ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 8, Issue, 10, pp.39756-39761, October, 2016

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

A STUDY ON THE GENETIC CONTROL AND POTENTIAL OF THE IMPORTANT AGRONOMIC CHARACTERS OF *MARANTA ARUNDINACEA* L.

***Shintu, P. V., Radhakrishnan, V. V. and Mohanan, K. V.**

Genetics and Plant Breeding Division, Department of Botany, University of Calicut, Kerala - 673 635, India

ARTICLE INFO

Article History:
Received 10th July, 2016
Received in revised form
05th August, 2016
Accepted 08th September, 2016
Published online 30th October, 2016

Key words:

Genetic analysis,
Genetic control,
Tuber,
Agronomy,
Maranta arundinacea.

ABSTRACT

Maranta arundinacea commonly known as the West Indian arrowroot is a perennial rhizomatous herb cultivated widely in tropical countries for its starchy rhizomes. The edible tuberous rhizomes are rich in starch and are also a commercial source of fine grade starch used often in weaning foods and biscuits. The starch is reported to have medicinal uses and is an important ingredient in the preparation of barium meals and tablets. The plant which grows under shade is generally resistant to pests and pathogens. Traditionally the tuberous rhizomes are used in the treatment of diarrhea. Being an important crop with underexplored and underexploited genetic potential, knowledge of the genetic control of its agronomic characters is one of the major steps towards the improvement of the genetic stock of this crop. Hence an experiment was carried out to analyze the genetic control of the major agronomic characters in *Maranta arundinacea*. Six growth characters and eight yield characters were studied and all of them showed continuous distribution indicating polygenic control. Among the growth characters, leaf breadth and leaf area showed accumulation of higher number of dominant alleles. In the case of yield characters, diameter of primary fingers and yield per plant showed maximum accumulation of dominant alleles as revealed by the frequency distribution of the variables. The other characters showed a symmetric distribution of different combinations of alleles or accumulation of recessive alleles in their gene pool. The study indicates the essentiality of selection of better phenotypes and genotypes with higher number of dominant contributing alleles to develop superior varieties.

Citation: Shintu, P. V., Radhakrishnan, V. V. and Mohanan, K. V. 2016. "A study on the genetic control and potential of the important agronomic characters of *Maranta arundinacea* L.", *International Journal of Current Research*, 8, (10), 39756-39761.

INTRODUCTION

Tuber crops are the third important group of food crops in the world after cereals and grain legumes. As per the statistics available for the year 2000, nearly 550 million people throughout the world depended upon these crops and the area of cultivation was about 50.85 million hectares and produces 679 million tons of tubers every year. The tubers are used as food items, animal feed and as industrial raw materials. In India, these crops are grown in over 1.7 million hectares producing about 30.55 million tons of tubers per year (FAO, 2000). Many of the tuber crops are cultivated, but others grow wild as a neglected group of economic plants. Many wild tubers form an important starchy food for tribal people inhabiting near forest tracts. Some are important due to their medicinal as well as industrial applications. Most of the tuber crops are capable to produce economic yields in a variety of marginal soils and environmental conditions. *Maranta arundinacea* L., commonly known as the West Indian arrowroot is a perennial rhizomatous herb belongs to the family Marantaceae. It is believed to have originated in the North-Western part of South America and the Lesser Antilles. It has been widely distributed throughout the tropical countries like India, Sri Lanka, Indonesia, Philippines, Australia and West Indies. In India, it is distributed in Uttar Pradesh, Orissa, Bihar, West Bengal, Assam and Kerala (Edison *et al*., 2006; Odeku, 2013). Arrowroot starch is a fine white powder, tasteless and odorless when dry, but evolve faint odour when it is wet or cooked. Generally arrowroot possess >85% of starch. The starch is easily digestible and significant in the food for infants, invalids and convalescent. It is also used in the production of biscuits, cakes, pudding and jellies. The starch also holds demulcent properties and is given in bowel complaints. It is used as a suspending agent in the preparation of barium meals and in tablet making since it disintegrates fast (Anonymous, 1962; Anonymous, 2015). The fresh rhizome of arrowroot contains moisture 63.4%, starch 27.8%, fiber 3%, dextrins and sugar 2.1%, crude protein 1.6%, ash 0.9% and fat 0.2%. The rhizome is also eaten as boiled or roasted and made into pastries (Thamburaj and Singh, 2001). Studies on diarrhea and its treatment in villages of South India revealed that World

