Exploration of plant biodiversity for nutrient harvesting

Moossa,P.P.[1*], Thulasi V.[2], Raji.P[3], and Prajesh .M.T[4]

Regional Agricultural Research Station, Pattambi, Kerala, India

Abstract— *There are considerable differences among plant species in the amount of nutrients required for biomass production, indicating the differential ability of the species to utilize nutrients for growth. Exploitation of this ability for nutrient absorption is a good option for nutrient management in organic agriculture. Different plant species growing in the wild habitats in the Western Ghats and wastelands of the western coasts were screened for phyto-accumulation capacity with respect to macro and micronutrients. Based on the analysis, phyto-accumulators of each nutrient was identified. Considering the overall nutrient concentration, ten plant species were identified as potential plants which can be utilized for nutrient management in organic farming. Plants like Mirabilis jalapa and Canna indica which are super accumulators and possess underground stems are promising plant species for nutrient harvesting as the above ground portion can be harvested without destroying the plants.*

Keywords— Canna indica, Mirabilis jalapa, Organic farming, Phyto accumulation, Western ghats.

I. INTRODUCTION

Crop nutrition with organic supplements is emerging as a challenge with the adoption of organic crop production in commercial scale. Among various nutrient management options, green manuring, green leaf manuring and use of composts are the major alternatives. Apart from crop residues, biomass of many plant species specifically utilized for crop nutrient management. Plant growth depends on the amount of nutrients present in biomass. However there are considerable differences between species in the amount of nutrients required to produce biomass (Wang et al.1991), indicating the differential ability in species to utilize nutrients for growth. *Glyricidia maculeata, Calatropis gigantean, Sesbania aculeate* etc. are traditionally utilized for nutrient management mainly to exploit the nitrogen fixing capacity of these plants. There are many plant species which have the capacity to selectively absorb and accumulate mineral elements. Plants such as *Thalaspi cearulescence*, *Alpine pennycress* (Gerbisu et al 2002) and *Brassica carinata* (Purakayastha et.al 2008) are used for phyto remediation. Majority of these are targeted to remove the heavy metal contaminants from the ecosystem. The ionome of plant species is highly plastic but tightly controlled by genes and plant gene interactions (Ivan Bexter et al.2012) Utilization of plant characteristics to absorb plant nutrients and exploitation of these properties for crop nutrition management is a un attended area of plant nutrition.

Humid tropics which receive abundant rainfall and have highly weathered soil experiences heavy nutrient loss due to leaching. Abundant plant growth in waste lands and river banks plays major role in catching these nutrients. Plants differ widely in their ability to absorb nutrients. Green manures and green leaf manure, especially for nitrogen fixing plants with high nitrogen content are widely used to enrich soils.. Imbalance of major nutrients especially potassium is a major problem in organic farming specifically for crops like coconut and banana which need high potassium. Agricultural biodiversity also include habitats and species outside farming system that benefit agriculture and enhance ecosystem functions(Heywood 2003). Identification of plant species with high and multiple nutrient content will be useful for crop nutrient management especially in organic farming.

II. MATERIALS AND METHODS

Detailed survey was conducted in western ghat region in Kerala–one of the biodiversity hot spots of the world- for weedy and waste land plant species. Five districts namely Kannur, Calicut, Wayanad, Malappuram and Palakkad were covered under the programme. Samples of 190 species of plants growing in the wild habitats and in waste lands were collected. Samples of each plant species were collected from minimum four locations to avoid site specificity. Only above ground portion were collected for the study purpose. These samples were washed to remove aerial adhering dust particles and dried under shade. The samples were then dried at 55^{o}C and powdered.

The powdered plants were subjected to nutrient analysis. Nitrogen was determined by *Semi-micro Kjeldahl method*, Phosphorous by V*anadate-molybdate colorimetry* and Potassium by *Flame photometer method*. Calcium, Magnesium, Zinc and Copper, were determined using *Atomic absorption spectro photometer*. Sulphur content was estimated using

Turbidimetry and boron was determined using *Colorimetry*. Nutrients were expressed on dry weight basis as percentage for N, P, K, Ca, Mg, S and as ppm for Zn, Cu and B.

III. RESULTS AND DISCUSSION

A total of 800 samples of 190 plant species under various categories as given in table 1 were collected. Herbs constituted major plant type in the waste lands and constituted 40 % of the total samples collected followed by shrubs.

