Growth and productivity of selected fodder grasses intercropped under mature coconut and rubber plantations at Vellanikkara, Thrissur

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ABSTRACT : A field experiment was conducted at Vellanikkara, Thrissur, Kerala to assess understory productivity of four fodder grasses *viz.*, *Brachiaria ruziziensis* (congo signal), *Panicum maximum* (guinea), hybrid napier cultivar CO-3 and CO-5 under mature coconut (*Cocos nucifera*) and rubber (*Hevea brasiliensis*) plantations, which are the two prominent land-use systems in Kerala, from May 2017 to February 2018. The selected fodder grasses were planted in beds (10 m × 1 m × 0.3 m) in the understory of mature coconut and rubber plantations. Coconut grown fodder grasses showed maximum plant height with a per cent increase of 3.73, 8.97 and 5.28%, respectively over control for first three harvests. Tiller production also varied significantly. At fourth harvest, with maximum number of tillers clump^{-1}, the coconut grown fodder grasses exhibited only 36.35% decrease in tillers whereas it was 78.29% in rubber as compared with open. The mean number of leaves clump^{-1} observed in open grown fodder grasses was 127.25, whereas it was only 66.71 and 16.04 in coconut and rubber plots, respectively at the second harvest, which recorded the maximum leaf production. Understory photosynthetically active radiation (PAR) transmittance ranged from 39.84-56.08% in rubber and coconut, respectively. Coconut grown fodder grasses showed an equally good performance in growth and yield attributes with the open whereas a substantial reduction in the yield was observed in fodder grasses grown in the understory of rubber.

Key words: *Brachiaria ruziziensis*, *Cocos nucifera*, *Hevea brasiliensis*, integrated farming and *Panicum maximum*.

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1. INTRODUCTION

The fodder resources of our country are hardly sufficient for feeding even half of the existing cattle population and the shortage of green fodder is well recognized. An expected deficit of 65% of green fodder and 25% of dry fodder is expected for Indian livestock by 2025 (Singh *et al.*, 2013). Among milk producing states in the country, Kerala ranks 14th with a share of just 1.5% of the total milk production in the country (GOK, 2017). Non-availability of land stands as a major hindrance for fodder cultivation. Due to marginal holdings coupled with increasing demand for food crops due to demographic pressure and shift in the land-use patterns followed in the state, exclusive fodder cultivation is not feasible. The cost of concentrate feeds is increasing, making it almost impossible for the dairy farmers in the state, especially those with limited financial resources to maintain cattle. The projected gap between demand and supply of green and dry fodder invites an attention to frame perspective planning, time bound strategies and concerted efforts to meet this challenge.

In this context, the vast area of interspaces available under commercial plantations dominated in Kerala offers excellent opportunity for integrating compatible fodder grasses with these plantations. Among these, mature coconut (>25 years) plantations are excellent option for intercropping on account of their wider spacing and ample light availability in the understory. Rubber is another plantation crop of importance for fodder grass integration, primarily on account of the vast stretches of land under rubber plantation and the deep rooted nature of the rubber trees (Sreenivasan *et al.*, 2004). Improved varieties like hybrid napier (*Pennisetum purpureum* × *Pennisetum americanum*) are recommended for intensively managed small-holder crop- livestock farming systems and are well suited for the "cut and carry" feeding system. Guinea grass (*Panicum maximum* Jacq.) and congo-signal grass (*Brachiaria ruziziensis* Germain & Everard) are also known for their strong persistence, palatability and suitability for intercropping. Intercropping in the tree-based system is primarily a function of the light demand, tree-root distributions and tree-crop interactions. A reliable information about influence of biophysical interactions on growth and productivity of fodder grasses under mature coconut and rubber plantations can be beneficial for small-holder dairy farmers. Keeping in view of these aspects, study on growth and productivity of selected fodder grasses intercropped under mature coconut and rubber plantations at Vellanikkara, Thrissur was undertaken.

2. MATERIALS AND METHODS

The two land-use systems studied *viz.*, coconut and rubber plantations and control plot were located in the KAU main campus, Vellanikkara, Thrissur, Kerala (10° 13' N latitude and 76° 13' E longitude and at an elevation of 40 m above mean sea level). The rubber and coconut consisted of mature trees aged 30 and 26 years and planted at spacing of 4.5 m × 4.5 m and 8 m

MangoDB:A Database of Mango Varieties and Landraces of the Indian Subcontinent

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Herbicide mixtures effect on weed seed bank in direct-seeded rice

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ABSTRACT

To study the effect of post-emergence applied herbicide mixtures, *viz.* bispyribac-sodium + metamifop and penoxsulam + cyhalofop-butyl on soil weed seed bank, weed seed bank assay were carried out at College of Agriculture Vellayani, Thiruvananthapuram during rainy season 2014 and winter season 2014-15. Weed seed bank assay results revealed a significant reduction in the emergence of sedges, broad-leaved weeds (BLW) and grasses from the soil treated with herbicide mixtures compared to individual application of bispyribac-sodium at 25 g/ha and penoxsulam at 22.5 g/ha. The results also revealed that penoxsulam + cyhalofop-butyl was more effective in reducing the weed seed bank than bispyribac sodium + metamifop. The higher doses of penoxsulam + cyhalofop-butyl (135, 130 and 125 g/ha) were found to be more effective than its lower dose of 120 g/ha. Among the tested doses of bipyribac-sodium + metamifop, its higher doses (90 and 80 g/ha) performed better than lower doses (60 and 70 g/ha) in reducing the soil weed seed bank. Hence, post-emergence application of penoxsulam + cyhalofop-butyl either at 125 or 130 or 135 g/ha or bispyribac-sodium + metamifop at 80 or 90 g/ha at 15 DAS (days after sowing) can be recommended for the effective management of weed seed bank in wet direct-seeded rice.

