DEVELOPMENT PROCEDURE IN MUTATION INDUCTION AND TRACER TECHNIQUE FOR GOOD AGRICULTURAL PRACTICES FOR 'UNDERUSED CROPS'

PEMBANGUNAN PROSEDUR MUTASI ARUHAN DAN TEKNIK PENYURIH UNTUK AMALAN PERTANIAN BAIK BAGI 'UNDERUSED CROPS'

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Abstract

'Underused crops' are those crop species which have high potential value in the supply of important raw material for secondary economy sector in food processing. The yield production of new 'Underused crops' varieties can be used as an important input in food production process for export products. The optimum production cost can be minimized since the price of raw material supplied from agriculture sector is cheaper compared with the international markets. Agriculture output can be increased through the development of 'Underused crops' using radiation mutagenesis and tracer technique for good agricultural practices. This paper work will discuss the development procedure of mutation induction method which includes irradiation of samples such as seeds of groundnut and in vitro shoots of banana using gamma rays and application of N-15 for nutrient use efficiency and screening of potential mutant lines with high yield and resistance to drought. These management practices using established procedures of water and nutrient use efficiency will be recommended to the growers.

Abstrak

'Underused crops' merupakan spesies tanaman yang mempunyai potensi tinggi untuk bekalan bahan mentah yang amat penting kepada sector ekonomi sekunder dalam pemprosesan makanan. Hasil pengeluran varieti baru 'Underused Crops' merupakan input yang dapat digunakan dalam proses pengeluaran bahan makanan yang boleh dijadikan sebagai produk eksport. Kos pengeluaran dapat diminimumkan untuk pengeluaran optimum kerana harga bahan mentah yang dibekalkan oleh sektor pertanian adalah murah berbanding dengan pasaran antarabangsa. Dengan penggunaan mutagenesis sinaran dan teknik penyurih untuk amalan pertanian yang baik, hasil pertanian dapat dilipat gandakan melalui pembangunan'Underused Crops'.Kertas kerja ini akan membincangkan pembangunan prosedur kaedah mutasi aruhan yang merangkumi penyinaran sampel seperti biji benih kacang tanah dan in vitro pucuk pokok pisang menggunakan sinaran gamma dan aplikasi N-15 untuk kecekapan penggunaan nutrien untuk penyaringan mutan yang tahan kemarau dan hasil tinggi. Amalan pengurusan menggunakan prosedur kecekapan penggunaan air dan nutrien yang sedia ada akan disyorkan kepada petani.

Keyword: Underused crops, mutation induction, tracer technique

INTRODUCTION

Underused crops are domesticated plant species or local varieties of major crops and commodities that have been used for their food, fibre, fodder, oil or medicinal properties but, currently abandoned by farmers or in decline but which could be revived through specific interventions such as adding value or marketing. About 7000 plant species have been used as human food. Unfortunately, recently decades have seen a reduction in number of crops come to dominate agriculture, to the exclusion of many others (FAO, 1998). Many of these crops still exist as minor or niche crops and, if still cultivated at all, are seen as of 'low status'.Farmers cultivate them less than in the past because these species are no longer competitive with the crops that have come to dominate the world food supply such as rice, wheat, maize and that are supported by seed supply systems, production and post-harvest technologies

and extension services. In order to bring underutilized species back into cultivation, their competitiveness has to be addressed and new opportunities such as new food and lifestyle trends and the developments taking place in production and post-harvest technologies have to be explored (Padulasi S. and Zeledon IH., 2004).

Currently, the food security is the major problem faced for most countries in the world. The need to provide food for nine billion people will require an intensification of farming at one end of the scale, but local issues, such as nutritional and dietary diversity and the loss of traditional diets, will increasingly demand attention if any long-term form of food security is to be achieved. In addition, simply producing enough food is not in itself enough, but that food must be harvested, processed, and distributed and the poor must be in a position to have the purchasing power in order to access that food resource. The effects of the urban poor being priced out of access to available food were seen in the world-wide food riots of 2008 (Mayes et al., 2011). Thus, underutilized or underused crops have the potential to play a number of roles in the improvement of food security.

Mutation induction is the best way to improve the underutilized crop productivity. Mutagenic agents, such as radiation and certain chemicals, then can be used to induce mutations and generate genetic variations from which desired mutants may be selected. Mutation induction has become a proven way of creating variation within a crop variety. It offers the possibility of inducing desired attributes that either cannot be found in nature or have been lost during evolution. When no gene, or genes, for resistance to a particular disease, or for tolerance to stress, can be found in the available gene pool, plant breeders have no obvious alternative but to attempt mutation induction. Plant breeding in conjunction with optimized soil nutrient and water management practices is probably the most viable approach to stabilizing underutilized crop production in Malaysia for the benefit of the rural communities in order to increase their income and livelihood.

DEVELOPMENT PROCEDURE

Identified potential underused crops

In developing strategic approaches, there has been the tendency to build on successful experiences with underused crops. Successful action mostly resulted from identifying a specific and important single end-use, assembling a substantial germplasm collection followed by selection, breeding and multilocational trials, agronomic practices and commercialization. Mutant varieties of Groundnut, Karisma Sweet had been developed by Malaysian Nuclear Agency in 2002 will be used for screening for drought tolerance and evaluation of soil, nutrient and water management practices. In addition, a popular Cooking Banana among the locals or Plantain called Pisang Tanduk will also be used in order to screen for drought tolerance with high yield, early maturity and resistance to diseases.