TABLE 1
GROUP OF PLANTS SELECTED

S.no.	Type of plant	No. of species. Collected
1	Herbs	76
2	Shrubs	57
3	Trees	27
4	Climbers	25
5	Ferns	2
6	Grasses	3
Total	-	190

The nutrient content in the bio mass of the collected plant species varied widely. Data on extent of variation with each nutrient in the above ground biomass of the sample collected is given in table 2. Among the nutrients analyzed, the ratio between highest and lowest concentration was low for nitrogen (6.92) followed by phosphorus. Highest ratio is for copper (1265) followed by sulphur.

TABLE 2
PLANTS WITH HIGHEST AND LOWEST NUTRIENT CONCENTRATIONS

Nutrient element	Plants with Lowest concentration	Plants with Highest concentration	Concentration Ratio
N (%)	Wattakaka volubilis (0.51)	Trianthema portulacastrum(3.53)	6.92
P (ppm)	Alseodaphne semecarpifolia (379.03)	Adenanthera pavonina(6875.00)	18.14
K(ppm)	Cleome burmannii (1264.5)	Colocasia esculenta (70352.25)	55.63
Ca(ppm)	Saccharum spontaneum (1897.5)	Spathodea campanulata(70626.25)	37.22
Mg (ppm)	Senna alata(510.93)	Agave sp.(13905.11)	27.22
S (ppm)	Thevetia peruviana (94.74)	Ipomoea cairica (11268.94)	118.94
Zn (ppm)	Thevetia peruviana(5.20)	Ixora coccinea (676.31)	130.06
Cu (ppm)	Adenanthera pavonina (0.4)	Briedelia stipularis (505.94)	1264.85
B (ppm)	Setaria palmifolia(1.5)	Rauvolfia tetraphylla(281.98)	187.99
Mn (ppm)	Diospyros candolleana (12.65)	Homonoia riparia (939.63)	74.28

The data indicated that plants have different nutrient composition and there are options for the utilization of specific plant species for nutrient management in situations where a particular nutrient is required. From the practical utility point of view, 20 plants which have high levels of macro and micronutrients were identified. (Fig. 1 and 2).

