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Preface

We would like to present, with great pleasure, the inaugural volume-6, Issue-8, August 2020, 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:

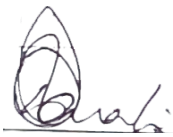
Environmental science and regulation, Ecotoxicology, Environmental health issues, Atmosphere and climate, Terrestric ecosystems, Aquatic ecosystems, Energy and environment, Marine research, Biodiversity, Pharmaceuticals in the environment, Genetically modified organisms, Biotechnology, Risk assessment, 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)



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Animal Science	Agricultural Economics
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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)
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Goats	Poultry
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Freshwater prawn farm	Integrated Multi-Trophic Aquaculture
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Dairy Sheep	Water Buffalo
Moose milk	Dairy product
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Silvopasture	Christmas tree cultivation
Maple syrup	Forestry Growth
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Harvesting equipment	Processing equipment
Hay & Silage/Forage equipment	Milking equipment
Hand tools & activities	Stock handling & control equipment
Agricultural buildings	Storage

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Environmental science and regulation	Ecotoxicology
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Commercial Eucalyptus and Poplar Plantations – New Approaches in Eastern UP

Anubha Srivastav and Anita Tomar

Forest Research Centre for Eco-rehabilitation, Prayagraj

Abstract— *The commercialization of Eucalyptus and Poplar plantations in western Uttar Pradesh attracted other parts of central and eastern UP in the past few years. In Eastern UP, plantation practices vary according to different agro-climatic conditions, land capability and socio-economic status of farmers. The status and pattern of these commercial practices across eastern region of UP reflect that traditional agriculture / farmers are transforming into multifunctional directions and are increasing in a progressive manner. With a view to study planting pattern, demand- supply gap and economic returns of these commercial species, the socio-economic studies in six districts viz. Raebareli, Barabanki, Gorakhpur, Bahraich, Sonbhadra and Prayagraj of the region was carried out . The planting pattern of trees showed that on an average, 23 % trees were scattered on farms, 36 % were in blocks/orchards, 24 % were on bunds and 17 % were around homesteads etc. Due to huge demand of these two species in plywood/veneer and other wood based industries, a wide demand supply gap persists. The results depicted that in districts, Gorakhpur, Bahraich and Raebareli where plywood/veneer industry exists; highest demand supply gap of 135450, 151410 and 75230 cft/yr respectively for Eucalyptus and 55741,111050 and 48100 cft/yr respectively for Poplar was recorded. The market value of Eucalyptus and Poplar trees are almost same with a gain of Rs. 2000 to 2500 per tree by 3.0 to 3.5 qt of wood after 6-7 years of planting. The results clearly show that there is a great scope of planting of these two species in the commercial manner in the region of Eastern UP as they are fast growing, exempted from felling and transit permit and availability of market places in wood industries. Thus, commercial approaches for developing profitable, ecologically and socio-economically viable plantation models of these species may further open a new path for economic strengthening of farmers and increasing green cover of the region.*

Keywords— Commercial agroforestry, demand-supply gap, economic strengthening, livelihood, planting pattern.

I. INTRODUCTION

Tree culture outside forests and specifically on farm land is immensely helping in increasing the tree and forest cover and also in over all rural development by generating employment in plantations and their growing, maintenance, harvesting, transportation; generating additional income to the growers from the sale of trees; and in establishing new wood based industry based on sustained availability of wood raw material from such tree resources. The main tree species planted by the farming community on their farmland are eucalypts, poplar semal, kadam, shisham etc which are fast grown and farmers are able to grow agriculture crops in their association. It is generating an employment of around 6 crore man-days in nursery and plantation culture and associated activities of harvesting, transportation and wood processing in wood based industry. Poplar is now a raw material for around three dozen products and has created a win-win situation for all that include government institutions which are earning appreciable revenue from taxation and licensing mechanisms (Dhiman, 2012). If Indian agriculture has to prosper, the situation in Uttar Pradesh has to improve in all sectors including crop diversification. Agroforestry can play a major role in bringing the desired level of diversification along with sustainability. The farm industry linkages have also helped the systems to be more sustainable than the traditional cropping systems (Kareemulla et al. 2005; Saxena, 2000).

The Eucalyptus and Poplar-based commercial agroforestry show that the technologies are widely adopted when their scientific principles are understood and socio-economic benefits are convincing. An examination of the impact of agroforestry technology generation and adoption in different parts of the country highlights the major role of smallholders as agroforestry producers of the future. It is crucial that progressive legal and institutional policies are created to eschew the historical dichotomy between agriculture and forestry and encourage integrated land-use systems. Government policies hold the key to agroforestry adoption (Puri and Nair, 2004).

Kumar et al. (2011) compared the status of agro forestry in eastern and western UP. Planting trees outside forests will be an additional source of raising forest cover. However, there is large disparity within the farmer communities for tree planting at their farm at regional scale. Economic motives in tree growing are evident in the share of commercial forest tree species in the farm forest tree content. The study concludes that social and economic environment within the households governs the

tree planting on both the regions besides external factors. The present study deals with existing status of Eucalyptus and Poplar based agro forestry, timber trade mechanism and prospects of cultivation of these species in commercial manner.

II. METHODOLOGY

The important commercial tree species – Eucalyptus and Poplar were selected for the study. The districts were selected from three agro-climatic zones lying under eastern UP - Gorakhpur, and Bahraich from tarai region , Raebareli and Barabanki from Eastern Gangetic plains and Prayagraj and Sonbhadra from Vindhyan region . The general information of villages, land holding pattern, demand supply gap of selected species and species type for assessing plantation under agroforestry were studied in selected districts through participatory rural appraisal technique and structured questionnaire. The existing timber traders for marketing mechanism, rates of wood, quantity of timber, role of middle men, market cost, profit margin of seller, rates of forest corporation, database of contractors, sawmills, wood markets, plywood/veneer industries and existing farmers involved in agro forestry were also studied through structured questionnaire.

III. RESULTS AND DISCUSSION

The results for all the six districts were summarized and comparisons were made for assessing a trend for the region. The plantation pattern of Eucalyptus and Poplar species in agro forestry was assessed under the study and found that 29 % plantation is covered by Eucalyptus itself followed by Poplar (08%) (Fig1). In agro forestry, block plantation was preferred by farmers (36%) followed by bunds plantation (24%) (Fig 2). The demand supply gap of timber for Eucalyptus and Poplar was also assessed and found that in studied districts, the demand supply gap for timber was more in Eucalyptus as compared to Poplar. For firewood, Poplar is more demanded as compared to Eucalyptus species (Fig 3).

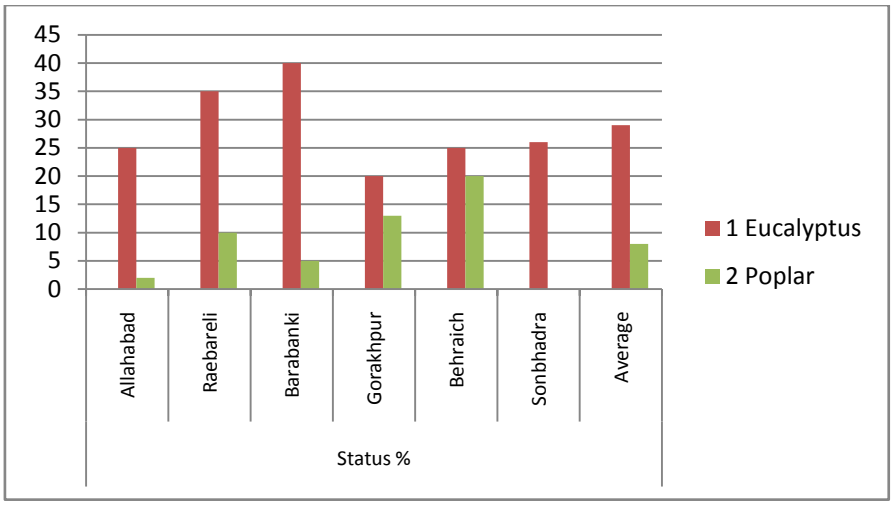

FIGURE 1: Status of species under plantation in study area

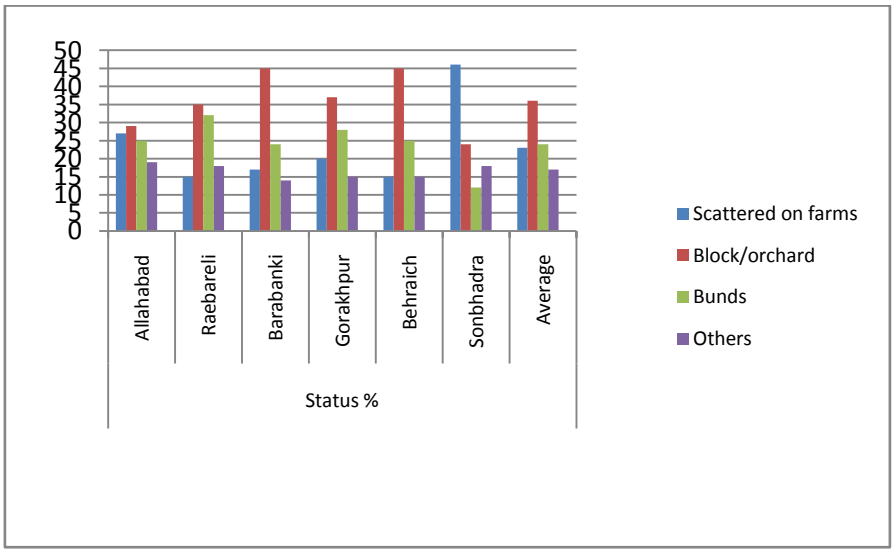

FIGURE 2: Planting Pattern under Agro forestry in study area

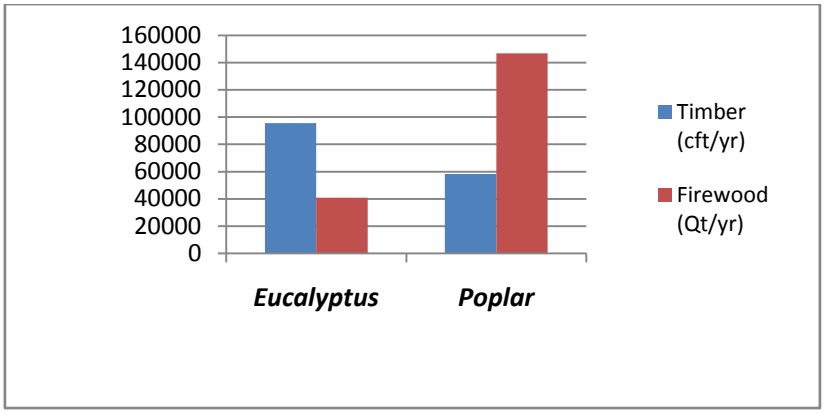

FIGURE 3: Demand supply gap of timber and firewood in Eastern UP

The timber trade mechanism in all six districts was compared and found that contractor is an important chain in the timber trade mechanism (Table 1). The majority of the farmers are trading their wood through contractor to avail all formalities/processing of the sale. The level of timber market uses was compared in all six districts and found that 37 % timber is used in door/window works, 30 % in furniture, 18 % in plywood/veneer, 05 % in packing boxes industry and rest 10 % in other uses as firewood etc (Table 2). The timber sources at sawmills was also analysed and the results depicted that only 14 % farmers are directly selling their timber at market. In the mechanism 53 % trade is through local contractor, 13 % wood is marketed by bordering districts/states, 17% through Forest Corporation especially in Gorakhpur and Sonbhadra (Table 3). In the market channel, contractors/middlemen are also involved at other market channels. The market rates of important timber species was also analysed and compared for selected districts.

The wood arrival at different market places was analysed and found that Eucalyptus consumption is best in Gorakhpur (275000 cft/yr) followed by Behraich, Raebareli and Prayagraj districts .The consumption of Poplar is best in Behraich district (1,04,550 cft/yr) followed by Barabanki (Fig 4).The Sawmills purchase timber from forest corporation through auction . The availability of Poplars is almost negligible in Sonbhadra district. Eucalyptus plantations are available in plenty at Prayagraj district but due to unavailability of markets and industries, most of the raw material is used in construction of houses, fencing etc. Timber is also supplied in bulk from Behraich and Gonda (Private trees of farmers and forest corporation auction) districts.

The market value is Rs. 2000-2500 per tree for 6-7 yr old matured tree of Eucalyptus. Approx. 3.5 – 4.0 qt wood comes out from this tree. In Prayagraj, Eucalyptus is mainly used in Balli and Phanti for construction purposes and packing boxes industries. In Raebareli, farmers are planting Eucalyptus on tree bunds of usar land. In district Raebareli, 22 veneer /plywood industries are existing. In these industries only 60-65 % raw material is available as per demand. In Lalganj range, despite of presence of plenty of eucalyptus trees, growers are not aware about their industrial uses. Thus, knowledge about source of market places may strengthen market channels of this area. Likewise, in district Prayagraj, eucalyptus trees are sold at very low rates in building construction work for phanti and balli etc. As this species is free for permit, it can be easily transported to adjacent Raebareli district for industrial consumption, but only some middlemen are involved in this practice. The common farmers are unable to get the benefit. In Bahraich, poor land holding is a major constraint for tree growers as their awareness is comparatively better than other sites. The availability of seedlings in forest department nursery is also very less as per their requirements. In some villages, poor knowledge about plantation techniques is also a hurdle in the way to success. The villages adjacent to forest fulfill their tree based needs by forest produce for wood as well as NWFPs. The lack of sufficient support to farmers by gram pradhans/forest officials is another constraint for tree growers. The farmers are not fully aware of tree felling and transit rules of trees and are harassed by police and forest department.

Muthoo (2004) examined the status of demand and supply of timber of the Indian market and the market opportunities for the tropical timber sectors. Demand for tropical timber is expected to continue to grow and could approach 10 million m 3 by the end of the decade. According to him the increasing demand for timber in India is due to the resurgence of the domestic economy which is poised to grow at over 6 % per annum and the rapid expansion of middle and upper income groups. Gangadharapp *et al* (2004) investigated that 37 percent of the agroforestry growers cut the tree in the age group of 20-30 years followed by 25 percent between 30-40 years and only 17 percent of farmers harvested above 40 years old trees. Further they revealed that 62 percent of the farmers sold their products through forest contractors, 27 percent through saw-mill

owners and 11 percent directly to consumers. Finally they explored that 58 percent of the farmers were not aware of the market price of their products.

