International Journal of Environmental & Agriculture Research

www.ijoear.com

ISSN 2454-1850

Volume-9, Issue-2, February 2023

Preface

We would like to present, with great pleasure, the inaugural volume-9, Issue-2, February 2023, of a scholarly journal, *International Journal of Environmental & Agriculture Research*. This journal is part of the AD Publications series *in the field of Environmental & Agriculture Research Development*, and is devoted to the gamut of Environmental & Agriculture issues, from theoretical aspects to application-dependent studies and the validation of emerging technologies.

This journal was envisioned and founded to represent the growing needs of Environmental & Agriculture as an emerging and increasingly vital field, now widely recognized as an integral part of scientific and technical investigations. Its mission is to become a voice of the Environmental & Agriculture community, addressing researchers and practitioners in below areas.

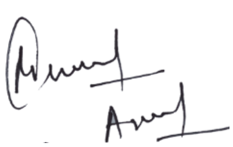
Environmental Research:

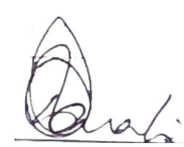
Environmental science and regulation, Ecotoxicology, Environmental health issues, Atmosphere and climate, Terrestric ecosystems, Aquatic ecosystems, Energy and environment, Marine research, Biodiversity, Pharmaceuticals in the environment, Genetically modified organisms, Biotechnology, Risk assessment, Environment society, Agricultural engineering, Animal science, Agronomy, including plant science, theoretical production ecology, horticulture, plant, breeding, plant fertilization, soil science and all field related to Environmental Research.

Agriculture Research:

Agriculture, Biological engineering, including genetic engineering, microbiology, Environmental impacts of agriculture, forestry, Food science, Husbandry, Irrigation and water management, Land use, Waste management and all fields related to Agriculture.

Each article in this issue provides an example of a concrete industrial application or a case study of the presented methodology to amplify the impact of the contribution. We are very thankful to everybody within that community who supported the idea of creating a new Research with *IJOEAR*. We are certain that this issue will be followed by many others, reporting new developments in the Environment and Agriculture Research Science field. This issue would not have been possible without the great support of the Reviewer, Editorial Board members and also with our Advisory Board Members, and we would like to express our sincere thanks to all of them. We would also like to express our gratitude to the editorial staff of AD Publications, who supported us at every stage of the project. It is our hope that this fine collection of articles will be a valuable resource for *IJOEAR* readers and will stimulate further research into the vibrant area of Environmental & Agriculture Research.





Mukesh Arora
(Managing Editor)

Dr. Bhagawan Bharali
(Chief Editor)

Fields of Interests

Agricultural Sciences	
Soil Science	Plant Science
Animal Science	Agricultural Economics
Agricultural Chemistry	Basic biology concepts
Sustainable Natural Resource Utilisation	Management of the Environment
Agricultural Management Practices	Agricultural Technology
Natural Resources	Basic Horticulture
Food System	Irrigation and water management
Crop Production	
Cereals or Basic Grains: Oats, Wheat, Barley, Rye, Triticale, Corn, Sorghum, Millet, Quinoa and Amaranth	Oilseeds: Canola, Rapeseed, Flax, Sunflowers, Corn and Hempseed
Pulse Crops: Peas (all types), field beans, faba beans, lentils, soybeans, peanuts and chickpeas.	Hay and Silage (Forage crop) Production
Vegetable crops or Olericulture: Crops utilized fresh or whole (wholefood crop, no or limited processing, i.e., fresh cut salad); (Lettuce, Cabbage, Carrots, Potatoes, Tomatoes, Herbs, etc.)	Tree Fruit crops: apples, oranges, stone fruit (i.e., peaches, plums, cherries)
Tree Nut crops: Hazlenuts. walnuts, almonds, cashews, pecans	Berry crops: strawberries, blueberries, raspberries
Sugar crops: sugarcane. sugar beets, sorghum	Potatoes varieties and production.
Livestock Production	
Animal husbandry	Ranch
Camel	Yak
Pigs	Sheep
Goats	Poultry
Bees	Dogs
Exotic species	Chicken Growth
Aquaculture	
Fish farm	Shrimp farm
Freshwater prawn farm	Integrated Multi-Trophic Aquaculture
Milk Production (Dairy)	
Dairy goat	Dairy cow
Dairy Sheep	Water Buffalo
Moose milk	Dairy product
Forest Products and Forest management	
Forestry/Silviculture	Agroforestry
Silvopasture	Christmas tree cultivation
Maple syrup	Forestry Growth
Mechanical	
General Farm Machinery	Tillage equipment
Harvesting equipment	Processing equipment
Hay & Silage/Forage equipment	Milking equipment
Hand tools & activities	Stock handling & control equipment
Agricultural buildings	Storage

Agricultural Input Products	
Crop Protection Chemicals	Feed supplements
Chemical based (inorganic) fertilizers	Organic fertilizers
Environmental Science	
Environmental science and regulation	Ecotoxicology
Environmental health issues	Atmosphere and climate
Terrestric ecosystems	Aquatic ecosystems
Energy and environment	Marine research
Biodiversity	Pharmaceuticals in the environment
Genetically modified organisms	Biotechnology
Risk assessment	Environment society
Theoretical production ecology	horticulture
Breeding	plant fertilization

Board Members

Dr. Goswami Tridib Kumar

Presently working as a Professor in IIT Kharagpur from year 2007, He Received PhD degree from IIT Kharagpur in the year of 1987.

Prof. Khalil Cherifi

Professor in Department of Biology at Faculty of Sciences, Agadir, Morocco.

Dr. Josiah Chidiebere Okonkwo

PhD Animal Science/ Biotech (DELSU), PGD Biotechnology (Hebrew University of Jerusalem Senior Lecturer, Department of Animal Science and Technology, Faculty of Agriculture, Nau, AWKA.

Prof. Özhan ŞİMŞEK

Agriculture Faculty, Department of Horticulture, Çukurova University, Adana, 01330 Turkey.

Dr. Anka Ozana Čavlović

Working as Professor in the department of Faculty of Forestry, University of Zagreb, Svetošimunska 25, Zagreb.

Dr. Rakesh Singh

Professor in Department of Agricultural Economics, Institute of Agricultural Sciences, Banaras Hindu University, Also Vice President of Indian Society of Agricultural Economics, Mumbai.

Dr. Sunil Wimalawansa

MD, PhD, MBA, DSc, is a former university professor, Professor of Medicine, Chief of Endocrinology, Metabolism & Nutrition, expert in endocrinology; osteoporosis and metabolic bone disease, vitamin D, and nutrition.

Dr. Ajeet singh Nain

Working as Professor in GBPUA&T, Pantnagar-263145, US Nagar, UK, India.

Dr. Salvinder Singh

Presently working as Associate Professor in the Department of Agricultural Biotechnology in Assam Agricultural University, Jorhat, Assam.

Dr. Salvinder received MacKnight Foundation Fellowship for pre-doc training at WSU, USA – January 2000- March 2002 and DBT overseas Associateship for Post-Doc at WSU, USA – April, 2012 to October, 2012.

Dr. V K Joshi

Professor V.K.Joshi is M.Sc., Ph.D. (Microbiology) from Punjab Agricultural University, Ludhiana and Guru Nanak Dev University, Amritsar, respectively with more than 35 years experience in Fruit Fermentation Technology, Indigenous fermented foods, patulin ,biocolour ,Quality Control and Waste Utilization. Presently, heading the dept. of Food Science and Technology in University of Horticulture and Forestry, Nauni-Solan (HP), India.

Dr. Mahendra Singh Pal

Presently working as Professor in the dept. of Agronomy in G. B. Pant University o Agriculture & Technology, Pantnagar-263145 (Uttarakhand).

Dr. Sanjoy Kumar Bordolui

M.Sc. (Ag.), PhD, FSTA, FSIESRP, Assistant Professor, Department of Seed Science and Technology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia. W.B., India. He received CWSS Young Scientist Award-2016, conferred by Crop and Weed Science Society, received Best Young Faculty Award 2019 conferred by Novel Research Academy, received Innovative Research & Dedicated Teaching Professional Award 2020 conferred by Society of Innovative Educationalist & Scientific Research Professional, Chennai.

Dr.Chiti Agarwal

Dr. Chiti Agarwal works as a postdoctoral associate at the University of Maryland in College Park, Maryland, USA. Her research focuses on fungicide resistance to fungal diseases that affect small fruits such as strawberries. She graduated from North Dakota State University in Fargo, North Dakota, with a B.S. in biotechnology and an M.S. in plant sciences. Dr. Agarwal completed her doctorate in Plant Pathology while working as a research and teaching assistant. During her time as a graduate research assistant, she learned about plant breeding, molecular genetics, quantitative trait locus mapping, genome-wide association analysis, and marker-assisted selection. She wants to engage with researchers from many fields and have a beneficial impact on a larger audience.

DR. Owais Yousuf

Presently working as Assistant professor in the Department of Bioengineering, Integral University-Lucknow, Uttar Pradesh, India.

Dr. Vijay A. Patil

Working as Assistant Research Scientist in Main Rice Research Centre, Navsari Agricultural University, Navsari. Gujarat- 396 450 (India).

Dr. Amit Kumar Maurya

Working asJunior Research Assistantin the Department of Plant Pathology at Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, U.P. India.

Prof. Salil Kumar Tewari

Presently working as Professor in College of Agriculture and Joint Director, Agroforestry Research Centre (AFRC) / Program Coordinator in G.B. Pant University of Agric. & Tech., Pantnagar - 263 145, Uttarakhand (INDIA).

Dr. S. K. Jain

Presently working as Officer Incharge of All India Coordinated Sorghum Improvement Project, S. D. Agricultural University, Deesa, Gujarat.

Dr. Deshmukh Amol Jagannath

Presently working as Assistant Professor in Dept. of Plant Pathology, College of Agriculture polytechnic, NAU, Waghai.

Mr. Anil Kumar

Working as Junior Research Officer/Asstt. Prof. in the dept. of Food Science & Technology in Agriculture & Technology, Pantnagar.

Mr. Jiban Shrestha

Scientist (Plant Breeding & Genetics)

Presently working as Scientist (Plant Breeding and Genetics) at National Maize Research Programme (NMRP), Rampur, Chitwan under Nepal Agricultural Research Council (NARC), Singhdarbar Plaza, Kathmandu, Nepal.

Mr. Aklilu Bajigo Madalcho

Working at Jigjiga University, Ethiopia, as lecturer and researcher at the College of Dry land Agriculture, department of Natural Resources Management.

Mr. Isaac Newton ATIVOR

MPhil. in Entomology, from University of Ghana.

He has extensive knowledge in tree fruit orchard pest management to evaluate insecticides and other control strategies such as use of pheromone traps and biological control to manage insect pests of horticultural crops. He has knowledge in agronomy, plant pathology and other areas in Agriculture which I can use to support any research from production to marketing.

Mr. Bimal Bahadur Kunwar

He received his Master Degree in Botany from Central Department of Botany, T.U., Kirtipur, Nepal. Currently working as consultant to prepare CCA-DRR Plan for Hariyo Ban Program/CARE in Nepal/GONESA.

Table of Contents

Volume-9, Issue-2, February 2023

Effects of Kinetin, Coconut Milk and Calcium Chloride on Biochemical Indices of Boro Rice (*Oryza Sativa* L.) in Presence of Higher Manganese Condition of Acid Soil

Nibedita Basumatary[1], Bhagawan Bharali[2*]

Department of Crop Physiology, Faculty of Agriculture, Assam Agricultural University, Jorhat
*Corresponding Author

Received:- 06 February 2022/ Revised:- 12 February 2022/ Accepted:- 20 February 2022/ Published: 28-02-2023

Abstract— *In North-east India including Assam, available Manganese [Mn^{2+}] in soil is 3- 52 ppm with a critical limit 2-3 ppm. In plants, [Mn^{2+}] is 15-20 ppm g^{-1} dry weight, in excess of which Mn becomes toxic to crop plants (Basumatary et al., 2014). There is a paucity of information on the effects of natural or synthetic plant growth regulating subnstances viz., Cytokinin, Coconut milk and Calcium chloride on amelioration of Mn toxicity of rice crop grown in acid soil condition of Assam. So, a pot experiment was conducted to investigate into the effects of root-dip treatments of rice crop with these substances on biochemical performance of four rice genotypes (Kanaklata, Bishnuprasad, Jyotiprasad and Numoli) cultivated in acid soil enriched with higher Mn (30ppm native Mn plus 20ppm added Mn). At 20 ppm Mn application, there were decreases in total chlorophyll content (14.52%), NR activity (17.77%), Carbohydrate content (3.83%). In contrast, soil treated with 20 ppm Mn as basal at vegetative stage along with the overnight (≈12h) root dip treatments (RDT) of rice varieties with Cytokinin (100ppm), Coconut milk (10 times dilution) and $CaCl_2$ (100ppm), enhenced Cholorophyll a (3-525-19.771%), Chlorophyll b (1.917-19.55%), total chlorophyll contents (4.13-6.35%),) in leaf, NR activity (4.46-10.08%) and carbohydrate content in grain (2.24-10.92%). The variety, Kanaklata was found to be the best based on the biochemical parameters (total Chl:1.861 mg g^{-1} f.w, Chl 'a' (0.924 mg g-1 f.w), Chl 'b' (0.933 mg g-1 f.w), Carbohydrate: 9.202 mg g^{-1}, and [Ca^{2+}] in roots (59.35ppm).*

Keywords— Acid soil, Calcium chloride, Carbohydrate, chlorophyll, Coconut milk, Cytokinin, Manganese, Nitrate reductase.

I. INTRODUCTION

Manganese (Mn) being a micronutrient, at a congenial concentration plays vital roles on growth and development of rice crop cultivated on acidic soil condition. Mn is involved in activating more than 35 enzymes in plants (Mousavi *et al*., 2011), Mn^{2+} along with Ca^{2+} has the power of catalysing the Hill's reaction in the process of photosynthesis (Aref, 2012). Application of Mn especially on older leaves helps in photoassimilation (Agustina, 2011). Because, Mn influences chlorophyll synthesis, and its presence is essential in photosystem II (Diedrick, 2010). However, an excess of Mn^{2+} is toxic for most plants (Millaleo *et al*., 2010). Moreover, Mn^{2+} becomes toxic to all susceptible plants on acid soils in contrast to calcareous soils (high soil pH) and organic soils (Alejandro *et al*., 2020).

Information how the excess Mn^{2+} brings about biochemical changes in upland rice crop grown in acid soil condition of Assam are available (Yomso and Bharali, 2021). Efforts on amelioration of physio-biochemical disorders in Boro rice due to higher Mn^{2+} are lacking. It's known that Cytokinin is involved in cell division, and Calcium is one of the integral components of cell wall and cell membrane in plants (Bharali *et al*., 2015). The hypothesis was that accumulation of root biomass through its proliferation, and maintenance of membrane integrity either directly by adherence of [Ca^{2+}] or indirectly by the action of growth regulating substances impart tolerance to Mn^{2+} toxicity on rice crop in acid soil condition of Assam. Therefore, the present research work was carried out incorporating Cytokinin, Coconut milk and Calcium chloride as root dip treatments of upland (Boro) rice crop in presence of higher Mn in acid soil condition.

II. MATERIALS AND METHODS

A pot experiment (Jan-July, 2021) replicated thrice, laid out in completely randomized design with two factors i.e. Varieties and Treatments, was executed in the department of Crop Physiology, Assam Agricultural University, Jorhat ($26^0$45' N Latitude, $94^0$12' E Longitude having an altitude of 87 meter above mean sea level). The crop growing season was marked by the moderate rainfall (total 30.5 mm), cumulative bright sunshine (38.5 hours), and average RH (87-98%). The soil was acidic in nature, characterised by low pH (4.89 and 5.60), higher Mn contents (26.5 & 30ppm) initially and at harvest of the crop respectively. Twenty five days old seedlings of four rice varieties (Kanaklata, Bishnuprasad, Jyotiprasad and Numoli) were up-rooted, washed the roots gently so that tender roots were not injured but the excess soil debris were removed. Then, the roots were dipped overnight (≈12 hours) in respective solutions viz. $CaCl_2$ (500ppm), Cytokinin (100ppm), Coconut milk (10 times dilution with distilled water) and control (distilled water). These root dip treated seedlings (n= 3 per pot) were transplanted on to pots. N, P and K fertilizers were applied in the form of Urea, Single super phosphate (SSP) and Muriate of Potash (MoP) at the rate of 60:40:40 Kg ha^{-1}. Accordingly, 17.4g Urea (first dose of nitrogen), 66.9g of SSP and 8.9g of MoP were applied as basal, and the rest of the Urea (17.4g) was applied at the maximum tillering of the crop. A persistent irrigation (2-3cm) was given from the time of transplanting of rice seedlings till one week prior to the harvest. Weeding was done manually as and when required. 20 ppm Mn as $MnSO_4.7H_2O$ was applied as basal at vegetative stage. Chlorophyll contents in leaf were estimated by non-maceration, Dimethyl Sulfoxide (DMSO) method (Hiscox and Israelstam,1979). Mn content in shoot at heading stage (≈70DAS) and in grain at harvest was solubilised by digestion with a mixture of sulphuric and nitric acids, and its contents were estimated spectrophotometrically using Methylene Blue method (Beck *et al.*,2006) In vivo nitrate reductase activity was estimated experimentally at 540nm (Thimmaiah, 1999). Total carbohydrate content in grain was estimated following Anthrone method (Hedge *et al*., 1962). Exchangeable [Ca^{2+}] was estimated using the EDTA (Ethelene Diamine Tetra Acetic Acid) method (Jackson, 1973).

III. RESULTS AND DISCUSSION

The soil used in the pots was acidic in nature throughout the experiment. Of course, there was 12.67% increase in soil pH at harvest stage of the crop over the initial soil pH. The exchangeable Mn content in soil varied (26.5-30ppm) during the crop growth stages. So, the Mn status of the soil was medium (Basumatary *et al*., 2014). There were significant variations in total chlorophyll contents in plants due to the treatments with the growth regulating substances. At maximum tillering stage (Table 1a), the highest (1.795 mgg^{-1} fw) total chlorophyll content was recorded in plants treated with 20 ppm Mn plus 100 ppm Cytokinin, and the lowest (1.471 mgg^{-1} fw) was found in plants grown with 20 ppm Mn. On an average, among the genotypes, Kanaklata recorded the highest total chlorophyll content (1.861 mgg^{-1} fw), and the lowest was in Bishnuprasad (1.335 mgg^{-1} fw). At heading stage (Table 1b), too, the highest (1.762mgg^{-1}fw) total chlorophyll content was recorded in plants under 20 ppm Mn plus 100 ppm Cytokinin treatments, and the lowest (1.418mgg^{-1}fw) was estimated in plants treated with 20 ppm $MnSO_4$. The variety Kanaklata recorded the highest total chlorophyll content (1.791 mgg^{-1}fw)>Nomuli (1.671 mgg^{-1}fw). Overall, Jyotiprasad (1.553 mgg^{-1}fw) had the highest, and Bishnuprasad (1.316 mgg^{-1}fw) possessed the lowest total chlorophyll contents. There was decline in total chlorophyll content by (14.06%) at 20 ppm Mn application. However, the plants treated with 20 ppm Mn as basal plus 500 ppm $CaCl_2$ (RDT) (10.90%) had the highest value followed by (>) 20 ppm Mn as basal plus 100 ppm Cytokinin RDT (6.35%)> 20 ppm Mn as basal plus Coconut milk RDT (3.03%).