Mutation breeding

Mutation breeding is one of the quick and fastest ways to improve germplasam performance compare with conventional breeding. Plant sample will irradiated with chemical or physical mutagen to generate new progeny

with desired traits. Groundnut seed (Matjan) were irradiated using gamma radiation at 200, 300, and 400 Gy. Then, screening for Cercospora leaf spot disease begins at M_2 population. Next, the multi location trial was done at several locations to evaluate growth performance and yield stability. Finally, at year 2002, the groundnut mutants varieties which tolerant to Cercospora leaf spot disease and formed active nodule with indigenous rhizobia was launched as new variety of groundnut.

Then, for plantain breeding, in vitro shoot of banana was used as starting plant material. Multiplication of individual shoot in culture media will be done. Next, hardening the rooted plant in glasshouse covering with plastic and netting will be done about 2 month before planting at the field.

Screening for drought tolerance

The glasshouse and field experiment were done for determine water use efficiency and yield traits of groundnuts. Analysis of soil nutrient, chemical, and physical characteristics need to done before starting the experiment in order to determine the fertilizer input needed for the crop. Two water levels were maintained at 75% (well watered) and 25% (water stressed) field capacity using soil moisture sensor and tensiometer. Soil water level was maintained uniformly at field capacity from planting to 14 days after planting and then soil moistures of stress treatments were allowed to gradually reduce until they reached predetermined levels at 75% (well watered) and 45% (water stress) stress treatments at 21 days after planting. The soil moisture was then held at these levels until harvest. Weather station were placed at the field to measure the climate data. One check variety which is Margenta (elite drought resistance variety) used to compare the yield performance with the mutant variety. The data collected during the harvesting are i) Biomass production consists of root, shoot, and pod dry weight, ii) number of pod per plant, iii) weight of pod per plant, iv) number of seed per plant, and v) weight 100 seeds. For plantain (pisang tanduk), agronomic traits will be evaluated are yield (kg/plant), number of fingers, plant height, and number of days for maturity.

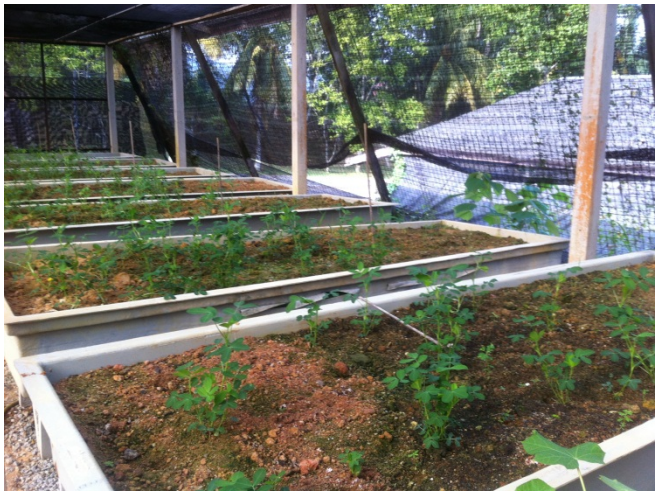

Figure 1: Screening drought tolerance of groundnut in the glasshouse

Figure 2: Intercroppping groundnut and pisang tanduk at the field

Figure 3: Tensiometer and soil moisture sensor used for determination of soil moisture level.

Figure 4: Weather station were placed at the field to record the climate data

Crop management

Seeds of groundnuts were treated with fungicide 'Captan' before planting. Then, basal fertilizers rate applied are 30 kg/ha nitrogen (N), 60 kg/ha phosphorus (P) and 60 kg/ha potassium (K). Plants were maintained free from pest and diseases by using appropriate plant protection measures.

Application of tracer technique

Stable radioisotope, N-15 will be used to evaluate the biological nitrogen fixation in the groundnuts. Fixed nitrogen will be determined after harvest by the N-difference method using the non-nodulating crop as reference plant. Beside, stable radioisotope N-15 also can be used to determine the fate of N fertilizer in plant. Thus, we can utilize N fertilizer efficiently and the cost of fertilizer input can be saved. The summarize procedure for analysis of N-15 in plant sample are shown in figure 5. Additionally, the good agriculture practices also can be recommended to the farmers for increasing the yield production of the underused crops.

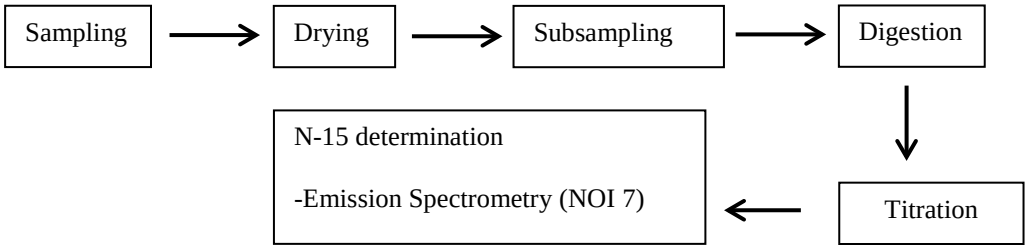

Figure 5: Procedure analysis of N-15 in plant tissue

CONCLUSION

Focus on priority underused crops in traditional agricultural areas and development of procedures for assessing the sustainability of their use tied to focused research to evaluate the potential and ecological requirements could go a long way in advancing knowledge and avoid the limited and piecemeal research. Combining procedure developed from mutation induction and tracer technique will assist the increasing production of underused crops as well as the income of the farmers. These development procedures can be used as a reference to increase yield productivity for underutilized crops. Besides, the good agricultural practices for underused crops will be recommended to the farmers.

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