****Corresponding author: Shintu, P. V.***
Genetics and Plant Breeding Division, Department of Botany, University of Calicut, Kerala - 673 635, India.

Health Organization Oral Rehydration Solution was less effective when compared to arrowroot water given to children during acute diarrhea (Rolston *et al*., 1990). Arrowroot starch is used boiled in water or milk as a popular remedy for diarrhea. It is highly nutritious and with soothing and softening effect on mucus membrane. It is a good astringent, sweet, refrigerant, tonic, aphrodiasic, emollient, expectorant, febrifuge and rubefacient. It is useful in dysentery, diarrhea, dyspepsia, bronchitis and cough and is also a nourishing food for infants and convalescents (Parjapati *et al.,* 2003). Starch isolated from West Indian arrowroot has been studied for its various physicochemical characteristics (Madineni *et al*., 2012; Ayala Valencia *et al*., 2015). Seed setting is absent in *Maranta arundinace* and the plant is propagated by means of rhizome. Even though physicochemical characterization as well as pharmacological studies of *Maranta arundinacea* has been reported, no concerted efforts have been made so far to explore the genetic diversity of this species on a geographical basis and also to understand the genetic control of its agronomic characters. In this context an experiment was conducted to find out the genetic structure of an experimental population of *Maranta arundinacea* raised from collections made from 60 diverse locations and grown under standard experimental conditions based on different agronomic characters.

MATERIALS AND METHODS

A population of 540 plants, raised from the 60 accessions of *Maranta arundinacea* collected, was evaluated for the genetic control of agronomic characters. The plants were grown in the experimental field of the Genetics and Plant Breeding Division of Department of Botany, University of Calicut, Kerala, India during the first crop season of 2013 (Fig.1).

Fig. 1. The population of *Maranta arundinacea* grown for the present study

Agronomic characters such as plant height, number of tillers, number of leaves per tiller, leaf length, leaf breadth, leaf area, yield per plant, number of rhizomes per plant, length of rhizome, diameter of rhizome, number of primary fingers, length of primary finger, diameter of primary finger and starch content were recorded. All the characters except starch content were observed morphometrically and starch content was assessed by Anthrone method proposed by Hodge and Hofreiter (1962). The data were pooled and subjected to frequency distribution analysis so as to study the nature of genetic control of the characters and also to analyze the pattern of distribution of dominant and recessive alleles in the gene pool studied.

RESULTS

Genetic control of the fourteen agronomic characters such as six growth characters and eight yield characters of *Maranta arundinacea* was analyzed presently by frequency distribution analysis.

Genetic control of growth characters

Six growth characters such as plant height, number of tillers, number of leaves per tiller, leaf length, leaf breadth and leaf area showed continuous frequency distribution as evidenced by their frequency curves (Fig. 2). Continuous frequency distribution with all possible intermediates indicates polygenic control of these characters. Among the characters studied, leaf breadth and leaf area showed skewness towards the distal half of the distribution indicating accumulation of higher number of dominant alleles. This shows that the gene pool of these characters have accumulation of higher number of dominant contributing alleles even when maintaining good genetic base ranging from comparatively lower to higher values. In a point of view of selection of promising genotypes, maximum accumulation of dominant contributing factors is desirable. Growth characters such as number of tillers and number of leaves per tiller show frequency of genotypes with higher accumulation of recessive contributing factors thus displaying skewness towards the proximal side of the distribution. This suggests that, scientific selection processes are to be carried out to develop varieties with maximum accumulation of dominant alleles of these characters. Frequency distribution of plant height and leaf length showed a balanced distribution of genotypes almost equally towards the left and right halves of the frequency curve. This suggests the existence of equal frequency of dominant and recessive alleles contributing to these characters. This points out that the frequency distributions of the contributing alleles controlling these characters are normally distributed and no skewness in allele frequency has developed in the case of these characters. Genotypes with higher number of dominant alleles are to be considered while carrying out selection programmes in relation to these characters.