TABLE 1
METHOD OF TIMBER TRADE (PURCHASE OR SALE) MECHANISM

✓	Farmer → Contractor → Commission agent →Timber Trader → End user
✓	Farmer→ Timber trader → End user
✓	Farmer → Consumer
✓	Farmer → Contractor → Timber Trader
✓	Farmer → Contractor → End user
✓	Farmer → Timber trader/ carpenter → End user
✓	Farmer → Contractor → Commission agent → End user
✓	Farmer → Commission agent → End user
✓	Van Nigam→ Contractor →Timber trader →End user
✓	Van Nigam→ Timber trader →End user
✓	Farmer→ Contractor →Timber trader →End user

TABLE 2
LEVEL OF TIMBER MARKET USES

S. No.	Market Particulars	Level in %						
		Prayagraj	Raebareli	Barabanki	Gorakhpur	Behraich	Sonbhadra	Average
1	Door / window	45	30	35	25	30	50	37
2	Furniture	35	10	40	40	25	30	30
3	Packing Industry	10	5	5	0	10	0	5
5	Plywood/veneer	0	40	10	25	30	0	18
6	Others	10	15	5	10	5	15	10

TABLE 3
SOURCE OF TIMBER AT SAWMILLS IN STUDY AREA

	Quantity (%) in selected districts						
	Prayagraj	Raebareli	Barabanki	Gorakhpur	Behraich	Sonbhadra	Average
Directly by farmers	20	12	18	12	12	12	14
Through contractors	60	70	60	42	50	35	53
Bordering district/ state	10	08	12	10	21	15	13
Forest corporation	05	08	06	35	15	35	17
Any other	05	02	04	01	02	03	3

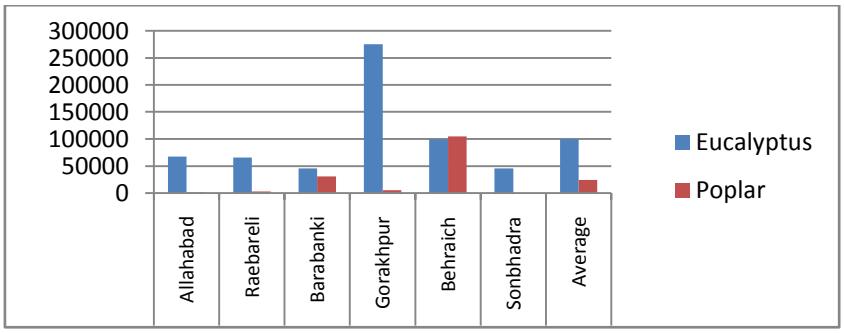

FIGURE 4: Approx. Quantity of Wood Per Annum Arrived at Saw Mills/ Wood Consuming Units

3.1 Constraints of traders/ growers in market channel of timber in Eastern U.P

Complexity of the system for tree growers to sell the produce directly to traders as getting felling and transit permit, contractor/ middlemen, felling loading/unloading, transportation etc are major hurdles in the way to success. Logs of wood

are rejected many times due to poor quality and these are sold in the market at very low rates compared to their actual cost. Brokerage / Arhat/ commission agent and Kat charges are major constraints in market channels. Interference of police is a major constraint for tree growers. There is less availability of industries for consumption of raw material, thus, lowering the rates of timber. In wood mandis, market is dominated by buyers as for sellers there is no provision of storage of wood. The commission agent and buyer get united during auction of wood. Poor availability of planting material and land availability are important reasons for tree growers for not adopting agro forestry.

3.2 Constraints for farmers in direct sale to forest corporation :

- Interference of police for felling and transportation
- Poor technical know-how for planting and marketing
- Problems by sales tax personnel
- Tree ownership certification by tree grower along with khasra/khatauni of land
- Limitation for minimum number of trees to forest corporation.
- Unrevised rates of corporation
- Long time in processing of sale
- Less publicity of the process of sale through forest corporation

IV. CONCLUSION

The most preferred and prospecting commercial species of agro forestry in the region are Eucalyptus and Poplar. The plantation of these species of the region should be taken on priority basis so as maintain the sustainability and fulfilling the requirement of wood based industries. The decentralized wood mandis should be organized and registered. The awareness of people should be regularly increased through extension and training programmes. The model demonstration of agro forestry species should be established in the villages for promoting plantation of species in the region. The existing market information should be disseminated well among tree growers/farmers and new avenues for market places as wood based industries should be initiated at planned level by the government. The species like Eucalyptus and Poplar which are exempted from felling/transit permit are not much known to the farmers of the region. So, increasing awareness of people is a must task for promotion of these species in the region.

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Effects of Biochar and Compost on Cocoa (*Theobroma Cacao*) Seedlings Growth

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Abstract— *The research was carried out at the experimental field of the Kumasi Institute of Tropical Agriculture (KITA) to evaluate the effect of biochar and compost on the growth of cocoa seedlings. There were four (4) treatments including biochar, compost, a combination of biochar + compost, and a control. Treatments were applied at a rate of 0 g (control), 60 g compost, 60 g biochar, and 30 g each of biochar and compost combination into 60 kg soil in polybags. The treatments were laid out in a randomized complete block design (RCBD) with three replications. Data were collected on the number of leaves, plant height, stem girth, and leaf area, all analyzed using analysis of variance. Significant treatment means were separated LSD at P≤0.05. The analysis of variance indicated significant differences among treatment types in plant height (P<0.00001), the number of leaves (P<0.034), stem girth (P<0.044) and leaf area (P<0.012). The highest seedlings height was recorded in soil amended with biochar (55.3 cm) and the least in the control (28.1 cm). Soils amended with compost (15.3) recorded the highest numbers of leaves while a relatively low number was recorded by control (9.0). Stem girth was very high in soils amended with compost+biochar (0.76 mm) and the least in the control (0.62 mm). The highest leaf area was recorded in soils amended with biochar (84.6 cm^2) while the control recorded 57.0 cm^2. It can be recommended that the application of 60g biochar influences significantly growth parameters of cocoa seedlings at nursery.*

Keywords— cocoa, biochar, compost, seedlings, growth, soil, treatments, nursery.

I. INTRODUCTION

Soil amendments are materials, which are worked into the soil to improve the soil's properties. The use of fertilizers (organic and inorganic) over the years on Ghanaian soil has been found to aid crop growth and yield tremendously. Synthetic fertilizers according to Chen (2006) have high nutrient contents, are relatively cheap, and also quickly taken by plants when applied. However, the increasingly continuous use of inorganic fertilizers in the soil results in soil acidity, decrease microorganisms, pollution of underground water, and nutrient loss (Aciego Pietri & Brookes, 2008). The use of biochar and compost as organic products has become an important technique for enhancing soil structure and also for improving soil water availability and holding capacity for plant growth. Biochar is an organic product partially burnt (carbonated with little or no oxygen) through a process called pyrolysis (Duku et.al.,2011, Zheng et.al.,2010). According to Braida et.al., 2003, the large pore spaces and high specific capacity possessed by make it a highly strong absorption material. Additionally, biochar is made up of major soil nutrient constituents such as Ca2+, K+, Mg2+ which help to improve soil base saturation and also increase the soil pH values (Chen et.al., 2013). The use of biochar has been confirmed to increase activities of beneficial microorganisms in the soil (Zheng et.al.2010), reduce greenhouse emissions through carbon sequestration (Crombie et.al., 2015), improve moisture or water holding capacity (Duku et.al., 2011) and also provide nutrients (Paz-Ferreiro et.al., 2014). To produce quality cocoa seedlings, there is a need to use an amendment that improves the quality of soil media. Amending soils with organic materials have been proven to improve soil quality and structure over the years. However, fewer studies have been done on the use of biochar made from cocoa pruned branches and compost in raising seedlings. The research work is carried out to evaluate the effect of biochar and compost (ACARP) on the growth of cocoa seedlings.

1.1 Statement of Problem

The use of infertile soil as a medium for the raising cocoa seedlings is major factor affecting large production of seedlings. Application of soil amendments is one major solution to improving the quality of growing medium and hence improving significant production of cocoa seedlings. Organic amendments improve soil fertility, increases aeration and water holding capacity of soil, improves effective nutrient use and plant growth. The study sought to investigate the impact of organic amendments such as compost and biochar on growth of cocoa seedlings.

1.2 Purpose of the Study

The purpose of the study was to evaluate the effect of biochar and compost(ACARP) on cocoa seedlings growth parameters such as height, number of leaves, stem girth and leaf area.

1.3 Research Questions

In order to achieve the purpose of the study, the following research questions were formulated to guide the study:

1) What impact do compost, biochar, biochar+compost and control have on cocoa seedlings height?
2) What are the differences in the number of leaves when growth of cocoa seedlings is amended with compost, biochar and biochar +compost?
3) What are the differences in stem girth of cocoa seedlings through the application of compost, biochar and biochar+compost?
4) What impact do compost, biochar, biochar+compost and control have on cocoa seedlings leaf area?

II. MATERIALS AND METHODS

2.1 Soil media preparation

The soil (growth media) was taken from the Research Centre of College of Tropical Agriculture. The experimental soil was sandy clay loam with a pH of 5.0 and a bulk density of 1.6 g cm^{-3}. The soil was air-dried for one (1) week, grounded to obtain finer particles and sieved in a 2mm mesh. The soil was sent to the laboratory for various analyses. Organic carbon, soil pH, total nitrogen, exchangeable bases, and other important soil properties were all determined using standard procedures.

2.2 Biochar preparation

The biochar used was made from pruned cocoa branches, which was chard in an oven with zero or no oxygen as documented by (Lehmann, 2007). The biochar was crushed and subsequently sieved to pass through a 2- mm sieve.

2.3 Experimental Design and Treatments

2.3.1 Experimental Design

The design for the study was Randomized Complete Block Design (RCBD). The RCBD is the standard design for agricultural experiments where similar experimental units are grouped into blocks or replicates. It is used to control variation in an experiment by accounting for spatial effects in field (Trudi, 2010). The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications; the distances between the plots were 60cm and 5cm between nursery bags.

2.3.2 Treatments

The following treatments were applied:

1) 0g=control (T1)
2) 60g=compost (T2)
3) 60g=biochar (T3)
4) A mixture of 30g biochar +30g compost=60g (T4)

The research was carried out in an open field. Shade was provided using palm fronds and structure fenced with bamboo.

The polybag was filled with 1600g of the soil and top dressed with 60g compost, 60g biochar, and (60g mixture) 30g compost + 30g biochar. The setup was watered to stabilize for 72 hours before the sowing of the cocoa seeds. Hybrid cocoa (PA7 X POUND7) seeds were sown at a seeding rate of two per polybag, which was later thinned to one seedling per polybag.

2.4 Parameters Assessed

Data were taken on the following growth parameters;

Stem girth (using digital vernier calipers taken at 3cm above soil surface at 4weeks Interval).

Stem height (using meter rule at 4weeks interval) measuring from the base (soil surface) to the tip of the apical leaf.

Leaf number (flushes) fully developed leaves was counted on each plant and recorded at 4weeks Interval).

Leaf Area (using Easy Leaf Area Free app).

2.5 Data Analysis

Data collected were subjected to statistical analysis by using GENSTAT discovery edition 3.0. analytical software. Means were separated by LSD test at 5% probability level.

III. RESULTS

3.1 Properties of planting media and various amendments used in the experiment

The results presented in Table 1.0 show that the soil has several fertility constraints: slightly acidic soil, high exchangeable Al content, low exchangeable base cations content (K, Ca, and Na). Aluminum (Al) toxicity is the main feature limiting plant growth in acidic soil especially cocoa crops, therefore the amelioration needs to be applied in this soil to alleviate the Al toxicity, increase pH and nutrient availability and improve the other soil properties. Results also showed that the organic materials (ACARP compost) had slightly alkaline properties with a pH of 7.5. The pH of biochar made from pruned cocoa branches (9.51) was higher than that of the compost (7.5).

TABLE 1
SELECTED SOIL PROPERTIES OF THE MEDIA AND AMENDMENTS

Properties	pH	Organic C	Total N	Available P	Exch. Al	Exch. K	Exch. Ca	Exch. Mg	Exch. Na
Units		(%)	(%)	mg/kg	(cmol kg-1)	……. (cmol (+) kg-1) ……..			
Soil	5.0	1.60	0.26	1.77	19.82	0.27	1.62	1.68	0.2
Biochar	9.51	8.61	0.33	7.96	-------	0.86	3.95	2.06	0.68
Compost (ACARP)	7.5	15-25	1.0-1.75	0.5-1.20	--------	-------	-------	-------	------

3.2 Mean germination percentage of cocoa seedlings using various amendments at 10 days.

The mean germination percentages of cocoa seedlings on the 10th day after sowing in the different treatments are reported in Table 2. Significant differences were observed in the various treatments. The type of growing media significantly ($p<0.05$) affected the emergence percentage of cocoa seedlings at ten days. Percentage emergence in T2, T3, and T4 was significantly ($p<0.05$) higher than control (T1). This shows that the amended soils (T2, T3, T4) released additional nutrients to aid the cocoa seedlings growth than the control soil (T1).

TABLE 2
MEAN GERMINATION PERCENTAGES OF COCOA SEEDLINGS USING VARIOUS AMENDMENTS AT 10 DAYS.

Treatment	Mean (%)
T1	52.2
T2	80.6
T3	80.6
T4	87.8

3.3 Growth parameters of Hybrid cocoa (PA7 X POUND7) seedlings grown in different media.

Growth parameters of Hybrid cocoa (PA7 X POUND7) seedlings amended with compost, biochar, compost+biochar, and control were assessed at 4 weeks, 8 weeks, and 12 weeks at nursery. The analysis of variance indicated a significant difference among treatments types in plant height ($P<0.00001$), the number of leaves ($P<0.034$), stem girth ($P<0.044$) and leaf area ($P<0.012$).

The highest seedlings height was recorded in soil amended with biochar (55.3 cm), followed by compost (44.0 cm), compost+biochar (43.3 cm), and control (28.1 cm). However, no significant differences were indicated between seedlings from soils amended with compost and compost+biochar (Table 3).

Soils amended with compost (15.3) recorded the highest numbers of leaves, followed by compost+biochar (15.0), biochar (14.7) while a relatively low number was recorded by control (9.0). No significant differences in the number of leaves were observed between seedlings amended with compost, biochar, and compost+biochar (Table 3).

Stem girth was very high in soils amended with compost+biochar (0.76 mm), followed by compost (0.73 mm), biochar (0.71 mm), and control (0.62 mm). However, no significant differences in stem girth were observed between seedlings amended with compost, biochar, and compost+biochar (Table 3).

The highest leaf area was recorded in soils amended with biochar (84.6 cm^2), followed by compost (82.7 cm^2), compost+biochar (74.0 cm^2) while control recorded 57.0 cm^2. No significant differences were observed in seedlings from compost, biochar, and compost+biochar amended soils (Table 3).

TABLE 3
GROWTH PARAMETERS OF HYBRID COCOA (PA7 X POUND7) SEEDLINGS GROWN IN DIFFERENT MEDIA

Treatments	Plant height(cm)	Number of leaves	Stem girth (mm)	Leaf area(cm^2)
Control	28.1c	9.0b	0.62b	57.0b
Compost	44.0b	15.3a	0.73a	82.7a
Biochar	55.3a	14.7a	0.71a	84.6a
Compost+Biochar	43.3b	15.0a	0.76a	74.0a
LSD	**5.24**	**4.37**	**0.09**	**14.45**
CV(%)	**6.14**	**16.20**	**6.58**	**9.7**

Means with different letters are significantly different at P<0.05

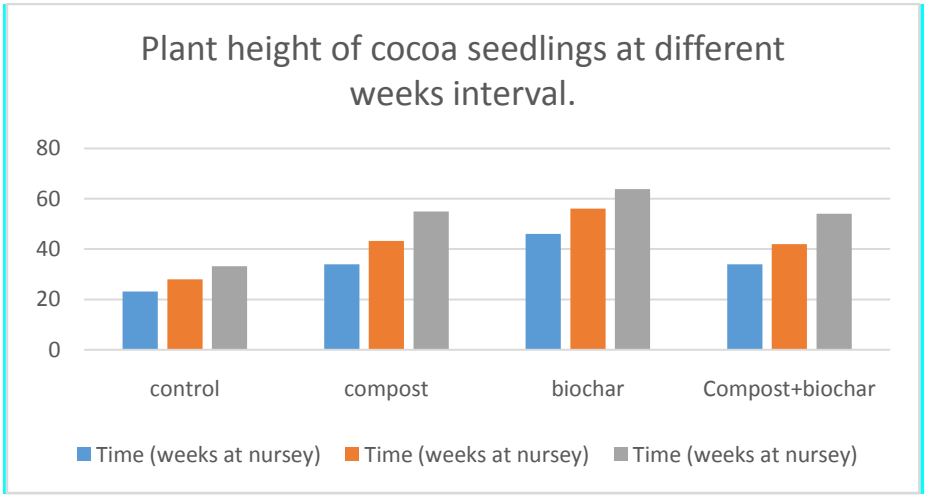

FIGURE 1: Plant height (cm) of 'Hybrid cocoa (PA7 X POUND7)' seedlings recorded from 4 weeks to 12 weeks at nursey.