INTRODUCTION

Weed seed bank is the reserve of viable weed seeds present in the soil surface and scattered in the soil profile. Weed seed bank is the main reason for the continued presence of weeds in the agricultural field (Cousens and Mortimer 1995) and it is an indicator of weed population in soil (Dhawan 2007). Annual fluctuations of climatic factors significantly influence the weed seed bank (Harbuck *et al.* 2009). Steinmann and Klingebiel (2004) opined that weed seed bank has impact on the distribution of annual and perennial weeds over the years and it affects the spread of weed community. Weed seed characteristics such as high output, efficient dispersal, longevity and seed dormancy, produce large seed banks in the soil (Pereira *et al.* 2013). Understanding the dynamics of soil seed bank can help in the development of integrated weed management programmes and also help to predict the degree to which the crop-weed competition affects the crop yield and quality (Menalled 2008). Accurate forecast of potential weed seedling density would allow the farmers to implement control measures more effectively thus avoiding inappropriate and over use of herbicides (Mobli and Hassannejad 2013).

Weed seed bank can be manipulated by altering seedling recruitment, seedling mortality, seed viability and fecundity. Manual weeding and herbicidal use reduce the weed population by increasing seedling mortality (Pandey and Pingali1996). Barberi *et al.* (1998) reported that herbicides reduced the weed density and number of weed seeds entering the seed bank. Buhler *et al.* (2001) pointed out that when weeds were controlled by cultivation only, the seed bank was approximately 25 times greater than where herbicides in conjunction with cultivation practices were adopted for weed control. Jain *et al.* (2006) reported that continuous use of clodinafop *fb* 2,4-D and isoproturon + 2,4-D for control of weeds in wheat field significantly reduced the number of weed seeds in the seed bank over weedy check. Walia and Brar (2006) also reported that herbicide treatments significantly reduced the seed bank of *Phalaris minor* in wheat field. According to Islam (2012), herbicide application influenced the seed number and species composition of the seed bank.

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Short Communication

Biochar as an organic source for soil carbon sequestration in acidic soil of Kerala

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ABSTRACT

Soil organic matter (SOM), a determinant of soil health, is highly responsive to global warming. Soil organic matter improves and stabilizes the soil structure which in turn can hold large amounts of water, thus leading to significant reduction in surface runoff and soil erosion. Biochar, a charcoal produced by pyrolysis of biomass food stock (eg. plant material), may be a substantial solution in reducing global warming. It is an excellent soil amendment that offers a cheap, easily accessible source of organic carbon (OC) which improves water retention as well as microbial activity. An experiment was conducted in wetland ecosystem (Ultisol) with the aim to improve the stabilisation of added soil C during rice crop for two continuous seasons, *kharif* and *rabi*. The treatments consisted of control and four different organic sources [Farmyard manure (FYM), green manure (daincha), *Artocarpus* leaves and rice husk biochar (RHB)] in combination with inorganic nitrogen *viz.*, urea at various levels such as no inorganic nitrogen, 35 kg N ha^{-1}, 70 kg N ha^{-1} and 105 kg N ha^{-1}. The RHB treatment recorded maximum value for SOC in both seasons (1.67 and of 2.05%). The SOC values had a decreasing trend as a whole in the second season, but the values were comparatively higher in the RHB treatment. It was also noticed that the SOC content in organic sources was obviously higher than the control treatment and through conversion to biochar, up to 50% of the initial biomass C can be sequestered. The highest values of organic carbon in biochar treated soils indicated the presence of recalcitrant organic carbon in biochar. Application of biochar increased maximum allocation of carbon both in the soil and in biomass, thus portraying the C sink capacity. Conversion to organic agricultural practices with biochar application can help in restoring the eco-system resilience without compromising food productivity.

Key words: Organic sources, Biochar, Wetland ecosystem, Soil organic carbon, Carbon sequestration

Soil carbon is of global importance because of its role in global C cycle and the part it plays in the mitigation of atmosphere levels of GHGs, with special reference to CO_2. It has been estimated that the land use change from natural to agriculture resulted in the transfer of 1–2 Pg C $year^{-1}$ from terrestrial ecosystem to the atmosphere of which 15–17% carbon is contributed by decomposition of soil organic carbon (SOC). Lal (2010) pointed out that soils in the Asia/Pacific region and Sub-Saharan Africa are impoverished in SOC and nutrient reserves, and severely degraded, which make about 90 per cent of the 1,020 million people food-insecure. The twin crises of climate change and food insecurity can however, be overcome by restoring the SOC pool which would improve the soil quality. Among the several options to mitigate climate change, the sequestration of C in agricultural soil is an important one. Wetland characteristics promote the deposition of organic matter in the soil and sediment, serving as carbon (C) sinks and making them one of the most effective ecosystems for storing soil carbon. According to Goyal *et al.* (1999) usage of different organic sources like manures, plant residues and waste materials in farming could improve chemical and biological properties of soils. Yadav and Arora (2018) opined that systematic understanding and management of residues can help in soil health management apart from recycling nutrients. Biochar, the solid residue from incomplete combustion, is increasingly being added to soils or sediments due to natural vegetation fires, anthropogenic pollution, and strategies for C sequestration (Keiluweit *et al.*, 2010). Biochar is a product of low temperature heating of plant residues or other lignocellulosic organic material in the presence of low O_2 concentration. It is potentially a soil amendment and may be used both to store C due in part to recalcitrant C, and to improve soil aeration, water-holding, and nutrient-