Genetic control of yield characters

The yield characters of *Maranta arundinacea* studied presently for genetic control of characters include yield per plant, number rhizomes, length of rhizome, diameter of rhizome, number of primary fingers, length of primary finger, diameter of primary finger and starch content. Among the characters, yield per plant showed frequency curve with skewness towards the distal side of the distribution indicating the presence of higher number of dominant contributing alleles in the gene pool of the character. Frequency distribution of number of rhizome per plant showed skewness towards the proximal side of the distribution indicating the accumulation of higher number of recessive alleles in the population studied. In the case of length of rhizome, frequency distribution curve showed continuous distribution with a fall in frequency towards the positive extreme. This type of behaviour of the character might be due to the presence of lower number of dominant alleles in the population.

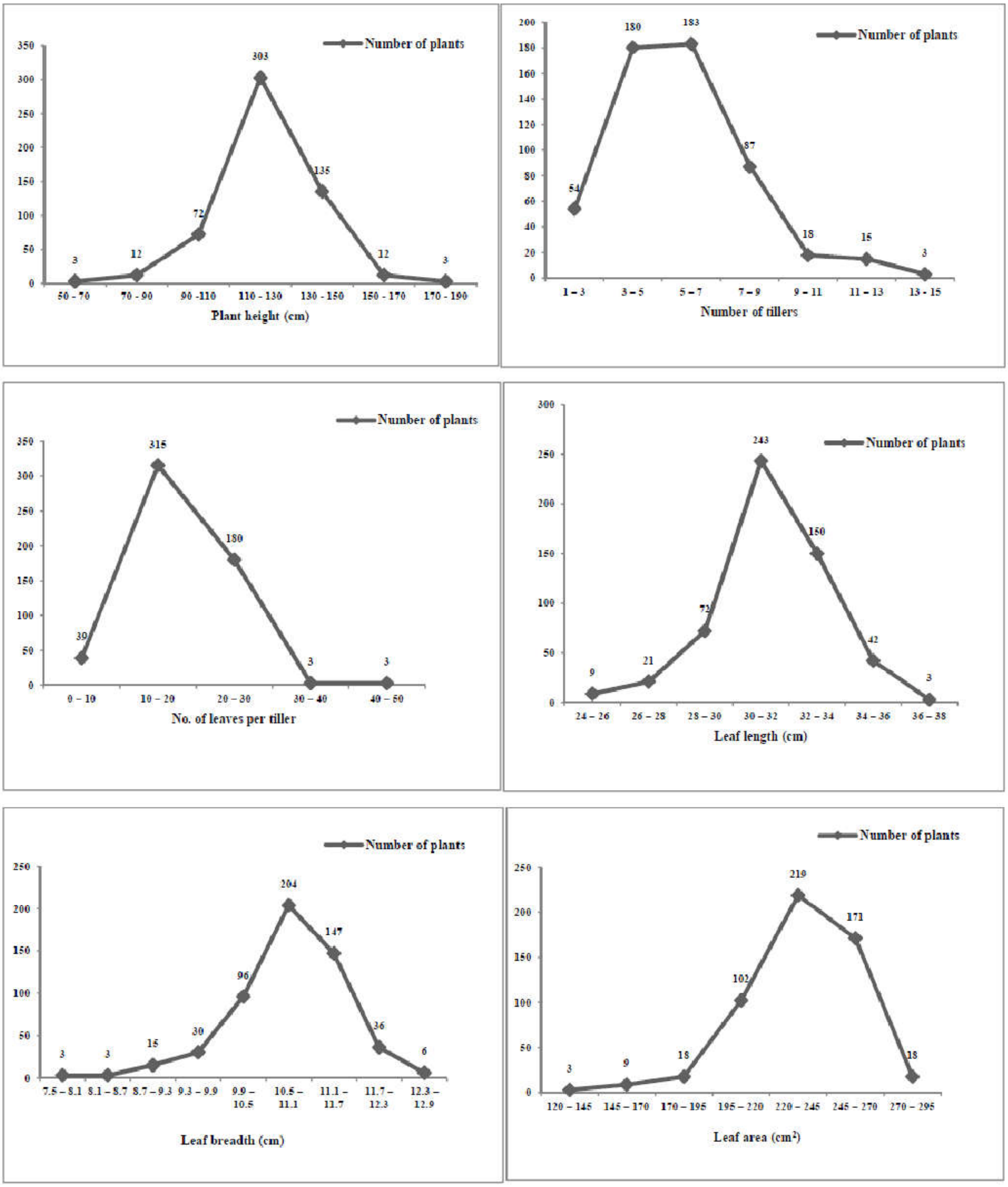

Fig. 2. Frequency distributions of the growth characters studied

Diameter of rhizome shows continuous distribution with accumulation of higher number of dominant alleles, thus shifting the skewness of the distribution towards the right half of the distribution. Number of primary fingers displayed continuous frequency distribution indicating the polygenic control of the character but the frequencies of the classes with higher number of primary fingers were low in the population under study. This shows that there is predominance in the frequency of recessive factors controlling the character in the gene pool of the population. In the case of length of primary fingers also the frequency of genotypes with higher accumulation of recessive contributing factors was found to be high. Regarding the diameter of primary finger, the frequency curve showed a fall from the mid value and it might also be due to the presence of dominant alleles in a lower frequency when compared to the recessive alleles. Frequency distribution of starch content showed skewness towards the proximal side of the distribution indicating the accumulation of higher number of recessive contributing alleles in the population studied.