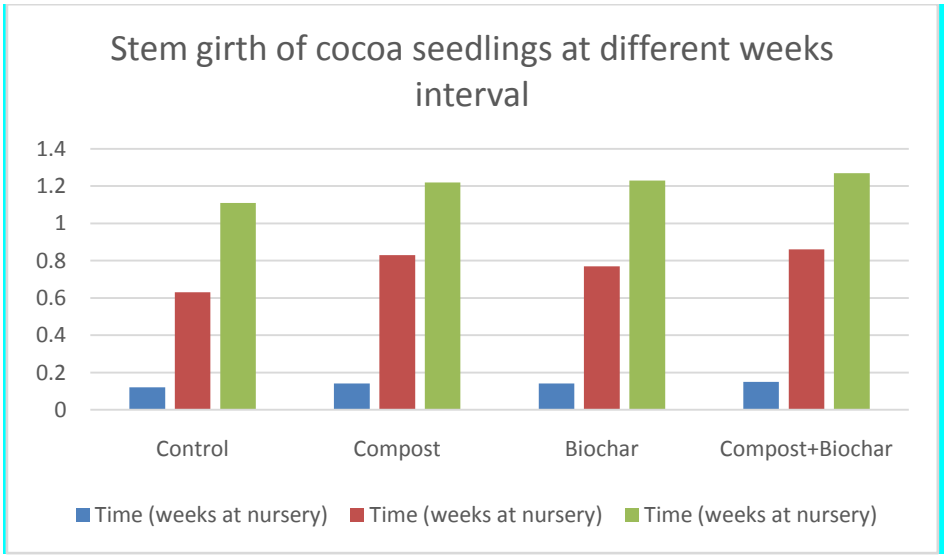

FIGURE 2. Stem girth (mm) of 'Hybrid cocoa (PA7 X POUND7)' seedlings recorded from 4 weeks to 12 weeks at nursey.

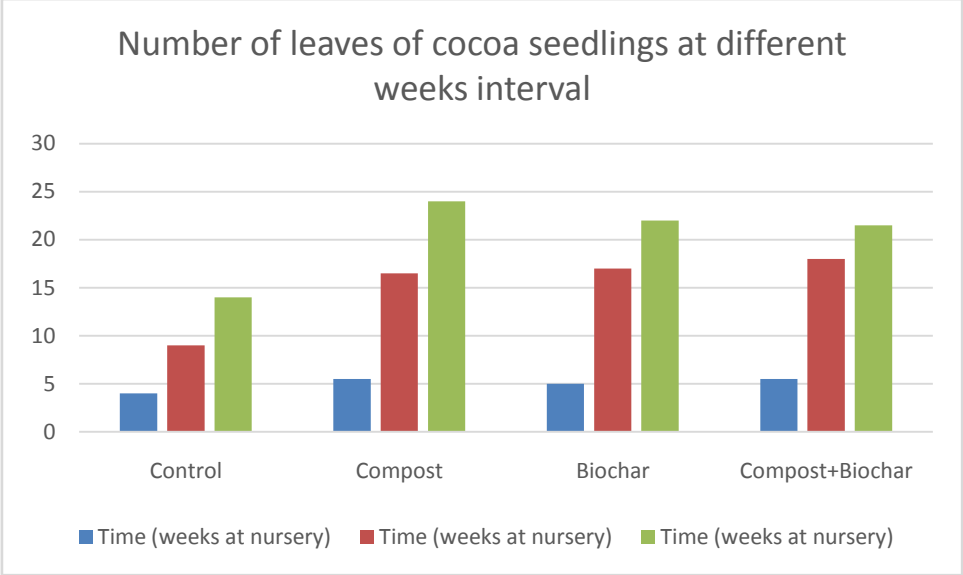

FIGURE 3: Number of leaves of cocoa seedlings recorded from 4 weeks to 12 weeks at nursery

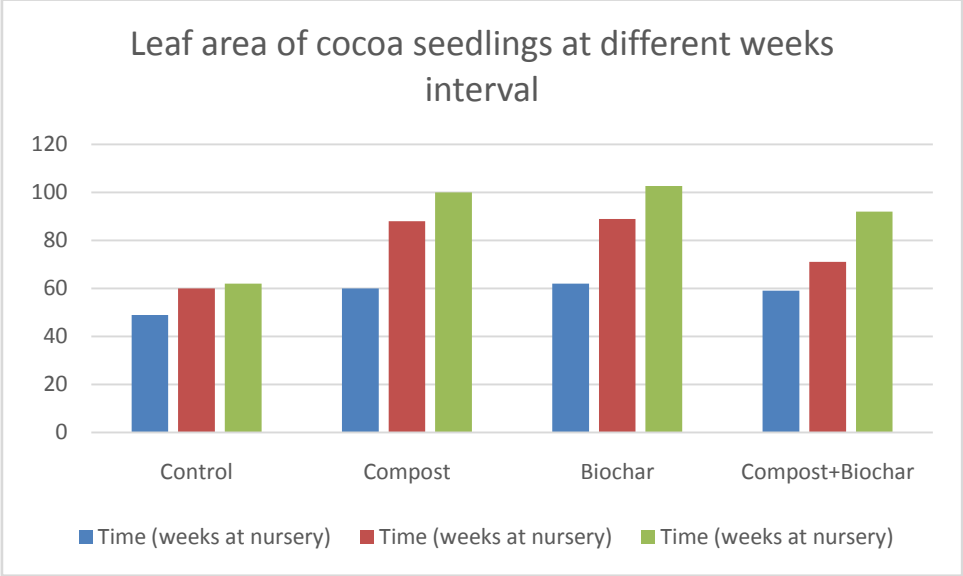

FIGURE 4: Leaf area (cm^2) of the cocoa seedlings from 4 weeks to 12 weeks at nursery.

IV. DISCUSSION

Effects of biochar on growth parameters (plant height and leaf area)

Applying amendments/fertilizers at nursery is very crucial as it helps to improve seedlings' growth and performance (Shen et.al., 2010). The present study results show that seedlings from soils amended with biochar recorded significantly the highest plant heights (55.3) and leaf area (84.6) respectively whereas soil with no amendment recorded the least plant height and leaf area. This positive result might be due to the high content of N and P supplementation available in the biochar. Nitrogen supplementations are needed to improve seedling biomass even in some legume varieties(Harper,1974). In a work by Albregts et.al. (1991) it was revealed that root and shoot development of plants are significantly affected by the level and the kind of fertilizer applied. Works detailing the beneficial effects of producing seedlings with biochar have been carried out by researchers such as Hartz et al., 1996, García-Gómez et al., 2002, and Akanbi et al., 2005 and (Lehmann, 2007). The result is again in conformity with the fact that biochar has low to neutral pH which makes it very efficient in acidic soils by reducing acidity which in turn builds up nutrient uptake and subsequent growth of plants (Lehman et al., 2003). The positive effects of biochar on seedling development for height and leaf area can also be attributed to increasing water holding capacity and availability to the seedlings (Haefele, 2011). Further, other researchers revealed that pot grown lettuce and cabbage plants increased in final biomass, root biomass, plant height, and the number of leaves in all cropping seasons in comparison with treatments with no biochar. Similar results had been reported by a study that biochar application media at plantain

nursery stage resulted in increased vegetative growth parameters (height, girth, number of roots/corm, and root diameter) and this was significantly different from sawdust and sawdust and carbonated rice husk media.

Effects of compost on growth parameter (number of leaves)

Results of the study showed that seedlings from soils amended with ACARP compost recorded a significantly higher number of leaves than biochar, biochar and compost and the control. The result is in agreement with the fact that the could be due to the significant N-component in the ACARP compost which is responsible for leaf growth and green coloration of leaves (Jones, 1983). A previous work by Zibilske, (1987) revealed compost improves water availability in the soil, improves organic matter content of the soil, and also enhances shoot and root development. Stoffella and Graetz, (1996) reported tomato seedlings grown in compost media yielded higher shoot and root response parameters than media not amended.

Effects of compost on growth parameter (stem girth)

Results show that seedlings from soils amended with compost and biochar recorded the highest stem girth. The result could be attributed to higher soil pH and hence higher P availability owing to the application of the organic fertilizers. Similar work by Liu et.al. (2012) revealed applications of both biochar and compost results improving nutrient use efficiency, improving water availability, reducing acidity, reducing leaching in soils, enhancing Carbon sequestration, and releasing collective nutrient supply for plant development, compared to applying compost and biochar individually.

V. CONCLUSION

The additions of biochar and compost either alone or in combination were found to increase significantly growth response parameters (plant height, number of leaves, stem girth, and leaf area) of cocoa seedlings. Application of 60g ACARP compost was found to increase significantly the number of leaves of cocoa seedlings, 60g of biochar increased significantly plant height and leaf area whiles 30g compost b+30g biochar increased significantly stem girth of cocoa seedlings. We recommend a study on the effects of the treatments on the yield response parameters of cocoa.

CONFLICTS OF INTERESTS

The authors declare that there are no conflicts of interest regarding the publication of this paper.

AUTHORS' CONTRIBUTION

We wish to state that all the authors have been personally and actively involved in substantive work leading to the research report. All the authors actively took part in the research design and data analysis of the manuscript preparation. We are therefore responsible for the content of this manuscript.

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Yield and Yield Parameters of 46 Cotton (*Gossypium spp.*) Cultivars under Kahramanmaras (Turkey) Conditions

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Abstract— *Variety yield and adaptation studies are of great importance in increasing cotton production and cultivation. This work was carry out to determine yield(seed cotton and fiber) and yield parameters (plant height, sympodial branches, boll number, seed cotton weight, 100 seed weight and ginning outturn) of 46 cotton genotypes, two of which belong to barbadense and forty-four of hirsutum species, under east Mediterranean ecological conditions of Kahramanmaras – Turkey in 2013 and 2014. According to the analysis of variance yield and yield parameters showed significant differences between genotypes. Year and genotype-year interactions were not significant for all characteristics studied. Based on two-year average results, cotton cultivars BA-119, ST-468 and Furkan gave higher seed cotton and fiber yield per hectare than the others. Minimum seed cotton and fiber yield was observed in Maydos. Cotton varieties BA-119, ST-468 and Furkan can be recommended to cotton producers for production regions due to their high seed cotton and fiber yield.*

Keywords— Seed cotton yield, fiber yield, yield parameters.

I. INTRODUCTION

The cotton plant is of great economic importance for country producers with its value and employment opportunities. Cotton is used by the gin industry, fiber and textile industry in terms of processing, and cotton seed that contains a significant amount of oil is the raw material of the feed industry. Cotton has an important place in Turkish agriculture and economy. Although Turkey produces a significant amount of cotton, the country is an important cotton importer due to the higher cotton fiber demand of the cotton textile industry. According to the average data of the last three years in Turkey, 499.452 hectares of cotton was cultivated and 2.400.000 tons of seed cotton was produced (Anonymous, 2019). Turkey's cotton fiber consumption has increased with advances in textile sectors and has reached 1.6 million tons per year. For cotton producers, cotton varieties must be highly yielding and well adapted to environmental conditions. For consumers, it must have quality fibers. The choice of cotton produced in our country by the domestic industry depends on their high fiber yields as well as their quality parameters such as length, fineness and strength at an acceptable level. For this reason, intense studies are carried out to improve cotton yield and quality parameters (Alam et al., 1991; Dolancay et al., 2015; Sullu et al., 2015; Cicek et al., 2015; Ogur et al., 2015; Tekeli et al., 2015; Cicek and Coban, 2017; Killi et al., 2019; Killi and Beycioglu, 2020a). Additionally, production and adaptation studies are performed to determine high yield and quality cotton varieties and lines suitable for production regions (Kıllı and Aloglu, 2000; Sivaslıoglu and Görmüş, 2001; Ünay et al., 2001; Dolancay et al., 2015; Kocturk et al., 2015; Sullu et al., 2015; Cicek et al., 2015; Ogur et al., 2015; Tekeli et al., 2015; Karademir et al., 2015; Cicek and Coban, 2017; Killi and Beycioglu, 2020b).In this study, it was aimed to determine yield and yield parameters of 46 cotton varieties under Kahramanmaras– Turkey ecological conditions.

II. MATERIALS AND METHODS

Forty-six different cotton genotypes (Table 1), two of which belong to *barbadense* and forty-four of *hirsutum* species, were grown during the 2013 and 2014 growing seasons in Kahramanmaras, which is located in the Eastern Mediterranean region of Turkey (between 37º 36' north parallel and 46º 56' east meridians). The soils where the experiment was established are alluvial soils carried by rivers and they are deposited horizontally in different layers. The slope of the land is close to flat, deep, good drainage, clayey-loam body and first class agricultural land. The pH of the experimental area soils is 7.5, slightly alkaline, lime content is high (20.24 %) and organic matter content (0.96 %) is very low (Anonymous, 2013). Kahramanmaras province has typical Mediterranean climatic conditions with hot and dry summers and mild, rainy winters. Climatic data were obtained at the nearest climate station placed about 5 km from the experimental area. Mean temperature, total rainfall, and humidity are given in Table 2.

TABLE 1
COTTON GENOTYPES USED IN THE STUDY

Genotype number	Genotype name	Genotype number	Genotype name	Genotype number	Genotype name
1	ST-468	17	Beli İzvor-432	33	Cosmos
2	ST-488	18	Carmen	34	Özbek-100
3	Primera	19	Neli	35	Hersi
4	Gaia	20	ST-453	36	Samon
5	Nazilli-87	21	Baly-308	37	GSN-12
6	Taşkent-1	22	Flash	38	Dicle-2002
7	Eisa	23	Julia	39	Famosa
8	Flora	24	İs-1	40	Veret
9	Candia	25	Urania	41	Gosipolsüz-86
10	Sahel-I	26	Orgost-644	42	Tamcot-24
11	Gedera-10	27*	Giza-45	43	MaydosYerlisi
12	BA-119	28	Bulgar-33	44	BA-525
13	Cascot-2910	29	Gacot-79	45	Gloria
14	ST-373	30	Fibermax-832	46	Furkan
15	Aleppo-1	31*	Giza-70		
16	Zeta-2	32	Claudia		

****) barbadense cotton cultivars.***

TABLE 2
SOME CLIMATOLOGICAL DATA OF THE RESEARCH LOCATION IN 2013 - 2014

Months	Mean temperature (°C)		Relative humidity (%)		Rainfall (mm)	
	2013	2014	2013	2014	2013	2014
April	17.2	15.6	51.9	32.7	65.9	45.4
May	22.2	16.1	51.0	41.3	76.5	52.8
June	25.6	20.4	41.5	44.9	16.3	19.8
July	28.8	26.0	35.4	34.9	0.0	1.0
August	27.0	26.7	52.0	44.4	0.0	0.9
September	24.8	19.4	40.0	46.7	37.9	44.6
October	17.5	12.5	32.8	30.7	35.1	37.6

Average air temperature during the growing season changed from 17.2°C (April) to 28.8°C (July) in 2013, and from 12.5°C to 26.7°C in 2014, respectively. The temperature at the experimental field during the growing season was convenient for cotton farming, while the temperatures of July and August were higher than the other months. There was considerable versatility in amount and distribution of precipitation from month to month. The rainfall was highest in May, and this was followed by April. There was an extended dry and hot period during July and August when only an average of 1.9 mm precipitation occurred. September was warm, with 37.9 mm and 44.6 mm of rainfall, for 2013 and 2014, respectively.

The experimental design was a randomized complete block with three replications. Genotypes, consisting of one rows 5.0 m long with 0.70 m spacing between rows, were planted on 10 May 2013 and 2014. These genotypes were initially over-seeded and then hand-thinned to the desired intra-row spacing of 0.20 m. Recommended insect and weed control methods were employed during each growing season as needed. Each year, the experimental area received 80 kg N and 80 kg P_2O_5 ha^{-1} as a

seedbed application. Additional band-dressing of 80 kg N ha^{-1} was applied at the square stage. Overall 6 irrigations were applied and weeds were controlled by hoeing. In the experiment, the harvest was done twice by hand. The first harvest commenced when the cotton was approximately 70% open; the second harvest was three weeks later. In the study seed cotton and fiber yield, yield components (plant height, sympodial branches, boll number, seed cotton weight, 100 seed weight and ginning outturn) were investigated. At harvesting time, 10 randomly tagged plants from each plot were evaluated plant height, sympodial branches and boll number. Seed cotton weight and 100 seed weight were determined as the average number of studying on seed cotton samples of the harvested twenty bolls in each plot. Yield was determined after hand harvesting from each plot twice and weighing the seed cotton. Harvested seed cotton was ginned with the machine of roller gin and separated as seed and lint. Fiber yield was calculated as: [ginning outturn X seed cotton yield]. Analysis of variance was performed for each characteristic by the MSTAT-C statistical program and where F- test indicated significant effects ($p<0.05$), means were separated using Duncan test.