TABLE 1

EFFECTS OF CYTOKININ, COCONUT MILK AND CALCIUM CHLORIDE ROOT DIP TREATMENT (RDT) ALONG WITH Mn APPLICATION ON TOTAL CHLOROPHYLL (mg g^{-1}f.w.) AT DIFFERENT GROWTH STAGES

(a) Maximum tillering stage							(b) Heading stage					
Treatments → Variety ↓	20 ppm Mnas basal from ($MnSO_4.3H_2O$)	20 ppm added Mn as basal + 100 ppm Cytokinin RDT	20 ppm added Mn as basal + coconut milk (10X dilution) RDT	20 ppm added Mn as basal + 500 ppm $CaCl_2$ RDT	Control (Without addition of 20ppm Mn as basal and without RDT	Mean	20 ppm Mnas basal from ($MnSO_4.3H_2O$)	20 ppm added Mn as basal + 100 ppm Cytokinin RDT	20 ppm added Mn as basal + coconut milk (10X dilution) RDT	20 ppm added Mn as basal + 500 ppm $CaCl_2$ RDT	Control (Without addition of 20ppm Mn as basal and without RDT	Mean
Kanaklata	1.638	2.051	1.897	1.733	1.988	1.861	1.564	1.993	1.874	1.612	1.910	1.791
Bishnuprasad	1.248	1.424	1.348	1.292	1.362	1.335	1.224	1.389	1.344	1.270	1.350	1.316
Jyotiprasad	1.439	1.781	1.572	1.462	1.713	1.593	1.417	1.760	1.550	1.441	1.598	1.553
Nomuli	1.560	1.927	1.674	1.612	1.822	1.7719	1.465	1.905	1.652	1.590	1.743	1.671
Mean	1.471	1.795	1.623	1.525	1.721		1.418	1.762	1.605	1.478	1.650	
	T	**V**	**T X V**				**T**	**V**	**T X V**			
S.Ed (±)	0.024	0.022	0.049				0.023	0.026	0.051			
CD (0.05)	0.049	0.044	0.099				0.046	0.052	0.104			

TABLE 2

EFFECTS OF CYTOKININ, COCONUT MILK AND CALCIUM CHLORIDE ROOT DIP TREATMENT (RDT) ALONG WITH Mn APPLICATION ON CHLOROPHYLL a (mg g^{-1}f.w.) AT DIFFERENT GROWTH STAGES

(a) Maximum tillering stage						(b) Heading stage						
Treatments (T) → Variety (V) ↓	**20 ppm Mnas basal from ($MnSO_4$. $3H_2O$)**	**20 ppm added Mn as basal + 100 ppm Cytokinin RDT**	**20 ppm added Mn as basal + coconut milk (10X dilution) RDT**	**20 ppm added Mn as basal + 500 ppm $CaCl_2$ RDT**	**Control (Without addition of 20ppm Mn as basal and without RDT**	**Mean**	**20 ppm Mnas basal from ($MnSO_4$.3 H_2O)**	**20 ppm added Mn as basal + 100 ppm Cytokini n RDT**	**20 ppm added Mn as basal + coconut milk (10X dilution) RDT**	**20 ppm added Mn as basal + 500 ppm $CaCl_2$ RDT**	**Control (Without addition of 20ppm Mn as basal and without RDT**	**Mean**
Kanaklata	0.817	1.003	0.946	0.863	0.991	0.924	0.799	0.976	0.934	0.851	0.949	0.902
Bishnuprasad	0.621	0.694	0.68	0.643	0.679	0.663	0.608	0.696	0.669	0.634	0.645	0.65
Jyotiprasad	0.717	0.888	0.779	0.729	0.854	0.794	0.705	0.878	0.769	0.718	0.748	0.74
Nomuli	0.778	0.961	0.834	0.803	0.908	0.857	0.695	0.949	0.822	0.792	0.832	0.818
Mean	0.733	0.886	0.810	0.760	0.858		0.702	0.875	0.801	0.749	0.794	
	T	**V**	**T X V**				**T**	**V**	**T X V**			
S.Ed (±)	0.013	0.012	0.026				0.014	0.012	0.028			
CD (0.05)	0.027	0.024	0.054				0.028	0.025	0.057			

At maximum tillering stage (Table 2a), the highest chlorophyll 'a' content was observed under the treatment 20 ppm Mn plus 100 ppm Cytokinin (0.886 $mgg^{-1}fw$)> Control treatment (0.858 $mgg^{-1}fw$) >20 ppm Mn plus Coconut milk (0.81 $mgg^{-1}fw$)>20 ppm Mn plus 500 ppm $CaCl_2$ (0.76 $mgg^{-1}fw$). The lowest chlorophyll 'a' content was recorded in the treatment with 20 ppm Mn application (0.733 $mgg^{-1}fw$). On an average, among the genotypes, Kanaklata recorded the highest chlorophyll 'a' content (0.924 $mgg^{-1}fw$), followed by genotype Nomuli (0.857 $mgg^{-1}fw$)>Jyotiprasad (0.754 $mgg^{-1}fw$), and the lowest of it was observed under the genotype Bishnuprasad (0.663 $mgg^{-1}fw$). At heading stage (Table 2b), the results revealed significant differences in chlorophyll 'a' content among the treatments. There was decrease in chlorophyll 'a' content (11.5%) at 20 ppm Mn application. Chlorophyll 'a' content increased under the treatments 20 ppm Mn as basal plus 100 ppm Cytokinin (RDT) (14.4%)>20 ppm Mn as basal plus 500 ppm $CaCl_2$RDT (5.66%)> 20 ppm Mn as basal plus Coconut milk RDT (0.87%).

At maximum tillering stage (Table 3a), the highest chlorophyll 'b' content was recorded under the treatment 20 ppm Mn plus 100 ppm Cytokinin (0.9$mgg^{-1}fw$)> Control (0.863 $mgg^{-1}fw$)> 20 ppm Mn plus Coconut milk (0.817 $mgg^{-1}fw$)> 20 ppm Mn plus 500 ppm $CaCl_2$ (0.765 $mgg^{-1}fw$). The lowest was observed under the treatment with 20 ppm Mn application (0.739 $mgg^{-1}fw$). At heading stage (Table 3b), the results revealed significant changes in chlorophyll 'b' content among the treatments. There was decrease in chlorophyll 'b' content by (15.36%) at 20 ppm Mn as basal application. There were increrases in Chlorophyll b in plants treated with 20 ppm Mn as basal plus 500 ppm $CaCl_2$RDT (13.7%)>20 ppm Mn as basal plus 100 pm Cytokinin RDT (4.94%)> 20 ppm Mn as basal plus Coconut milk RDT (4.60%).

One of the classical functions of the Cytokinin is the regulation of plastid development, but the underlying molecular mechanisms remain elusive. Cortleven *et al.,* (2016) employed a genetic approach to evaluate the role of Cytokinin and it's signalling pathway in the light-induced development of chloroplasts from etioplasts in Arabidopsis (*Arabidopsis thaliana*). Cytokinin increases the rate of greening and stimulates ultrastructural changes characteristic for the etioplast-to-chloroplast transition. In younger roots, Ca^{2+} is bound between an exchangeable state in the cell walls and the outside of the plasma lemma before rapidly penetrating the apoplast upon adsorption. Exchange adsorption between the apoplast and xylem tissues of whole stems or mass flow caused by transpiration stream are two ways that calcium might enter chloroplasts (Kirby and Pilbeam,1984). It has been demonstrated that Ca^{2+} in leaves reduces the loss of chlorophyll and the degradation of proteins in corn plants (Poovaiah and leopold,1973). Calcium has an anti-senescence effect on plants (Ferguson, 1983). The concentration of chlorophyll, however, rapidly dropped as the length of the growing season increased. Due to its dual purpose, calcium must have a threshold level at which it no longer benefits plants.

At maximum tillering stage (Table 4a), the treatment with 20ppm Mn plus 100 ppm Cytokinin recorded the highest NR activity (1.52)>20 ppm Mn plus Coconut milk (1.43)>control treatment (1.367)> 20 ppm Mn plus 500 ppm $CaCl_2$ (1.318), and the lowest was observed under the treatment with 20 ppm Mn application (1.124). On an average, comparing all varieties, genotype Kanaklata recorded the highest NR activity (1.442), followed by genotype Nomuli (1.435)> Bishnuprasad (1.302), and the lowest was observed in the variety Jyotiprasad (1.229). At heading stage, the highest NR activity was recorded under the treatment 20 ppm Mn plus 100 ppm Cytokinin (1.596)> 20 ppm Mn plus Coconut milk (1.502)> control plants (1.435)>20 ppm Mn plus 500 ppm $CaCl_2$ (1.3840), and the lowest was observed under the treatment 20 ppm Mn (1.155).

The results revealed significant variation in NR activity among the treatments at maximum tillering stage. There was decrease in NR activity by (17.77%) at 20 ppm Mn application as basal. But there was increase in NR activity under treatments 20 ppm Mn as basal plus 100 ppm Cytokinin as RDT (10.66%), 20 ppm Mn as basal plus Coconut milk as RDT (4.40%). There was decrease in NR activity under treatment 20 ppm Mn as basal plus 500 ppm $CaCl_2$as RDT (3.584%).

At Heading stage (Table 4b), the results revealed significant variation in NR activity among the treatments. There was decrease in NR activity (19.51%) at 20 ppm Mn application as basal. The NR activity at heading stage increased under the treatment 20 ppm Mn as basal plus 100 ppm Cytokinin as RDT (10.08%) and under treatment 20 ppm Mn as basal plus Coconut milk as RDT (4.46%). But NR activity decreased under treatment with 20 ppm Mn as basal plus 500 ppm $CaCl_2$ as RDT (3.55%). According to Santos *et al.,* (2014), cereals treated with Cytokinin exhibited a 40% increase in NR activity as compared to control. Hemalatha (2002) studied regulation of NR activity in rice by growth regulator namely Kinetin. The effect of three growth regulators, namely kinetin, 6 benzyl adenine, 2 chloro ethyl trimethyl ammonium chloride at three concentrations (10-6 M, 5 x 10-5 M 10-4 M) was studied on the catalytic activity of NR enzyme in green and etiolated seedlings. A concentration of 5 x 10^{-5} M was optimal for all the growth regulators treatments. All the growth regulators stimulated NR activity effectively at 5 x 10^{-5}M concentration in both etiolated and green seedlings and had an additive effect when supplemented by NO^{-}_3 up to 140% to 160%. There were 99.2% and 93.4% inhibition of NR activity in etiolated and green seedlings, respectively when treated with eukaryotic 80S ribosome protein synthesis inhibitor cycloheximide.

TABLE 3
EFFECTS OF CYTOKININ, COCONUT MILK AND CALCIUM CHLORIDE ROOT DIP TREATMENT (RDT) ALONG WITH Mn APPLICATION ON CHLOROPHYLL b (mg g^{-1}f.w.) AT DIFFERENT GROWTH STAGES

(a) Maximum tillering stage							(b) Heading stage					
Treatments (T) → Variety (V) ↓	**20 ppm Mnas basal from ($MnSO_4$.3 H_2O)**	**20 ppm added Mn as basal + 100 ppm Cytokinin RDT**	**20 ppm added Mn as basal + coconut milk (10X dilution) RDT**	**20 ppm added Mn as basal + 500 ppm $CaCl_2$ RDT**	**Control (Without addition of 20ppm Mn as basal and without RDT**	**Mean**	**20 ppm Mnas basal from ($MnSO_4$.3 H_2O)**	**20 ppm added Mn as basal + 100 ppm Cytokini n RDT**	**20 ppm added Mn as basal + coconut milk (10X dilution) RDT**	**20 ppm added Mn as basal + 500 ppm $CaCl_2$ RDT**	**Control (Without addition of 20ppm Mn as basal and without RDT**	**Mean**
Kanaklata	0.822	1.028	0.951	0.87	0.996	0.933	0.765	1.017	0.941	0.76	0.96	0.889
Bishnuprasad	0.627	0.714	0.685	0.648	0.683	0.672	0.617	0.704	0.675	0.637	0.671	0.661
Jyotiprasad	0.723	0.893	0.790	0.733	0.860	0.800	0.712	0.882	0.791	0.723	0.849	0.789
Nomuli	0.783	0.966	0.841	0.809	0.914	0.863	0.768	0.956	0.831	0.798	0.904	0.852
Mean	0.739	0.900	0.817	0.765	0.863		0.716	0.890	0.807	0.730	0.846	
	T	**V**	**T X V**				**T**	**V**	**T X V**			
S.Ed (±)	0.012	0.011	0.038				0.019	0.017	0.038			
CD (0.05)	0.024	0.022	0.024				0.039	0.035	0.078			

TABLE 4
EFFECTS OF CYTOKININ, COCONUT MILK AND CALCIUM CHLORIDE ROOT DIP TREATMENT (RDT) ALONG WITH Mn APPLICATION ON NR ACTIVITY (µmole NO_3^- g^{-1} fw hr$^{-1)}$ AT DIFFERENT GROWTH STAGES

(a) Maximum tillering stage						(b) Heading stage						
Treatments (T) → Variety (V) ↓	**20 ppm Mnas basal from ($MnSO_4$.3 H_2O)**	**20 ppm added Mn as basal + 100 ppm Cytokinin RDT**	**20 ppm added Mn as basal + coconut milk (10X dilution) RDT**	**20 ppm added Mn as basal + 500 ppm $CaCl_2$ RDT**	**Control (Without addition of 20ppm Mn as basal and without RDT**	**Mean**	**20 ppm Mnas basal from ($MnSO_4$.3 H_2O)**	**20 ppm added Mn as basal + 100 ppm Cytokini n RDT**	**20 ppm added Mn as basal + coconut milk (10X dilution) RDT**	**20 ppm added Mn as basal + 500 ppm $CaCl_2$ RDT**	**Control (Without addition of 20ppm Mn as basal and without RDT**	**Mean**
Kanaklata	1.099	1.649	1.562	1.447	1.452	1.442	1.154	1.731	1.639	1.519	1.525	1.513
Bishnuprasad	1.050	1.452	1.367	1.274	1.369	1.302	1.102	1.525	1.435	1.338	1.437	1.367
Jyotiprasad	1.062	1.364	1.244	1.160	1.316	1.229	1.115	1.432	1.305	1.217	1.382	1.29
Nomuli	1.285	1.616	1.550	1.393	1.331	1.435	1.249	1.696	1.627	1.462	1.397	1.486
Mean	1.124	1.520	1.430	1.318	1.367		1.155	1.596	1.502	1.384	1.435	
	T	**V**	**T X V**				**T**	**V**	**T X V**			
S.Ed (±)	0.015	0.013	0.029				0.025	0.022	0.05			
CD (0.05)	0.030	0.027	0.060				0.051	0.045	0.101			

TABLE 5
CYTOKININ, COCONUT MILK AND CALCIUM CHLORIDE ROOT DIP TREATMENT (RDT) ALONG WITH Mn APPLICATION ON CARBOHYDRATE CONTENT IN GRAINS AT HARVEST

Carbohydrate content ($mgg^{-1}dw$)						
Treatment → / Variety ↓	20 ppm Mnas basal from ($MnSO_4.3H_2O$)	20 ppm added Mn as basal + 100 ppm Cytokinin RDT	20 ppm added Mn as basal + coconut milk (10X dilution) RDT	20 ppm added Mn as basal + 500 ppm $CaCl_2$ RDT	Control (Without addition of 20ppm Mn as basal and without RDT	Mean
Kanaklata	8.800	9.620	9.290	9.110	9.120	9.202
Bishnuprasad	4.600	6.780	5.670	5.400	4.890	5.470
Jyotiprasad	8.310	9.240	8.870	8.540	8.720	8.740
Nomuli	8.360	9.510	9.100	8.900	8.500	8.901
Mean	7.530	8.790	8.230	8.010	7.830	
	Treatment	**Variety**	**T X V**			
S.Ed (±)	0.091	0.082	0.182			
CD (0.05)	0.185	0.166	0.370			

The highest carbohydrate content in grain (Table 5) was observed in treatment 20ppm Mn^{2+} plus 100 ppm Cytokinin (8.79)>20ppm Mn + Coconut milk (zeatin):10X dilution (8.23)>20 ppm Mn application (7.83)>20 ppm Mn + 500 ppm $CaCl_2$ (8.01). The lowest carbohydrate content was recorded under control treatment (7.53). On an average, among the rice varieties, the highest amount of carbohydrate content was recorded in the genotype Kanaklata (9.202)>Nomuli (8.901)> Jyotiprasad (8.738), and the least carbohydrate content was recorded in the genotype Bishnuprasad (5.47). Overall, there was higher carbohydrate content in grain in varieties under treatment of 20ppm Mn plus 100 ppm Cytokinin as compared to other treatments. The results revealed significant changes in carbohydrate content among the treatments. As compared to control, there was decrease in carbohydrate content by (3.03%) under 20 ppm Mn as basal treatment. On the otherhand, at RDT with the plant growth regulating substances along with the basal Mn enhenced the carbohydrate content in grains *viz.* 20 ppm Mn plus 100 ppm Cytokinin (10.92%), 20 ppm Mn plus Coconut milk (4.86%) and 20 ppm Mn plus 500 ppm $CaCl_2$ (2.24%). Leaf photosynthesis regulating the production of carbohydrate, accounts for most of the variations in biomass production and yield (Yoshida and Horie 2009; Evans, 1993; Sinclair *et al.,* 2004). Recent studies indicate that growth rate around heading stage is critically related with final yield in rice (Takai *et al.*,2006; Horie *et al.*, 2006). Cytokinins play a key role in preserving the structure and function of the photosynthetic machinery under stress conditions (Cherniad'ev, 2009). Cytokinin increases sink activities by stimulating assimilate accumulation in chloroplasts of older leaves (Criado *et al.*, 2009). Cytokinin has roles in the biosynthesis of Chlorolphyll, stimulation of tetrapyrole biosynthesis, chloroplast transcription (Zubo *et al.*, 2008), and enhancement of photosynthetic efficiency (Yaronskaya *et al.,* 2006).

The highest [Mn] in grain (Table 6a) was found in treatment 20 ppm Mn (103.58)>20 ppm Mn plus 100 ppm Cytokinin (89.47ppm) >20 ppm Mn plus coconut milk (84.81) :10x dilution>20 ppm Mn application plus 500 ppm $CaCl_2$, and the lowest (17.39) was in controlled plants. On an average among genotypes, the highest [Mn] was observed in the genotype Kanaklata (88.442) > Nomuli (80.494), and the lowest was observed in the variety Bishnuprasad (62.116) > Jyotiprasad (68.604). The results revealed significant variations of [Mn] in grains among the treatments (Table 6a). There was increase in [Mn] in grains with all the treatments *viz.* 20 ppm Mn treatment as basal (83.2%), and in treatments with RDT with the plant growth regulating substances along with Mn as basal 20 ppm Mn plus 100 ppm Cytokinin (80.56%), 20 ppm Mn plus Coconut milk (79.49%) and 20 ppm Mn plus 500 ppm $CaCl_2$ (78.13%).