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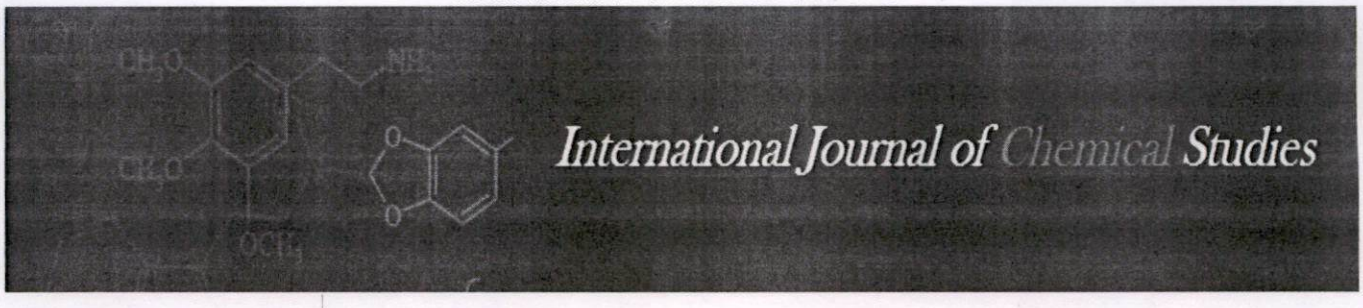

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Effect of different organic and inorganic sources on physico-chemical properties of paddy soils in Kerala

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Abstract
Appropriate fertilizer application is an important management practice in agriculture to improve soil fertility. In the present study, we examined the effects of four organic sources (OS) in an integrated approach on soil bulk density (BD), water holding capacity (WHC), pH and soil organic carbon (SOC) contents in the surface layer (0–15 cm) of paddy soil in Kerala. The treatments consisted of one control [no organic source (CT), Farm yard manure (FYM), artocarpus (jack tree) leaves (JCK), daincha (DNC) and rice husk biochar (RHB)] along with inorganic fertilizers (NPK) involving different levels of N. Results showed that the soil BD was considerably reduced (1.06 Mg m^{-3}) with the use of organic source, RHB. The WHC was also found to be maximum in this treatment with the highest being 54.66 percent. Soil pH was the lowest in CT with a value of 4.58 and was significantly higher in RHB treated plots (5.10 and 5.28). The application of manures have remarkably improved SOC value compared with the CT and specifically, the OS treatment, RHB resulted in the highest SOC (2.05%). During the experimental period, the increase in OC content was double the value over CT. These results indicated that organic sources/manure should be recommended to improve soil physico-chemical fertility. Considering the longterm use efficiency, rice husk biochar can be suggested to improve the soil acidity in the region thereby enhancing soil fertility.

Keywords: Green manure; fertilizer; organic sources; soil physico-chemical property; rice husk biochar

Introduction
Rice (*Oryza sativa* L.) is the main cereal crop, contributing 19 percent and 29 percent of the world rice area and rice production, respectively. In recent years, due to the rapid population growth and a continuous decline in the cultivated land area, the rate of fertilizer application keeps on rising in order to obtain high crop production in agriculture. Nevertheless, instead of improving the soil structure and fertility, the long-term unbalanced fertilization has caused severe degradation of rice soils, characterized by high acidity, low available nutrients and a disturbed ecosystem. Therefore, it has become necessary to ameliorate degraded paddy soils and maintain the region's sustainable development of agricultural production. Recently, soil quality has gained attention as a result of environmental issues related to soil degradation and production sustainability under different farming systems. It has been considered that the physico-chemical properties such as bulk density (BD), water holding capacity (WHC), pH, organic carbon (OC) content of soil are good indicators of soil quality and productivity because of their favourable effects on the physical, chemical, and biological properties of soil. Soil pH affects the chemical reactions in soil. Extremes of pH in soils, for example, will lead to a rapid increase in net negative surface charge and thus increase the soil's affinity for metal ions (Yang *et al*., 2006) [13]. The organic component of soil, organic carbon (OC) is the most critical index of paddy soil fertility (Liu *et al.,* 2011) [7].
Some studies had revealed that continuous fertilizer application increased the concentration of SOC and other nutrients in plough layers compared with the initial value (Benbi, 2013) [2]. Manure amendments markedly increased the contents of SOC and soil structure, water retention capacity and decreased bulk density (Liu *et al.,* 2011) [7]. Combined application of organic and inorganic fertilizers is often found to be effective in increasing SOC stock by enhancing biomass production and decreasing decomposition of soil organic matter. A regular application of biomass-C with chemical fertilizer is essential to enhance SOC sequestration in Central India by improving soil quality and minimizing the depletion of SOC stock under continuous cropping (Shirani *et al*., 2002) [10].