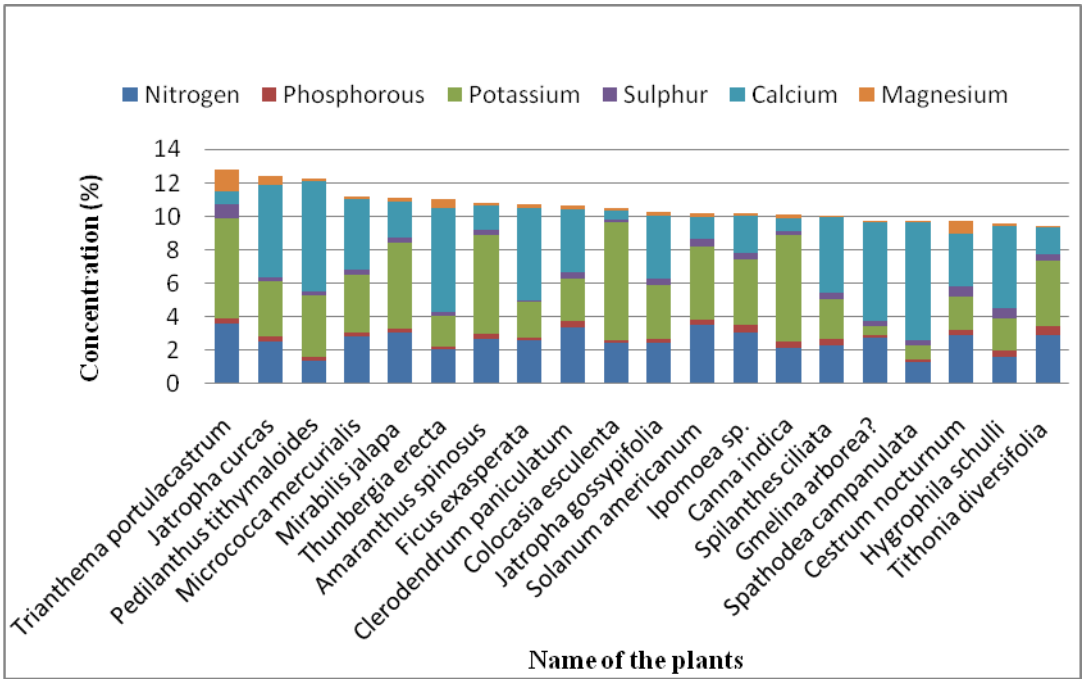

FIG. 1 PLANTS WITH HIGH CONCENTRATION OF MACRO NUTRIENTS

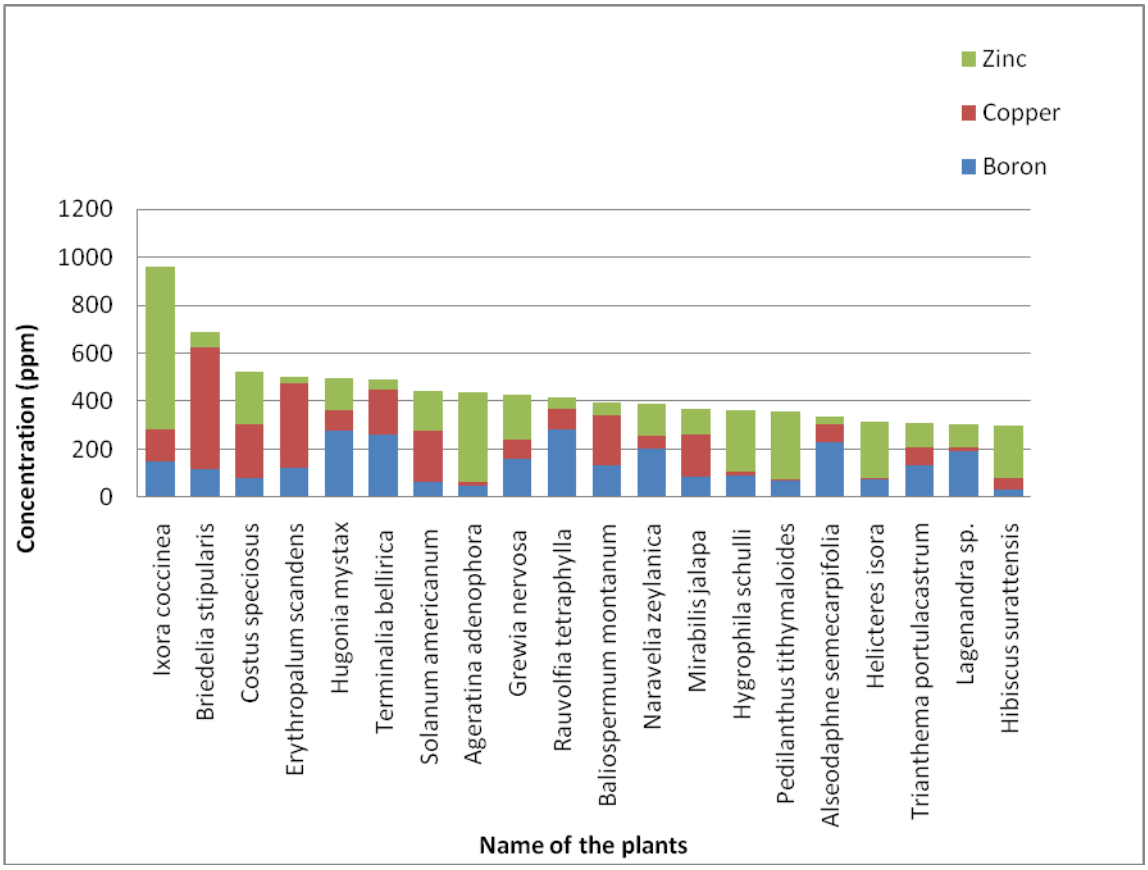

FIG.2 PLANTS WITH HIGH CONCENTRATION OF MICRO NUTRIENTS

Cumulative levels of macro nutrients are high in *Trianthema portulacastrum* (12.7%) followed by *Jatropha curcas* (12.4%). Concentration of macro nutrients are more than 9% in the selected plants. Based on the requirement of specific nutrients and local availability of these plants, it can be utilized for nutrient management.

With respect to micronutrients 20 plants with cumulative micronutrients more than 300 ppm was shortlisted for practical utilization as in Fig. 2. With respect to Zinc, Copper and Boron *Ixora coccinea* has the highest cumulative concentration of 905 ppm.

Species with high levels of macro and micro nutrients will be useful for balanced nutrition of crop plants. Ten plant species with more than 8% nutrients is given in table-3. These species can be utilized as green manure or material for composting and plants with high levels of individual nutrients can be utilized for specific nutrient supplement. Commercial utilization of these species as green manure or material for composting depends on few other factors as well. Ability to grow under wide soil fertility status, capacity to survive under biotic and abiotic stress situations, threat as a noxious weed and suitability for multiple harvest are some considerations to be taken in to account for their utilization as a nutrient harvesting plants.