At maximum tillering stage, the highest [Ca^{2+}] in plant roots (Table 6b) was observed in the treatment with 20 ppm Mn plus 500 ppm $CaCl_2$ (89.75ppm)>20 ppm Mn plus 100 ppm Cytokinin (67.22ppm)>treatment with 20 ppm Mn plus Coconut milk (63.395ppm)> 20 ppm Mn application (32.9ppm), and the lowest [Ca^{2+}] in plant roots was observed under the control treatment (22.975ppm). On an average, among the genotypes, the highest [Ca^{2+}] in plant roots was observed in the variety Kanaklata (59.35ppm)>Nomuli (56.093ppm)> Jyotiprasad (54.575), and the least [Ca^{2+}] in plant roots was presented by the variety Bishnuprasad (50.975ppm). The result revealed significant variations in [Ca^{2+}] in roots at maximum tillering stage. There was increase in [Ca^{2+}] in roots with all the treatments *viz.* 20 ppm Mn treatment (28.34%) as basal and at RDT with PGRS along with basal Mn 20 ppm Mn plus 100 ppm Cytokinin (65.82%), 20 ppm Mn plus Coconut milk (63.75%) and 20 ppm Mn plus 500 ppm $CaCl_2$ (74.40%).

TABLE 6
EFFECTS OF CYTOKININ, COCONUT MILK AND CALCIUM CHLORIDE ROOT DIP TREATMENT (RDT) ALONG WITH MN APPLICATION ON Mn CONTENT IN GRAIN AT HARVEST AND Ca^{2+} CONTENT IN ROOTS (ppm) AT MAXIMUM TILLERING STAGE

(a) Mn^{2+} content (ppm) in grain							(b) Ca^{2+} content (ppm) in roots					
Treatments (T) → Variety (V) ↓	**20 ppm Mnas basal from ($MnSO_4.3H_2O$)**	**20 ppm added Mn as basal + 100 ppm Cytokinin RDT**	**20 ppm added Mn as basal + coconut milk (10X dilution) RDT**	**20 ppm added Mn as basal + 500 ppm $CaCl_2$ RDT**	**Control (Without addition of 20ppm Mn as basal and without RDT**	**Mean**	**20 ppm Mnas basal from ($MnSO_4.3H_2O$)**	**20 ppm added Mn as basal + 100 ppm Cytokinin RDT**	**20 ppm added Mn as basal + coconut milk (10X dilution) RDT**	**20 ppm added Mn as basal + 500 ppm $CaCl_2$ RDT**	**Control (Without addition of 20ppm Mn as basal and without RDT**	**Mean**
Kanaklata	127.500	102.200	100.100	95.200	17.210	88.442	36.633	72.000	68.847	93.930	25.330	59.350
Bishnuprasad	80.030	75.600	71.420	68.500	15.030	62.116	28.567	62.880	57.930	85.360	20.133	50.975
Jyotiprasad	85.900	86.710	80.200	72.800	18.410	68.604	34.100	66.067	62.133	88.540	22.033	54.575
Nomuli	120.900	93.400	87.530	81.710	18.930	80.494	32.300	67.933	64.667	91.167	24.400	56.093
Mean	103.580	89.470	84.810	79.550	17.390		32.900	67.220	63.395	89.750	22.975	
	T	**V**	**T X V**				**Treatment**	**Variety**	**T X V**			
S.Ed (±)	0.973	0.871	1.947				0.324	0.290	0.648			
CD (0.05)	0.420	0.324	1.234				0.658	0.588	1.315			

TABLE 7

EFFECTS OF CYTOKININ, COCONUT MILK AND CALCIUM CHLORIDE ROOT DIP TREATMENT (RDT) ALONG WITH Mn APPLICATION ON Ca^{2+} CONTENTS IN ROOTS (ppm) AT HEADING AND HARVEST STAGES

(a) Ca^{2+} content (ppm) at Heading stage							(b) Ca^{2+} content (ppm) at harvest stage					
Treatments (T) → Variety (V) ↓	**20 ppm Mnas basal from ($MnSO_4.3H_2O$)**	**20 ppm added Mn as basal + 100 ppm Cytokinin RDT**	**20 ppm added Mn as basal + coconut milk (10X dilution) RDT**	**20 ppm added Mn as basal + 500 ppm $CaCl_2$ RDT**	**Control (Without addition of 20ppm Mn as basal and without RDT**	**Mean**	**20 ppm Mnas basal from ($MnSO_4.3H_2O$)**	**20 ppm added Mn as basal + 100 ppm Cytokinin RDT**	**20 ppm added Mn as basal + coconut milk (10X dilution) RDT**	**20 ppm added Mn as basal + 500 ppm $CaCl_2$ RDT**	**Control (Without addition of 20ppm Mn as basal and without RDT**	**Mean**
Kanaklata	31.733	65.667	61.633	90.687	22.380	54.420	30.133	61.617	56.367	84.030	18.400	50.11
Bishnuprasad	24.900	58.633	54.600	82.843	18.133	47.822	22.300	54.800	51.76	77.967	14.700	44.307
Jyotiprasad	28.600	61.400	58.367	84.970	19.850	50.637	25.8	56.963	53.067	81.467	17.00	46.859
Nomuli	29.900	63.730	61.133	87.317	22.113	52.839	27.133	59.033	54.707	83.133	18.733	48.56
Mean	28.783	62.358	58.933	86.454	20.618		26.342	58.103	53.992	81.65	17.208	
	Treatment	**Variety**	**T X V**				**Treatment**	**Variety**	**T X V**			
S.Ed (±)	0.354	0.316	0.707				0.389	0.348	0.778			
CD (0.05)	0.717	0.642	1.435				0.789	0.766	1.578			

At heading stage (Table 7a), the maximum [Ca^{2+}] in plant roots was recorded under the treatment 20 ppm Mn plus 500 ppm $CaCl_2$ (86.454ppm)> 20 ppm Mn plus 100 ppm Cytokinin (62.358ppm)>20 ppm Mn plus Coconut milk (zeatin) (58.933ppm)>20 ppm Mn application (28.783ppm), and the lowest [Ca^{2+}] in roots were observed in the control treatment (20.618ppm). On an average, among the genotypes, the genotype Kanaklata recorded the highest [Ca^{2+}] in plant roots (54.42ppm)>Nomuli (52.839ppm)> Jyotiprasad (50.637ppm), and the least [Ca^{2+}] in plant roots was observed in the variety Bishnuprasad (47.822ppm). At heading stage, the results revealed significant variations of [Ca^{2+}]. There was increase in [Ca^{2+}] in roots with all the treatments *viz.* 20 ppm Mn as basal (28.36%) and at RDT with PGRS along with basal Mn 20 ppm Mn plus 100 ppm Cytokinin (66.93%), 20 ppm Mn plus Coconut milk (65.01%) and 20 ppm Mn plus 500 ppm $CaCl_2$ (76.15%).

At the time of harvest (Table 7b), the highest [Ca^{2+}] in plant roots was observed under the treatment 20 ppm Mn plus 500 ppm $CaCl_2$ (81.65ppm)>20 ppm Mn plus 100 ppm Cytokinin (58.103ppm)>treatment 20 ppm Mn plus Coconut milk (53.992ppm)>20ppm Mn application (26.342ppm), and the lowest [Ca^{2+}] was observed under the Control treatment (17.208ppm). At harvest stage, [Ca^{2+}] in roots varied significantly. There was increase in [Ca^{2+}] in roots with all the treatments *viz.* 20 ppm Mn treatment as basal (34.67%), and at RDT along with basal Mn and the growth regulating substances *viz.*20 ppm Mn plus 100 ppm Cytokinin (70.38%), 20 ppm Mn plus Coconut milk (68.128%) and 20 ppm Mn plus 500 pm $CaCl_2$ (78.92%).

Sharma (2002) reported that there were substantial increases in [Ca^{2+}] by 55-97% in the roots after root dip treatments in a pot experiment. The increment was proportional to the increase in the $CaCl_2$ concentration (100-1000 ppm) in the treatment. Sharma (2002) also reported that [Ca^{2+}] in all parts e.g., pods, leaves, stems and roots increased in commensuration with $CaCl_2$ supply.

Ca^{2+} is an important nutrient for root development (White and Broadly, 2003; Mengel and Kirby, 1982; Sharma, 2002). Other way, Ca^{2+} protects membrane from free radical or peroxidative break down when only a large amount of Ca^{2+} binding is present in membranes. Ca^{2+} aids packing of lipids and brings about their aggregation (Ohishi and Ito, 1974). Ca^{2+} bridges membranes by phosphate and COOH- groups to maintain its permeability (Legge *et al.*,1984; Epstein, 1992; Bharali and Bates, 2014; Bharali et al., 2015). Thus, the study enlightened the actions of Cytokinin (i.e. enhancement of root biomass) and Calcium (probably, the membrane stability) which are regarded as the features of the tolerance of rice crops under higher [Mn] in acid soil situation.

ACKNOWLEDGEMENTS

The authors remain grateful to Dr. Ranjan Das, Professor (Crop Physiology), Dr. Khagen Kurmi, Professor (Agronomy) and Dr. Raju Prasad Paswan, Professor and Head (Agricultural Statistics), Faculty of Agriculture, Assam Agricultural University (AAU), Jorhat for their valuable inputs during the course of Masters' research. All helps received from AAU, Jorhat, are duly acknowledged.

REFERENCES

[1] Agustina, L. (2011). Micro nutrients I (Fe, Mn, Zn, Cu, B, Mo and Cl) importance of nutrient deficiency and toxicity. *Post-Graduate Program University of Brawijaya. Malang*, 25-32.

[2] Alejandro, S., Höller, S., Meier, B., and Peiter, E. (2020). Manganese in plants: from acquisition to subcellular allocation. *Frontiers in Plant Science*, ***11***: 300.

[3] Aref, F. (2012). Manganese, iron and copper contents in leaves of maize plants (*Zea mays* L.) grown with different boron and zinc micronutrients. *African Journal of Biotechnology*, ***11*** (4): 896-903.

[4] Basumatary, A., Rashmi, B., and Medhi, B. K. (2014). Spatial variability of fertility status of soils of upper Brahmaputra valley zone of Assam. *Asian Journal of Soil Science*, ***9*** (1): 142-148.

[5] Beck, H. P., Kostova, D., and Zhang, B. (2006). Determination of manganese with methylene blue in various vegetable crops. *Agronomy Research*, ***4*** (2) :493-498.

[6] Bharali, B. and J.W. Bates, (2014) Influences of extracellular calcium and iron on membrane sensitivity to bisulphite in the mosses *Pleurozium schreberi* and Rhytidiadelphustriquetrus. *Journal of Bryology*. **26** (1): 53-59.

[7] Bharali, B., Haloi, B., Chutia, J., Chack, S., and Hazarika, K. (2015). Susceptibility of some wheat (Triticum aestivum L.) varieties to aerosols of oxidised and reduced nitrogen. *Adv. Crop Sci. Technol*, ***3*** (4).

[8] Chernyad'ev, I. I. (2009). The protective action of cytokinins on the photosynthetic machinery and productivity of plants under stress. *Applied Biochemistry and Microbiology*, ***45*** (4): 351-362.

[9] Cortleven, A., Marg, I., Yamburenko, M. V., Schlicke, H., Hill, K., Grimm, B., ... and Schmülling, T. (2016). Cytokinin regulates the etioplast-chloroplast transition through the two-component signaling system and activation of chloroplast-related genes. *Plant Physiology*, ***172*** (1): 464-478.

[10] Criado, M. V., Caputo, C., Roberts, I. N., Castro, M. A., and Barneix, A. J. (2009). Cytokinin-induced changes of nitrogen remobilization and chloroplast ultrastructure in wheat (*Triticum aestivum L*). *Journal of Plant Physiology*, ***166*** (16): 1775-1785.

[11] Diedrick, K. (2010). Manganese fertility in soybean production. *Pioneer Hi-Bred agronomy sciences*, ***20*** (14): 23-28.

[12] Epstein, E. (1972). *Mineral nutrition of plants: principles and perspectives*. John Wiley &Sons,Inc.,605 Third Ave.New York, N.Y.1006. 412:http://doi.org/10.2136/sssaj1972.03615995000360004 0012x.

[13] Evans, L. T. (1993). Crop evolution, adaptation and yield, (Cambridge University Press: New York).

[14] Ferguson, I. B., Watkins, C. B., and Harman, J. E. (1983). Inhibition by calcium of senescence of detached cucumber cotyledons: effect on ethylene and hydroperoxide production. *Plant physiology*, ***71*** (1): 182-186.

[15] Hiscox, J. D., & Israelstam, G. F. (1979). A method for the extraction of chlorophyll from leaf tissue without maceration. *Canadian journal of botany*, ***57*** (12): 1332-1334.

[16] Hedge, J. E., and Hofreiter, B. T. (1962). Determination of total carbohydrate by anthrone method. *Methods in carbohydrate chemistry*, *17*.

[17] Hemalatha, S. (2002) Regulation of nitrate reductase activity in rice (*Oryza sativa* L.) by growth regulators. *Journal of Central European Agriculture*.3(3):231-238.

[18] Horie, T., Matsuura, S., Takai, T., Kuwasaki, K., Ohsumi, A., and Shiraiwa, T. (2006). Genotypic difference in canopy diffusive conductance measured by a new remote-sensing method and its association with the difference in rice yield potential. *Plant, Cell and Environment*, ***29*** (4): 653-660.

[19] Jackson, M. L. (1973). Soil chemical analysis, pentice hall of India Pvt. *Ltd., New Delhi, India*, ***498***: 151-154.

[20] Kirkby, E. A., and Pilbeam, D. J. (1984). Calcium as a plant nutrient. *Plant, Cell and Environment*, ***7*** (6): 397-405.

[21] Legge, R. L., Thompson, J. E., Baker, J. E., and Lieberman, M. (1982). The effect of calcium on the fluidity and phase properties of microsomal membranes isolated from postclimacteric Golden Delicious apples. *Plant and Cell Physiology*, **23** (2): 161-169

[22] Mengel, K., and Kirby, E. (1987). Principles of crop nutrition. *International Potash Institute. Berna, Suiza*.

[23] Millaleo, R., Reyes-Díaz, M., Ivanov, A. G., Mora, M. L., and Alberdi, M. (2010). Manganese as essential and toxic element for plants: transport, accumulation and resistance mechanisms. *Journal of soil science and plant nutrition*, ***10*** (4): 470-481.

[24] Mousavi, S. R., Shahsavari, M., and Rezaei, M. (2011). A general overview on manganese (Mn) importance for crops production. *Australian Journal of Basic and Applied Sciences*, ***5*** (9): 1799-1803.

[25] Ohnishi, S., and Ito, T. (1974). Calcium-induced phase separations in phosphatidylserine-phosphatidylcholine membranes. *Biochemistry*, ***13*** (5): 881-887.

[26] Poovaiah, B. W., and Leopold, A. C. (1973). Deferral of leaf senescence with calcium. *Plant Physiology*, ***52*** (3): 236-239.

[27] Santos, CLR, Cazetta JO, Saran LM, and Sanches A (2014) Otimização da análise da atividade da redutase do nitrato e sua caracterização em folhas de canade-açúcar. Pesqui Agropecu Bras, **49**:384–394

[28] Sharma, S. K., Petrusevski, B., & Schippers, J. C. (2002). Characterisation of coated sand from iron removal plants. *Water Science and Technology: Water Supply*, ***2*** (2): 247-257.

[29] Sinclair, T. R., Purcell, L. C., and Sneller, C. H. (2004). Crop transformation and the challenge to increase yield potential. Trends in plant science, **9** (2): 70-75.

[30] Takai, T., Matsuura, S., Nishio, T., Ohsumi, A., Shiraiwa, T., and Horie, T. (2006). Rice yield potential is closely related to crop growth rate during late reproductive period. *Field Crops Research*, ***96*** (2-3): 328-335.

[31] Thimmaiah, S. K. (1999). Methods of biochemical analysis: carbohydrates. *Standard methods of biochemical analysis. Kalyani publishers, Noida*, 49-77.

[32] White, P. J., and Broadley, M. R. (2003). Calcium in plants. *Annals of botany*, ***92*** (4): 487-511.

[33] Yaronskaya, E., Vershilovskaya, I., Poers, Y., Alawady, A. E., Averina, N., and Grimm, B. (2006). Cytokinin effects on tetrapyrrole biosynthesis and photosynthetic activity in barley seedlings. *Planta*, ***224*** (3): 700-709.

[34] Yomso, A., and Bharali, B. (2021). Effects of Manganese on Some Biochemical Indices of Rice (*Oryza sativa* L.) Crop in Acid Soil Condition. *Ind. J. Pure App. Biosci*, ***9*** (2): 103-114.

[35] Yoshida, H., and Horie, T. (2009). A process model for explaining genotypic and environmental variation in growth and yield of rice based on measured plant N accumulation. *Field Crops Research*, ***113*** (3): 227-237.

[36] Zubo, Y. O., Yamburenko, M. V., Selivankina, S. Y., Shakirova, F. M., Avalbaev, A. M., Kudryakova, N. V., and Börner, T. (2008). Cytokinin stimulates chloroplast transcription in detached barley leaves. *Plant Physiology*, ***148*** (2): 1082-1093.

Land Resource Inventory: A Primary Tool for Sustainable Integrated Watershed Management

Shreyasi Gupta Choudhury[1], Tapati Banerjee[2]

Regional Centre, Kolkata, ICAR-National Bureau of Soil Survey and Land Use Planning, Kolkata-700091
*Corresponding Author

Received:- 08 February 2022/ Revised:- 15 February 2022/ Accepted:- 21 February 2022/ Published: 28-02-2023

Abstract— *Land, the most indispensable natural resource has been facing challenges of soil degradation, water scarcity, reduced productivity, climate change, social deterioration etc. In these consequences, the rainfed areas might get the priority to develop because of its area coverage in India and great potentiality towards crop yields increment through improved resource management practices. Rainfed areas can best be managed through integrated watershed management approach involving human intervention in manipulating natural resources for overall societal development. Land resource inventory (LRI) is the first and primary step followed by planning, implementation, monitoring and evaluation in the watershed management programme. We surveyed and studied Dwarkeshwar microwatershed in Puruliya district of West Bengal for land resource inventory at 1:3960 scale considering soil, parent material, existing land use, physiography, climate and vegetation. Nine soil series and ten physiographic units were identified and mapped. Considering the above parameters with the existing socio-economic status and need, a management unit map regarding land use planning has been developed for further use as a primary tool for implementation purpose.*

Keywords— Land resource inventory, Watershed management, Geospatial technique, Purulia district, landuse.