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RESEARCH ARTICLE :

Socio-economic factors affecting entrepreneurial behaviour of agripreneurs of KAU technology

Raju Parashuram Naik and S. Helen

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SUMMARY : Socio-economic factors influencing entrepreneurial behaviour among agripreneurs of Kerala Agricultural University's technology were analysed. The specific objective was to study the factors affecting entrepreneurial behaviour of agripreneurs. Data were collected from100 respondents who had adopted KAU technology were selected using simple random sampling technique. Structured interview schedule was used to collect the data. Data collected were analysed using Karl Pearson's correlation co-efficient. The result revealed that socio-economic factors such as education, attitude towards self-employment, mass media contact, social participation and economic motivation were significantly and positively influencing the entrepreneurial behaviour of agripreneurs. Whereas age, annual income, trainings received, self-reliance and occupational status had no significant relationship with entrepreneurial behaviour of agripreneurs.

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KEY WORDS:
Agripreneurs, Socio-economic factor, KAU technology

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Constraints Faced by Agripreneurs in Adopting KAU (Kerala Agricultural University) Technology

Raju Parashuram Naik[1] and S. Helen[2]

ABSTRACT

A study was conducted with the objective of studying the constraints faced by agripreneurs in adopting KAU (Kerala Agricultural University) technology. A sample of 100 respondents who had adopted KAU technology were selected using simple random sampling technique. The study revealed that lack of adequate money for day-to-day expenses was the most important financial constraint faced by the agripreneurs, followed by lack of market information. Non-availability of input materials and high labour cost were the major production and labour constraints and multiple roles was the major personal constraint faced by the agripreneurs.

Keywords : *Agripreneurs; Constraints; Kerala Agricultural University; Technology*

INTRODUCTION

A shift from farming to agribusiness is an important pathway to rejuvenate Indian agriculture and to make more appealing and profitable venture. Agripreneurship have the potential to add to a scope of social and economic advancement, for example, income generation, employment creation, poverty reduction and development in health, nutrition and overall food security in the national economy.

Agripreneurship is defined as "generally, sustainable, community-oriented, directly-marketed agriculture. Sustainable agriculture denotes a holistic, system oriented approach to farming that focuses on the interrelationships of social, economic, and environmental processes" (Nagalakshmi and Sudhakar, 2013). Agricultural businesses are always coupled with inherent ambiguity associated with agricultural production. Some significant sources of uncertainty in agribusiness include production risk, price risk, financial risk and changes in government programmes.

In India, 52% of the total land is cultivable as against 11% in the world (Uplaonkar and Biradar, 2015). Large population of India is dependent on agriculture for their source of revenue. But Indian agriculture is low in productivity with large number of disguised unemployment. But it is clear that there is a great scope for entrepreneurship in agriculture and this potential can be tapped only by effective

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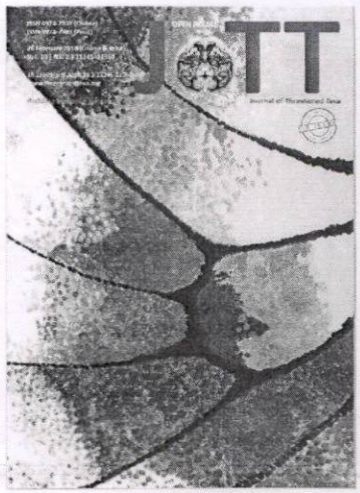

RESPONSE & REPLY

NON-INVERSE J - SHAPED POPULATION DISTRIBUTION: PECULIARITY OF RED SANDERS FORESTS

S. Suresh Ramanan & T.K. Kunhamu

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Effect of pre-treatments on quality parameters of vacuum fried ripened banana (*Nendran)* chips

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Abstract

India is the major producer of banana in the world. Ripened banana chips is the favourite snack of the consumers of all age groups. In the present study, attempts were made to improve the quality and reduce the residual oil content of vacuum fried ripened banana chips through pre-treatments *viz.*, blanching cum drying, gum coating, and freezing. The quality attributes like oil absorption, moisture content, water activity, texture, colour and sensory values were determined for all the products treated at frying temperature, pressure and time of 100° C, 20 k Pa and 10 min, respectively. The blanching cum drying pre-treatment showed significant ($p<0.0001$) oil reduction but exhibited poor consumer acceptability. However the freezing pre-treatment scored high consumer acceptability with high oil content of 38.2%. The gum coating pre-treatment was on par with untreated vacuum fried chips. Untreated vacuum fried chips with post centrifugation at 1000 rpm for 5 min had low residual oil content of 13.4% and good consumer acceptability. Analysis revealed that untreated products were superior not only in terms of quality but also in terms of reduced cost and time for the protocol.

Keywords: Pre-treatments, Ripened banana chips, Vacuum frying

Introduction

India is the largest producer of banana in the world with a production area of 776 hectares and a production capacity of 29.7 million tonnes (GOI, 2017). Banana, *The Apple of Paradise,* is the climacteric fruit that produces ethylene after harvest, ripen rapidly and is highly prone to storage loss (Uma and Shanmugam, 2015). The estimated post-harvest loss in fruits and vegetables is 5 to 30 per cent of its total production (FAO, 2015). The estimated loss for banana was 10-12 per cent (GOI, 2017), the main reason being its improper post-harvest handling and its specific storage temperature requirement of 12-14° C which demanded a separate cold storage chamber. A pragmatic solution for reducing the post-harvest loss in *Nendran* banana is the adoption of suitable processing strategies.