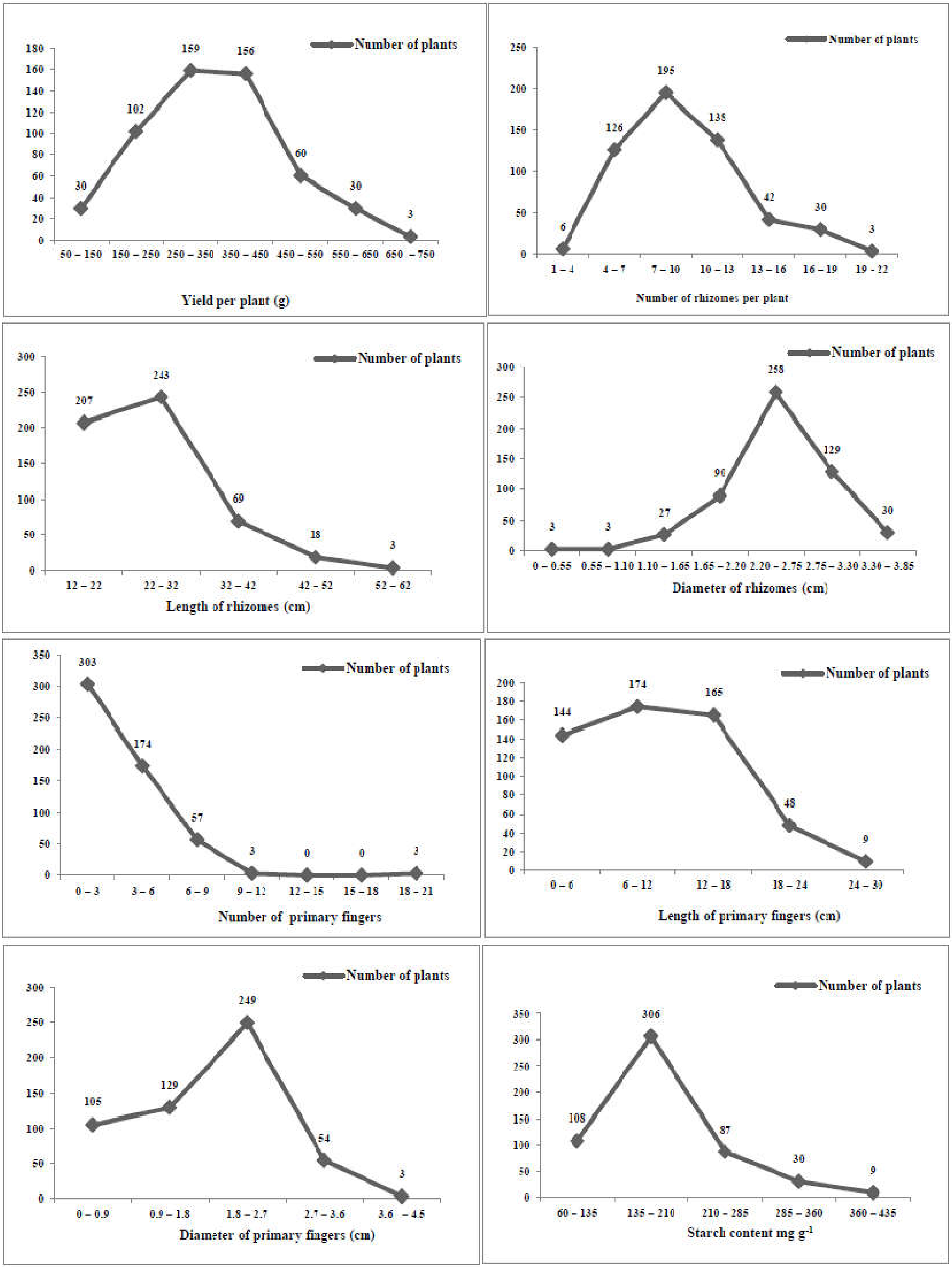

Fig. 3. Frequency distributions of the yield characters studied

DISCUSSION

Continuous frequency distributions with all possible intermediates indicate the polygenic control of characters. Quantitative characters with polygenic control show normal frequency distribution when the allelic combinations are distributed in the gene pool of population as per the principles of probability and when the dominant and recessive alleles are in equal frequencies. The bell shaped normal distribution curve shows skewness when there is variation in the frequency of dominant and recessive alleles in the distribution (Chahal and Gosal, 2002). The above study reveals that the growth as well as yield characters of *Maranta arundinacea* show continuous frequency distribution which indicates polygenic control of the characters. Within the growth characters studied, only plant height and leaf length showed normal symmetrical distribution. The characters like plant height and leaf length display the accumulation of recessive contributing factors in higher frequencies while leaf breadth and leaf area showed the accumulation of dominant alleles. It also confirms the essentiality of selection for better phenotypes and genotypes having larger number of dominant contributing alleles so as to develop superior varieties. Still, the frequency curve of these characters also showed broad spread indicating the advantage of such distributions from the point of view of conservation potential. Among the yield characters studied, yield per plant and diameter of rhizomes showed frequency curves with skewness towards right side which indicates the occurrence of higher number of dominant alleles in their gene pools. Number of rhizomes, length of rhizomes, number of primary fingers, length of primary fingers, diameter of primary fingers and starch content indicate the presence of higher number of recessive alleles in their gene pools and it implies the necessity of selection of plants with desirable characters for crop improvement purposes. The present study shows that in the study population, the characters such as leaf breadth, leaf area, yield per plant