I. INTRODUCTION

The judicious use of irreproducible natural resources acts as the most sensitive indicators of societal economic growth, development, resilience and empowerment. Land is the most indispensable natural resource consisting of soil, water, natural flora and fauna involving the ecosystem component. The ever-shrinking land resources and the decreasing trend of productivity might increase the probability of getting attention towards rainfed areas. India's 60% land is under rainfed condition which is characterized by poor soil health, water scarcity, land degradation, low input use and productivity. Still, these areas have huge potential for enhancing crop yield through improved resource management practices. To address the multiple issues of environmental, ecological, agricultural, geological aspects and other related natural resources, there is an imperative need of site-specific information and situation specific recommendations. The unavailability of site-specific soil and land information along with the recommendation at farm level might have been forming the hurdles towards the success of many developmental schemes around the country. This wide gap could have been filled with systematic land resource inventory at large scale and its subsequent mapping using geo-spatial techniques. Watershed approach has been recognized as a vital landmark in the direction of bringing visible benefits in rainfed areas, while attracting people's participation in watershed programme (Saxena and Prasad 2008) for the improvement and sustainability of agricultural and allied sectors for overall community development. The rainfed areas could be brought under the limelight of developmental and climate resilient agricultural practices through integrated watershed management programmes involving the process of human interventions in maneuvering natural resources for the overall societal upliftment under the natural boundary of watershed (Vittala et al 2008). A sustainable integrated watershed management programme includes three steps namely- land resource inventory, land use planning and implementation, monitoring and evaluation. The most basic and initial tool is land resource inventory without which precisely, the other following steps would seem to be futile in true sense. The detailed land resource inventory (LRI) at large scale can only discover the necessary soil and land information, which will be further exploited for subsequent agricultural land use planning and implementation purpose at watershed level. Simultaneously, the evaluation of the suitability of land for remunerative kinds of use requires a detailed natural resource survey to define and map the land units together with the collection of descriptive database of land characteristics and resources like soil, rock, climate, slope, erosion, landform, vegetation and socio-economic status as follows-

Soil Survey- For farm level land use planning in a watershed, a detailed soil survey at cadastral level is the primary need. Different soil series existing in different physiography might have a relationship with land use changes. Identification of soil series, delineation of soil boundaries and its mapping will assess the potential of the soils for increased and profitable agricultural production for societal sustenance.

Rock identification- The rock type has an influence on soil type and formation, surface stability and land use of any site. The existing rock type has to be surveyed for parent material identification, genesis and characterization of soils. Even the identification and delineation of lineament also helps to find out the underground source of water.

Climate-Climate plays a major role in land use potentiality assessment. Climatic data indicates the suitability of the existing land/ soil for agricultural/ horticultural/ pastoral cropping or forestry/ plantation use. It has a direct influence on soil formation processes, surface erosion, which are indicators of fertility and productivity of the system. The different climatic components like maximum and minimum temperature, rainfall, evapo-transpiration etc. are to be collected and considered while doing the survey work for having a sustainable land use plan.

Physiography– the physiographic delineation with elevation, slope gradients and aspect, erosional and depositional phases for each surface features are the basic components for soil characterization followed by future land use planning. It is to be measured through DEM analysis in GIS platform followed by field observation and ground checking.

Vegetation - Existing land use and vegetation are the essential components for preparing soil-based land use model for future land use planning. Vegetation is a good indicator of temporal land use changes and is to be derived from field survey and correlated with satellite imagery. The existing vegetative cover and land use often integrated with soil survey database to produce sustainable land use plan.

Socio-economic survey – the existing social status, norms, faiths and need of the villagers are the steering factor for a successful watershed management programme. A thorough survey of the socio-economic condition, future need and the villagers view towards acceptance of the changes in the pathway of development has to be acquired with their active participation for economic development and employment generation as well during the land resource inventory process.

The procedures of a land resource inventory within a watershed boundary contains checklist of thematic data that might be required in land evaluation. This approach allows the user to protect and conserve soil, water and other biotic resources with a rational planning process to combat the societal degradation and climate change.

II. A CASE STUDY FOR LAND RESOURCE INVENTORY

Considering the above facts, the Dwarkeshwar microwatershed has been surveyed and studied for land resource inventory in the eastern fringe of Chhotonagpur plateau consisting of three villages namely Parasibona, Batabathan and Kalaboni of Hura block in Puruliya district, West Bengal (Bhattacharya et al 1985). The microwatershed is characterised by high temperature with high variability of monsoon rainfall. The average normal climatic parameters (rainfall, potential evapo-transpiration, maximum and minimum temperature) were considered while doing the land resource inventory. It was observed that the average monthly rainfall for the last thirty years was 11.3 cm, while potential evapo-transpiration (PET) was 18.6% higher than rainfall with an aridity index 0.16, which categorized the area under dry sub-humid zone in eastern India. The observed mean annual normal maximum and minimum temperatures were 31.9 °C and 20.9 °C, with the highest rise in the month of June having 37 °C and 26 °C, respectively (Figure 1). Agriculture is the dominant livelihood option with monocrop paddy having an average yield of 1.8 to 2.0 t ha^{-1}. During land resource inventory, detailed work was carried out on landform, land use analysis followed by detailed soil survey at 1:3960 scale. Nine soil series with phases were identified and mapped in fourteen units on ten physiographic units developed over granite-gneissic formation (Figure 2). Land capability and suitability analyses of rice, wheat, maize, mustard, groundnut, cowpea, pigeon pea and sabai grass were done for the area with a focus on the application of the principles of sustainable development in order to maximize the benefits derived by the farmers from the existing resources of land and water through utilizing them in a scientific manner. Considering this, a management unit map (Figure 3) has been developed based on derived resource information of the microwatershed for implementation purpose. Even the base flow of water through the lineament in the Tilaboni hill and existing water structures at the upper reaches and their utilisation to irrigate the cultivated lands in the lower reaches were also explored in the microwatershed. Thus, land resource inventory has been admitted to be a primary tool for developing management units suggesting rational and scientific land use plan, which could be further utilized for implementation, monitoring and evaluation of the watershed management programme.

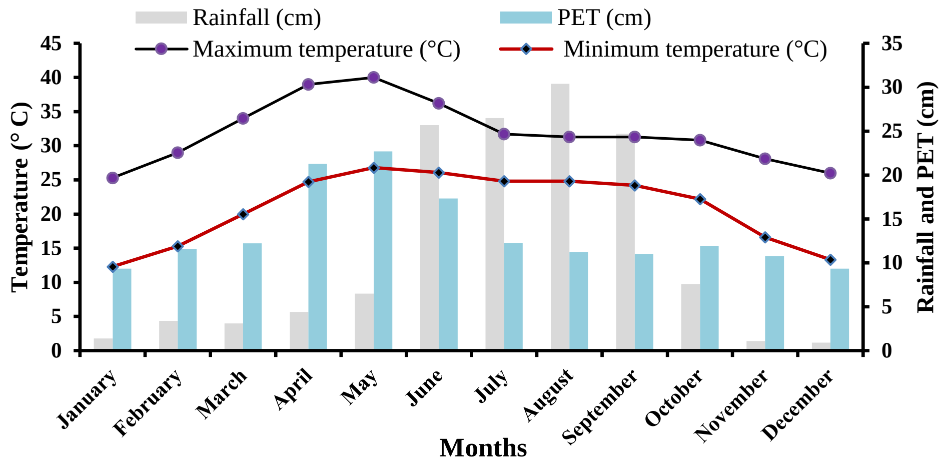


FIGURE 1: The normal monthly average temperature, rainfall, potential evapo-transpiration of the site

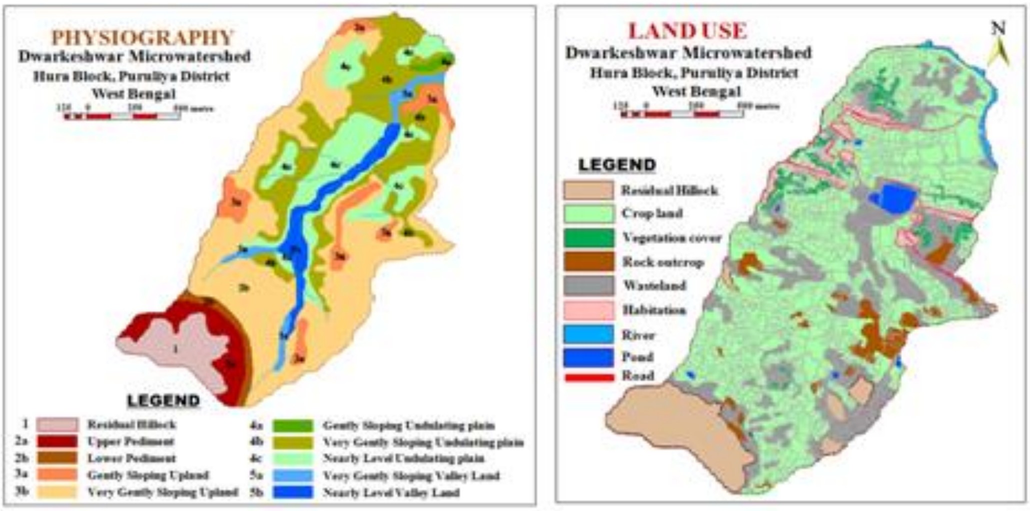


FIGURE 2: Physiography and land use maps for the Dwarkeshwar microwatershed

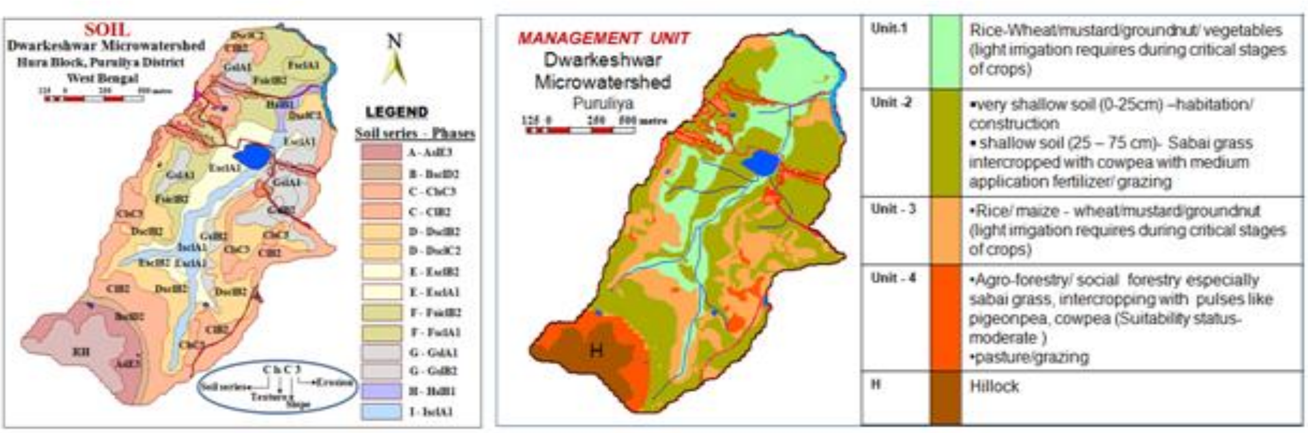


FIGURE 3: Soil and management unit maps for the Dwarkeshwar microwatershed

Although, watershed management has evolved long back, and passed through several developmental stages, but, initially, it only dealt with forestry related hydrology without any active involvement of people. With the passage of time, it changed its direction towards land resources management including activities with an emphasized view on economic benefits of the stakeholders. Wösten *et al*. (1985) transformed soil patterns on detailed soil maps into patterns of "functional units" that each had distinctly different hydraulic conductivity and moisture retention characteristics. A more sophisticated procedure was followed by Bouma *et al*. (2002) who delineated "management units" for precision agriculture on the basis of simulation runs for nitrogen transformations and pesticide leaching for point data, followed by interpolation. Knowing the internal variability within these "management units" allows estimates to be made of the variability obtained for simulation runs for the units. Therefore, effective functional unit is imperative based on hydrological parameters for achieving the goal of sustainable agriculture.

The new generation approach is focused on the participatory and integrated watershed management, with active participation and contribution of the local people. A concise and organized step should be maintained while working with the watershed management as it directly deals with the livelihood and social upgradation of the farmers, whose wellbeing is thoroughly dependent on the survey, planning, implementation, monitoring and cooperation of the planners with a scientific and authentic land resource inventory

III. CONCLUSION

The modern day microwatershed program includes the strategic and efficient use of natural resources with the participatory approach of community users that led to carry out inventory of resources. The paradigm shift from traditional structure-driven watershed program alone to holistic approach of poverty alleviation with livelihood promotion choosing the alternate income option through conservation of local resources. The authors tried to explain this concept in this paper which is the only possible way by converging the natural resources and the society without any further degradation of resource base. This new paradigm especially in rainfed agricultural region may be a powerful tool that may be enhanced in a more innovative and cost-effective manner to secure land and society.

REFERENCES

[1] All India Soil & Land Use Survey (1985) Report on Demarcation of PrioritySubwatersheds of the Rupnarayan Flood Prone River Catchment, WB. R.K.Dutta, M.K.Mitra, S.S. Mishra, R.R.Biswas, RC, Calcutta, Report No AGRI 691.

[2] Bhattacharya, B.K; Chakraborti, B.R.; Sen, N.N.; Mukherji S., Ray P., Sengupta S., Sengupta K.S. and Maity T. (1985). West Bengal District Gazetteers, Puruliya, Govt of West Bengal

[3] Bouma J, van Alphen BJ, Stoorvogel JJ (2002) Fine tuning water quality regulations In agriculture to soil differences. Environ Sci Policy 5:113–120, Current Science, Vol. 95, No. 3, 10 August

[4] FAO (1976) Framework for Land Evaluation, Food and Agriculture Organisation, Rome, 72 Pp.

[5] FAO (1983) Guidelines: Land Evaluation for Rainfed Agriculture, Food and Agriculture Organisation, Rome, 237 Pp.

[6] Hennrich Kirsten. Jochen Schniidt& Richard Dikau (1999) Regionalization of geomorphometric parameters in hydrological modelling using GIS Regionalozation in Hydrology, Proceedings of a conference held at Braunschwerg, March 1997 IAHS Publ. No.254, 1999.

[7] IARI (1971) Soil Survey Manual, All India Soil and Land Use Survey Organisation, IARI, New Delhi, 121 Pp.

[8] Naidu, L.G.K, V. Ramamurthy, O. Chella, R.Hegde and P. Krishnan (2006) manual soil site suitability criteria for major crops. NBSS Publ. No. 129, NBSS&LUP, Nagpur, 118p.

[9] Natarajan, A., Krishnan, P., Velayutham, M. and Gajbhiye, K.S.(2002) Land Resources of Kudankulam, Vijayapati and Erukkandurai Villages, Radhapuram Taluk, Tirunelveli District, Tamil Nadu.

[10] Saini, H.S. (2008). Climate Change and its Future Impact on the Indo-Gangetic Plain (IGP), Earth Science India, Vol. I (III), 2008, pp. 138-147

[11] Saxena, P. R. and Prasad, N.S.R. (2008). Integrated Land And Water Resources Conservation And Management-Development Plan Using Remote Sensing And GIS of Chevella Sub-Watershed, R.R.Distict, Andhra Pradesh, India. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. Vol. XXXVII. Part B8. Beijing

[12] Vittala Srinivasa S., S. Govindaiah and H. Honne Gowda 2008 Prioritization of sub-watersheds for sustainable development and management of natural resources: An integrated approach using remote sensing, GIS and socio-economic data

[13] Wösten J. H. M., Bouma. J. and Stoffelsen G.H. Use of Soil Survey Data for Regional Soil Water Simulation Models. Soil Science Society of America Journal, Volume 49, Issue: 5September-October 1985Pg:1238-1244

Study of Antioxidants in Leaves of Xerophytes of Georgia

Gulnara Badridze[1*], Eva Chkhubianishvili[2], Luara Rapava[3], Medea Kikvidze[4], Lali Chigladze[5], Ketevan Tsilosani[6]

[1]Department of plant physiology of the Institute of Botany of Ilia State University, Tbilisi, Georgia. Department of agrarian technologies of the faculty of Agrarian Technologies and Biosystems Ingineering of Georgian Technical University, Tbilisi, Georgia

[2,3,4,5,6]Department of plant physiology of the Institute of Botany of Ilia State University, Tbilisi, Georgia

*Corresponding Author

Received:- 10 February 2022/ Revised:- 16 February 2022/ Accepted:- 24 February 2022/ Published: 28-02-2023

Abstract— *Climate warming may appear fatal for many plant species. Thanks to evolutionary formed mechanisms of resistance xerophytes possess high ability of adaptation to elevated temperature and water deficiency. That is why the knowledge of biology of drought resistant species seems very important for possible recovering of deserted regions in future. Antioxidant system is regarded to play an essential role in plant resistance against water deficiency. On the base of analysis of antioxidant system, stress-adaptation strategies of xerophytes, growing at two arid habitats of Georgia – v. Udabno (Iori plateau) and Kotsakhura gorge (Kvernaqi hill), has been investigated. It was established that several mechanisms of antioxidant system are involved in stress-resistance of studied xerophytes. In some cases these mechanisms were similar in species of the same habitat and may be linked with environmental conditions; while in some cases the specific peculiarities of plants were revealed. In particular, ascorbate-tocopherol system was activated in most experimental species. Protective mechanism of phenolic substances accumulation was active in all species as well. Udabno plants were distinguished by the accumulation of osmoprotective soluble carbohydrates; while accumulation of another osmoprotectant - proline was common in both habitat plants.*

Keywords— Antioxidants, Georgia, water deficiency, xerophytes.

I. INTRODUCTION

Recent scientific investigations offer a strong evidence of climate global change to undesirable direction. Moreover, last seven years are regarded as the hottest during the whole history of climate observation (WMO provisional report, 2021).

Climate warming may appear fatal for many plant species. Presumably the geographic range and borders of a great number of species will change (Garamvolgyi and Hufnagel, 2013; Allen et al., 2015). Thanks to evolutionary formed nonspecific biological mechanisms of resistance xerophytes possess high ability of adaptation to elevated temperature, water deficiency, intensive irradiation, etc.; especially the antioxidant system plays an essential role (Laxa et al., 2019). That is why the knowledge of biology of drought resistant species seems very important for future forecasting and possible recovering of deserted regions.

The investigation of stress-adaptation strategies of xerophytes, growing at two arid habitats of Georgia – v. Udabno (Iori plateau) and Kotsakhura gorge (Kvernaqi hill), on the base of analysis of antioxidant system, was the purpose of the presented study. Demonstrated data may be regarded as the part of long-term investigations, which aim to explore the drought resistance mechanisms of plant species occupying dry habitats of Georgia (Badridze et al., 2021; Badridze et al., 2022).

Content of ascorbic acid, tocopherol, carotenoids, anthocyanins, soluble phenols, proline, total proteins, soluble carbohydrates and activity of catalase and peroxidase were studied in leaves of experimental plants.

II. MATERIALS AND METHODS

2.1 Research area

Iori plateau (Sagarejo municipality, East Georgia) is distinguished by lack of water and poor vegetation. Its landscape varies from desert to steppe and forest-steppe. Climate is dry subtropical; annual amount of precipitations is 499-600mm; in village Udabno, where the plant material was picked – 434mm (Kordzakhia and Djavakhishvili, 1971).

Kvernaqi hill is situated near the city Kaspi (East Georgia). Its climate is transitional from subtropical to humid. Annual amount of precipitations is 450mm (Kordzakhia and Djavakhishvili, 1971; Ukleba, 2018).

2.2 Experimental plants

Experimental plant species collected in v. Udabno were: *Pyrus* sp. L., *Peucedanum ruthenicum* M. Bieb., *Galium humifusum* M. Bieb.; in Kvernaqi hills - *Berberis iberica* Stev & Fisch., *Rhamnus pallasii* Fisch & C.A.May, *Peganum harmala* L., *Cotinus coggygria* Scop., *Elaeagnus angustifolia* L. Middle age, mature, healthy leaves were picked at least from 5 different individuals of each experimental species in post-flowering phase, in July - the hottest period for these locations (38^o-40^oC). Analyses were performed both on raw and dry material, with 3-fold repetitions.