Banana chips is the flagship product among its processed products and are known as '*The taste of Kerala*'. These fried products are an inevitable component of marriages and traditional celebrations of the state. The presence of high oil content in fried snacks is often a deterant to product quality and is disadvantageous to consumers and producers in terms of profit margin based on reusable cycle (Oginni et al., 2014). The development of superior quality fried products with minimum oil is of great interest to food industry and to consumers. Vacuum frying is a promising alternative frying technology to improve the quality of fried products (Song et al., 2007). During vacuum frying, the sample is heated under a negative pressure that lowers the boiling and smoking points of water and oil (Troncoso et al., 2009). It is note worthy that adoption of vacuum frying technology could lead to a remarkable

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Physiological studies of *Colletotrichum musae* the causal agent of Anthracnose disease of banana

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ABSTRACT

Effect of different temperature, light intensity and pH were tested against the growth and sporulation of *Colletotrichum musae* under *in vitro* conditions. Results indicated that the growth of *Colletotrichum musae* was maximum at 30 ^{0}C (72.25 mm) followed by 25 ^{0}C (68.25 mm), 20 ^{0}C (53.00 mm), 15 ^{0}C (52.75 mm) and it was lowest growth (12.00 mm) at 35 ^{0}C. Exposure of *Colletotrichum musae* to alternate cycles of 12 hr light and 12 hr darkness, continous light and under normal condition (room temperature) resulted in the maximum mycelial growth (90.00 mm) and heavy sporulation. The variation in growth of *Colletotrichum musae* at different pH were found to be significant. Result of the study revealed that at pH 7.0 fungus produced maximum growth of 977.0 mg followed by 960.0 mg at pH 8.0, 957.0 mg at pH 6.0, 948.0 mg at pH 5.0 and 922.0 mg at pH 4.0.

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Effect of tillage, water regimes and weed management methods on weeds and transplanted rice

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ABSTRACT

Field experiments were conducted during 2016 rainy and winter seasons to study the effect of tillage, water regimes and weed management methods on weeds and transplanted rice. The design was split plot with combinations of tillage and water regimes as main plot treatments and weed management methods as subplot treatments. The weed biomass was significantly reduced and the rice performance was superior under intensive tillage (three ploughings followed by (*fb*) puddling), when compared to the conventional farmers' practice of land preparation. Among the water regimes, continuous deep water ponding (> 7.5 cm water) either till panicle initiation or grain filling stage suppressed weed growth better than that under the recommended practice of maintaining about 5 cm water level with intermittent drainage. Weed control efficiency (WCE) was maximum under azimsulfuron 35 g/ha applied at 15 days after transplanting (DAT), followed by pre-plant application of oxyflourfen *fb* one hand weeding at 20 DAT.

INTRODUCTION

The attainment of optimal crop productivity in rice is hindered by several factors, of which weeds are recognized as the major biological constraint. The yield loss caused by weeds resulted from their competition for growth factors, *viz.* nutrients, soil moisture, light, space, *etc.* (Walia 2006, Rao and Nagamani 2010). In order to achieve higher benefits from applied inputs, weeds must be kept below economic threshold level through strategic management practices. Good land preparation, effective water management and use of herbicides are often considered as cost-effective alternatives to manual weeding. Subramanyam *et al.* (2007) reported that intensive puddling with continuous submergence could effectively reduce weed biomass in rice. Varughese (1996) observed that germination of grassy weeds could be effectively prevented by field submergence. According to De Datta (1981) herbicides are the most practical, effective and economical means of weed management in rice. The present study was therefore taken up to evaluate the effect of tillage, water regimes and weed control methods on weeds and crop performance in transplanted rice.

MATERIALS AND METHODS

The field experiment was conducted at the State seed farm, Kottarakkara, Kollam district, Kerala during rainy and winter seasons of 2016. The selected wetlands experienced humid tropical climate and there was a predominance of grassy weeds in the field (**Table 1**). The soil was sandy clay loam in texture with acidic pH (4.52). It was high in organic carbon (1.69%), available N (303.34 kg/ha), available P (13.52 kg/ha) and available K (153.42 kg/ha). The experiment was laid out in split plot design with 3 replications. Combinations of tillage and water regimes were the main plot treatments and weed management methods were taken as the sub-plot treatments. The tillage treatments included were: intensive tillage (three ploughings *fb* puddling) and farmers' practice (two ploughings *fb* puddling). The water regimes were: continuous deep water ponding *i.e.* > 7.5 cm from 7 days after transplanting (DAT) till grain filling stage, deep water ponding *i.e.* >7.5 cm from 7 DAT to panicle initiation and saturation thereafter and maintaining about 5 cm water level with intermittent drainage (KAU 2011). The weed management practices in the subplot treatments were: oxyflourfen 0.15 kg/ha *fb* HW at 20 DAT, azimsulfuron 35 g/ha, bispyribac sodium + metamifop

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Management of blood grass (*Isachne miliacea* Roth ex Roem et Schult) in wetland rice