and diameter of rhizome show higher level of accumulation of dominant alleles whereas all other characters either display equal number of dominant and recessive alleles or higher number of recessive alleles. Higher frequency of dominant alleles is the pre requisite for the development of superior varieties. It could be found that the genetic potential of the plants as good yielders is limited by the presences of very high frequency of recessive alleles in the gene pools of the natural populations of underexploited crop plants. This shows that selection process should be initiated to develop improved and high yielding varieties of such species so that better yield and quality are ensured. The study also points out that the genetic base of *Maranta arudinacea* in the study area is comparatively broad and there exists no threat of narrowing of genetic diversity among the species. However, due to crop conversion, shift to monocropping and industrialized agriculture, marginal crops including *Maranta arundinacea* face acute threat in their natural habitats and traditional homesteads. Hence steps should be taken to protect the species in its natural habitats so that the diversity of the species is maintained. Similar studies have been reported in *Curcuma amada* (Jayasree, 2007). In the study, length of primary fingers and diameter of secondary fingers displayed the presence of higher number of dominant alleles. A study of frequency distribution of cardamom (Radhakrishnan, 2003) revealed that characters such as leaf breadth, seeds per capsule and recovery percentage showed higher frequency towards dominant alleles. According to Soorya *et al*. (2016) the frequency distribution of yield characters like number of primary fingers, number of secondary fingers, length of mother rhizome and yield per plant showed skewness towards the left side of the distribution in *Curcuma aeruginosa*. Polygenic control of agronomic characters has already been reported in the case of plantation crops (Dharmaj and Sreenivasan, 1992; Sreenivasan and Santharam, 1993; Nikhila *et al*., 2002; Raghu *et al.,* 2003), cereals (Paramasivan and Sreerangaswamy, 1988; Shobha, 1993; Mohanan, 1996) and medicinal plants (Khandalkar *et al*., 1993; Misra *et al*., 1998; Jayasree, 2002; Chandramohanan and Mohanan, 2005).