2.3 Biochemical assays

Biochemical analysis of studied antioxidans was based on spectrophotometrical methods described in our early work (Badridze et al., 2022). That is why we give here their short description.

Tocopherol was studied spectrophotometrically at 470 nm (SPEKOL 11, KARL ZEISS, Germany) (Fillipovich et al., 1982).

Anthocyanins were studied spectrophotometrically. Optical density of the leaves extract in 96% ethanol with 1% HCL was measured at 540nm (Ermakov, 1987).

Proline was investigated after Bates at al. spectrophotometerically at 520 nm (Bates et al., 1973).

Soluble phenols were determined using Folin-Ciocalteu reagent. Optical density was measured at 765 nm (Ferraris et al., 1987).

The content of proteins was studied after Lowry (Lowry et al., 1951).

Soluble carbohydrates were tested with anthrone reagent at 620 nm with a spectrophotometer (SPECOL 11, KARL ZEISS, Germany) (Turkina and Sokolova, 1971).

Carotenoids were determined spectrophotometricaly. Optical density of the extract of fresh leaves in ethanol was measured (spectrophotometer SPEKOL 11, KARL ZEISS, Germany). Calculations were done by Wettstein formula (Ermakov, 1987).

Activity of peroxidase was determined spectrophotometrically, using guaiacole. Optical density of guaiacole oxidized products was measured at wavelength of 470 nm over a period of 2 min (Ermakov, 1987). Results are given in conditional units per one gram of fresh weight.

Catalase activity was studied gasometrically: volume of the oxygen released in the process of reaction between hydrogen peroxide and enzyme was measured (Pleshkov, 1985).

2.4 Statistical processing of data

One way ANOVA and Tukey's multiple comparison tests were used to test differences between the means. All calculations were performed using statistical software Sigma Plot 14.5.

III. RESULTS AND DISCUSSION

Water deficiency combined with high temperature and intensive irradiation is the main stress, affecting the species which inhabit the studied habitats. Correspondingly, the characteristics of antioxidant system of experimental species has been analyzed on the background of mentioned stressors.

3.1 Ascorbic acid and tocopherol

According to observations content of ascorbic acid and tocopherol in leaves of tested plants was mainly high (Fig.1). *Rhamnus* was especially distinguished by ascorbate content. Statistically similar amount of the vitamin was found in *Galium, Eleagnus and Cotinus* ($p>0.05$). The lowest value of ascorbate was mentioned in *Berberis* leaves (Fig. 1).

Content of tocopherol in leaves of experimental species was high as well (Fig. 1). Statistically similar and higher ($p>0.05$) amounts of the vitamin was discovered in Udabno plants, compared to Kvernaqi species. Among Kvernaqi plants statistically similar ($p>0.05$) was tocopherol content in leaves of *Rhamnus, Elaeagnus* and *Cotinus*; the lowest value of the vitamin was revealed in *Berberis* (Fig. 1).

Both ascorbate and tocopherol are important protectors of the cell against different stresses (Hasanuzzaman et al., 2014; Kolupaev and Kokorev, 2019). Their increase is one of the primary responses to drought and intensive irradiation (Giacomelli et al., 2007; Yang et al., 2008). Thus, high content of ascorbate and tocopherol in tested plants may be regarded as one of the protective mechanisms against the stress conditions of the studied habitats. Moreover, in case of necessity these species may become a natural alternative source of the mentioned vitamins.

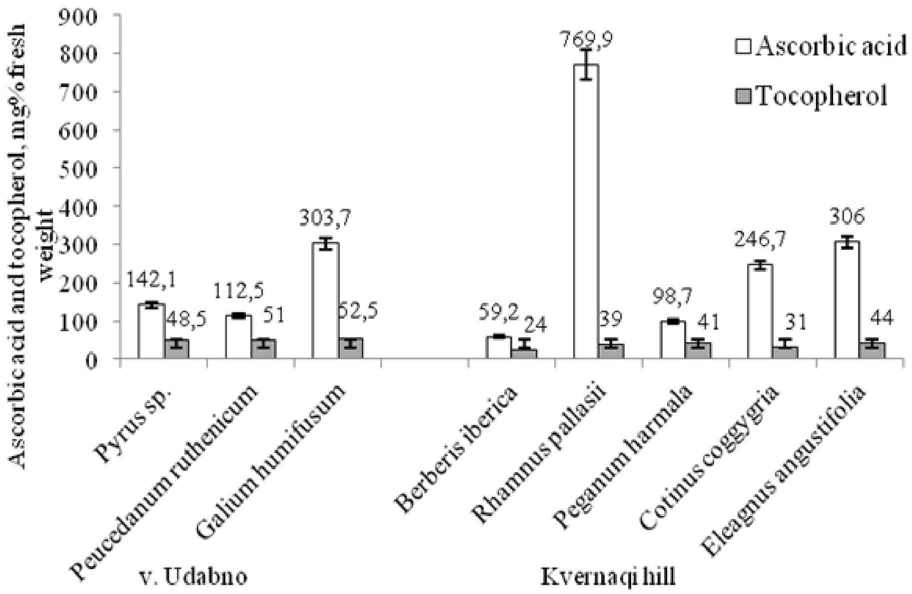


FIGURE 1: Content of ascorbic acid and tocopherol in leaves of xerophytes from v. Udabno and Kvernaqi hill

3.2 Carotenoids and anthocyanns

The highest, but statistically different ($p<0.05$) values of carotenoids were revealed in leaves of *Rhamnus* and *Pyrus*; while in *Peganum* and *Berveris* the results were minimal among the tested plants (Fig. 2). Any regularity of carotenoids content among the experimental plants following the habitats has not been revealed.

By the value of carotenoids one can judge about stress affecting a plant as well as about its resistance (Strzalka et al., 2003). From this point of view species with high content of carotenoids possess one additional mechanism of stress resistance.

Content of anthocyanins appeared to be higher in Kvernaqi plants, compared to Udabno ones (except *Peganum*). The highest and statistically similar ($p>0.05$) results were received in *Rhamnus* and *Elaeagnus* (Fig. 2).

It is established that accumulation of anthocyanins in vegetative tissues of plants increases under the drought and intensive irradiation (Kamjad et al., 2021). These substances are regarded to decrease the osmotic potential of the cell as well, supporting its turgor and water retention (Chalker-Scott, 2002).

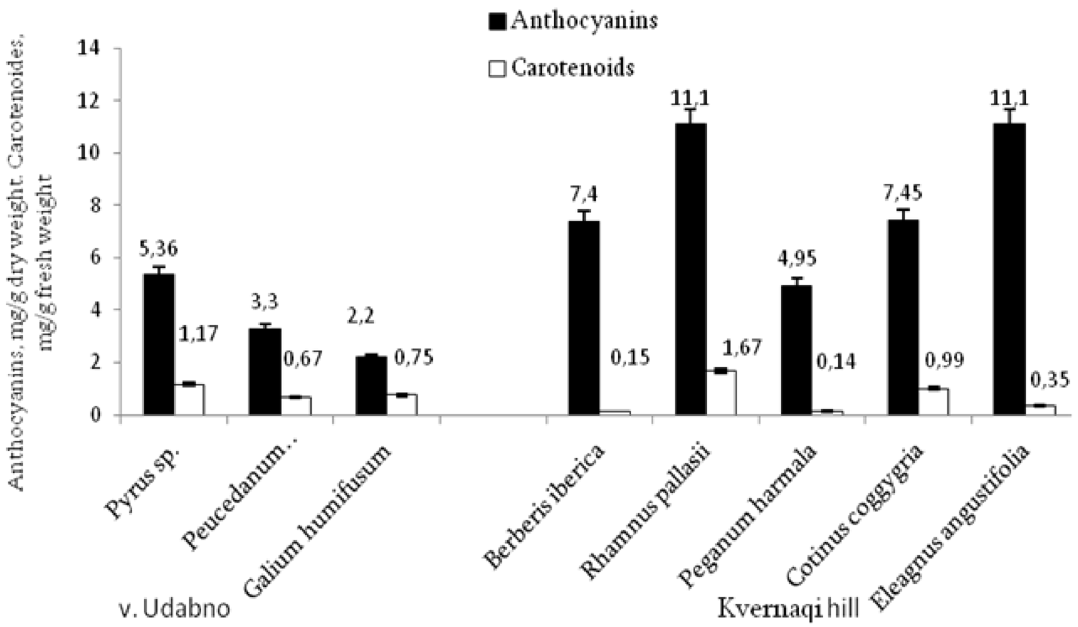


FIGURE 2: Content of Carotenoids and anthocyanins in leaves of xerophytes from v. Udabno and Kvernaqi hill

According to obtained results it may be supposed that anthocyanins accumulation under Kvernaqi conditions is one additional stress-protective mechanism of studied xerophytes.

3.3 Soluble phenols, carbohydrates, proteins and proline

Amount of soluble phenols was high in all tested plants (except *Peganum*). By this index especially were distinguished *Cotinus, Berberis* and *Peucedanum* (Fig. 3).

Among low-molecular antioxidants the role of phenolic substances in protection of cell membrane against stressors is very significant (Cesar and Fraga, 2010). Different authors mention increase of phenolic substances under water deficiency (Sharma et al., 2019).

Experimental results clearly demonstrate the leading role of phenolic substances in protection of tested plants from existing stresses.

It has been established that together with antioxidants so called osmoprotectants like free amino acids, soluble carbohydrates, proteins, etc. may take an active part in protection of plants from different stresses (Iqbal et al., 2020).

High content of total proteins was revealed in leaves of studied species (except *Galium*). Especially high, but statistically diverse results ($p<0.05$) were revealed in *Pyrus* and *Peganum*. Other plant species demonstrated similar, but statistically different results as well ($p<0.05$) (Fig. 3).

The qualitative and quantitative content of plant proteins changes under unfavorable conditions. The synthesis of stress-proteins – dehydrins is activated, which reveal osmolite-like effect and take part in membrane proteins stabilization and cell osmotic regulation (Ashraf et al., 2018; Iqbal et al., 2020).

High content of proteins in experimental plants may be one of the stress-protective reactions.

The content of soluble carbohydrates in tested species clearly differed by habitats. The index was two and more-times higher in Udabno species (Fig. 3). Among Kvernaqi species only in *Peganum* was mentioned comparatively high result.

Accumulation of soluble carbohydrates as a response to stress has been mentioned in many plants. These substances support decrease of the cell water potential and its water retention. At the same time they protect membrane proteins from denaturation and stabilize the membrane (Couee et al., 2006; Mohammadkhani and Heidari, 2008; Laxa, 2019).

From the obtained results is clear that accumulation of soluble sugars in Udabno plants is one of the stress-adaptive mechanisms in this habitat.

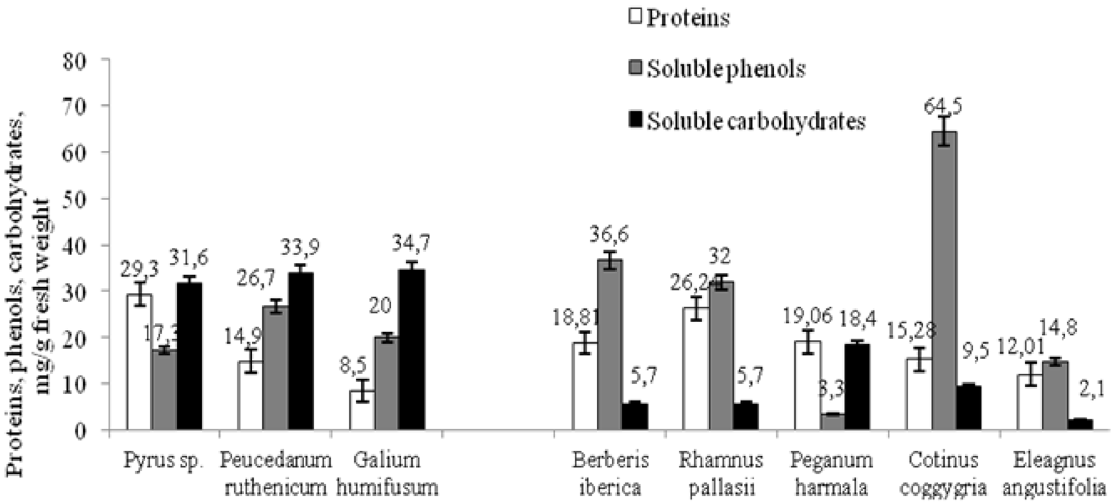


FIGURE 3: Content of total proteins, soluble phenols and soluble carbohydrates in leaves of xerophytes from v. Udabno and Kvernaqi hill

Especially high content of another osmoprotectant - amino acid proline was revealed in leaves of *Peganum* and *Cotinus*. The minimal amount of this amino acid was mentioned in *Pyrus*. In other tested species the content of proline was also high, but statistically differed ($p<0.05$) (Fig. 4).

Many authors mention the role of proline in drought resistance of plants. It retains water in the cell under deficiency conditions and supports its turgor (Ashraf et al., 2018). It is evident that proline accumulation in leaves of experimental plants is one of the stress-protective mechanisms under existing conditions.

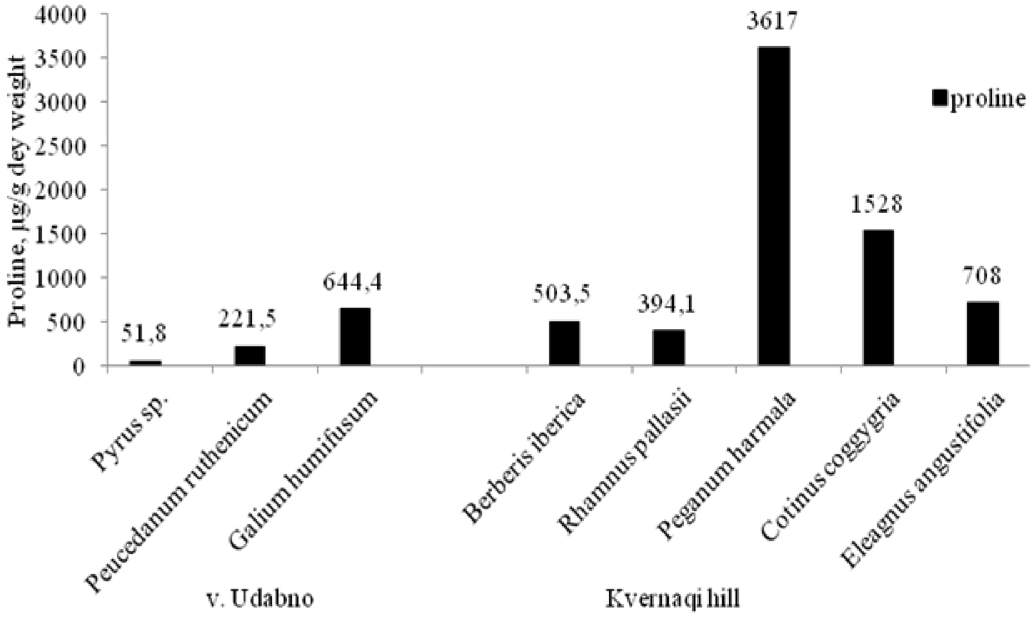


FIGURE 4: Content of amino acid proline in leaves of xerophytes from v. Udabno and Kvernaqi hill

3.4 Catalase and peroxidase

In drought resistant species the activity of antioxidant enzymes – catalase and peroxidase is high (Laxa, 2019; Kapoor et al., 2020). Though, enzymatic antioxidants have high specificity of activity. They affect a particular type of radicals, with specific cell- and organ localization. Moreover, decrease of catalase activity is possible under stress conditions (Chupakhina, 2011). As it is supposed, this fact is linked with an important role of peroxidases and ascorbate-glutathione cycle in oxygen binding (Harinasut. 2003).

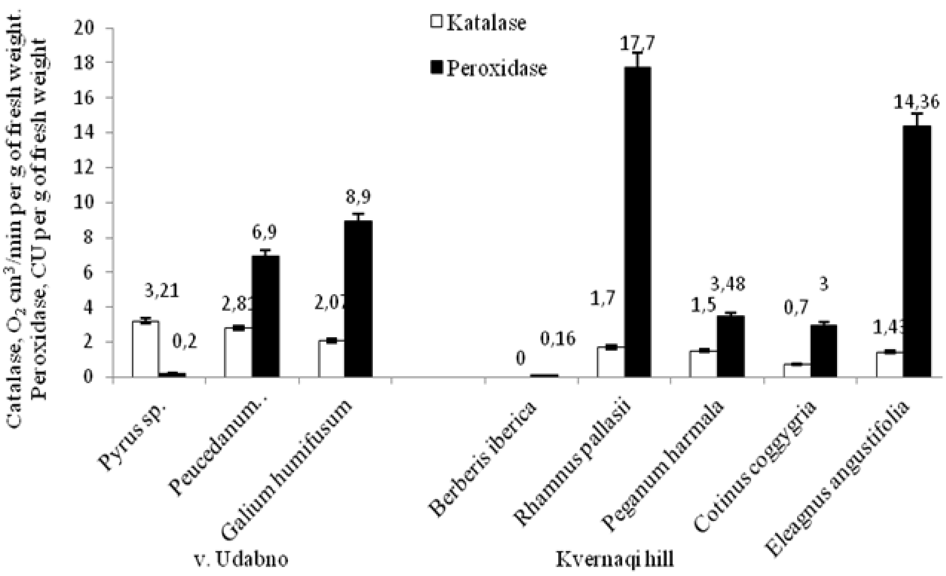


FIGURE 5: Activity of catalase and peroxidase in leaves of xerophytes from v. Udabno and Kvernaqi hill

Udabno plants revealted two- and more times higher activity of catalase, compared to Kvernaqi species (Fig. 5); while the activity of peroxidase demonstrated species individual peculiarities rather than habitat influence. In particular, the highest activity of peroxidase was mentioned in leaves of *Rhamnu*s and *Elaeagnus*; the minimal – in *Pyru*s and *Berberis* leaves (Fig. 5). It is known that catalase has low affinity to hydrogen peroxide, compared to peroxidase. That is why it is more active under the high concentration of peroxide (Chakrabarty, 2016). High catalase activity of Udabno plants may be indication to high concentration of hydrogen peroxide there; this points to more stressful conditions of Udabno habitat, compared to Kvernaqi.

IV. CONCLUSION

Analyzing the experimental results it may be concluded that several mechanisms of the antioxidant system are involved in stress-resistance of studied xerophytes. In some cases these mechanisms were similar in species of the same habitat and may be linked with environmental conditions; while in some cases the specific peculiarities of plants were revealed. In particular: 1. ascorbate-tocopherol system was activated in all experimental species (except *Berberis*). 2. Protective mechanism of phenolic substances accumulation was active in all species as well (except *Peganum*). 3. Udabno plants were distinguished by the accumulation of soluble carbohydrates; while accumulation of another osmoprotectant - proline was common in both habitat plants (except *Pyrus*)

REFERENCES

[1] Allen, C.D.D., D. Breshears and N.G. McDowell. 2015. On underestimation of global vulnerability to tree mortality and forest die-off from hotter drought in the Anthropocene. Ecosphere. 6(8):129.