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Abstract

Field experiments were conducted during *Kharif* and *Rabi* seasons of 2015 at the State seed farm, Kottarakkara, Kerala in a wetland field heavily infested with blood grass (*Isachne milacea* Roth ex Roem et Schult) to develop an effective strategy for managing the weed. The experiment was laid out in a split plot design with combinations of tillage and water regimes as main plot treatments and weed management practices as sub-plot treatments. The results revealed that an integrated strategy involving intensive tillage (three ploughings *fb* puddling), deep water ponding (i.e., > 7.5 cm up to panicle initiation and saturation thereafter) and application of azimsulfuron @ 35 g ha^{-1} at 3-5 leaf stage of the weed was the most efficient treatment for managing the weed in terms of weed control efficiency (WCE), crop performance and net income. Combining these modified cultural practices with either (bispyribac sodium + metamifop) @ 70 g ha^{-1} or fenoxaprop-*p*-ethyl @ 60 g ha^{-1} were alternate strategies for management of this noxious wetland weed. Pre-plant application of oxyflourfen @ 0.15 kg ha^{-1} *fb* hand weeding when combined with deep water ponding and intensive tillage recorded high WCE, but was inferior in terms of economics. Combinations with manual weeding though uneconomic, were efficient in managing the weed, and recorded higher yield and hence could be an option for organic rice cultivation.

Key words: Blood grass, Grain yield, Tillage, Water regime, Weed management

Introduction

Blood grass (*Isahcne miliacea*), locally known as *valari/changalipullu/naringa,* is a very troublesome wetland weed belonging to Poaceae family which has infested vast tracts of rice fields in Kerala state. According to Babu et al. (2014), the relative density of blood grass was > 65 per cent in many of the wetland fields in Kerala. The highly competitive nature of the weed potentially reduces rice yields when significant populations exist. The weed is resistant to the prevalent farmers' practice of tillage and hand pulling and it's mat forming roots interfere with the movement of simple implements like rotary weeder, restricting their efficient use. Though herbicides are considered as the most practical, effective and economical means of weed management in rice (De Datta, 1981), most of the conventional herbicides fail to manage the perennial grass.

According to Clements et al. (1994), integrated weed management (IWM) strategies alone can reduce the dominance of specific noxious weeds in any agro–ecosystem. Studies from the tropical regions on possible effects of tillage and water control on weed emergence and growth in the presence and absence of herbicides have yielded conflicting results due to site specificity. Interactions among water, tillage and weed management practices are complex, and are further complicated by soil and climatic variability and heterogeneities (Bhagat et al., 1996). Most of the past studies have been confined to evaluation of the independent

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Short Communication

Low cost carrier material for mass production of *Trichoderma* inoculants

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Abstract

A study was conducted to explore the possibility of solid state fermentation technique for mass production of *Trichoderma viride* using sterilized rice powder. Sterilized rice powder was supplemented with dextrose (3%) and the population reached $123x10^{15}$ cfu g^{-1} at 10th day and the inoculum could be stored upto 180 days with a population of $10x10^{9}$ cfu g^{-1} under room temperature. The viability increased ($28x10^{12}$ cfu g^{-1}) when it was stored at refrigerated condition. The spore biomass produced could be either used directly for seed treatment, seed biopriming, soil/root treatment, wound dressing etc., or for formulation. Talc with rice powder+dextrose based inoculum @ 2% along with 8% sterile water sustained the viability of $6x10^{8}$ cfu g^{-1} at 180 days and could be a feasible method for large scale inoculum production of fungal biocontrol agents.

Key words: Formulation, Rice powder and Dextrose, Shelf life, Solid state fermentation, *Trichoderma viride*.

Trichoderma spp. has gained significant scientific attention as a potential biocontrol agent for the management of several soil borne diseases. A number of *Trichoderma* based products have been commercialized in India and abroad. For industry based large scale production, liquid state fermentation technology has been employed while solid state fermentation technology has been in use for on-farm production or small scale production (Ramanujam et al., 2010). In large scale production, *Trichoderma* inoculum is generally multiplied in liquid media like molasses – yeast or potato dextrose broth and mixed in inert carrier materials (Prasad and Rangeshwaran, 1998). However, in this process, it is experienced that the viability of inoculum in liquid media reduced drastically within a few weeks (Papavizas et al., 1984), and hence the inoculum could not be stored for longer periods.

Production of large quantities of good quality inoculum with longer shelf life which can be formulated with any carrier material is an essential requirement for meeting the escalating demand of this biocontrol agent. Compared to the submerged (liquid state) fermentation technology, solid state fermentation has several advantages such as easiness in preparation, high productivity, low cost equipments, lesser waste generation and lesser time and energy requirement (Kocher et al., 2008). Several organic substrates including grains like sorghum, wheat, maize, rice etc. depending upon local availability have been utilized for mass cultivation of *Trichoderma* inoculum (Rini and Sulochana, 2007; Mridula et al., 2012; Kishore et al., 2014). Hence, the present study was taken up to explore the feasibility of utilizing solid state fermentation technology using sterilized rice grain

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Research Article

In vitro mutagenesis creates distinct morphological variants in cassava (*Manihot esculenta* Crantz.): a characterisation study

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Abstract
The present investigation was conducted to evaluate the variability created due to induction of *in vitro* mutagenesis in cassava. The calli and somatic embryos from the leaf explants of superior cassava genotypes Sree Jaya and CC1 established in Murashigue and Schoog (MS) media supplemented with 8 mg L^{-1} picloram were subjected to treatment with Ethyl Methyl Sulphonate (EMS), 0.6-1.2 per cent at 0.1 per cent interval. Forty-four plants survived out of sixty-eight regenerated plants kept for hardening under pad and fan greenhouse followed by rain shelter. Irrespective of the dosage field evaluation of these plants showed variations in morphological traits with respect to their respective controls at 3, 6 and 9 months after planting (MAP). These plants can be clonally propagated and the genetics of the observed variations in quantitative traits of these plants can be validated under different conditions.