TABLE 3
SELECTED SPECIES WITH HIGH LEVELS OF NUTRIENTS

No	Name	N (%)	P (%)	K (%)	S (%)	Ca (%)	Mg (%)	B (ppm)	Cu (ppm)	Zn (ppm)	Mn (ppm)	Total Nutrient (%)
1	Mirabilis jalapa	2.99	0.24	5.15	0.29	2.19	0.19	71.92	33.28	116.04	87.21	11.08
2	Thunbergia erecta	1.97	0.21	1.83	0.19	6.29	0.52	44.63	7.44	23.45	422.95	11.06
3	Amaranthus spinosus	2.58	0.32	5.91	0.37	1.41	0.18	108.4	17.07	110.44	141.89	10.81
4	Tithonia diversifolia	2.85	0.54	3.9	0.35	2.87	0.11	64.88	52.54	172.89	186.29	10.67
5	Jatropha gossypifolia	2.41	0.21	3.23	0.4	3.77	0.18	37.92	19.1	49.13	122.8	10.22
6	Solanum americanum	3.44	0.36	4.37	0.41	1.38	0.19	64.04	70.5	84.7	88.84	10.18
7	Ipomoea sp.	3.01	0.44	3.97	0.32	2.24	0.14	66.14	74.44	100.31	151.95	10.16
8	Canna indica	2.05	0.42	6.37	0.22	0.81	0.17	41.52	83.71	97.49	137.99	10.08
9	Justicia betonica	1.87	0.31	2.75	0.35	3.44	0.15	57.81	18.31	40.46	94	8.89
10	Xanthium indicum	2.62	0.57	3.39	0.61	1.11	0.15	108.77	25.82	117.65	144.13	8.48

Plant species with high biomass production, ability to grow in marginal lands and having underground tubers can effectively utilized for nutrient harvesting. Plant species like *Mirabilis jalapa* and *Canna indica* with profuse growth and underground stem which grow in marginal lands, has very good potential as nutrient harvesters for organic farming

IV. CONCLUSION

Nutrient addition through organic source is an integral part of organic farming and green manuring is one of the options available. Identification and utilization of plant species which are hyper accumulators and capable of coming up in marginal lands is essential. The identified phyto-accumulators can be utilized as nutrient harvesters from waste lands and maginal lands. It also provides an option to correct specific nutrient deficiencies in organic management systems utilizing specific phyo-accumulators. Plant species with specific accumulation as well as multinutrient accumulation capacity have been identified in this study. Plant species like *Mirabilis jalapa* and *Canna indica* are waste land species with profuse growth and underground stem. These plants have good potential as nutrient harvesting plants.

ACKNOWLEDGEMENTS

Financial assistance received from the Kerala State Council for Science Technology and Environment, Government of Kerala is greatly acknowledged

REFERENCES

[1] Heywood VH (2003) Conservation strategies, plant breeding, wild species and land races in mann K, Jacot Y, Braun R (eds) Methods for Risk Assessment of Transgenic Plants IV. Biodiversity and biotechnology, Birkhauser Verlag, Basel/ Switzerland, pp 143–159

[2] Ivan Baxter, Christian Hermans, Brett Lahner, Elena Yakubova, Marina Tikhonova, Nathalie Verbruggen, Dai-yin Chao, David E Salt (2012) Biodiversity of Mineral Nutrient and Trace Element Accumulation in Arabidopsis thaliana, PLoS ONE , open access journal, 7(4).

[3] Moses Imo (2012) Managing Competition for Nutrients in Agro-Ecosystems in Weed Control, Dr. Andrew Price(ed), ISBN: 978-953-51-0159-8

[4] Purakayastha TJ, Thulasi Viswanath, Bhadraray S, Chhonkar PK, Adhikari PP and Suribabu K (2008) Phyto extraction of copper, zinc, nickel and lead from a contaminated soil by different species of Brassica. International journal of Phytoremediatiomn,10, pp 63-74

[5] Van den Driessche R (1991) Effects of nutrients on stock performance in the forest in van den Driessche R (ed) Mineral Nutrition of Conifer Seedlings. CRS Press, Boca Raton, Boston

[6] Wang D, Bormann FH, Lugo AE, Bowden RD (1991) Comparison of nutrient use efficiency and biomass production in five tropical tree taxa, Forest Ecology and Management. 46, pp 1-21

[7] Weldon CW, Slauson WL, Ward RT (1988) Competition and abiotic stress shrubs in northwest Colorado, Ecology, 69, pp 1566-1577.