III. RESULTS AND DISCUSSION

From the analysis of variance (Table 3), plant height (PH), sympodial branches (SB), boll number (BN), seed cotton weight (SCW), 100 seed weight (SW), ginning outturn (GO), seed cotton yield (SCY) and fiber yield(FY) showed significant differences between genotypes. Year and genotype-year interactions were not significant for all characteristics studied, indicating that genotypes responded similarly to the years.

TABLE 3
RESULTS OF VARIANCE ANALYSIS FOR YIELD AND YIELD PARAMETERS

Source of variation	PH	SB	BN	SCW	SW	GO	SCY	FY
G[a]	**	*	*	**	*	**	**	**
Y[b]	NS[d]	NS	NS	NS	NS	NS	NS	NS
G x Y[c]	NS	NS	NS	NS	NS	NS	NS	NS

[a]G, genotypes; [b]Y, years; [c]GxY, genotype x year interactions; [d]NS, Non significant at the 0.05 probability level.
*,**Significant at the 0.05 and 0.01probability level.

PH: Plant height; SB: Sympodial branches; BN: Boll number; SCW: Seed cotton weight; SW: 100 seed weight; GO: Ginning outturn; SCY: Seed cotton yield; FY: Fiber yield

3.1 Yield components

Differences in plant height among cultivars are presented in Table 4. Two year average plant height values of genotypes were ranged from 68.32 cm to 107.37 cm. Maydos gave the maximum plant height (107.37 cm), followed by Baly-308 (105.73 cm) and Giza-45 (104.71 cm), and minimum plant height (68.32 cm) was recorded in Candia. In some of studies related with cotton genotypes in similar ecological conditions, Kaynak et al. (1997), Mert and Bayraktar (1997) and Yılmaz (1997) reported that plant height values of cotton cultivars ranged from 70.35 cm to 129.50 cm. These differences are due to variability in environmental conditions and genetic makeup [Usman et al. 2017]. Our results are also in accordance with Mert and Bayraktar (1997) and Bibi et al. [2011], they reported that cotton cultivars significantly differed in plant height and this difference might be due to cultivar behavior and ecological conditions. The sympodial branches were significantly changed in cotton genotypes with values from 4.62 to 9.75 when averaged across cultivars (Table 4). The highest sympodial branches was obtained from the Giza-45 while the lowest value was obtained Is-I genotype. Shape of plant, position of levels and branches are traits that affect crop productivity (McGarry et al. 2016). Ahmad et al. (2009) stated that sympodial branches changed in cotton cultivars. Similar findings with cotton were also reported by Kaynak et al. (1997).

Variance analysis table shows significant ($P\leq0.05$) differences among genotypes for boll number per plant while non-significant difference was observed in year and interaction (Table 3). Two year average boll number per plant values of genotypes were ranged from 4.37 to 11.05 (no, $plant^{-1}$). Furkan gave the maximum boll number per plant (11.05 no, $plant^{-1}$), followed by ST-468 (10.87no, $plant^{-1}$) and BA-119 (10.67 no, $plant^{-1}$), and minimum boll number per plant (4.37 no, $plant^{-1}$) was recorded in Is-I variety. In some of studies related with boll number per plant, Khan et al. (2007), Bibi et al. (2011) and Usman et al. (2017) observed variation in variety. This variable response of different cultivars might be attributed to the unavoidable genetic diversity among cultivars. Highly significant ($P\leq0.01$) differences were recorded in genotypes for seed cotton weight whereas year and interaction was non-significant.

TABLE 4
TWO YEAR AVERAGE VALUES OF INVESTIGATED PARAMETERS OF COTTON CULTIVARS

Cultivars	PH	SB	BN	SCW	SW	GO	SCY	FY
ST-468	80,60	7,20	10,87	4,89	9,37	41,17	4255,3	1770,4
ST-488	80,79	8,15	8,95	5,85	11,10	40,44	4049,7	1637,7
Primera	88,85	9,32	5,70	4,42	9,61	42,12	2016,3	849,1
Gaia	78,38	8,27	8,52	5,36	9,97	40,81	3218,9	1313,5
Nazilli-87	86,38	6,25	5,05	6,13	12,20	36,53	2479,5	901,1
Taşkent-I	82,22	5,85	5,87	4,91	11,02	36,31	2224,2	807,7
Eisa	79,26	5,72	6,35	4,59	10,02	39,76	2328,2	926,9
Flora	76,41	7,42	6,45	5,71	10,74	39,38	2757,8	1086,3
Candia	68,32	6,12	6,82	4,69	10,02	42,57	2562,8	1091,0
Sahel-I	87,28	6,20	7,17	5,38	11,18	36,35	3164,1	1150,1
Gedera-10	95,44	8,15	6,15	5,85	13,05	38,67	2932,5	1133,9
BA-119	80,85	8,55	10,67	5,11	10,44	41,89	4246,9	1779,2
Cascot-2910	76,12	7,60	5,40	5,15	10,60	37,09	2014,8	780,7
ST-373	78,95	6,72	9,10	5,03	11,87	40,28	3729,6	1502,2
Aleppo-I	86,82	6,50	5,05	5,18	12,40	34,68	2094,8	726,5
Zeta-2	89,82	5,57	5,87	5,99	12,59	37,37	2626,4	981,5
Beli İzvor-432	94,75	5,35	6,87	4,76	10,86	35,87	2348,3	842,1
Carmen	79,00	5,12	8,60	5,26	10,51	39,82	3615,5	1441,5
Neli	80,41	5,25	4,87	5,34	10,63	37,28	2081,0	775,6
ST-453	86,28	8,15	7,50	5,19	10,94	39,03	3116,9	1210,8
Baly-308	105,73	8,12	7,82	5,24	11,47	37,83	3193,1	1207,4
Flash	81,71	5,50	6,90	4,75	9,34	41,39	2622,8	1087,0
Julia	70,96	5,37	6,35	5,16	10,27	39,96	2602,7	1040,0
Is-I	83,45	4,62	4,37	5,32	12,83	37,71	1859,8	701,3
Urania	83,30	5,85	6,67	6,06	12,52	37,19	3235,7	1203,6
Orgost-644	92,81	5,00	6,02	4,55	10,75	35,58	2195,5	781,2
Giza-45	104,71	9,75	8,05	4,89	11,51	33,13	3008,4	996,6
Bulgar-33	92,58	6,47	5,20	4,94	9,64	30,64	2057,1	630,2
Gacot-79	86,59	6,37	5,10	5,02	9,88	37,64	2048,1	770,7
Fibermax-832	76,82	5,67	6,85	5,48	10,86	39,11	3004,0	1174,8
Giza-70	83,80	5,22	6,90	4,61	9,72	37,06	2631,2	975,0
Claudia	70,36	5,57	6,07	5,05	9,62	42,15	2455,4	1034,9
Cosmos	72,53	5,15	6,10	4,74	10,25	40,13	2200,8	884,2
Özbek-100	77,00	4,92	7,07	4,48	10,68	37,99	2563,2	973,6
Hersi	75,32	6,50	5,05	5,45	11,04	38,73	2238,8	867,1
Samon	95,32	8,17	5,20	4,75	11,89	37,56	2021,6	759,2
GSN-12	90,80	8,77	7,07	5,77	10,62	41,73	3229,5	1347,4
Dicle-2002	93,62	6,85	7,22	4,76	10,57	38,94	2794,4	1071,3
Famosa	83,36	7,07	9,35	4,68	10,30	39,92	3516,3	1403,9
Veret	96,45	6,95	5,67	5,22	13,23	39,72	2369,4	941,0
Gosipolsüz-86	95,17	6,82	6,02	5,49	10,49	40,37	2646,0	1068,5
Tamcot-24	100,67	7,62	6,05	5,27	10,95	37,93	2554,2	969,3
Maydos	107,37	6,62	4,05	4,86	11,12	28,57	1574,5	449,7
BA-525	77,92	6,90	7,07	6,02	9,95	40,61	3410,3	1385,2
Gloria	80,73	7,60	8,00	4,91	10,04	40,86	3145,6	1285,4
Furkan	91,67	8,20	11,05	5,09	11,67	38,94	4497,1	1701,1
Average	85,38	6,72	6,81	5,16	10,87	38,45	2772,6	1074,3

PH: Plant height (cm), SB: Sympodial branches (no. plant^{-1}), BN: Boll number (no, plant^{-1}), SCW: Seed cotton weight (g, boll^{-1}), SW: 100 seed weight (g), GO: Ginning outturn (%), SCY: Seed cotton yield (kg, ha^{-1}) and FY: Fiber yield (kg, ha^{-1}).

Two year average seed cotton weight values of genotypes were ranged from 4.42 to 6.13 g. Maximum seed cotton weight was observed in N-87 followed by Urania and BA-525 while minimum seed cotton weight was observed in Primera. Seed cotton weight is directly related to the seed cotton yield (Usman et al., 2017). The differences among cultivars for seed cotton weight per boll might have been due to the difference in genetic potential of the cultivars. The significant differences among varieties for seed cotton weight per boll had also been reported by Ehsan et al. (2008).

Significant differences in 100 seed weight of genotypes were observed (Table 3) and two year average 100 seed weight of genotypes varied from 9.37 to 13.23 g (Table 4). Veret (13.23 g) and Gedera-10 (13.05 g) gave higher 100 seed weight than the weight of other genotypes. The lowest 100 seed weight values were obtained from Flash (9.34 g) and ST-468 (9.37 g). Genotypes differed in the ginning outturn with values varying from 28.57 to 42.57 %. Candia cultivar showed the highest ginning outturn, while Maydos cultivar showed the lowest. Ginning outturn values of 14 cultivars (ST-468, ST-488, Primera, Gaia, Candia, BA-119), ST-373, Flash, Claudia, Cosmos, GSN-12, Gosipolsüz-86, BA-525 and Gloria) were over 40%. Ahuja et al. (2018) reported that ginning outturn values of cotton cultivars ranged from 32.73 to 40.60 %.

3.2 Seed cotton and fiber yield

Results of variance analysis table shows highly significant ($P \leq 0.01$) differences among varieties for seed cotton and fiber yield while non-significant difference was observed in year and interaction (Table 3). All cultivars produced similar response from year to year in seed cotton and fiber yield, so the cultivar-year interaction was not significant. According to two-year results genotypes responded differently in terms of yield. Maximum seed cotton yield was observed in Furkan with 44097.1 kg ha^{-1} followed by ST-468 and BA-119 in which seed cotton yield was 4255.3 and 4246.9 kg ha^{-1} respectively. Minimum seed cotton and fiber yield was observed in Maydos with 1574.5 and 449.7 kg ha^{-1} respectively. Low boll number per plant and ginning outturn caused a decrease in yield of Maydos variety. Maximum fiber yield was obtained from BA-119 (1779.2 kg ha^{-1}), ST-468 (1770.4 kg ha^{-1}) and Furkan (1701.1 kg ha^{-1}), respectively. These three genotypes (BA-119, ST-468 and Furkan) showed high yield potential, while two genotypes (Maydos and Is-I) showed very low yield potential. Fiber yield characteristic has been shown to differ due to genotype and growing conditions, and ginning (Fransen and Verschraege, 1985). The high yield of BA-119, ST-468 and Furkan varieties is due to their high number of bolls per plant. Seed cotton yield was positively correlated with boll number per plant (Gul et al., 2016). Ismail and Al-Enani (1986), Killi (1995) and Gul et al. (2016) reported that there are positive and significant relationship between fiber yield and seed cotton yield, ginning outturn.

IV. CONCLUSION

In this experiment, which was carry out under Kahramanmaras (Turkey) province condition to find out the yield and yield components of 46 cotton genotypes, demonstrated that all investigated characteristics were significantly affected by genotypes. Among the investigated cultivars, plant height of 68.32-107.37 cm, number of sympodial branches per plant of 4.62-9.75, boll number per plant of 4.37-11.05, seed cotton weight per boll of 4.42-6.13 g, 100 seed weight of 9.37-13.23 g, ginning outturn of 28.57-42.57 %, seed cotton yield of 1574.5-4497.1 kg ha^{-1} and fiber yield of 49.7-1779.2 kg ha^{-1} were changed. Overall, genotypes BA-119, ST-468 and Furkan showed best performance and found more adaptive to the growing conditions.

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Isolation and Selection of Actinobacteria Against Pathogenic Bacteria From Shrimp Pond Water on Duyen Hai District, Tra Vinh Province, Vietnam

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Abstract— *In the shrimp-farming process at Vietnam has used antibiotic mostly, this leads status of antibiotic resistant bacteria and product do not qualified to the market. Bacteria, especially actinobacteria, had resistant ability to human pathogenic bacteria in water and they have an important role in sustainable aquaculture. This study aimed to isolate and select good actinobacterial strains against pathogenic bacteria, from 8 samples of shrimp-pond water at 3 sites Ngu Lac, Phuoc Tri and Long Toan of Duyen Hai district, Tra Vinh province on Gause-1 agar medium. Fifty-three actinobacterial isolates were isolated in which 23 isolates resistant to at least one of pathogenic bacteria by well-diffusion method. Among them, 15 isolates were identified as resistant to Bacillus cereus, 12 to Staphylococcus aureus, 11 to Escherichia coli and 18 to Vibrio parahaemolyticus. There were 7 isolates had good resistance to select for PCR technique and sequencing and the result were determined 7 these strains: NL1-1.9, NL1-18a, NL2-2.1b1, NL2-2.2, PT1-1.7a, PT2-2.8a, LT1-1.3 belonged to three genere: Streptomyces, Nocardioides, and Glutamicibacter.*

Keywords— actinobacteria, antimicrobial, schrimp-pond water, Vibrio parahaemolyticus.

I. INTRODUCTION

Vietnam has a suitable location and condition for fishery and aquaculture with shoreline length 3,260 km, together with abundant river canal system, Aquaculture is one an important export of agricultural production among shrimp cultivation jas large contribution in general report of Vietnam agriculture. Shrimp cultivation has been faced with pathogenic bacterial infections, such as luminous vibriosis and acute hepatopancreatic necrosis disease (AHPND) caused by *Vibrio harveyi* and *Vibrio parahaemolyticus*, respectively [1]. Shrimp production in Southeast Asia steadily averaged 6.0% annual growth from 2008 to 2011; however, the production declined from 3.45 million metric tons (MMT) to 3.25 MMT in 2012 (down 5.8%) and to 3.21 MMT in 2013 (down 1.1%) due to the impact of early mortality syndrome (EMS) in China, Thailand, Vietnam and Malaysia [2]. To solve these problems, shrimp farmers normally use antibiotics to eliminate the pathogenic bacteria; however, antibiotics can be harmful to consumer health. In addition, long term use of antibiotics leads to residual compounds in sediment and water, and the bacteria can adapt themselves by selection for antibiotic resistant genes [3]. For sustainable shrimp cultivation, probiotics and/or their anti-vibrio compounds as biocontrol agents have been explored to control vibriosis in shrimp farming. Gram-positive actinobacteria have been identified as potential probiotics for aquaculture, with effects against various pathogens [4]. The objective of this work was to isolate and select together with identify bacterial isolates having good resistance to *V. parahaemolyticus* and human pathogenic bacteria in water of shrimp ponds on Duyen Hai district, Tra Vinh province, Vietnam in order to product a probiotic for shrimp cultivation sustainably.

II. MATERIALS AND METHODS

2.1 Materials

Water samples were collected at the depth of 0.2 m and distance shore 4 m, from 8 shrimp-ponds of 3 villages (Long Toan, Ngu Lac, Dinh An) (9°64’37” to 9°67’88” East and 106°45’29” to 106°51’73” North) of Duyen Hai district, Tra Vinh province, Vietnam, they stored in an ice box and transferred to Can Tho University laboratory, stored -4°C in refrigator until to analysis.

Vibrio parahaemolyticus provided from Department of Aquaculture Pathology, College of Aquaculture, Can Tho University.