Keywords
In vitro, hardening, callus, somatic embryo, mutation

Intoduction

Cassava (*Manihot esculanta* Crantz.) is a nutritionally important root crop grown in tropics with global production expanding by an average of 1.2 per cent annually (Ford, 2015). As cassava seeds are dormant and germinate very slowly, setts which are uniform with respect to different traits are used for propagation. However, this leads to the accumulation of viral and bacterial diseases Nassar and Ortiz (2007). Creation of variability for improvement of cassava through hybridisation is severely constrained by low fertility, low hybrid seed set and poor germination rate (Nassar, 2007). Hence, the breeder has to adopt alternate strategies like induction of mutation. *In vitro* techniques have been standardized in cassava by Magaia (2015) and he reported that the frequency of obtaining desired variability is more when mutation is done *in vitro*. Hence, an attempt was made to create variability in cassava through *in vitro* mutagenesis and characterise the treated plants.

Materials and Methods

The newly sprouted shoots of four to five centimetres were collected and properly labelled. Leaf bits with veins of about 1 × 1cm from unfolded to partially unfolded leaves of cassava genotypes, Sree Jaya and CC1 were inoculated in MS medium supplemented with 8 mg L^{-1} picloram. The Friable embryogenic callus and somatic embryos at torpido stage were then treated with chemical mutagen Ethyl Methyl Sulphonate (EMS) at 0.6, 0.7, 0.8, 0.9, 1.0, 1.1 and 1.2 per cent. The treated calli when attained friable stage was used for induction of SEs which was germinated in medium, MS + 8 mg L^{-1} picloram Magaia(2015).

When the *in vitro* derived plants attained at least 3 cm height with 3 to 5 roots, primary hardening was done, under pad and fan green house for three months. The Plants were grown in plastic pots of 15 cm height and 5 cm radius in Soilrite™ (commercial product consisting on perlite, Irish peat moss and vermiculite) at the proportion of 1:1. The temperature and humidity inside the chamber were maintained at 24.0- 27.0°C and 80-85 per cent, respectively. A water-soluble fertilizer concentrate Greencare TM ($N:P_2O_5:K_2O$ - 30:10:10), secondary and micronutrients like Boron, Calcium, Copper, Iron, Magnesium, Manganese, Molybdenum, Sulphur, Zinc) was applied as foliar spray at a concentration of 0.01 per cent. Initially nutrient preparation was applied only once in a week. Subsequently the frequency was increased to thrice a week up to third week and then on daily basis Magaia, (2015). Secondary hardening was done under rain shelter (temperature and relative humidity during hardening ranged from 27-32 °C and 60-90 per cent, respectively) for three months. The hardened plants were transplanted into large pots (60 cm × 40 cm) which were placed in rain shelter for one week, later transferred to the field

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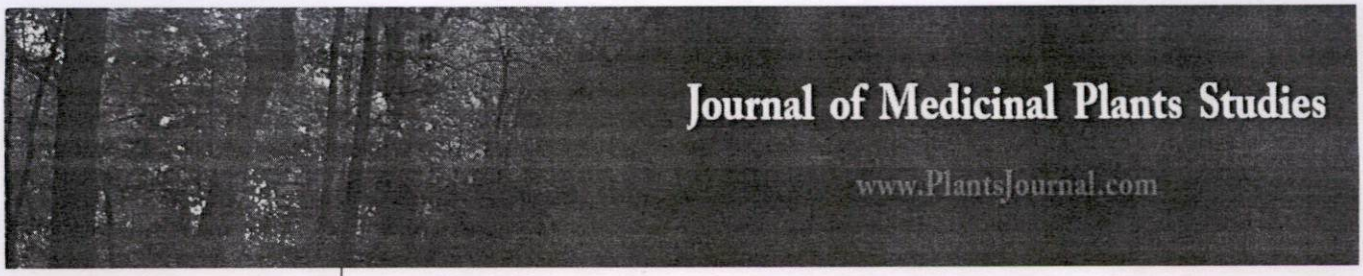

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Traditional knowledge on use of medicinal plants grown in homesteads as home remedies

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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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KNOWLEDGE LEVEL OF MEDICINAL PLANT CULTIVATORS IN THRISSUR DISTRICT OF KERALA

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Abstract: *The State of Kerala is enormously graced with the medicinal plants due to its diverse agro - climatic conditions. As per the report of Government of Kerala (2017), out of 26, 24,624 hectare of total cropped area, only 2435 hectare of land is utilized for the cultivation of medicinal plants.The present study was conducted to find out the knowledge level of farmers on medicinal plant cultivation in Thrissur District of Kerala. A total of 30 farmers drawn purposively from two panchayats of Thrissur constituted the sample for the study. Data were collected on personal, socio-economic, communicational and psychological profile of farmers and knowledge on cultivation of medicinal plants by using exploratory design of social research. Data from the respondents were collected by personally interviewing with the help of well-structured interview schedule and suitable statistical tools were used for the analysis of data. It was observed from present study, 66.6 per cent of respondents had medium level knowledge, while 23.4 per cent had low level of knowledge. Only 10 per cent of medicinal plant cultivators had high level of knowledge.*