Conclusion

The present study shows that genetic base of *Maranta arundinacea* in the study area is comparatively broad and there exists no threat of narrowing of genetic diversity of the crop presently. However, due to crop conservation, shift to monocropping and industrialized agriculture, marginal crops including *Maranta arundinacea* face acute threat in their natural habitats and traditional homesteads where they are conventionally cultivated. Hence steps should be taken to protect the species in its natural habitats so that the diversity of the species is maintained. Most of the characters studied displayed the existence of high frequency of recessive alleles. This indicates the fact that selection process should be initiated to develop improved and high yielding varieties of this species so that better yield is ensured to farmers carrying out cultivation of this crop.

REFERENCES

Anonymous 1962. The Wealth of India: A Dictionary of Indian Raw Materials and Industrial Products - Vol. 6, *Council of Scientific and Industrial Research*, New Delhi, India.

Anonymous 2015. Arrowroot – *Maranta arundinacea* L. http://edis.ifas.ufl.edu.

Ayala Valencia, GA., Moraes, ICF., Lourenço, RV., Barbosa Bittante, AMB. and do Amaral Sobral, PJ. 2015. Physicochemical Properties of Maranta (*Maranta arundinacea* L.) Starch, *Int J Food Prop*., 18: 1990-2001.

Chahal, GS. and Gosal, SS. 2002. Principles and Procedures of Plant Breeding- Biotechnological and Conventional Approaches. Narosa Publishing House, New Delhi.

Chandramohanan, KT. and Mohanan, KV. 2005. Genetic control and phenotypic variability of morphometric characters in *Cassia tora* L. *Agric Sci Dig*., 25: 275 – 277.

Dharmaj, PS. and Sreenivasan, MS. 1992. Heterosis and combining ability in *Coffea canephora*. *J Plant Crops,* 20:157-161.

Edison, S., Unnikrishnan, M., Vimala, B., Pillai, SV., Sheela, MN., Sreekumari, MT. and Abraham, K. 2006. Biodiversity of Tropical Tuber Crops in India. *NBA Scientific Bulletin Number -7*, National Biodiversity Authority, Chennai, TamilNadu, India.

