successful[2–4]. For higher yields, planting should be done using monoecious plants or at the sex ratio of one male plant for 10 female plants. Thus, the development of a marker will enable identification of monoecy at seedling phase itself and hence the selection of seedlings for planting.

The southern part of India has considerable genetic variability in this cross-pollinated crop, especially for growth, sex forms, yield and traits of fruits, mace and nuts[5–7]. A systematic genetic diversity analysis will enable determination of population structure[8] and to develop conservation strategies. The molecular marker-based analysis of genetic variability and population structure is an approved strategy and in plants with little genomic information, random primer-based systems are more reliable[9]. Hence, in the present study we used random amplified polymorphic DNA (RAPD) marker system[10]. The study performed using *Myristica fragrans* core collection from

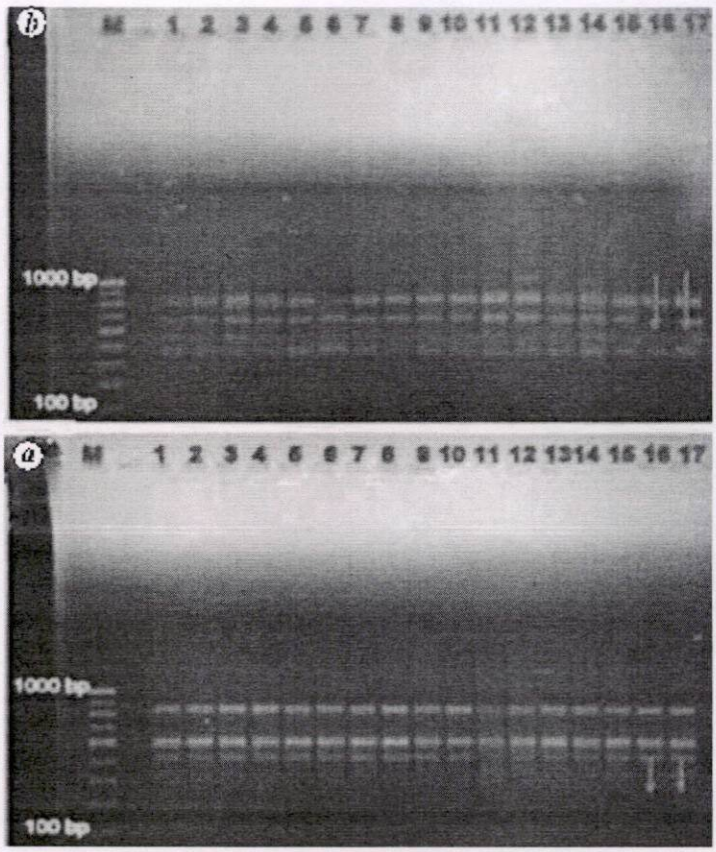

Figure 1. Amplification pattern in select nutmeg accessions with RAPD primers – ***a***, OPE15 and ***b***, OPE16. Lanes M, Ladder (*Eco*RI/*Hin*dIII, 1000 bp); lane 1, Acc.1; lane 2, Acc.5; lane 3, Acc.8; lane 4, Acc.9; lane 5, Acc.11; lane 6, Acc.14; lane 7, Acc.18; lane 8, Acc.21; lane 9, Acc.23; lane 10, Acc.24; lane 11, Acc.30; lane 12, Acc.35; lane 13, Acc.36; lane 14, Acc.37; lane 15, Acc.38; lane 16, Acc(H).1 and lane 17, Acc(H).4.