[2] Ashraf, M.A., A. Akbar, S.H. Askari, M. Iqbal R. Rasheed and I. Hussain. 2018. Recent advances in abiotic stress tolerance of plants through chemical priming: An Overview. In: Rakshit, A., Singh, HB. (Eds.) Advances in Seed Priming. Springer Nature Singapore Pte Ltd., pp. 51-79.

[3] Badridze, G., E. Chkhubianishvili, M. Kikvidze, L. Rapava, L. Chigladze, K. Tsilosani, N. Tsiklauri. 2021. The Biochemical Indices of Drought Resistant Species of Iori Plateau (East Georgia). International Journal of Environmental & Agriculture Research (IJOEAR), 7 (3):33-59.

[4] Badridze, G., E. Chkhubianishvili, L. Rapava, M. Kikvidze, L. Chigladze, K. Tsilosani. 2022. Biochemical Strategy of Drought Resistance of Dry Habitat Plants of Georgia. International Journal of Environmental & Agriculture Research: 8 (7): 21-33

[5] Bates, L.S., R.P. Waldren and I.D. Treare. 1973. Rapid determination of free proline for water-stress studies. Plant Soil. 39, 205-207.

[6] Cesar, G. and C.G. Fraga. 2010. Plant Phenolics and Human Health: Biochemistry, Nutrition, and Pharmacology, John Wiley & Sons, Inc.

[7] Chakrabarty, A., M. Aditya, N. Dey, N. Bani and S. Bhattacharjee. 2016. Antioxidant signaling and redox regulation in drought — and salinity-stressed plants. In Hossain, M. et al. (Eds.). Drought Stress Tolerance in Plants. Springer, Cham. Vol. 1, pp. 465-498.

[8] Chalker-Scott, L. 2002. Do anthocyanins function as osmoregulators in leaf tissues? In: Anthocyanins in Leaves. Advances in Botanical Research (Gould KS, Lee DW, eds) Amsterdam, Academic Press; 37, 103–127.

[9] Chupakhina, G.N., P.V. Maslennikov and L.N. Skrypnik. 2011. Prirodnye antioksidanty (ekologicheskiy aspect) [Natural antioxidants (ecological aspect)]. Kant Baltic Federal University, Leningrad. 111p. (in Russian).

[10] Couee, I., C. Sulmon, G. Gouesbet, and A. El Amrani. 2006. Involvement of soluble sugars in reactive oxygen species balance and responses to oxidative stress in plants. Journal of Experimental Botany. 57(3):449-459.

[11] Ermakov, A.I. 1987. Metody biokhimicheskogo issledovaniya rasteniy [Methods of biochemical investigation of plants]. Agropromizdat, Leningrad. pp.41-42 (Russian).

[12] Ferraris, L., I. Abbatista-Gentile and A. Matta. 1987. Variations of phenolics concentrations as a consequence of stress that induce resistance to Fusarium wilt of tomato. J Plant Dis. Protect. 94, 624-629.

[13] Fillipovich, I.M., T.A. Egorova and G.A. Sevastianova. 1982. Prakticheskoe rukovodstvo po biokhimii [Practical handbook in biochemistry], Mir, Moscow, p.40-60. (Russian).

[14] Garamvolgyi, Á. amd L. Hufnagel. 2013. Impacts of climate change on vegetation distribution No 1. Climate change induced vegetation shifts in the Palearctic region. Applied Ecology and Environmental research. 11(1): 79-122.

[15] Giacomelli, L., A. Masi, D.R. Ripoll, M.J. Lee, and K.J. van Wijk. 2007. *Arabidopsis thaliana* deficient in two chloroplast ascorbate peroxidases shows accelerated light-induced necrosis when levels of cellular ascorbate are low. Plant Mol Biol. 65: 627–644.

[16] Harinasut, P., D. Poonsopa, K. Roengmongkoi and R. Charoensataporn. 2003. Salt effects on antioxidant enzymes in mulberry cultivar. Science Asia. 29:109–113.

[17] Hasanuzzaman, M., K. Nahar and M. Fujita. 2014. Role of Tocopherol (Vitamin E) in Plants: Abiotic Stress Tolerance and Beyond. In: Emerging Technologies and Management of Crop Stress Tolerance. A Sustainable Approach. Volume 2, Chapter 12, pp. 267-289.

[18] Iqbal, A., Q. Don, X. Wang, H. Gui, H. Zhang, X. Zhang and M. Song. 2020. High Nitrogen Enhance Drought Tolerance in Cotton through Antioxidant Enzymatic Activities, Nitrogen Metabolism and Osmotic Adjustment. Plants. 9, 178; doi: 10.3390/plants9020178.

[19] Kamjad, Y., S. Kettipok, T. Chaochaiphat, R. Wongpanya, A. Promboon and W. Pornsiriwong. 2021. Effects of Drought Stress on Anthocyanin Accumulation in Mulberry Fruits. Asian Journal of Plant Sciences. 20(3): 450-460.

[20] Kapoor, D., S. Bhardwaj, M. Landi, A. Sharma, M. Ramakrishnan and A. Sharma. 2020. The Impact of Drought in Plant Metabolism: How to Exploit Tolerance Mechanisms to Increase Crop Production. Appl. Sci., 10, 5692; doi: 10.3390/app10165692.

[21] Kolupaev, Yu.E., and A.I. Kokorev. 2019. Antioxidantnaya sistema i ustoychivost rasteniy k nedostatku vody [Antioxidant system and plant resistance to water deficiency]. Plant physiology and genetics. 51(1):28-54. https://doi.org/10.15407/frg2019.01.028. (in Russian).

[22] Kordzakhia, M. and Sh. Djavakhishvili. 1971. Saqartvelos hava [Climate of Georgia] Ganatleba, Tbilisi. 86p. (in Georgian).

[23] Laxa, M., M. Liebthal, W. Telman, K. Chibani and K-J. Dietz. 2019. The Role of the Plant Antioxidant System in Drought Tolerance. Antioxidants.8(94):1-31.

[24] Lowry, O.H., N.T. Rosebrough, A.L. Farr and R.J. Randall. 1951. Protein measurement with the folin phenol reagent. *J. Biol. Chem*., 139, 256-275.

[25] Mohammadkhani, N. and R. Heidari. 2008. Effects of Drought Stress on Soluble Proteins in two Maize Varieties. Turk J Biol. 32, 23-30.

[26] Pleshkov, B.P. 1985. Prakticheskoe rukovodstvo po biokhimii rasteniy [Practical handbook in plant biochemistry]. Moskva, Kolos. pp. 203-206. (in Russian).

[27] Sharma, A., B. Shahzad, A. Rehman, R. Bhardwaj, M. Landi and B. Zheng. 2019. Response of Phenylpropanoid Pathway and the Role of Polyphenols in Plants under Abiotic Stress. Molecules. 24, 2452.

[28] Strzalka, K., A. Kostecka-Gugala and D. Latowski. 2003. Carotenoids and environmental stress in plants: significance of carotenoid-mediated modulation of membrane physical properties. Russ. J. Plant Physiol. 50:168–172.

[29] Turkina, M.V. and S.V. Sokolova. 1971. Methods of determination of mono- and olygosacharids. In: Pavlinova, O.A. ed. Biokhimicheskie metody v fiziologii rasteniy [Biochemical methods in plant physiology]. Nauka, Moskva, 20-26. (Russian).

[30] Ukleba, D. 2018. Encyclopedia “Saqartvelo” [Encyclopedy “Georgoa”], v.4. Saqartvelos enciklopediis mtavari gamomtsemloba, Tbilisi 662p. (in Georgian).

[31] WMO provisional report on the state of the global climate. 2021. https://reliefweb.int/report/world/wmo-provisional-report-state-global-climate-2021.

[32] Yang, Y., C. Han, Q. Liu, B. Lin and J. Wang. 2008. Effect of drought and low light on growth and enzymatic antioxidant system of *Picea asperata* seedlings. Acta Physiol Plant. 30: 433–440.

Impact of Subsidies Schemes on the Development of the Agricultural Sector in Nagaland

Dr. J. Suresh Kumar[1*], Pauyileube Thou[2], Mrs. D.Shobana[3]

[1]Associate Professor, Department of Economics, St. Joseph University, Chümoukedima, Nagaland, India.
[2]M.A Scholar, Department of Economics, St. Joseph University, Chümoukedima, Nagaland, India.
[3]Assistant Professor, Department of Management Studies, St. Joseph University, Chümoukedima, Nagaland, India
*Corresponding Author

Received:- 07 February 2022/ Revised:- 16 February 2022/ Accepted:- 20 February 2022/ Published: 28-02-2023

Abstract— *Agriculture plays an important role in the livelihood of the people of Nagaland, where about seventy per cent of the people are either engaged directly or indirectly to agricultural activities. Naga farmers practices old- traditional cultivation of shifting/jhum cultivation. Despite of having more than half of its population engaged in agriculture it still depends on other states of the country in many ways. Growth in agricultural sector is one of the effective means of reducing poverty in rural areas and which can be achieved through subsidies from the government. This paper highlights the impact and drawbacks of subsidies on agricultural sector in Nagaland. The study reviews the literature available in various policy documents, reports, journals and previous studies related to subsidies on agricultural sector. This study focuses in particular on the types, effects, roles, employment, economic contribution, farmer benefit, issues, and recommendations for Nagaland's agricultural development. We contend that the Government should implement some policies where the subsidies can be effectively provided to the farmers because we recognize the necessity of subsidies for the expansion of the agricultural sector in Nagaland.*

Keywords— Agriculture, Subsidies, Growth, Farmers, Traditional Cultivation, Shifting/Jhum Cultivation.

I. INTRODUCTION

Agriculture is important all over the world when it comes to economic development. It contributed 4 percent of the world GDP in 2018 and up to more than 25 percent in some developing countries. The agricultural sector provides for the daily needs of more than half of India's population and contributes significantly to the country's economy. The country that produces rice and wheat in India on a second-place basis. Indian agriculture provides a living for about 58 percent of the country's people. Between 2019-2020 and 2020-21, the GDP share of agriculture in India increased from 17.8 to 19.9 percent. The population of Nagaland, a state in northeastern India with 1.65 million hectares, was 1,978,502 as of the 2011 census. The majority of people in Nagaland work in agriculture, either directly or indirectly, making it a significant economic activity there. 70 percent of the population in Nagaland, a hilly state with abundant natural resources, is employed in agriculture, making it primarily an agrarian state. High-yielding crops in the state of Nagaland include rice, oilseeds, tobacco, pulses, fibers, sugarcane, potato, corn, and millets. Nagaland is primarily an area of traditional jhum/shifting agriculture because of its topographical terrain. The Gross State Domestic Product (GSDP) of Nagaland in 2011–12 was approximately 12,065 cores. Forestry and agriculture account for the majority of Nagaland's GDP. About 80 percent of the cropped land in Nagaland is used for growing rice. Despite the fact that Nagaland has a sizable agricultural population, the state is dependent on other Indian states for its production due to a lack of resources. Low productivity may be caused by a variety of factors, including outdated agricultural practises, a lack of funding for the purchase of modern tools and machinery, poor marketing infrastructure, a lack of skills, etc. The state department of agriculture was established in 1963 with the declaration of Nagaland as the 16th state under the Indian Union and is currently headed by Director. During the 12th five-year plan, the Indian government (GOI) introduced several national flagship programmes with a focus on sustainable agricultural development. It implemented a number of programmes, such as RKVY, NEC, PMKSY, ATMA, NFSM, EARAS, etc., which significantly aided in the advancement of agriculture. By implementing various agricultural policies, the Nagaland government has taken a proactive approach and worked hard to strengthen the economy. Given that agriculture is the primary source of livelihood in rural India, both the Nagaland and the Indian governments have been offering various subsidies and programmes to improve the country's agricultural sector.

II. REVIEW OF LITERATURE

S.P. Sinha, (1982) in their study, the authors makes an effort to evaluate how subsidies affect agricultural productivity, income, and employment. In Bihar's Muzaffarpur during the pre-subsidy years of 1979–80 and 1981–82, the study focused on a group of selected beneficiary farmers (Post subsidy period). The beneficiary farms' cropping intensity increased from 154 to 160 percent after using the subsidy to boost farm productivity. The conclusion they reach is that the subsidy programme must be selective and discriminating. The beneficiaries must be properly identified in order to prevent financial abuse. (S.P. Sinha, 1982)

Mitra, (1982) The success of the Small Farmers Development Agency's (SFDA) credit and subsidy programmes in enhancing the financial standing of marginal and small farmers in the Orissan district of Ganjam. It was discovered that when credit and subsidies were available, it was difficult to use them effectively because HYV seeds, chemical fertilisers, and pesticides were not readily available. It prevents many subsidy recipients from utilising new technology to its fullest potential, which would improve their economic situation. (Mitra, 1982)

Harshal A. Salunkhe, (2012) the authors compared India's gross cropped area and total agricultural subsidies. Every year, there is an increase in the total amount of subsidies. The total amount in 1980–81 was Rs. 1 228.5 crore, and in 2008–09, it was Rs. 1 15,952.20 crore. The Gross cropped area was 1, 73, 324 hectares in the 1980–1981 fiscal year; it increased to 1,88,403 hectares; and then decreased to 1,75,678 hectares in the 2006–2007 fiscal year. India's population increased concurrently, reaching 68.52 crores in 1980–1981; 84.39 crores in 1991; 102.70 crores in 2001; and 121 crores in 2012. These facts demonstrate unequivocally that agricultural subsidies increased from 1980–1981 to 2008–2009, and the gross cropped area is probably the same, despite a gradually growing population. (Harshal A. Salunkhe, 2012)

Attempts to ascertain the effect of subsidies on the income of small and marginal farmers in the Ajitwal Block of the Etawah District of Uttar Pradesh in 1980–81 **(S.R. Yadav, (1982).** The authors noted that beneficiaries' overall income increased as a result of the subsidy's provision. Comparing beneficiaries to non-beneficiaries, it was projected to be somewhere around 50 percent. According to the study, farm income from crop growing was about 70 percent higher for beneficiaries than for non-beneficiaries. (S.R. Yadav, 1982)

Halmandage, (2009) The author draws the conclusion that the Indian economy benefited greatly from subsidies prior to their removal. The marginal farmers and less fortunate groups in society benefited more from the fertiliser subsidy. Subsidies increased the purchasing power of marginal farmers. It aids in raising agricultural output and boosting the Indian economy. In 2003, the federal government ended the fertiliser subsidy. Following that, agricultural output will progressively decline. The farmers are unable to afford the more expensive fertiliser. When farmers used fertiliser, their agricultural output gradually fell back to pre-subsidy levels. Due to the removal of agricultural subsidies, the overall rate of agricultural production is falling and production costs are rising. (Halmandage, 2009)

III. OBJECTIVES OF THE STUDY

1. To conduct research on the different types and effects of subsidies and programmes offered to Nagaland's agricultural sector.
2. To examine the role, employment, and economic contribution of the agricultural sector in Nagaland.
3. To investigate how Nagaland's farmers benefited from subsidies and other programmes.
4. To research the main issues and make recommendations for the better application of subsidies and programmes in Nagaland's agricultural sector.

IV. RESEARCH METHODOLOGY

The current study is supported by secondary information. The secondary data were gathered from academic articles, government documents, books, working papers, white papers, doctoral theses, documents from the internet, and other sources.

V. RESULT AND DISCUSSION

5.1 The various types of subsidies and programmes offered to the agriculture sector in Nagaland:

Subsidies are a type of financial assistance or support given to an industry with the general intent of advancing social and economic policy. It is a financial favour, economic break, or privilege that a government bestows on individuals, families, or other governmental entities in the form of direct or indirect payment. The Latin word "subsidies" which connotes providing assistance from behind is where the word "subsidy" originates. As a result, the term "subsidies" refers to financial assistance or support given to a sector of the economy with the aim of achieving or advancing economic and social policy.

TABLE 1
DIFFERENT PROGRAMS AND SUBSIDIES IN NAGALAND'S AGRICULTURE

Sl. No.	Subsidies & Schemes	Year	Purpose
1	Rashtriya Krishi Vikas Yojana (RKVY)	2007	To ensure holistic development of agriculture and allied sector
2	Farm Mechanization under SMAM & RKVY	2016-2017	To boost up production through farm mechanization
3	National Food Security Mission (NFSM)	2007	To increase annual production of rice, wheat and pulses.
4	NMOOP	2014-15	To boost the production of oilseeds
5	ATMA	2005-06	To improve farm productivity and ensure better utilization of resources of the country
6	Seed Production Programme under RKVY	2016-17	To upgrade the quality of farmer saved seed
7	SMPP	2015-16	To minimize use of hazardous chemical pesticides and to manage , insect pest and disease attack increasing production
8	PMKSY	2006	For integrating Research and Extension activities and decentralising day to day management of public ATS
9	NHM	2005-2006	To enhance horticulture production

Sources: Department of Agriculture, Government of Nagaland

The subsidies are offered through a number of programmes and policies and come in the form of equipment, fertilizer, seeds, irrigation facilities, credits, and other things that can assist farmers in increasing their output by using a variety of inputs. Various subsidy programmes, it has significantly improved the farmers' ability to produce, boosting Nagaland's agricultural sector.

The agricultural sector is a critical component of the economy of Nagaland, and the state government provides several subsidies and schemes to support farmers and promote agricultural development. Here are some of the types of subsidies and schemes provided for the agriculture sector in Nagaland:

1. **Agricultural Input Subsidy:** The agricultural input subsidy provides financial assistance to farmers for the purchase of inputs such as seeds, fertilizers, and pesticides. The subsidy is aimed at reducing the cost of production for farmers and increasing the productivity of their crops.

2. **Agricultural Credit Scheme:** The agricultural credit scheme provides loans to farmers for the purchase of agricultural inputs and improvement of their farms. The scheme also provides loans for the establishment of agri-business enterprises and the creation of new employment opportunities in the agriculture sector.

3. **Soil Health Card Scheme:** This scheme provides farmers with information on the nutrient status of their soil, allowing them to make informed decisions on the use of fertilizers and other inputs. The scheme also provides subsidies for soil testing and for the implementation of soil conservation measures.

4. **Crop Insurance Scheme:** This scheme provides financial protection to farmers in the event of crop failure due to natural calamities such as drought, floods, and hailstorms. The scheme provides subsidies for the premium paid by farmers for crop insurance coverage.

5. **Pradhan Mantri Fasal Bima Yojana:** This is a national crop insurance scheme that provides financial protection to farmers against crop losses due to natural calamities. The scheme provides subsidies for the premium paid by farmers for crop insurance coverage.

6. **National Food Security Mission:** This provides subsidies and support to farmers for the improvement of crop yields and the diversification of agricultural production. The mission also provides subsidies for the development of new technologies and the promotion of organic farming practices.

5.2 Subsidies and Schemes in Agriculture Sector of Nagaland

The government of Nagaland has initiated various subsidies and schemes to promote the growth and development of the agriculture sector in the state. These subsidies and scheme aim to improve agricultural productivity, increase farmer's income, and promote sustainable agriculture practices. Some of the key subsidies and scheme in the agriculture sector of Nagaland are:

1. **Rashtriya Krishi Vikas Yojana (RKVY):** This is a flagship scheme of the government of India, which aims to provide financial assistance to states for the development of the agriculture sector. Under the scheme, Nagaland receives financial assistance for various activities such as crop diversification, organic farming, and infrastructure development.