Nutrient Agar (Difco) medium supplemented with Aginalxic (10 µg/l) and Nystatin (25 µg/l) into medium after autoclaving; Luria Bertani medium [5].

2.2 Methods

2.2.1 Isolation and culture

Water samples were serially diluted with sterile saline water (0.01%). Hundred microlitres of the suspensions were spreaded onto NB agar medium. All plates were inoculated at room temperature for 24 h; the disjointed colonies recorded and re-streaded to obtain pure culture. The colonies bearing distinct morphological characteristics were picked up and transferred to freshly prepared media until pure cultures were obtained.

2.2.2 Screening assays for antibacterial activity

The liquid cultures were grown with shaking at 150 rpm for 1 day depending on their growth rate at 30°C. The broth was centrifuged in 50 mL falcon tubes (5000 rpm, 15 min at room temperature; Megafuge 1.0R, Heraeus) and the supernatant was stored at 4°C. The bacterial test organisms were plated in LB medium. Antimicrobial extract was added to the wells, the plates were incubated at 4°C for 2 h for diffusion of antimicrobial extract and observed for the zones of inhibition at 28°C after 48 h incubation.

2.2.3 The Agar well diffusion method

The active isolates were cultured by the method given in the previous step. The supernatants were used for testing extracellular antimicrobial activity by agar well diffusion method. By using a sterile cork borer, wells were punctured in appropriate agar medium previously seeded with one of the test organisms. One hundred microlitre of the culture supernatants were added to each well. The plates were then incubated at 4^{o}C for at least 2 h to allow the diffusion of crude extracts followed by incubation for 24 h at 37^{o}C for bacteria and 48 h at 28^{o}C for yeast. The diameters of inhibition zones were monitored and measured [6] and positive control was penicillin.

2.2.4 Genomic DNA Extraction

Bacterial cells from these cultures were collected by centrifugation and genomic DNA was extracted [5].

2.2.5 PCR Amplification and Sequencing of 16S rDNA

PCR was used with primer 27F (5'-AGAGTTTGATCCTGGCTCAG-3') [7] and 1492R (5'-TACGGTTACCTTGTTACGACTT-3') [8] Cyclying condition were as follows: initial denaturation at 95°C for 5 min, 30 cycles of 95°C for 30 sec, 55°C for 30 sec, and 72°C for 90 sec, and a final extension of 5 min for 72°C.

2.2.6 Sequence Analysis

The 16S rRNA gene sequences were compared with those from the type strains available in NCBI (http://www.ncbi.nlm.nih.gov/) using the Basic Local Alignment Search Tool (BLAST) [9].

For phylogenetic analysis, multiple sequence alignment was performed using CLUSTALX, version 1.81. Phylogenetic tree was constructed using Mega 7.0 [10]. The consistency of the trees was verified by bootstrapping (1000 replicates) for maximum likelihood.

2.2.7 Data analyses

The experimental results were analysed as a two-way ANOVA with the isolates and with levels of diameters of inhibition zones. All analyses were conducted using the programme MSTATC, Minitab 16. The data were considered significantly different at $P<0.01$. Duncan test at $P=0.01$ was used to differentiate between statistically.

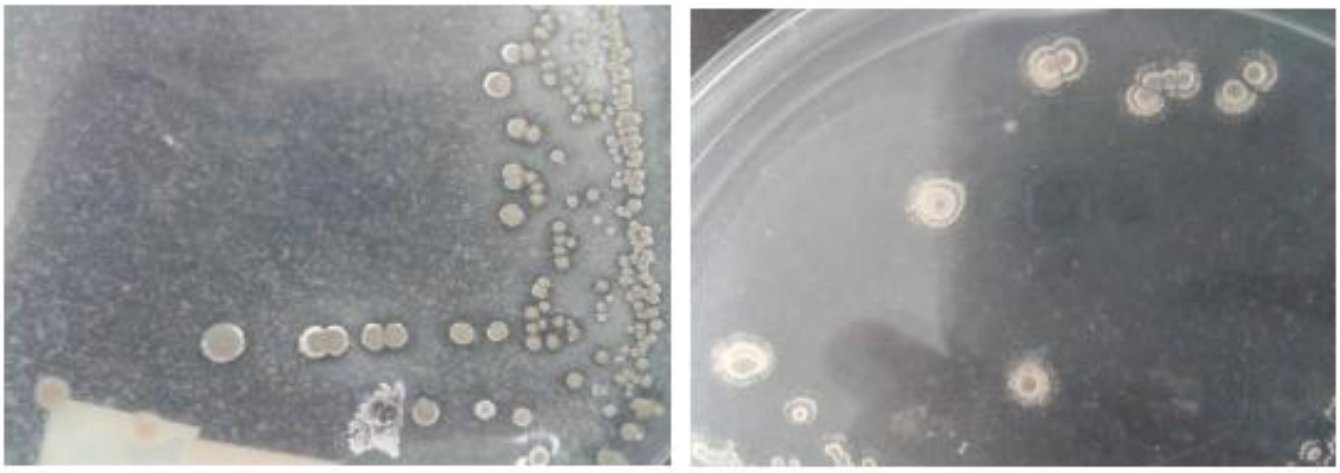
III. RESULTS AND DISCUSSION

3.1 Isolation of bacteria

A total of 53 isolates of bacteria was purified from 8 water samples collected at 3 sites (Long Toan, Phuoc An and Ngu Lac) (Table 1). Almost their colonies have round-shaped; milky, white clear and yellow, entire or loabate margin; diameter size of these colonies varied from 0.2 to 3.0 mm (Figure 1) and all of them have Gram-positive.

TABLE 1
ACTINOBACYERIAL ISOLATES ISOLATED AT THREE SITES ON GAUSE-1 MEDIUM

No	Site	Samples	Isolated Bacterial Isolates
1	Long toan	3	14
2	Phuoc Tri	3	22
3	Ngu Lac	2	17
Total		**8**	**53**

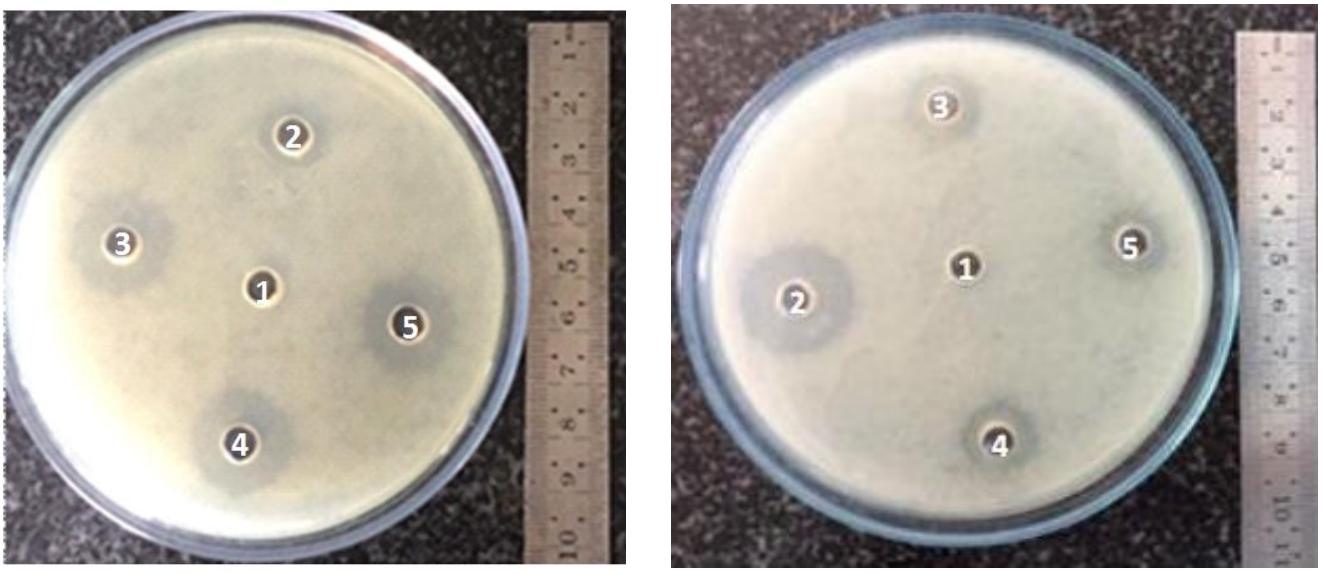


NL1.1.8a **NL1.1.9b**

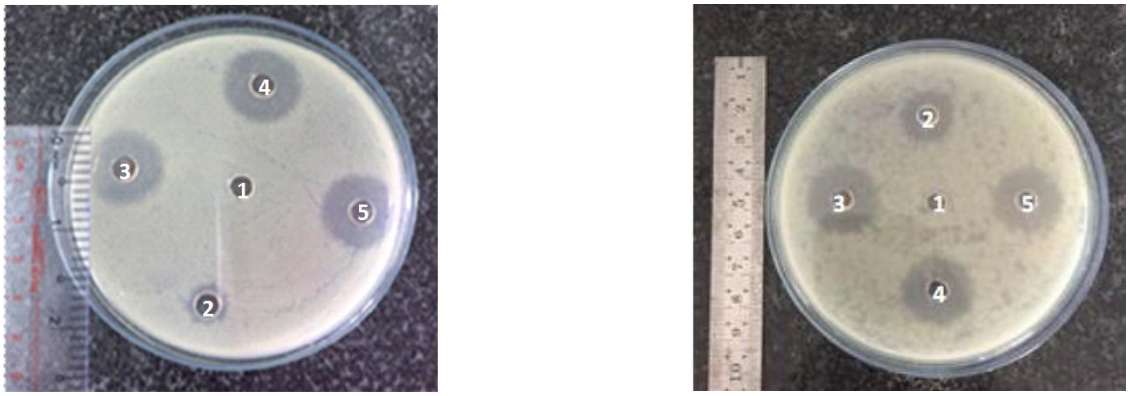
FIGURE 1. Colonies of actinobacterial isolates on Gause-1 medium

3.2 Antimicrobial activity by agar well diffusion method

In 53 isolates, there are 23 isolates produce antimicrobial active metabolites inhibiting at least one of four pathogenic bacteria including *Bacillus cereus*, *Staphylococcus aureus*, *Escherichia coli*, *Vibrio parahaemolyticus* by well-diffusion method (Figure 2) and (Table 2).



(A) (B)



(C) (D)

(1: Negative; 2: Positive with antibiotic; 2,3,4: sample of Actinobacyerial isolates)
(A): Antibacterial activity to Bacillus cereus of NL1-1.9b isolate
(B): Antibacterial activity to Staphylococcus aureus of NL2-2.1b1 isolate
(C): Antibacterial activity to Escherichia coli of NL1-1.8a isolate
(D): Antibacterial activity to Vibrio parahaemolyticus of NL2-2.2 isolate

FIGURE 2. Antibacterial activity to pathogenic bacteria of Actinobacyerial isolates

TABLE 2
ANTIMICROBIAL ACTIVITY OF 23 BACTERRIAL ISOLATES TO PATHOGENIC BACTERIA

STT	Isolates	Antimicrobial activity: inhibition zone diameter [D = d_1 - d_2] (mm)			
		Bacillus cereus	***Staphylococcus aureus***	***Escherichia coli***	***Vibrio parahaemolyticus***
1.	LT1-1.1	-	4.33fg	3.67^{cde}	3.00^{k}
2.	LT1-1.3	8.33^{bc}	-	-	9.67^{cd}
3.	LT1-1.3c	6.00^{fg}	-	-	8.67^{de}
4.	LT1-1.3d	4.67^{gh}	4.33fg	3.00^{e}	6.67^{fgh}
5.	LT2-2.2	-	-	-	7.67^{efg}
6.	LT3-3.3a1	-	-	-	3.33^{k}
7.	LT3-3.3	6.67^{de}	5.67^{ef}	5.00^{cd}	8.00^{def}
8.	LT3-3.3a	3.33^{h}	7.33^{cd}	-	5.33^{hij}
9.	LT3-3.3a2	-	-	-	11.67^{b}
10.	NL1-1.1	6.33^{ef}	6.67^{cde}	3.67^{cde}	-
11.	NL1-1.8a	12.33^{a}	5.67^{ef}	12.33^{a}	11.00^{bc}
12.	NL1-1.9	8.33^{bc}	9.33^{b}	4.33^{cde}	4.00^{jk}
13.	NL1-1.9b	8.33^{bc}	-	9.00^{b}	9.6^{7cd}
14.	NL2-2.1	6.33^{ef}	-	-	-
15.	NL2-2.1b1	-	8.00^{bc}	3.33^{de}	15.00^{a}
16.	NL2-2.2	7.67^{cde}	3.33^{g}	9.00^{b}	4.00^{jk}
17.	NL2-2.2d	4.33^{h}	3.33^{g}	-	-
18.	NL2-2.6a	9.33^{b}	-	-	-
19.	NL2-2.6b	-	8.00^{bc}	-	4.66^{ijk}
20.	PT1-1.7a	6.67^{def}	6.00^{de}	5.33^{c}	6.00^{ghi}
21.	PT1-1.8b	-	-	-	3.33^{k}
22.	PT2-2.8a	-		7.67^{b}	9.33^{cde}
23.	PT3-3.12a	11.33^{a}	-	-	-
control (penicillin)		*8.00^{bcd}*	*11.33^{a}*	*7.33^{b}*	*11.67^{b}*
Total	**23**	**15**	**12**	**11**	**18**
CV (%)		**7.69**	**9.25**	9.45	**7.8**

Means within a column followed by the same letter/s are not significantly different at p<0.01

3.2.1 Antimicrobial activity to *Bacillus cereus*

There are 15 isolates produce antimicrobial active metabolites inhibiting *Bacillus cereus*, (Figure 3)

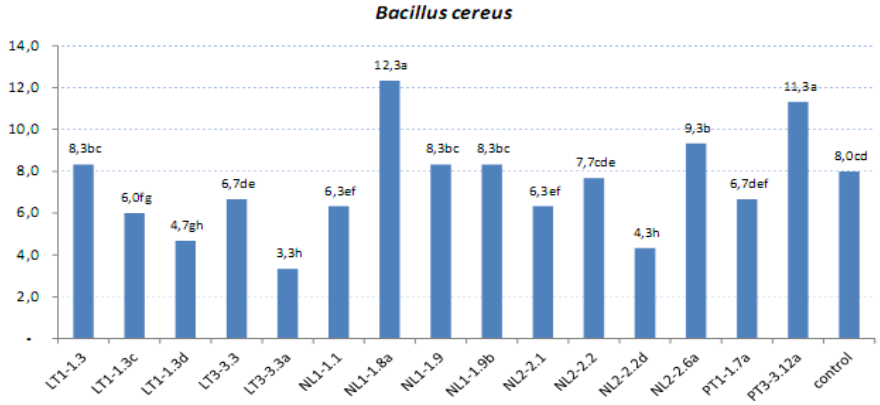


FIGURE 3: Antimicrobial activity of Actinobacyerial isolates to *Bacillus cereus* (inhibition zone diameter -mm)

3.2.2 Antimicrobial activity to *Staphylococcus aureus*

There are 12 isolates produce antimicrobial active metabolites inhibiting *Staphylococcus aureus*, (Figure 4).

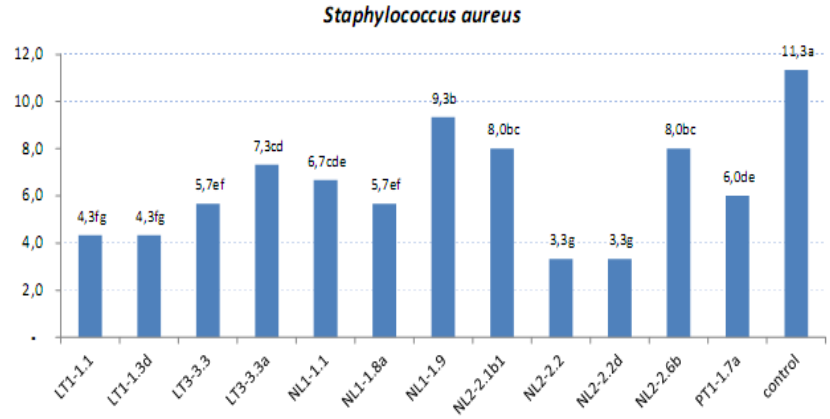


FIGURE 4: Antimicrobial activity of Actinobacyerial isolates to *Staphylococcus aureus* (inhibition zone diameter -mm)

3.2.3 Antimicrobial activity to *Escherichia coli*

There are 11 isolates produce antimicrobial active metabolites inhibiting *Escherichia coli*, (Figure 5).