FAO 2000. The State of Food Agriculture, FAO, Rome. 329p.

Hodge, J.E. and Hofreiter, B.T. 1962. Carbohydrates. In: Methods in Carbohydrate Chemistry (Eds. Whistler, R.L. and Be Miller, J.N.) Academic Press, New York. pp. 17-22.

Jayasree, M. 2002. A study of variability and pruning response of butterfly pea, *Clitoria ternatea* L. M Phil Dissertation, University of Calicut, Kerala, India.

Jayasree, M. 2009. Studies on variability, divergence and improvement of *Curcuma amada* Roxb. and *Kaempferia* *galangal* L. PhD. Dissertation, University of Calicut, Kerala, India.

Khandalkar, VS., Patidar, H. and Nigam, KB. 1993. Genotypic association and path coefficient analysis in aswagandha (*Withania somnifera*). *Ind J Genet Plant Breeding*, 53(3): 257-260.

Madineni, MN., Faiza, S., Surekha, RS., Ravi, R. and Guha, M. 2012. Morphological, structural, and functional properties of Maranta (*Maranta arundinacea* L.) starch. *Food Sci Biotechnol*., 21: 747-752.

Misra, HD., Sharma, JR., Lal, RK. and Sharma, S. 1998. Genetic variability and path coefficient analysis in aswagandha (*Withania somnifera*). *J Med Arom Plant Sci*., 20: 753-756.

Mohanan, KV. 1996. Genetical and certain allied studies on *in vivo* cloning in rice, *Oryza sativa* L. Ph D Dissertation, University of Calicut, Kerala, India.

Nikhila, KR., Reddy, AGS., Sureshkumar, VB. and Mohanan, KV. 2002. Consequences of sibmating in C×R (*Coffea congensis* × *Coffea canephora*) coffee. Abs. Placrosym XV: 29.

Odeku, OA. 2013. Potentials of tropical starches as pharmaceutical excipients:A review. Starch-Stärk, 65:89-106.

Paramasivan, KS. and Sreerangasamy, SR. 1988. Genetic analysis of yield and its components in rice. Oryza, 25: 111-119.

Parjapati, ND., Purohit, SS., Sharma, AK. and Kumar, T. 2003. A Handbook of Medicinal Plants: A Complete Source Book. Agrobios (India), Jodhpur.

Radhakrishnan, VV. 2003. Studies on variability, genetic divergence and crop improvement in cardamom (*Elettaria cardamomum* Maton). Ph D Dissertation, University of Calicut, Kerala, India.

Raghu, AV., Mohanan, KV., Reddy, AGS., and Sureshkumar, VB. 2003. Variability in sibmating in C×R (*Coffea congensis* × *Coffea canephora*) coffee. *Ind J Agri Res*., 37(2): 110-114.

Rolston, DDK., Mathew P. and Mathan VI. 1990. Food based solutions are a viable alternative to glucose-electrolyte solutions for oral hydration in acute diarrhea studies in a rat model of secretory diarrhea. *Trans R Soc Trop Med Hyg*., 84: 156-159.

Shobha, B. 1993. Studies on mutagenesis in early upland rice. Ph.D. Dissertation, University of Calicut, Kerala, India.

Soorya, V., Radhakrishnan, VV. and Mohanan, KV. 2016. A study on genetic variability and genetic control of the important morphometric characters of *Curcuma aeruginosa* Roxb. *J Non-Timb Forest Prod*., 23: 61-65.

Sreenivasan, MS. and Santharam, A. 1993. Heterosis for yield in coffee. *J Plant Crops*, 21: 248-252.

Thamburaj, S. and Singh, N. 2001. The Text Book of Vegetables, Tuber Crops and Spices. Indian Council of Agricultural Research, New Delhi, India.

****