2. **National Food Security Mission (NFSM):** The NFSM aims to increase the production of rice, wheat, and pulses in the country. Under the scheme, Nagaland receives financial assistance for activities such as distribution of high-yielding varieties of seeds, use of modern farming techniques, and promotion of crop diversification.

3. **National Mission for Sustainable Agriculture (NMSA):** The NMSA aims to promote sustainable agriculture practices such as soil health management, water use efficiency, and natural resource management. Under the scheme, Nagaland receives financial assistance for activities such as promotion of organic farming, conservation of land and water resources, and use of renewable energy in agriculture.

4. **Pradhan Mantri Fasal Bima Yojana (PMFBY):** The PMFBY is a crop insurance scheme, which provides financial assistance to farmers in case of crop failure due to natural calamities. Under the scheme, Nagaland's farmers receive premium subsidies for crop insurance.

5. **Mission Organic Value Chain Development for North Eastern Region (MOVCDNER):** The MOVCDNER aims to promote organic farming in the northeast region, including Nagaland. Under the scheme, financial assistance is provided for activities such as capacity building, training, and certification of organic farming.

6. **Nagaland State Seed Certification Agency (NSSCA):** The NSSCA aims to ensure the quality of seeds sold in the state. The agency provides subsidies for seed certification, seed production, and distribution of certified seeds.

5.3 Impact on Subsidies and Schemes of Agricultural Sector in Nagaland

The impact of subsidies and schemes on the agricultural sector in Nagaland has been generally positive, although it can vary depending on the specific scheme and the region in which it is implemented. Here are some of the positive impacts of subsidies and schemes on the agricultural sector in Nagaland:

1. **Increased Access to Credit:** The availability of agricultural credit has increased, allowing farmers to purchase inputs, improve their farms, and diversify their production. This has improved the competitiveness of farmers and increased their incomes.

2. **Improved Crop Yields:** The availability of subsidies for inputs, such as seeds and fertilizers, has improved the productivity of crops, leading to increased yields and income for farmers.

3. **Reduced Cost of Production:** Subsidies for inputs, such as fertilizers and pesticides, have reduced the cost of production for farmers, allowing them to earn higher profits from their crops.

4. **Increased Adoption of Technology:** The availability of subsidies for technology, such as precision farming and soil conservation measures, has encouraged farmers to adopt new technologies, leading to increased productivity and efficiency.

5. **Improved Food Security:** The increased production of food crops as a result of subsidies and schemes has improved food security in Nagaland and reduced the dependence on imports.

6. **Promotion of Organic Farming:** The availability of subsidies and support for organic farming practices has encouraged farmers to adopts environmentally sustainable agriculture practices, leading to improved soil health and reduced dependence on chemical inputs.

5.4 Benefits from Schemes and Subsides

The Nagaland Department of Agriculture under RKVY successfully constructed and inaugurated A/C Organic Market at NE Agri-Expo 4th mile, Dimapur, in 2020. In addition, as part of the Sub-Mission Agricultural Mechanization, the department gave farmers 93 tractors, 878 power tillers, 460 brush cutters, 215 rotary tillers, and 372 other small but useful pieces of equipment (SMAM). A total of 2, 13,613 farmers registered for PM Kisan on February 4th, 2021, and each received 216.08 crores. Under RKVY, the department constructed 19 marketing sheds and 12 collection stores across various districts. 87.5 MT of certified potatoes covering 35 ha was distributed as part of the Seed Production Program in the first year of the RKVY programme, 2016–17. (EMN, 2022)

The department of agriculture was capable of exceeding the national average of 2.69 and attaining an agro-based growth rate of 6.14 percent thanks to the state's RKVY being intercepted. About 67.52 thousand hectares of oilseed cultivation are carried out in the state under the National Mission on Oilseed and Oil Palm (NMOOP), primarily on marginal lands. From 2016 to 2017, oil palm plantations covered 1200 ha. The Agricultural Technology Management Agency in Nagaland has benefited food producers and societies in 74 blocks across 11 districts (ATMA). The 11th and 12th five-year plans included the National Food Security Mission (NFSM), which was created with the goal of boosting the annual output of rice, wheat, and pulses. Integrated Pest Management (RKVY) successfully conducted instruction and demos on vegetables, paddy, and cereals in 60 Farmers' Field Schools (FFS) in 2016–17. All 11 districts and 19 subdivisions underwent surveillance and monitoring surveys to determine the presence of pests, and 20000 Tricho cards were given to farmers. The federal and state governments' various programmes and subsidies, which have aided farmers and massively increased their output, have greatly benefited the agricultural sector. (Yanthan, 2023)

5.5 Role of Agriculture Sector in Nagaland

Agriculture plays a crucial role in the economy of Nagaland, as it is the primary source of livelihood for a majority of the population. Here are some of the roles that agriculture plays in Nagaland:

1. **Employment Generation:** Agriculture is the largest employer in Nagaland, providing livelihoods to a majority of the rural population. It is estimated that around 70% if the state's population is engaged in agriculture and allied activities.

2. **Food Security:** Agriculture is the main source of food for the people of Nagaland. The state's diverse agro-climatic conditions allow for the cultivation of a variety of food crops, including rice, maize, millets, pulses, and vegetables.

3. **Contribution to State Economy:** Agriculture contributes significantly to the state's economy, accounting for around 28 percent of the state's Gross State Domestic Product (GSDP) and employing over 60 percent of the workforce in the primary sector.

4. **Preservation of Biodiversity:** Agriculture in Nagaland is characterized by a unique mix of traditional and modern farming practices, leading to the preservation of the state's rich biodiversity. The state id home to a variety of indigenous crops, including Naga chillies, aromatic rice, and organic vegetables.

5. **Export of Agricultural Produce:** Nagaland's unique agricultural produce, such as the Naga King Chilli, has attracted international attention and crated new opportunities for exporting organic produce to international markets, such as Europe and the Middle East.

6. **Promoting Rural Development:** Agriculture plays an important role in the overall development of rural areas in Nagaland, as it provides livelihood opportunities and contributes to the creation of rural infrastructure.

5.6 Economic Contribution of Agriculture Sector in Nagaland

The agriculture sector is a vital contributor to the economy of Nagaland, providing employment and livelihood opportunities to a large number of people. Agriculture, along with allied sectors, such as livestock and forestry, accounts for a significant share of the state's economy. Here are some of the key economic contributions of the agriculture sector in Nagaland:

1. **Employment:** Agriculture is a major source of employment in Nagaland, providing livelihood opportunities to a large number of people, especially in rural areas. According to the 2011Census, around 70 percent of the state's population is engages in agriculture.
2. **Contribution to GDP:** The agriculture sector is a significant contributor to the Gross Domestic Product (GDP) of Nagaland. According to the Economic Survey of Nagaland (2019-20), the share of agriculture and allied sectors in the state's GDP was around 20 percent in 2018-19.
3. **Export Earnings:** Agriculture is a major contributor to the state's export earnings. Nagaland is known for its high-quality agricultural products such as organic fruits and vegetables, spices, and medicinal plants. The state has a significant potential for exports of agricultural products, and several initiatives have been taken to promote agricultural exports from the state.
4. **Food Security:** Agriculture is a critical sector for ensuring food security in Nagaland. The state is largely dependent on agriculture for its food requirements, and a significant part of the state's population is engaged in subsistence agriculture.
5. **Rural Development:** Agriculture is a crucial driver of rural development in Nagaland. The growth and development of the agriculture sector can lead to the development of rural area, create employment opportunities, and improve the standard of living of people in rural areas.

5.7 Employment Opportunities in Agriculture of Nagaland

Agriculture in Nagaland provides significant employment opportunities, particularly in the rural areas of the state. Here are some of the employment opportunities available in the agriculture sector in Nagaland:

1. **Farming:** It is the most common agricultural activity in Nagaland, and it provides employment to a majority of the population in the rural areas. Farmers are engaged in the cultivation of various crops, including rice, maize, millets, pulses, and vegetables.
2. **Livestock Rearing:** Livestock rearing is another important agricultural activity in Nagaland. The state has a significant population of livestock, including cattle, pigs, and poultry. Livestock rearing provides employment opportunities for many people, including small-scale farmers, livestock keepers, and dairy farmers.
3. **Horticulture:** Horticulture is another significant agricultural activity in Nagaland, with the cultivation of fruits, flowers, and medicinal plants. Horticulture provides employment opportunities for both men and women, particularly in the post-harvest management and processing of horticultural produce.
4. **Fisheries:** Nagaland has a significant potential for fisheries development, with several rivers, streams, and natural water bodies. Fisheries provide employment opportunities for fish farmers, fish traders, and fish processors.
5. **Values Addition and Marketing:** The agricultural produce' value addition and marketing provide employment opportunities for people engaged in food processing, packaging, and marketing. It also creates opportunities for entrepreneurs and small-scale industries.
6. **Agricultural Services:** The agricultural sector in Nagaland also provided employment opportunities for people engages in agricultural services such as extension services, research and development, and farm mechanization services.

5.8 Major Issues of Agriculture Sector in Nagaland

Despite the crucial role of agriculture in Nagaland's economy, the sector faces several challenges and issues that hinder its growth and development. Some of the main issues in Nagaland agriculture include:

1. **Land Fragmentation:** Land in Nagaland is fragmented and divided into small and scattered parcels, which makes it difficult for farmers to adopt modern farming practices and technologies. This also limits the scope for commercial farming and investment in agriculture.
2. **Lack of Irrigation Facilities:** Nagaland has a high dependence on rainfall for agriculture, and there is a lack of adequate irrigation facilities. This limits the ability of farmers to cultivate crops throughout the year and reduces productivity.
3. **Low Productivity:** Agriculture in Nagaland is characterized by low productivity due to the use of traditional and low-yielding varieties of crops, limited access to modern inputs such as fertilizers and pesticides, and poor farming practices.

4. **Post-Harvest Losses:** Nagaland faces significant post-harvest losses due to inadequate storage facilities, lack of processing and marketing infrastructure, and limited access to credit and market linkages.
5. **Limited Access to Credit:** Farmers in Nagaland face limited access to credit, which hinders their ability to invest in farming and adopt modern farming practices.
6. **Limited Research and Development:** There is a lack of research and development in agriculture in Nagaland, which limits the ability of farmers to adopt new technologies and farming practices. This also hinders the development of high-value crops and value addition in agriculture.

5.9 Suggestion for the better implication of subsidies and Schemes in Agriculture sectors of Nagaland

To ensure the effective implementation of subsidies and schemes in the agriculture sector of Nagaland.

1. **Awareness and Outreach:** One of the primary challenges in the effective implementation of subsidies and schemes is the lack of awareness and outreach. The government should ensure that farmers are well-informed about the various subsidies and schemes available to them. This can be done through awareness campaigns, workshops, and training programs.
2. **Timely Disbursement of Funds:** The timely disbursement of funds is critical to the success of subsidies and schemes. The government should ensure that funds are disbursed on time and that there are no delays in the implementation of projects.
3. **Customized Schemes:** These can be designed to suit the specific needs of farmers in different regions of the state. This can ensure that subsidies and schemes are tailored to meet the requirements of the farmers and are more effective.
4. **Capacity Building:** It is essential for the effective implementation of subsidies and schemes. The government should provide training and capacity building programs for farmers and other stakeholders involved in the agriculture sector.
5. **Monitoring and Evaluation:** These are crucial to ensure the effective implementation of subsidies and schemes. The government should establish a monitoring and evaluation mechanism to assess the impact of subsidies and schemes and identify areas that require improvement.
6. **Public-Private Partnership:** The government can encourage Public-Private Partnership to promote the development of the agriculture sector. Private sector players can be involved in the implementation of subsidies and schemes, which can lead to better results.

VI. CONCLUSION

Subsidies play an important role in promoting an economic and social policy of a country by supporting the economic sector, for a state like Nagaland without the help of subsidies, the development of the agricultural sector is not possible as it lacks various facilities and technologies required for improvement of the agricultural sector. The subsidies and schemes in the agriculture sector of Nagaland aim to promote sustainable agriculture practices, increase agricultural productivity, and improve farmers' income. These schemes provide financial assistance for various activities such as infrastructure development, the use of modern farming techniques, and the promotion of organic farming. While there are some positive impacts of subsidies and schemes on the agricultural sector in Nagaland, it is important to note that the impact can vary depending on the specific scheme and the region in which it is implemented. Effective implementation, monitoring, and evaluation are important factors in ensuring that the full potential of these subsidies and schemes is realized. The agriculture sector is a crucial contributor to the economy of Nagaland, providing employment, contributing to the GDP, generating export earnings, ensuring food security, and driving rural development. Given the vast potential of the sector, there is a need for sustained efforts to promote the growth and development of agriculture in the state. The state government has initiated various schemes and programs to promote employment in agriculture, including skill development programs, financial assistance, and support for the development of agro-based industries. It requires a multipronged approach that involves improving access to credit, irrigation, and storage facilities, promoting modern farming practices, encouraging the use of high-yielding crop varieties, and investing in research and development in agriculture. The effective implementation of subsidies and schemes in the agriculture sector of Nagaland can be achieved through awareness and outreach, timely disbursement of funds, customized schemes, capacity building, monitoring and evaluation, and public-private partnerships. These measures can lead to a more sustainable and productive agriculture sector in Nagaland.

REFERENCES

[1] EMN. (2022, June 24). *easternmirrornagaland*. Retrieved February 19, 2023, from Nagaland Agriculture Department launches distribution of farm machinery: https://easternmirrornagaland.com/nagaland-agriculture-department-launches-distribution-of-farm-machinery/

[2] Halmandage, P. B. (2009). A Study Of Fertilizer Subsidy In India. . *International Journal Shodh Samishha or Mulyankan* , 114-115.

[3] Harshal A. Salunkhe, D. (2012). The overview of Government subsidies to agricultural sector in India. . *IOSR Journal of Agricultural and Veterinary Science (IOSR-JAVS)* , 43-47.

[4] Mitra, A. K. (1982). Subsidy as an Instrument for Improveing the Economic Condition of Marginal & Small Farmers: A Case Study of District of the Ganjam, Orissa. *Indian Journal of Agricultural Economics* , 37 (3), 178.

[5] S.P. Sinha, J. P. (1982). Impact of Farm Subsidies on Production, Income & Employment in Bihar: A case Study in Masahara Block, Muzaffarpu, Bihar. *Indian Journal of Agricultural Economics* , 37 (3), 277.

[6] S.R. Yadav, S. D. (1982). Role of Subsidy in Agricultural Development: A Case Study in Ajitwal block,District Etawah. . *Indian Journal of Agricultural Economics*, 37 (3), 278-279.

[7] Yanthan, S. M. (2023). *Activity of the Department, Department of Agriculture, Government of Nagaland*. Retrieved February 19, 2023, from Department of Agriculture, Government of Nagaland: https://agriculture.nagaland.gov.in/activities-of-the-department/

[8] EMN. (2022, June 24). *easternmirrornagaland*. Retrieved February 19, 2023, from Nagaland Agriculture Department launches distribution of farm machinery: https://easternmirrornagaland.com/nagaland-agriculture-department-launches-distribution-of-farm-machinery/

[9] EMN. (2022, June 24). *easternmirrornagaland*. Retrieved February 19, 2023, from Nagaland Agriculture Department launches distribution of farm machinery: https://easternmirrornagaland.com/nagaland-agriculture-department-launches-distribution-of-farm-machinery/

[10] Yanthan, S. M. (2023). *Activity of the Department, Department of Agriculture, Government of Nagaland*. Retrieved February 19, 2023, from Department of Agriculture, Government of Nagaland: https://agriculture.nagaland.gov.in/activities-of-the-department/

[11] Salunkhe, H.A. and Deshmush, B.B (2014) Impact of Subsidy on Agricultural Sector in India- an Analytical study. *International Journal of Agricultural Sciences and Research*, 4(2), pp.9-16.

[12] Kaur, R. and Sharma, M (2012) Agricultural Subsidies in India Boon or Curse. *IOSR Journal of Humanities and Social Sciences*, 2(4), pp40-46.

[13] Nakro V (2009). Traditional Agricultural Practices and Sustainable Livelihood: A thematic report. Published by: Nagaland Empowerment of People through Economic Development (NEPED) & Members of the Project Operation Unit (POU) NEPED Department of Planning and Coordination, Government of Nagaland, Nagaland, Kohima 797001.

[14] Shilpa, R.S and Benni, B.S. (2017) Agricultural Subsidies in India. *Indian Journal of Research*, 6(6), pp.450-453.

[15] Anonymous (2013) Status of Organic Farming in Nagaland. Nagaland State Agricultural Marketing Board.
nsamb.com/sidebar%20links/Nagaland_organic_policy.htmly.

[16] Sharma, V.P. and Thaker, H (2009) *Fertilizer Subsidy in India: Who are the Beneficiaries*. IIM Ahmedabad Research and Publication.

[17] Gulati, A. and Sharma, A. (1995) Subsidy Syndrome in Indian Agriculture. Economic and Political Weekly, 30(39), pp. 93-102.

Studies on the Development of Papaya and Musk Melon Fruit Bar

S. Nazma Hafeeza[1*], K. Niveditha[2], M. Sai Srinivas[3], M. D. K Rao[4], M. C. Aswitha[5], W. Indu Priya[6], B Swetha[7], V. L. Babu[8]

College of Food Science and Technology, Pulivendula, Acharya N.G. Ranga Agricultural University, Andhra Pradesh
*Corresponding Author

Received:- 09 February 2022/ Revised:- 15 February 2022/ Accepted:- 23 February 2022/ Published: 28-02-2023

Abstract— *Papaya and Muskmelon fruit bar enriched with palm jaggery is a nutritious product which has been shown to be effective in providing health and nutritious benefits for human beings. In present study on the development of papaya-muskmelon fruit bar enriched with palm jaggery, Papaya- muskmelon fruit bar was prepared from blend of ripe papaya and muskmelon pulp in the ratio of (50:50), cane sugar (25%), Pectin (1%), Citric acid (0.5%), on weight basis and taken as standard or control. The main aim of the present study is to replace the cane sugar with the palm jaggery in order to increase the nutrient composition of papaya- muskmelon fruit bar. The palm jaggery incorporated in three different compositions (25%, 20%, 30%) and analyzed physico- chemical, colour, texture and sensory characteristics of the Papaya-muskmelon fruit bar. The results obtained that papaya and muskmelon fruit bar enriched with palm jaggery had moisture content of about 12-15%, TSS 65-75 Brix, Total ash content of 0.04-0.5%. Colour study revealed that standard is totally different from three samples which is dark chocolate colour. Sensory characteristics revealed all the samples of the Papaya-muskmelon fruit bar enriched with palm jaggery are acceptable. In that 30% palm jaggery enriched papaya-muskmelon fruit bar is highly acceptable in appearance, taste, aroma and overall acceptability. The samples are packed in LDPE pouches, stored at room temperature (27ºC).*

Keywords— Fruit bar, palm jaggery, colour.

