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Research Application Summary

Production of disease-free papaya planting materials of known sex for commercial fruit production

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Abstract

Papaya (*Carica papaya* L.) is a medium sized fruit crop with a potential to produce fruits throughout the year. The ripe fruits, which are very rich in vitamins A and C, are popularly used for dessert or processed into jam or wine. Due to its nature as a single stemmed tree it can be economically produced in any size of land from kitchen gardens to large plantations. Papaya producers and researchers encounter some very serious challenges. These include unreliable methods of picking the required sex of seedlings at planting time, lack of disease-free planting materials, lack of improved varieties and devastating diseases that are difficult to control. Some immediate and long term remedies need to be sought to save this crop from extinction. The goal of this research is to contribute to efforts to eradicate poverty and hunger in papaya producing regions through improvement of fruit yield and quality. It will address some current production constraints especially production of disease-free papaya seedlings through *in vitro* culture of merisematic tissues and micro grafting.

Key words: Agronomic evaluation, *Carica papaya*, meristem culture, micrografting, protocol development, sex type

Résumé

La papaye (*Carica papaya* L.*)* est une culture de fruits de taille moyenne avec un potentiel à produire des fruits toute l'année. Les fruits mûrs, qui sont très riches en vitamines A et C, sont couramment utilisés pour le dessert ou transformés en confiture ou au vin. En raison de son caractère unique, d'arbre à une tige, il peut être économiquement produit dans toutes les dimensions de la terre de jardins potagers et les grandes plantations. Les producteurs de papaye et les chercheurs rencontrent quelques défis majeurs. Il s'agit notamment de méthodes fiables pour choisir le sexe des plants nécessaires au moment des semis, le manque de matériel végétal exempt de maladies, le manque de variétés améliorées et des maladies

dévastatrices qui sont difficiles à contrôler. Certains remèdes immédiats et à long terme doivent être recherchées pour sauver cette culture de l'extinction. Le but de cette recherche est de contribuer aux efforts visant à éradiquer la pauvreté et la faim dans les régions productrices de la papaye par l'amélioration de la production de fruits et de qualité. Il abordera certaines contraintes de production actuels notamment la production de plants de papaye intact de la maladie grâce à la culture *in vitro* de tissus merisematic et micro greffe.

Mots clés: Évaluation agronomique, *Carica papaya*, la culture de méristèmes, microgreffe, élaboration d'un protocole, Type de sexe

Background

Papaya is a polygamous species with three sex types, male, female, and hermaphrodite. It is among the very few fruit crops that can produce fruits throughout the year.

Papaya is mainly propagated sexually. Prior to flowering, the seedlings look alike irrespective of their sex. As such producers have to wait until flowering time to differentiate among the sexes. The general recommendation has been to plant 3 seedlings per hole and destroy the extra plants at the onset of flowering. Since only a few males are required for pollination (ratio of 1 male: 9 females), this recommendation is very uneconomical for producers in terms of both capital and time investment. Asexual propagation is a major procedure for production of offspring that are true to type of parental material.

Further, the recent outbreak of papaya ring spot ponty-virus (PRSV) in all major papaya-producing areas of the world (Manhsardt, 1992) has not spared the Kenyan industry. As a result papaya is being wiped out at a fast rate, and the devastation is already becoming obvious in both research institutions and farmers' fields. Effective control has proved difficult since resistant cultivars are not available and chemical control of insect vectors using insecticides is impractical since PRSV is non-persistently transmitted. In vitro meristem culture has proved useful in eradication of viral and other plant diseases (Poehlman, 1987). This research seeks to solve the sex and viral disease paradox through in vitro culture of merisematic tissues and micro grafting. Secondly, the resulting disease free plants will be evaluated agronomically to establish their suitability in commercial production.

Literature Summary

Papaya is conventionally propagated by seed. As such cultivation is hindered by problems due to inherent heterozygosity and dioecious nature of this crop (Winnaar, 1988). Pure papaya seed can be produced in artificially controlled condition. Controlled pollination maintains maximum varietal purity but is cumbersome and requires skilled labour (Rajan and Markose, 2007). Seed produced by isolation is superior in quality but very expensive.

Efforts to propagate papaya by budding have been made through research using patch budding and shield budding methods. Patch budding has been commercially adapted to some extent due to its 90% success (Rajan, and Markose, 2007). On the other hand, grafting also ensures wind firmness since grafted plants are shorter and stronger. The advantage also extends the economic period of a fruit tree by enabling production of dwarfed fruit trees which would otherwise be too tall to access the fruits for harvesting. In papaya grafting has been attempted in an effort to address the problem of raising plants with the desired sex.

Protocols for *in-vitro* plantlet regeneration from shoot meristems of papaya have been developed (Winnaar, 1988; Shi-Tao and Liaw, 2007) in other regions of the world. However, most of the protocols are genotype dependent and can not be easily reproduced (Mishra *et al.*, 2007). No protocol has been developed for any locally available papaya germplasm in East Africa, so far.

Study Description

The apical meristems of the stock papaya plants will be destroyed to encourage branching. Apical meristems of the upcoming shoots will be extracted under sterile conditions, cultured and multiplied in vitro using Murashige and Skoog (MS) basal medium (Murashige and Skoog, 1962) and its modified forms supplemented with low concentration of Naphthalene acetic acid (NAA) (0.1 to 1ppm) and BA (0.1 to 1ppm) for multiple shoot induction. Shoots about 2 cm long will be either rooted using low concentration of Indolbutyric acid (IBA) (5 to 100mg/l) or grafted in vitro.

Scion materials will be raised in vitro through meristem culture. Seeds of locally adapted commercial papaya (*Carica papaya* L.*)* varieties and mountain papaya (*Carica candamacencis* L.) will be raised in vermiculite under in vitro conditions. Wedge

and approach grafting methods will be carried out in vitro using cactus thorns for joining the scions and root stocks together.

Meristem cultured and micrografted papaya plants from the experiments above will be evaluated at Jomo Kenyatta University of Agriculture and Technology in central Kenya and at Kenya Agriculture Research Institute (KARI)-Thika, Kenya. Seedlings will be transplanted when about 10cm tall and data on size of stem, internodes, representative leaves, stomatal conductance, flowering dates, fruit maturation dates and fruit quality will be collected once a week.

Fruits from the new strains will be analyzed for skin and flesh colour, flesh firmness, total soluble solids, total titratable acidity, total carotenoids (Vitamin A) and reduced ascorbic acid (Vitamin C). Organoleptic analysis will be carried out using a panel of 15 participants to define taste and eating quality of the fruits.

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