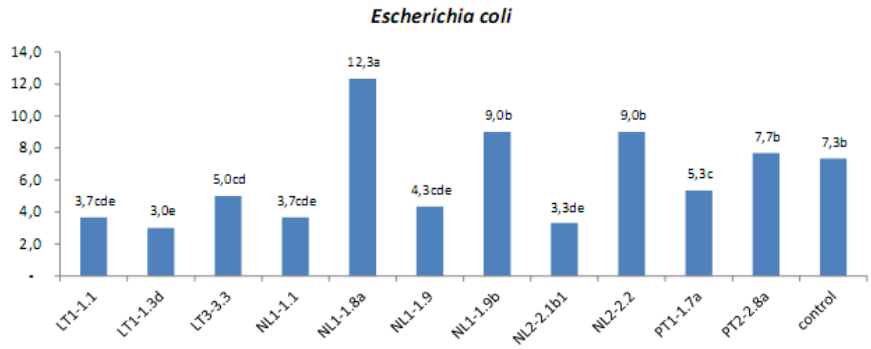


FIGURE 5: Antimicrobial activity of Actinobacyerial isolates to *Escherichia coli* (inhibition zone diameter -mm)

3.2.4 Antimicrobial activity to *Vibrio parahaemolyticus*

There are 18 isolates produce antimicrobial active metabolites inhibiting *Vibrio parahaemolyticus*, (Figure 6).

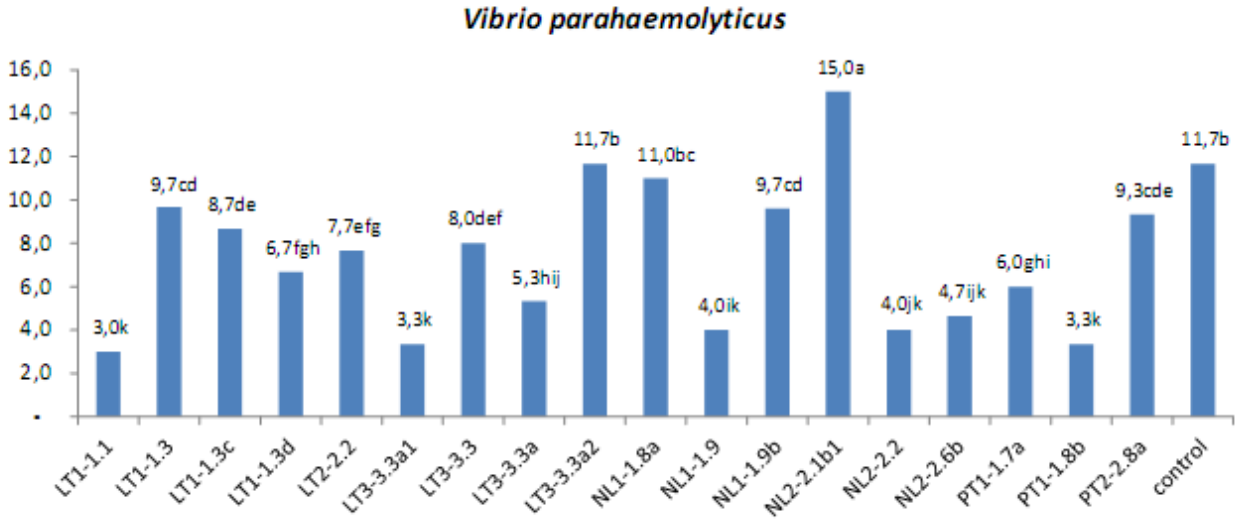


FIGURE 6: Antimicrobial activity of Actinobacyerial isolates to *Vibrio parahaemolyticus* (inhibition zone diameter -mm)

3.3 Identification of bacterial isolates

Seven good bacterial isolates: NL1-1.9, NL1-18a, NL2-2.1b1, NL2-2.2, PT1-1.7a, PT2-2.8a, LT1-1.3 were selected to PCR and sequencing. The result was presented in (Table 3).

TABLE 3
PHYLOGENETIC AFFILIATION OF ISOLATES ON THE BASIS OF 16S rRNA GENE SEQUENCES BY USING BLAST PROGRAMME IN THE GENBANK DATABASE BASED ON SEQUENCES SIMILARITY

Isolate	Closest species relative	Gene length (nu)	Somolarity (%)	NCBI Number
NL1-1.9	*Nocardioides luteus*	1325	99	MH182604.1
NL1-1.8a	*Glutamicibacter uratoxydans*	1281	99	HM625746.1
NL2-2.1b1	*Streptomyces* sp.	1289	99	JF751041.1
NL2-2.2	*Glutamicibacter uratoxydans.*	1280	99	KY938042
PT1-1.7a	*Streptomyces* sp.	1328	99	KJ534269
PT2-2.8a	*Nocardioides luteus*	1326	99	MH182604
LT1-1.3	*Streptomyces cyaneofuscatus*	1328	99	NR_041226

An UPGMA phylogenetic tree (Figure 7) in these strains showing the two clusters: cluster A with 4 strains with 2 strains belonged to genus *Streptomyces* sp. and 2 strains: *Nocardioides luteus* Cluster B had 3 strains among 2 strains: *Glutamicibacter uratoxydans* ans 1 strain *Streptomyces cyaneofuscatus*. Therefore 7 actinobacterial strains belonged to 3 genre as *Streptomyces, Nocardioides* và *Glutamicibacter*.

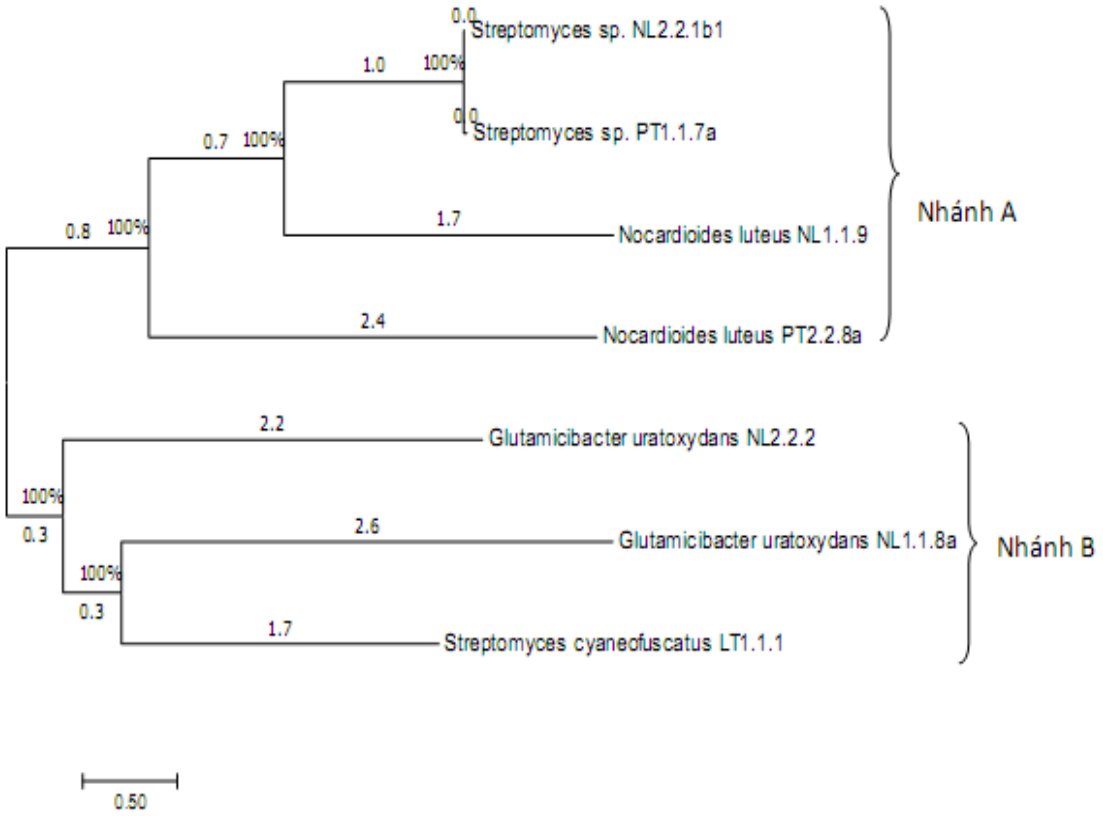


FIGURE 7: UPGMA phylogenetic tree of partial 16S rRNA gene sequences from the bacterial isolates from water pond-shrimp and closely related type strains. Numbers are percentage bootstrap values which were calculated for 1000 replicates. Bar, 0.02 was per nucleotide position.

Previously, the actinobacteria were called actinomycetes, name of greek origin, where aktis means "lightning" and mykes, fungus, or "radgrowth as fungus" that were initially classified as an intermediate group between fungi and bacteria. Investigations with electron microscopy and cytological studies showed that filamentous bacteria are prokaryotic. Since the discovery of actinomycin [11), actinobacteria have been found to produce many commercially bioactive compounds and antitumor agents in addition to enzymes of industrial interest [12]. Approximately, two-thirds of the thousands of naturally occurring antibiotics have been isolated from these organisms [13]. Of them, many have been obtained from Streptomyces [14] and these natural products have been an extraordinary source for lead structures in the development of new drugs [15].

The genus, *Streptomyces*, is responsible for the formation of more than 60% known antibiotics while a further 15% are made by a number of related *Actinomycetes*, *Micromonospora, Actinomadura, Streptoverticillium* and *Thermoactinomycetes* [16]. *Actinomycetes* centered mainly on their ability to form antibiotics.

In fact, the distributions of actinomycetes in the sea remain largely undescribed, and even today, conclusive evidence that these bacteria play important an ecological role in the marine environment has remained elusive. Speculation regarding the existence of indigenous populations of marine actinomycetes arises because these bacteria produce resistant spores that are known to be transported from land into the sea where they can remain viable but dormant for many years [17]. In the recent years, the value of marine sediments as a resource of rich actinobacteria and they produce secondary metabolites [18]. According to [19] cho rằng *Streptomyces* Marine *Streptomyces* occur in different biological sources such as fishes, molluscs, sponges, seaweeds and mangroves, besides seawater and sediments. From the Indian peninsula, 41 species of actinobacteria belonging to 8 genera have been recorded. The genus, *Streptomyces* of marine origin has been more frequently recorded. Of 9 maritime states of India, only 4 have been extensively covered for the study of marine actinobacteria [15]. Bioactive compounds from marine actinobacteria possess distinct chemical structures that may form the basis for synthesis of new drugs that could be used to combat resistant pathogens. With the increasing advancement in science and technology, there would be a greater demand for new bioactive compounds synthesized by actinobacteria from various marine sources in future [20]. In this study, we discovered actinobacteria strain against positiva-gram bacteria and negative-gram bacteria as *Glutamicibacter uratoxydans* strain NL1-1.8a and we will identify structure of bioactive compound by GC-MS method in the future.

IV. CONCLUSION

Fifty-three actinobacteria isolates isolated from 8 water samples of 3 sites of schrimp-pomfs, identying 17 isolates produce antimicrobial active metabolites inhibiting positiva-gram bacteria and negative-gram bacteria. Seven actinobacteria strains as: NL1-1.9, NL1-18a, NL2-2.1b1, NL2-2.2, PT1-1.7a, PT2-2.8a, LT1-1.1 belonged to 3 genera: *Streptomyces, Nocardioides* and *Glutamicibacter.*

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Proliferation of *Citrus aurantifolia* by In Vitro Epicotyl Segment Culture

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Abstract— *It is clear that, beneficial species of Citrus need to improvement especially by new methods due to limitations of conventional methods. New methods like biotechnology and gene transfer need to establishment of regeneration plants by tissue culture. Shoot proliferation in Citrus is easy but rooting of proliferated micro shoots has been discussed in various articles. The goal of this study is presentation of a proper method for rooting of micro shoots in Citrus by manipulation of media content. Hypocotyl segments of Citrus aurantifolia from 45 day old seedlings and 0.5 – 0.7 cm in length were cultured on MS media supplemented with different kinds and concentrations of plant hormones suitable for shooting and rooting such as BA, IBA and NAA alone or together. 1 mg/l BA and 1.5 mg/l NAA on MS media was the best treatment for shooting and rooting respectively. In this study we can overcome one of the most important problems of establishing regeneration system in Citrus and opening the way for biotechnology and gene transfer for this important and economic plant*.

Keywords— Citrus aurantifolia, gene transfer, rooting, shooting.

I. INTRODUCTION

Citrus fruits duo to extremely pleasant aroma and taste also effect on human health for its useful substances, which is one of the most important fruits in Iran like all over the world. There are many biotic and abiotic stresses that have negative and harmful effects on cultivation of these valuable horticultural products. For example fungal diseases that cause significant problems in the production of *Citrus* fruits, such as postbloom fruit drop, caused by *Colletotrichum acutatum*; Alternaria brown spot, caused by *Alternaria alternata*; scab diseases, caused by *Elsinoe fawsettii* and *E. australis*; melanose, caused by *Diaporthe citri*; and greasy spot caused by *Mycosphaerella citri*[1][1] and bacterial diseases such as *Citrus* canker, *Citrus* variegated chlorosis, and Huanglongbing (HLB) that caused by members of the bacterial species *Xanthomonas citri*, *Xylella fastidiosa* and '*Candidatus Liberibacter*' respectively[2] and Virus and Virus – Like diseases as *Citrus Tristeza Virus* (CTV), *Citrus Psorosis* (CPV), *Citrus Exocortis Viroid* (CEVd), and also some of the agents pathogen such as Candidatus *Phytoplasma aurantifolia* that causes WBDL (Witches Broom Disease) [3 and 4]. Some of these diseases are very important in Iran. So it is very clear that *Citrus* industry mainly need to a strong program for improvement for supply of new cultivars with desirable characteristics like resistance against diseases.

Conventional breeding methods have demonstrated limitations with respect to *Citrus* improvement due to some of the biological characteristics of woody plants such as nucellar polyembryony, high heterozygosity, long juvenile period, and auto incompatibility [5 and 6].Genetic engineering of *Citrus* presents the possibility to produce *Citrus* plants with resistance to different diseases. Genetic engineering needs to viable shoots which can be regenerated via organogenesis firstly.

Regeneration of plants from single cells and complex explants is therefore the key process in every genetic manipulation work; unless this can be achieved consistently and efficiently, no genetic improvement by somatic methods is possible. To accomplish this, a source of genetically homogeneous cells and tissues is necessary. Micropropagation cultures are an ideal source of homogeneous cells and tissues and this system is useful for the propagation of plants emanating from experiments of genetic variation [7]. So we need to a proper regeneration system via regeneration of shoots and roots and whole regenerated plants finally for gene transfer protocols.

There are several reports indicative problems of rooting of regenerated shoots in *Citrus* [8; 9 and 10]. It is clear that, this seemingly insignificant problem complicates the transformation process. Therefore optimizing as much as possible of regeneration systems is necessary. The goal of this study is presentation of simple and repeatable proliferation system for one of the most important species of *Citrus* (*Citrus aurantifolia*).

II. MATERIAL AND METHODS

These experiments were conducted in Iranian Research Institute of Plant Protection, Agricultural Research, Education and Extension Organization (AREEO), Tehran, Iran during April to October 2019.