I. INTRODUCTION

Papaya (*Carica papaya L*) is considered as one of the important fruit because it is rich source of antioxidants, phyto-chemicals, nutrients such as; carotenes, vitamin C, and flavonoids, the B vitamins including folate and panthothenic acid, minerals such as potassium and magnesium, and dietary fiber ((Murcia et al. & Leong and Shui, 2004). The fruit is mostly consumed fresh but the immature fruit is also cooked or used in fruit salads, preserves, sauces and pies. The fruit is characterized for its active pectinolytic enzymes during ripening. Papaya (Carica papaya L) is a good source of α-carotene. Health benefits of Papaya (Carica papaya L) are diabetic cure, improves Heart health, improves digestion, cancer prevention, activate human growth hormone, reduce stress and improves bone health (Jain, 2004). Musk melon fruit is commonly known as Kharbooja in Hindi and Musk melon or Cantaloupe in English. Musk melon (Cucumis melo) vary in size, shape and rind. The outer skin may be smooth, netted, ribbed, furrowed. The Fruits are many seeded. The unique aroma of melon is composed of many volatile compounds, biosynthetically derived from fatty acids, carotenoids, amino acids and terpenes. Musk melon (Cucumis melo) is cultivated in all tropical and subtropical areas of the world for its nutritional and medicinal value. This fruit possess useful medicinal properties such as analgesic, anti-inflammatory, anti-oxidant, free radical scavenging, anti-platelet, anti- ulcer, anti-cancer, anti-microbial, hepato-protective, diuretic, anti-diabetic, anthelmintic and anti-fertility activity. The phytoconstituents from various parts of the plant include β-carotenes, Apo-carotenoids, ascorbic acid, flavonoids, terpenoids, chromone derivatives, carbohydrates, amino acids, fatty acids, phospholipids, glycolipids, volatile components and various minerals.

India stands first in terms of its wealth of palmyrah palms with a population estimated to nearly 122 million palms in the world, it has great economic potential referred to as tree of life and all parts of the palm are useful to human beings in different forms such as food, beverage, fiber, fodder and timber. The edible palm products are rich vitamin and minerals, but products are not commercialized as lack of value addition. Palm Jaggery is made from the extract of Palm trees in Southern India. These trees are also known as Toddy palm trees or Palmyra trees. The Jaggery is processed from the unfermented Palmyra tree sap called Neera. It is highly priced due to its medicinal properties. The Palm Jaggery obtained after processing is darker and richer in colour. Palm Jaggery is quite popular in the Southern states of Tamil Nadu (called Karupattivellam or panavellam), Karnataka (it is called Thaatibella in some places and Olebella in Mangalore, which is believed to be the best), Kerala and Andhra Pradesh. Palm Jaggery usually contains 65-85% sucrose and 5-15% reducing sugars, and is consumed directly or used for preparation of sweet confectionary items (like Payasams and neyyi appams) and ayurvedic/traditional medicines, and it may have a role to reduce the chance of lung cancer. It is a good source of minerals like calcium, phosphorous and iron. Due to its cooling effects over human body, it is of high value. It does not have the bone meal content which is used for whitening processed sugar. Health benefits of Palm Jaggery includes Liver detoxification, purifies blood, activates digestive enzymes, acts as energy booster, helps to reduce weight and also prevent constipation (by stimulating bowel movements). Excess consumption of sugar which is calorie rich food leads to Obesity, Heart disease and Type 2 diabetes. The attempt was made to use of palm jaggery which is substitute for Sugar in the Process technology of Papaya – Musk melon Fruit bar is to overcome the calorie intake, obesity, moreover it also reduces the risk of Heart disease and Type 2 diabetes. It offers many opportunities to develop balanced health product high in quality with respect to both sensory and nutritional aspects. Therefore the present study on “Studies on the Development of papaya- muskmelon fruit bar enriched with palm jaggery” was undertaken.

II. MATERIALS AND METHODS

The present study entitled “Studies on the Development of papaya- muskmelon fruit bar enriched with palm jaggery” was attempted to analyze the texture and appearance of the fruit bar enriched with Palm Jaggery

2.1 Preparation of Papaya and Muskmelon Fruit Pulp:

Fruits are washed and sanitized in Chlorinated water (100ppm).Leathery skin of papaya and hard rind of the muskmelons are peeled off and seeds are removed. Then, fruits are cut into cubes and pulping is done by using mechanical pulper. The papaya pulp and muskmelon pulp are blended indefinite proportions. Sugar (25%) and Palm Jaggery syrup (20%, 25%, 30%) areadded to the blended pulp and are thermally processed till it satisfies sheeting test. Then the mix is transferred to the trays and dried in cabinet tray drier for 4-6 hrs at 60°C. Finally cut the bar sheet into suitable sizes (2.5x5.0 cm) and packaged in LDPE.

TABLE 1
FORMULATION USED TO PREPARE PAPAYA-MUSKMELON FRUIT BAR ENRICHED WITH PALM JAGGERY

Papaya: Muskmelon 50:50	Citric Acid	Sugar	Palm Jaggery	Pectin
C(Control)	0.50%	25%	-	1%
S1	0.50%	-	20%	1%
S2	0.50%	-	25%	1%
S3	0.50%	-	30%	1%

The sample blended with papaya: muskmelon pulp 50:50, and sugar (25%) is now taken as control and the physical, chemical and sensory properties are studied. Papaya pulp and Musk melon pulp taken in equal proportions (50:50) were blended with each other with an amount of Citric acid, Palm Jaggery and Pectin each in different.

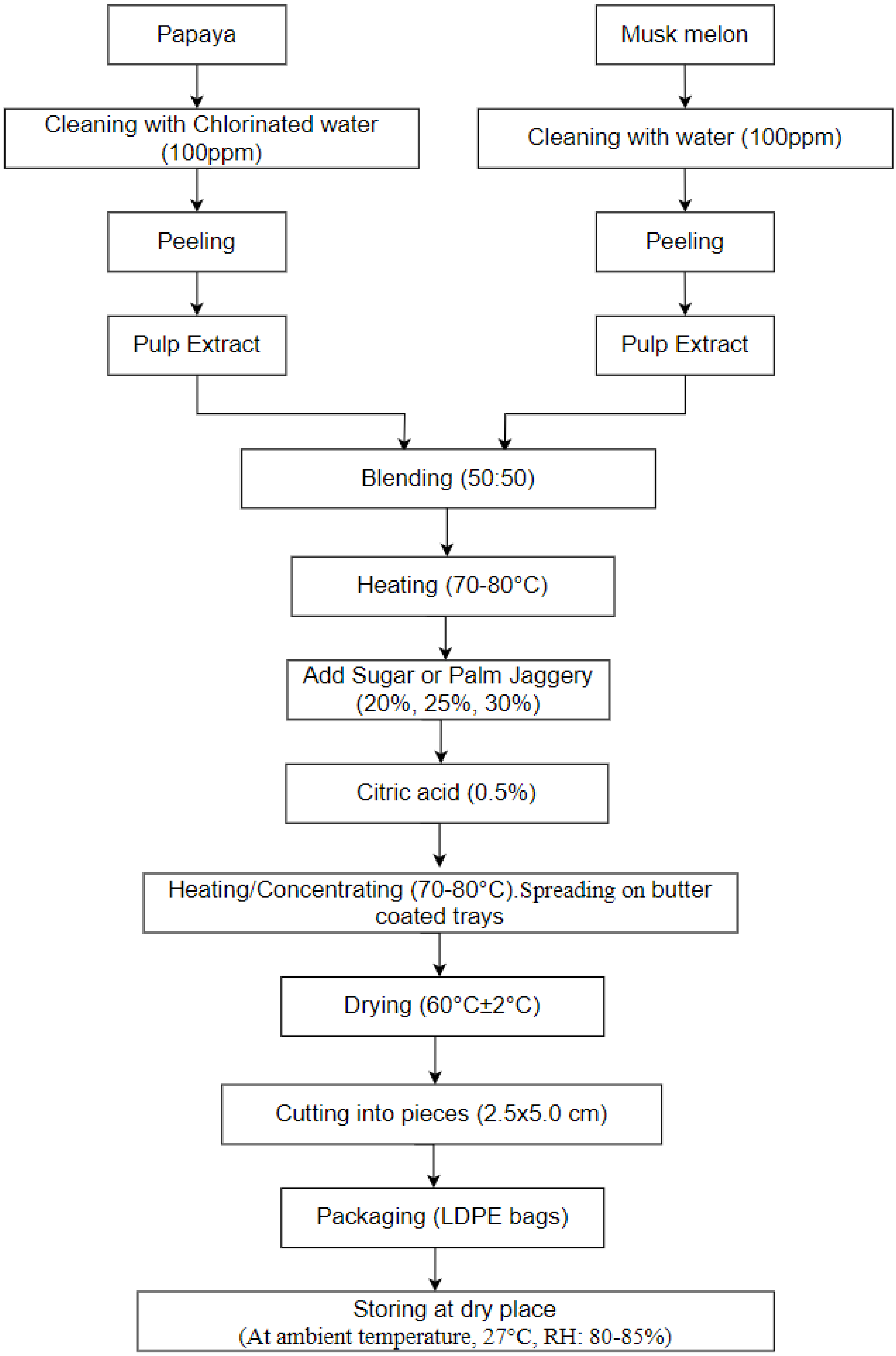


FIGURE 1: Flow chart of the process technology of papaya-muskmelon fruit barenriched with palm jaggery

2.2 Physico-chemical analysis:

2.2.1 Moisture content:

Moisture content of the Papaya-Musk melon fruit bar enriched with Palm Jaggery determined according to (AOAC, Analysis, Official methods of Agricultural Chemists, 1990) method.

2.2.2 Total Soluble Solids:

TSS is the most important quality parameter used to indicate sweetness of fresh and processed food products. A hand refractometer is used to measure the total solublesolids of the sample. A Hand refractometer works on the principle of total refraction. A few drops of sample were taken on prism of refractometer and direct reading was taken and the results were expressed as percent soluble solids (^{0}Brix). The total soluble solids in all the treatments of samples were directly recorded with the help of hand refractometer for 21 days at 7 days of intervals.

2.2.3 pH:

The pH of each sample was determined with the help of digital pH meter. The pH meter was standardized by using buffers of pH 7.00 and 4.00 prior to recording pHof the samples. A sufficient quantity (50mL) of beverage was taken in 100mL beaker and pH meter was used to record pH according to method described by (Ranganna, 1986)

2.2.4 Colour:

Colour parameters of the Papaya-Musk melon fruit bar enriched with Palm Jaggery were measured by using Hunter Lab Colorimeter. Results were reported as L value and chroma at hunter scale, where L and chroma correspond to lightness and color saturation or intensity, respectively.

2.3 Total Ash content:

Total Ash content of the Papaya-Musk melon fruit bar enriched with Palm Jaggery can be determined using according to (AOAC, 1970) method.

III. RESULTS AND DISCUSSION

3.1 Total Soluble Solids:

The Total soluble solids data obtained for the prepared Papaya-Muskmelon Fruit bars are presented in Table. The data revealed that the increasing trend of total soluble solids content was noticed by the increase in Palm Jaggery Concentration. The initial variation in TSS was found in different samples which are attributed to processing variation. Among samples the highest TSS recorded in S_3(71.15) followed by S_2(65.99), S_1(65.33) and the control sample S_0 (75).Increase of TSS may be due to conversion of Polysaccharides to simple sugars.

TABLE 2
TSS VALUES OF PAPAYA-MUSK MELON FRUIT BAR SAMPLES

S.No	Particulars	TSS(Brix)
1	Fruit bar- Control (25% Cane sugar)	75
2	Fruit bar- Sample 1 (20% Palm Jaggery)	65
3	Fruit bar- Sample 2 (25% Palm Jaggery)	66
4	Fruit bar- Sample 3 (30% Palm Jaggery)	71

3.2 pH:

The pH values of the prepared Papaya-Musk melon Fruit bars are presented in Table 3. The pH of the prepared Papaya-Musk melon Fruit bar samples recorded an increasing trend. The maximum pH of 4.11 was observed in sample 3.

TABLE 3
PH VALUES FOR THE PAPAYA-MUSK MELON FRUIT BAR SAMPLES

S.No	Particulars	pH
1	Fruit bar- Control (25% Cane sugar)	3.75
2	Fruit bar- Sample 1 (20% Palm Jaggery)	3.39
3	Fruit bar- Sample 2 (25% Palm Jaggery)	3.73
4	Fruit bar- Sample 3 (30% Palm Jaggery)	4.11

3.3 Moisture content:

The Moisture content in % values of the prepared Papaya-Muskmelon Fruit bars are presented in Table 4. The moisture content of the samples showing decreasing trend and sample 3 obtained lowest value which is desirable than other sample fruit bars.

TABLE 4
MOISTURE CONTENT IN % VALUES FOR THE PAPAYA-MUSK MELON FRUIT BAR SAMPLES

S. No	Particulars	Moisture content %
1	Fruit bar- Control (25% Cane sugar)	12.54
2	Fruit bar- Sample 1 (20% Palm Jaggery)	14.21
3	Fruit bar- Sample 2 (25% Palm Jaggery)	13.62
4	Fruit bar- Sample 3 (30% Palm Jaggery)	12.36

3.4 Colour:

For food items, colour is being used as a measure to signify value and freshness. It has therefore been vital for food producers to be able to determine the value of their product. The colour of different dried fruit bars were reported by L^*, a^*, b^* values corresponding to lightness, greenness and yellowness respectively. Colour plays an important role in attracting consumers. The colour of fruit bar sample 3 was remarkably better than other sample fruit bars. The Colour values of the prepared Papaya-Musk melon Fruit barsare presented in Table 5.

TABLE 5
COLOUR PARAMETER VALUES FOR THE PAPAYA-MUSK MELON FRUIT BAR SAMPLES

S. No	Particulars	ΔL*	Δa*	Δb*	ΔE*
1	Fruit bar- Control (25% Cane sugar)	0.33	1.96	0.32	2.01
2	Fruit bar- Sample 1 (20% Cane sugar)	-8.77	-6.67	-8.28	13.78
3	Fruit bar- Sample 2 (25% Palm Jaggery)	-7.25	-7.64	-10.42	14.81
4	Fruit bar- Sample 3 (30% Palm Jaggery)	-13.21	-5.87	-6.49	15.85

3.5 Total ash content:

The total ash content values of the prepared papaya-musk melon fruit bars are presented in Table 6. Total ash content values showing better in sample 3 than other sample fruit bars which is recommendable for more availability of minerals.

TABLE 6
TOTAL ASH CONTENT VALUES FOR THE PAPAYA-MUSK MELON FRUIT BAR SAMPLES

S. No	Particulars	Total ash content %
1	Fruit bar- Control (25% Cane sugar)	1
2	Fruit bar- Sample 1 (20% Palm Jaggery)	0.4
3	Fruit bar- Sample 2 (25% Palm Jaggery)	0.6
4	Fruit bar- Sample 3 (30% Palm Jaggery)	0.9

3.6 Sensory Analysis:

Sensory attributes like appearance, taste, flavour and overallacceptability were analysed by using 9-point hedonic scale and results were shown in Table 7.

TABLE 7
SENSORY ANALYSIS VALUES OF PAPAYA-MUSK MELON FRUIT BAR SAMPLES

S. NO	Particulars	Attributes			
		Appearance	Taste	Flavor	Overall acceptability
1	Fruit bar- Control (25% Cane sugar)	8.25	8.33	8.58	8.38
2	Fruit bar- Sample 1 (20% Palm Jaggery)	7.91	6.75	7.08	7.24
3	Fruit bar- Sample 2 (25% Palm Jaggery)	8	7.33	7.58	7.63
4	Fruit bar- Sample 3 (30% Palm Jaggery)	8.83	8.16	7.91	8.4

The score for appearance was found highest in sample 3 Papaya- Musk melon Fruit bar enriched with Palm Jaggery (30%) with a score of 8.83. The score for Taste in sample 3 papaya-musk melon fruit barenriched with palm jaggery (30%) with a score of 8.16. Flavour of sample 3 Papaya-Musk melon Fruit bar enriched withpalm jaggery (30%) with a score of 7.91. The sensory score presented in Table 7. Significant increase in overall acceptability was found with increase in palm jaggery content. Themaximum overall acceptability (8.40) was obtained by the sample 3 papaya-musk melon fruit bar enriched with palm jaggery (30%).

IV. CONCLUSION

Fruit bar was prepared by blending papaya-musk melon fruit pulp (50:50) withenrichment of palm jaggery syrup in the proportions of 20%, 25% and 30%. The formulations were analysed to study their physico-chemical parameters and overall acceptability. In the sensory evaluation and also in Textural Evaluation, highest overall acceptability was attained by Papaya-Musk melon Fruit barenriched with Palm Jaggery (30%). Thus, it may be recommended that the palm jaggery syrup may be utilized in abetter way by blending with papaya-musk melon fruit pulp (50:50). This ultimately can be boon for calorie conscious population in replacement ofSugar which is Non-nutritious and calorie rich for their daily intake.

REFERENCES

[1] Murcia, M. A., ANTONIA M., and Magdalena M. Evaluation of the antioxidant properties of Mediterranean tropical fruits compared with common food additives. *Journal of Food Protection., 64(12)*, 2037–2046.

[2] Take, A.M., Bhotmange, M. G. and Shastri, P. N. (2012). Studies on Preparation of Fortified Sapota-Papaya Fruit Bar. J*ournal of Nutrition and Food Sciences* 2:150.

[3] AOAC. (1990). *Analysis, Official methods of Agricultural Chemist.* (Vol..15th Edition). Washington.DC

[4] AOAC. (1970). Official methods of Analysis. In A. o. Chemists, *Official methods of Analysis* (15th ed.). Washington DC: AOAC.

[5] Chauhan, S.K, Joshi, V.K, Lal, B.B. 1993. Apricot-soy Fruit bar:a new protein enriched Fruit Product. *Journal of Food Science and Technology,* 30(6), 457-458.

[6] Chavan, R. J. (2016). Studies on Preparation of Mango Sapota Mixed Fruit bar. *South Asian J. Food Technol. Environ., , 2(2)*, 361-365.

[7] Jain, P. (2004). Evaluation of papaya cultivars for pulp preparation. *Journal of Food Science and Technology, 41(6)*, 684-686.

[8] Diamante, L.M., Bai, X. and Busch, J., 2014. Fruit leathers: method of preparation and effect of different conditions on qualities. *International journal of food science*, *2014*(1), p.139890.

[9] Parekh, J. P. (2014). Quality evaluation of mango bar with fortified desiccated coconut powdert during storage. *Journal of Bioresource Engineering and Technology, 2(3)*, 34-41.

[10] Ranganna. (1986). In Ranganna, *Handbook of Analysis and quality control for fruit and vegetable products* (2nd ed.). New Delhi, India: Tata Mc.Graw Hill Publishing Company.

[11] S. Ahmad, A. V. (2005). Quality Attributes of Fruit Bar Made from Papaya and Tomato by Incorporating Hydrocolloids. *International Journal of Food Properties, 8:1,* 89-99.

[12] Singh, S. (2003). Quality of mango bar stored in three types of packaging material. *Jouranl of Food Science and Technology, 40(1)*, 84-88.

[13] Vengaiah, P. C., Ravindrababu, D., Murthy, G.N., and Prasad, K.R. (2013). Jaggery from Palmyrah palm (*Borassus flabellifer. L*)-Present status and scope.*Indian Journal of Traditional Knowledge,* 12(4), 714-717.


AD Publications
Sector-3, MP Nagar, Rajasthan, India
www.adpublications.org, www.ijoear.com, info@ijoear.com