Keywords: *Knowledge level, Medicinal plants.*

Introduction

The State of Kerala is enormously graced with a rich biodiversity of medicinal plants due to its diverse agro-climatic conditions and this state has a prominent place in the health map of India as it is the main center for Ayurvedic treatment and is a globally favored health tourism destination. In Kerala, cultivation of medicinal plants is confined to homesteads, along the boundary of farms, forest areas, leased land and as intercrops in coconut or rubber plantations. Ayurvedic medicine manufacturing units and practitioners use considerable quantities of parts of medicinal plants as raw drugs and most of these medicinal plants are harvested from forest areas, which seriously threatens not only the future supply but also leads to extinction of medicinal plant species.For sustainable utilization of medicinal plants these species are to be conserved, hence it is necessary to cultivate medicinal plants to meet the internal and external demand. With this background it was thought important to know the level of knowledge possessed by farmers in cultivation of medicinal plants, so that shortcomings if any could be overcome by suitable interventions. The following are the specific objectives of the study.

- To understand profile characteristics of farmers involved in medicinal plant cultivation
- To understand the extent of knowledge of farmers in cultivation of medicinal plants

Methodology

The study was carried out during the year 2017-18 in Thrissur district of Kerala. Kodakara block of Thrissur district was purposively selected for the study, since it is the highest medicinal plant cultivating area. It is located 20 km towards south from district head-quarters Thrissur.Kodakara block

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Management of calliandra (*Calliandra calothyrsus* Meissn.) in coconut plantation for boosting forage yield and nutritive value

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Abstract
Calliandra (*Calliandra calothyrsus* Meissner), a prominent agroforestry tree species, is a potential animal fodder as a supplement to poor quality roughages, but management practices that ensure both quantity and suitable quality as cattle feed underneath coconut plantation were to be standardized under humid tropical conditions of India. We therefore, investigated the comparative forage yields and nutritive value of young stands of calliandra under three levels of tree density *viz.* 27,777 plants ha^{-1} (60 x 60 cm spacing), 22,222 plants ha^{-1} (75 x 60 cm spacing) and 17,777 plants ha^{-1} (75 x 75 cm spacing), two cutting heights (0.5 and 1.0 m from ground level) and three cutting intervals of 8, 12 and 16 weeks, laid out in 3 x 2 x 3 factorial randomized block design replicated thrice. The study clearly indicated that in humid tropical conditions, calliandra should be planted at a closer spacing of 60 x 60 cm, pruned at 1.0 m height and at an interval of 12 weeks to achieve greater dry matter and nutrient yields. Establishment and proper management of calliandra hedgerows in coconut plantations thus offers a cheap source of quality forage to land crunch humid tropical farmers against the highly expensive concentrate feeds.

Keywords: Calliandra, Coconut, Cutting height, Cutting interval, Fodder yield, Nutritive value

Introduction

The livestock sector has emerged as one of the key components of agricultural growth in developing countries in recent years. Over 70 per cent of the Indian rural households depend on livestock farming for supplementary income. Though livestock sector makes significant contribution to the economy of Kerala state, it is facing serious constraints due to scarcity of cheap and quality fodder resources and high crude protein deficit for livestock nutrition. The state produces only 60 per cent of the required fodders (Kerala State Planning Board, 2010) and 90 per cent of the raw materials needed for concentrate feed are coming from nearby states, thus forcing farmers to purchase costly concentrate feeds which offset their profit to a great extent. Due to land scarcity, the scope for further expansion of area under fodder crop is also very limited. In this context, cultivation of protein rich fodder trees by integrating with existing cropping systems like coconut is a viable option to enhance quality forage production in land crunch state like Kerala. Trees and shrubs can play a significant role not only in improving fodder production but also providing assured supply of fodder throughout the year (Singh and Singh, 2017).

Among fodder trees, *Calliandra calothyrsus* Meissner (calliandra) is a promising fodder tree by virtue of its nutritive foliage, ability to withstand severe pruning and good coppicing ability (Pye-Smith, 2010). It is a fast growing, multipurpose tree legume native to Central America and Mexico and is suitable for different ecological zones. Annual forage yield is reported to be in the range of 7-10 t/ha dry matter (Ella *et al.*, 1989). The leaves, flowers and twigs are edible and contain 20-25% crude protein and is a good supplement to the diet of most animals. Wiersum and Rika (1992) reported 22% crude protein content, 30-70% fibre content, 4-5% ash and 2-3% fat in dried leaves of calliandra. But higher tannin levels in calliandra reduced its digestibility and animal growth when used as a sole feed. However, when used as supplement to low to moderate quality basal diets, growth of animals supplemented with calliandra is reported to be higher than supplemented with lower tannin plants such as gliricidia, lucerne and sesbania (Rusdy, 2016). In Kenya, feeding calliandra as a concentrate substitute to dairy cows improved the milk yield without any adverse effect (Paterson *et al.*, 1999). Studies conducted in crossbred cows of Kerala also confirmed the nutritive value of calliandra with relatively high protein (18.45%), minerals, ether extract and energy content, and suitability as a partial substitute for concentrate feeds to the extent of 10 to 20 per cent without affecting animal