2.1 Preparation of sterile seedlings and explants

Seeds of [*Citrus aurantifolia* (lime)] were sterilized with commercial hypochlorite sodium for 60 min. Then in order to complete removal of harmful effects of disinfectant, seed were rinsed with sterile distilled water 4 – 5 times. Seeds were incubated in dark and in sterile distilled water for 72 h. Afterwards seeds were cultured on MS (Murashige and Skoog 1962) [11] medium without Plants Growth Regulators for 30 days in dark and 10 days in room light and 25 ± 2ºC respectively. All steps were done in a laminar airflow cabinet. For preparation of explants, epicotyls of sterile seedlings were cut (0.5 – 0.7 cm in length). A figure of sterile seedling is presented in Fig. 1.

FIGURE 1: Seedling of *Citrus Aurantifolia*

2.2 Media and other conditions of experiments

Explants were cultured on MS basal media supplemented with different kinds of Plant Growth Regulators such as BA alone or with NAA for shooting and NAA,IBA and BA for rooting. Also all of media contained 30 g/l sucrose and 7/5 g/l bacteriological agar that were added to media after adjusting their pH on 5/8 media autoclaved for 20 min at 121ºC.

2.3 Experimental design and data analysis

Experiments were conducted in a completely randomized design. Data were analyzed by Dunkan Multiple Range Test.

III. RESULTS AND DISCUSSION

3.1 Shoot regeneration

The results of Table 1 showed significant effect of different concentrations of BA alone or plus NAA (especially alone) on adventitious buds induction, growth of them and proliferation of micro shoots on epicotyl explants. A lot of adventitious bud and micro shoots formed at both ends of the explant on MS media supplemented with different concentration of BA directly or with very small amount of callus (Fig. 2).

TABLE 1
EFFECT OF DIFFERENT CONCENTRATIONS OF BA AND NAA ON SHOOT PROLIFERATION PERCENTAGE, NUMBER OF SHOOT PER EXPLANT AND AVERAGE OF SHOOT LENGTH

PGRs (mg/l)		Explants with shoot proliferated	Number of shoot/explant	Average of shoot length
BA	NAA			
1	0	99[a]	6.453[a]	3.667[a]
2	0	91[b]	5.194[b]	3.541[a]
3	0	95[ab]	6.001[ab]	3.332[a]
1	0.01	97[ab]	5.219[b]	3.441[ab]
2	0.01	95[ab]	6.476[a]	2.996[b]
3	0.01	97[ab]	5.553[a]	3.001a[b]

Mean followed by same letter(s) are not significantly different

So we can result that gradient endogenous plant hormonal of this plant had no effect or had low effect on shoot organogenesis. The advantage of using the conjugate system of BA as PGRs (Plant Growth Regulators) or plant hormone and epicotyl as explant has been mentioned in tissue culture and biotechnology (gene transfer) program in *Citrus* [12 ; 13; 14 ; 15 ; and 16]. Also the results showed that there is not a direct relationship between the concentration of BA and quantity and quality of shooting. The results were reported by Dejam *et al*., [17] are similar to this study (0 – 2 mg/l) and opposed (2 – 4 mg/l) for another species of *Citru*s genius, Bakrai (*Citrus reticulata* Blanco × *C. limetta* Swing). Apparently it seems that the concentrations of BA more than 2 mg/l have preventive effects on the majority of *Citrus* species. Sometimes and few instance it seemed that on media with 2 mg/l BA or more the number of regenerated shoots were more but with very small leaves (Fig. 3) and also the best results of the number of proliferated shoots, dimension of leaves and plantlet regeneration were resulted on media with 1 mg/l BA (Fig. 4). One of the best results of our experiments was the effect of media supplemented with BA on proliferation of micro shoots and longitudinal length of them (Fig.5). Therefore we did not need to subculture of explants on media proper for elongation of micro shoots.

3.2 Root regeneration

Different kind and concentrations of plant hormones were tested for rooting of regenerated micro shoots in this study and micro shoots were cultured on the mentioned media. The results of Table 2 showed that NAA is the one of the best of these hormones for rooting. On MS media with 1.5 mg/l NAA 99% micro shoots rooted after 14 – 20 days in culture practically (Fig.6). Also on other media that were contained other plant hormones such as IBA and BA (asauxin), the rooting was observed also. These roots was long, white and thick, but versus the roots on media with 1.5 mg/l, NAA they were fewer in number (Fig. 7). And the best and the most complete whole plantlets were obtained on this media (that they contained NAA as auxin) extremity (Fig. 8). The important point here is facility of rooting of micro shoots. There are many reports that showed rooting of micro shoots in *Citrus* species is not easy [18; 19 and 20]. Soheilivand *et al*., in order to rescue rootles micro shoots of sour lime (*Citrus aurantifolia* L.) used microgragfting method. It is clear that rooting of micro shoots on tissue culture media and subculture of explants from shoot induction media to root induction media is very easier method with microgragfting method. This method need to evaluate many factors for achievement such as size and type of scions, grafting type, micro grated plantlets and usage of nutrient media [20].

TABLE 2
EFFECT OF DIFFERENT CONCENTRATIONS OF BA AND NAA ON ROOT PROLIFERATION PERCENTAGE, NUMBER OF ROOT PER EXPLANT AND AVERAGE OF ROOT LENGTH

PGRs (mg/l)			Explants with root proliferated	Number of root/explants	Average of root length
NAA	IBA	BA			
1	0	0	99[a]	3.75[ab]	2075[b]
1.5	0	0	99[a]	4.2[a]	3.23[a]
2	0	0	93[b]	3.33[b]	2.74[b]
0	1	0	74[c]	1.29[d]	2.55[b]
0	1.5	0	44[ed]	1.88[cd]	1.99[c]
0	2	0	38[e]	0.77[e]	1.84[c]
0	1	0.2	55[d]	2.46[bc]	1[cd]
0	1.5	0.3	51[d]	2.51[bc]	1.33[c]
0	2	0.3	29[f]	0.84[e]	0.92[d]

Mean followed by same letter(s) are not significantly different

3.3 Whole plantlet regeneration

Rooted micro shoots or whole plantlets after initial hardening in sterile perlite were transfer to disposable glasses containing of sterile pot soil. The glasses were covered with another glass in order to moisture retention and placed in lab for a few days. The covers were perforated daily and step by step. Maximum survival was 85% and plants grew well and acquired new leaves.

IV. CONCLUSION

Biotechnology programs and gene transfer studies need to establishment of a proper, repeatable and easy plant regeneration method by tissue culture systems. Proliferation of shoots in *Citrus* species is feasible but rooting of proliferated shoots and whole plantlets regeneration need to optimizing of method as it mentioned in discussion sections. In this study we present a simple and repeatable method for rooting of regenerated micro shoots in *Citrus* so it was prepared an introduction of gene transfer program in this very important species in order to attaining new cultivars.

FIGURE 2-8: Plantlet regeneration of *Citrus aurantifolia* on MS media with different kinds and concentrations of PGRs. 2. Shoot proliferation on MS media supplemented by 1 mg/l BA. 3. Shoot proliferation on MS media supplemented by 2 mg/l BA. 4 and 5. Growth and foliation of micro shoots on MS media supplemented by 1 mg/l BA. 6. Rooting of micros hoots on MS media supplemented by 1.5 mg/l NAA. 7. Weak rooting of micro shoots on MS media with 1 mg/l IBA and 0.3 mg/l BA (the arrows show only 2 roots). Whole regenerated plantlet of *Citrus aurantifolia*).

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Impact of Technology on Improving Cassava Yield and Value

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Abstract— *Many cassava farmers suffer from low production and low profit because of little or no support in terms of improved technology to improve yield and add value to their produce. In this paper we examined the available improved production and processing technologies among cassava farmers and how they are propagated and used in Momo Division. Descriptive survey research design was used, and primary data was collected using the purposive and random sampling techniques from a sample size of 350 respondents. Data were extracted through excels and computed using the SPSS.20 software. The results of this study revealed that most producers (35%) were in Mbengwi Sub Division, the majority (76%) were women, most of them (71.2%) were married; have had primary education (51.8%); fell within the active age range of 31- 50 years. Households with children were majority (93.64%) and relied on family labor. Hypothesis testing results attested that some techniques like the use of improved varieties and planting distances were well propagated, while the use of mechanized equipment, fertilizers and pesticides were very minimal. All categories of the variables studied, occurred with equal probabilities with one sample Chi – Square test at 0.05% level of significance. Suggestions were made to all actors, to ameliorate the situation by improving on the social amenities, road infrastructure; farm cultivation and processing equipment, seed material, and capacity building of farmers to make them more self-sustaining.*

Keywords— Cassava, propagation, use, improved technology, production, value chain.

I. INTRODUCTION

Cassava (*Manihot esculenta* Crantz) a perennial food crop, grown throughout the lowland tropics is a useful major source of carbohydrate, starch, vitamins and iron. It is not traded internationally in its fresh state because the tubers deteriorate very rapidly (FAO STAT, 2017). According to Mvondo and Liang (2012), cassava serves as raw material for more than 80 industrial products worldwide and is used for human consumption, animal feed and industries. It is also said to be more productive per unit of land and labor than even the high yielding cereals, (Nweke, 2004). The increased demand for cassava and its products necessitates increased production and yields. Cassava processing as one of the off-farm activities of rural women in this area of study is carried out using local methods with the hand grater, while the use of improved technologies seems to be insufficient. According to IITA (2013), it is necessary to device and propagates improved techniques capable of increasing the income generating capability of cassava producers while promoting the marketability of cassava products. These studies had been conducted in some countries (Sewando et al., 2011; Donkor et al., 2018). Published works on such studies in Cameroon and particularly Momo Division are scanty in literature. We hope that this study shall bring more insight to the cassava value chain. The main objective of this research activity is to evaluate the factors that influence the propagation and usage of improved technologies by cassava farmers, and specifically to characterize cassava farmers in the study area, examine the availability, level of propagation and usage of these technologies and suggest solutions that can better explain the relationship between the variables studied to better explain the results. The results would help to suggest what can be done to fasten farmers' use of these technologies.

II. METHODOLOGY

Momo administrative unit is one of the seven Divisions of the North West Region of Cameroon, with Mbengwi, Ngie, Batibo, Widikum and Njikwa as Sub Divisions. This area covers a surface area of 1790 km^2 and population of 194,080 inhabitants (INS, 2019). It is geographically located between latitude 5^0 45'N and 6^0 15'N and longitudes 9^0 40'W and 10^0 10'W. The climate has two main seasons; a rainy season from mid-March to mid-November and a dry season from mid-November to mid-March. Average daily temperatures for the year range from 09.97 ^{0}C to 24.12 ^{0}C, with maximum and minimum daily temperatures of 26.83 ^{o}C and 08.24 ^{0}C respectively (DDARD Momo Annual report, 2017). The soils play a very important role in the type of crops grown, and are generally volcanic and ferralitic. The growth of cassava among many other crops like perennials, cereals, vegetables, fruits and none timber forest products is highly favored by the good climate, vegetation and rich soil types.

Using the purposive and random sampling and verifying with the Yamane Theory, (1967) formula for sample size determination, a sample size of 350 respondents was taken from a population of 3320 cassava farmers, staff of MINADER, Traders of cassava and cassava products and some stakeholders. Three hundred and fifty questionnaires were administered to the respondents while qualitative information was got from observations, interviews and discussions with farmers during field visits in the five Sub Divisions.

2.1 Data Analysis

Descriptive statistics using percentages, mean and standard deviation were used. The data collected during this study was extracted using excel, and then coded and analyzed with the use of excel and the Statistical Package for Social Sciences (SPSS) version 20. The frequencies and percentages were computed to show the weight of some variables, and the chi square test of significance was used to determine whether there was any significant relationship between the independent and the dependent variables. This also helped to appreciate the links among variables.

III. FINDINGS AND DISCUSSION

3.1 Propagation of improved technologies and characterization of Cassava Farmers

Farmer distribution according to farm location revealed more cassava farms (35%) in Mbengwi Sub division, followed by Batibo with 26%, Widikum with 19%, Njikwa with 17%, and Ngie with 3%. Mbengwi farmers concentrate in cassava production because cassava is their main income generating food crop. Sub Divisions like Ngie have other important economic crops like oil palm, cocoa and coffee that make them to divert from cassava. The soils in Momo and the hilly nature of the land scape tolerate cassava production. This finding confirmed that of Elliott in 2017, that cassava is one of the most drought tolerant crops that can grow on low fertile soils on marginal land.

Findings on gender distribution of farmers revealed that more women (76.59%) were involved in cassava production and processing than men, (23.41%). This agrees with the findings of Mouafor et al. (2015), that 90% of cassava producers are rural poor women. This can be explained by the fact that men concentrate mostly on non- food crop farming activities, and the fact that women are usually patient in house hold and farming activities in this study area. It is also confirmed by (ECAM 111, 2008), that women constitute about 60% of the total labor force. This finding contrasts the result of (Akerele et al., 2018) that majority of cassava farmers are men. Age distribution revealed that most farmers fell within the active and productive ages of 31-40, (29.10%) and ages of 41-50, (32.44%). It can be understood that at this age, they are parents looking for means to sustain their families, and should be more active than the younger ones of 21-30 years (17.39%), who are school goers. Also older people of 51 years and above (21.07%) may be tired and retired from farming activities. Results from Akerele et Al., 2018 confirm the active age bracket of 31-50 years as the normal age for the working population.

Findings showed that the majority of farmers were married (71.24%) meaning that couples can work better as father and mother. Akerele et Al., 2018, also confirm that 46.9% of farmers are married with responsibilities to their families. This indicated that cassava as an economic crop is a source of income for couples to pay their children's school fees, medical costs and other basic family needs. The unmarried (11.71%) and widows (13.71%) who had the double responsibility of being father and mother at the same time, also strived to look for money to take care of their families, while the divorced (1.34%) and widowers (2%) were few in this farming activity. Religion was absent (0%), and this could be explained by the nature of their activities of preaching the word of God hence it did not influence the cassava value chain activities. However, as highlighted by Apata, T. G. (2019), Religion played a greater role as Muslims were majority in cassava farming then the Christians.

Most farmers fell within primary education level (51.84%), and when this number was compared to no formal education level of (11.71%), it meant that many aspects of improved technologies were understood by the majority, even though it could be much better with secondary Education (24.41%), higher education (4.01%) and others (8.03%). This indicated that farmers need more training to build up their capacities to better understand new improved technologies in the cassava value chain activities. Studies by Akerele et al. (2018) revealed that majority of farmers (68%) only attended primary education.

Results of household size indicated that many families had large house hold sizes of close to 7 members in each (66.56%), indicating that family labor in this case could be assured as well as increased yields. This result is also in line with those of Akerele et al. (2018) who had house hold size of between 6- 10. Results of household composition revealed that most households had children 909, followed by households with adults only 676. Though these children could be intercepted by school, some may have dropped out of school to carry out cassava farming activities to earn a living, and also provide labor

for their parents. They could also help during non- schooling hours and during holidays. According to the Cameroon's National Institute of Statistics (NIS, 2015) as quoted by Gildas and Manu, (2015), 41% of children from 5-17 years old are involved in child labor and 85% of them work in the agricultural sector. The number of household's members involved in cassava farming from both households (896), indicated that the majority of members in each of these households were involved in improved cassava production, processing and marketing. From this finding, most households propagated and used improved technologies in their farms and this explains why family labor was mostly used in the various activities of the cassava value chain.

3.2 Propagation and Usage of improved Technologies amongst Cassava Farmers

3.2.1 Available Social Amenities

Social amenities are needed to facilitate cassava production, processing and marketing activities. Electricity is essential for lighting of homes, running motorized processing engines, and other activities like pumping of water which is essential for all farm activities. A good road network is necessary for easy transportation of farm inputs and produce. Good storage facilities and effective preservation methods are also needed. Findings (Table 1) revealed that markets (292), hospitals (283), potable water (224), electricity (214) and regular schools (180), were available, but there was a remarkable insufficiency of electricity in areas like Njikwa and Ngie Sub Divisions. Sub Divisions like Mbengwi (85), Batibo (75), and Widikium (41) had electricity that was subjected to frequent power cuts. In all Sub Divisions, the insufficiency of research institutions was a limiting factor. The presence of public taps with water, regular schools, markets, and Professional schools had a positive impact. According to (GP-DERUDEP, 2015), social amenities like good roads, markets, Bridges, schools, drying platforms and food processing units in the Widikum basin were necessary to enhance crop production.

TABLE 1
AVAILABLE SOCIAL AMENITIES IN THEIR LOCALITIES

Location	Public tap with water	Electricity	Solar Power Plants	Regular school	Professional school	Research institution	Local market	Hospital	Others
Ngie	6	1	2	0	0	0	9	8	2
Mbengwi	75	85	35	46	42	0	104	98	38
Batibo	68	75	5	68	0	1	72	73	12
Njikwa	33	12	19	37	4	3	50	48	4
Widikum	42	41	15	29	0	1	57	56	9
Total	**224**	**214**	**76**	**180**	**46**	**5**	**292**	**283**	**65**

3.2.2 Tools Used in the Farm

Findings in table 2 indicated that, there was insufficient or no mechanized tools like tractors in the study area, as no cassava farmers (0) possessed them. However under others were power tillers, locally made cassava peeling and grinding machines and few food processing machines (170), which indicated the presence of improved technologies. The use of rudimentary tools like cutlasses and hoes (299) were very significant as from all indications, all cassava farmers possessed them. They were mostly used during the harvesting of cassava, in the absence of harvesters.

TABLE 2
TOOLS USED IN THE FARM

Location	Cutlasses	Hoes	Digger	Tractor	Hand Cart	Others
Ngie	9	9	1	0	0	0
Mbengwi	105	105	8	0	1	63
Batibo	76	76	0	0	0	71
Njikwa	51	51	0	0	0	11
Widikum	58	58	10	0	0	25
Totals	**299**	**299**	**19**	**0**	**1**	**170**

3.2.3 Use of Improved Cassava Seed Material (Cuttings)

Most farmers (64%) used improved cassava varieties while (36%) preferred the local varieties mostly in Mbengwi Sub Division. Farmers in the other four localities used more improved cassava varieties which were mostly Team 419, 8034 and TMS 92/0326 provided by IRAD, in collaboration with IITA. Cameroon's National Development project for Roots and

Tubers (PNDRT) 2014, estimated yields between 19-35 tons per hectare for improved varieties, compared to local varieties that are limited to 8 tons per hectare. Interviews with Mbengwi farmers, who processed cassava roots, indicated that they preferred the local varieties, because of the whiter colour of the products, despite the lower yields.

3.2.4 Planting Method

Most of the farmers (96.32%) made ridges before planting meaning that they actually followed the recommendations from the agricultural extension agents as ridging is an improved planting method. This method requires much labor, and that is why cassava production is considered time consuming and tedious. Those that planted on flat surfaces were mainly in Widikum Sub Division because tree roots in this forest area made ridging difficult. Ridging gives the cassava plant a larger surface area on which the roots can freely penetrate deeper to their satisfaction.

3.2.5 Planting Distances

Findings in table 3 show that most farmers (230) maintained planting distances of 51cm to 100cm between rows, and (173) maintained 76cm to 100 cm within rows. This showed that they followed planting distances of 1m by 1m (100cm by 100cm) for cassava, as recommended by the agricultural extension agents. The main reasons for the deviation of 8.9 of the planting distances between rows in Table 4 and of 22.7 within rows on Table 5 could be explained by the fact that farmers usually like to economize land space by shortening planting distances. This technique seems to be well understood by cassava farmers, despite the slight deviation from the normal.

TABLE 3
PLANTING DISTANCES

	Between Rows				Within Rows			
Location	**0-50cm**	**51-100cm**	**101-150cm**	**151-200cm**	**0-25cm**	**26-50cm**	**51-75cm**	**76-100cm**
Ngie	0	2	5	2	0	6	3	0
Mbengwi	0	83	12	10	0	60	18	27
Batibo	6	65	3	2	0	4	0	72
Njikwa	2	38	10	1	0	23	10	18
Widikum	0	42	16	0	0	2	0	56
Totals	**8**	**230**	**46**	**15**	**0**	**95**	**31**	**173**

TABLE 4
DEVIATION OF PLANTING DISTANCES BETWEEN ROWS

Location	No. of farmers	Mean distance between rows/cm	Over all mean distance/cm	Standard deviation
Ngie	9	125	86.6	8.9
Mbengwi	105	90	86.6	8.9
Batibo	76	75.7	86.6	8.9
Njikwa	51	86.5	86.6	8.9
Widikum	58	88.8	86.6	8.9
Totals	**299**	**466**		

TABLE 5
DEVIATION OF PLANTING DISTANCES WITHIN ROWS

Location	No. of farmers	Mean distance within rows/cm	Overall mean distance/cm	Standard deviation
Ngie	9	46.3	69.5	22.7
Mbengwi	105	55.1	69.5	22,7
Batibo	76	85.4	69.5	22.7
Njikwa	51	60.5	69.5	22.7
Widikum	58	86.3	69.5	22.7
Totals	299			

3.2.6 Weeding Techniques

Most farmers (282) weeded their farms by hand picking. The method of weeding was greatly seen to depend on the cost of the herbicide as the minority (47), used herbicides, while 26 used both hand picking and herbicide. This shows that the technique was not actually very well propagated and used.

TABLE 6
TECHNIQUES USE IN WEEDING FARMS ACCORDING TO THE DIFFERENT LOCATIONS

Location	Hand picking	Herbicides	Both hand picking and use of herbicides
Ngie	9	1	1
Mbengwi	100	19	13
Batibo	73	8	5
Njikwa	47	6	1
Widikum	53	13	6
Totals	**282**	**47**	**26**

3.2.7 Quantity of Herbicide Used Per Cropping Cycle

Quantities used between 1 and 9 litres have little variation, showing that the chemical was actually available, but not well propagated. This could also be explained that herbicides are expensive at the level of the farmer. Here the majority of respondents (83.6%) preferred to limit the cost of production by not using at all, as compared to16.4% that used 1 to 9 litres and above. This is therefore one of the least propagated technologies in this area of study.

TABLE 7
QUANTITY OF HERBICIDE USED

Location	1-4 litres	5-8 litres	9 litres and above	None of the above
Ngie	0	1	0	8
Mbengwi	6	11	4	84
Batibo	8	0	0	68
Njikwa	1	2	3	45
Widikum	5	4	4	45
Totals	**20**	**18**	**11**	**250**
Percentages	**6.7**	**6**	**3.7**	**83.6**

3.2.8 Type of Substance Used to Improve Soil Fertility

Findings indicate that most farmers (203) did not apply any input to improve soil fertility. Farmers who used manure (71) were more than those who used chemical fertilizers (58). This could be explained by the high prices of chemical fertilizers in the market, (Annual Report of DDARD Momo 2018), and more accessibility of manure to farmers. Those using both manure and chemical fertilizer were least (32), indicating that farmers actually improved the soil in their cassava farms. Little or no fertilizers were used in Ngie, Njikwa and Widikum as compared to Mbengwi, Batibo and Widikum, where organic fertilizers were mostly used. This indicates that this technology is actually understood, but insufficiently propagated and used.

TABLE 8
TYPE OF SUBSTANCE USED TO IMPROVE SOIL FERTILITY

Location	Manure	Fertilizer	Both	none of the above
Ngie	0	1	0	8
Mbengwi	32	36	20	58
Batibo	19	8	4	53
Njikwa	9	5	3	40
Widikum	11	8	5	44
Totals	**71**	**58**	**32**	**203**

3.2.9 Quantity of chemical fertilizer Used to Fertilize the Soil

Chemical inputs used by cassava farmers varied and the high cost could have been the determining factor because of the fact that few respondents (79), used above 50Kg, (16) below 50Kg, while, the majority (204) did not use any quantities at all. Most of the farmers in the study area, felt that their soils could give better yields, even without adding fertility, but those who added fertility to the soil acknowledged that the yields were higher. Studies carried out by (Kuehne, 2017), confirmed that the main constraints to cassava production were the high cost of fertilizer and agro- chemicals.

3.2.10 Methods Used to Fight Cassava Diseases

Findings in (Table 9) indicated that cassava diseases were common and farmers fought these diseases, by the use of insecticides, fungicides and nematicides at very low levels. The variation between the uses of the three pesticides was not much in this study, but many farmers (231) did not use any pesticide at all, and did not fight against cassava diseases. Findings showed that the high cost of pesticides, was the determining factor here. Another reason was the good cultural practices of keeping the farms clean, in rich soils that enhanced the cultivation of cassava giving good yields even without the use of pesticides. Same studies carried out by Akerele et al., 2016, showed that the adoption of herbicides, fertilizers, pesticides, modern processing and storage techniques in cassava farming were relatively low.

TABLE 9
METHODS USED TO FIGHT AGAINST CASSAVA DISEASES

Location	Insecticides	Nematicides	Fungicides	None of the above
Ngie	1	1	1	8
Mbengwi	17	5	18	81
Batibo	3	16	2	57
Njikwa	6	4	3	44
Widikum	17	1	9	41
Totals	**44**	**27**	**33**	**231**

3.2.11 Source of Labor

Findings show that most of the respondents (93.64%) relied on their families for labor, while 26.09% used hired labor, and 18.73% used both family and hired labor. This was assured by the higher house hold sizes already discussed. Njukwe et al., 2014, also reported that production at house hold level in Cameroon is characterized by small farm sizes, relying on family labor for processing, in order to meet family food requirements and generate income.

3.2.12 Access to Credit Facilities

Findings show that 36% of respondents had access to credit facilities as compared to no access with 64%. This indicated that credit facilities were available, but farmers did not have adequate access to, because of the numerous requirements attached to the acquisition of these credits. Some farmers also did not always pay back their loans on time causing financial institutions to become strict on them.

3.2.13 Farmers who Process Cassava Roots

About 86.62% of respondents processed their cassava while 13.38% did not. Cassava root is a highly perishable food stuff that cannot stay for long if not transformed to other products (FAO STAT, 2017). Farmers confirmed that processing made cassava products easy to store and less bulky to transport.

3.2.14 Processed Products from Cassava Roots

Findings on table 10, showed that garri (224) was the highest processed cassava product, followed by “water fufu”, cassava flour (“Kumkum”), and “bobolo”. Others included products like starch, cassava cake, cassava coki, accra cassava etc. Methods used to process cassava roots into garri which was the main product, involved pilling, washing, grinding, tying in bags, squeezing to remove water, sieving, and frying. Cassava flour “Kumkum”, “water fufu”, “bobolo”, starch and other

products were also processed. As highlighted by Gray Smith 2017, processing helps to eliminate the cyanide substance in cassava, which can be very poisonous if cassava is eaten rough.

3.2.15 Use of Processed Cassava Product

From this study, 85.62% of the farmers processed their cassava mainly for the market, 82.28% processed for consumption, while 82.62% of the farmers processed for both market and consumption. The two reasons for processing cassava roots did not vary much as the distributions were all above 80%, but producing for the market was higher than for consumption, due to the fact that marketing of cassava products gave more income to farmers than the marketing of fresh roots.

3.2.16 Advantages from Processing Cassava Roots

Most farmers (53.85%) processed their cassava roots so as to increase income by selling the products at higher prices, 33.78% processed to give the product a longer shelf life and made storage easier, 29.10% processed to improve on the nutritional state of the cassava, 26.42% processed to sell faster and 4.35% processed to reduce loss from the roots. However 21.40% processed for other reasons, some of which were to ease packaging and transportation.

TABLE 10
PROCESSED PRODUCTS FROM CASSAVA ROOTS

Location	Garri	Water fufu	Kumkum	Bobolo	Others
Ngie	2	2	0	0	0
Mbengwi	86	63	32	5	12
Batibo	60	41	19	1	16
Njikwa	29	17	6	2	2
Widikum	47	34	11	0	3
Total	**224**	**157**	**68**	**8**	**33**

3.2.17 Uses of Cassava Roots by Those Who do Not Process

Farmers who did not process their cassava either consumed or sold the roots. Findings revealed that all respondents from Ngie processed their cassava roots, while nearly all of Batibo processed their cassava roots. The variation was not much as farmers either consumed or sold almost the same quantities of the roots in all the localities.

3.2.18 Method of Preservation

The preservation of products was identified as a problem because over 89% of the producers did not preserve their products as they sold to avoid losses. This was done either immediately after processing, or a few weeks after processing. This indicated the need for research on better storage and preservation facilities for both cassava and cassava products.

3.2.19 Methods of Transportation of Products

Transportation from farm to market was seemingly a big huddle as most farmers (42.3%) carried produce on their heads, (26%) carried in vehicles, (21.4%) carried on bikes, (8.8%) pushed in wheelbarrows and others (14.6%) represented those who did not carry at all, they preferred to sell roots at the farm gate. This indicated that a good road network is needed for better transportation in vehicles as bigger quantities cannot be transported on the head.

3.2.20 Distance Covered from Farm to Market

Farmers covered enormous distances from the farms to the markets with the highest, from 1 to 5 kilometers, and the lowest from 11 kilometers and above, meaning that the markets were not too far from the farms. This may have been the reason why most of the cassava was carried on the head. This stressful and tedious activity due to the bulky and heavy nature of cassava roots, expressed the need for good farm to market roads. Studies by Mouafor et al.(2018) also found out that an average market distance is about 3.91miles from production sites to small village market.

3.2.21 Changes in Yields Witnessed Due to Improved Technologies

Significant changes in yields as a result of improved cassava farming techniques were acknowledged by 89.97% farmers who attested that their cassava yields had increased with the practice of improved farming techniques. These farmers were mostly

those who propagated and used improved planting materials and practised improved production methods, like the correct planting distances. This result confirms the result of Mvondo and Liang (2012), which revealed that farmers who attended farmer field school, adopted improved planting materials and propagated them in their communities, had their yields increased significantly. Most cassava farmers had passed through primary and secondary schools and this a positive impact on the cassava value chain activities in this area of study.

3.2.22 Quantities of Cassava Products Produced over Three Successive Years

The main product from cassava was garri. The quantity of garri produced over three successive years had witnessed a remarkable drop from 2000 kg in 2015/2016 to 1500 kg in 2017/2018 (Figure 1). Water fufu had the same trend, while cassava flour" kumkum" was constant. This drop in production could be explained by the high availability of competitive food stuffs to cassava like maize, beans, rice, solanum potatoes, sweet potatoes, plantains etc., which led to low market prices in local markets. The price of garri (Figure 2) also dropped due to the fact that some buyers were not able to come from towns to buy in the villages because of the insecurity and road blocks which were constraints to farming activities during the last two months of this study. On the other hand as indicated in the Cadre Harmolise, (2019), the prices of local foodstuffs in the towns become higher, as the quantities brought into the towns were limited because of the same road blocks. The increased number of displaced population in towns also brought about price increases.

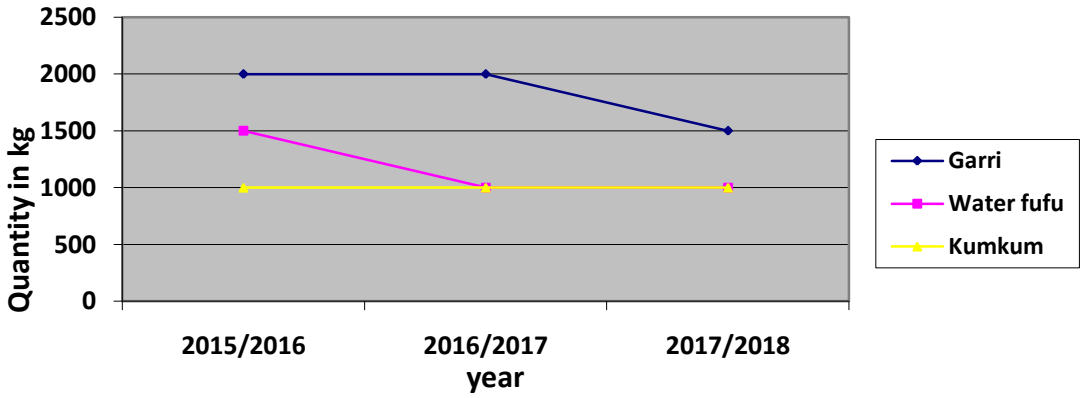

FIGURE 1. Trends in quantities of cassava products produced over three successive years.

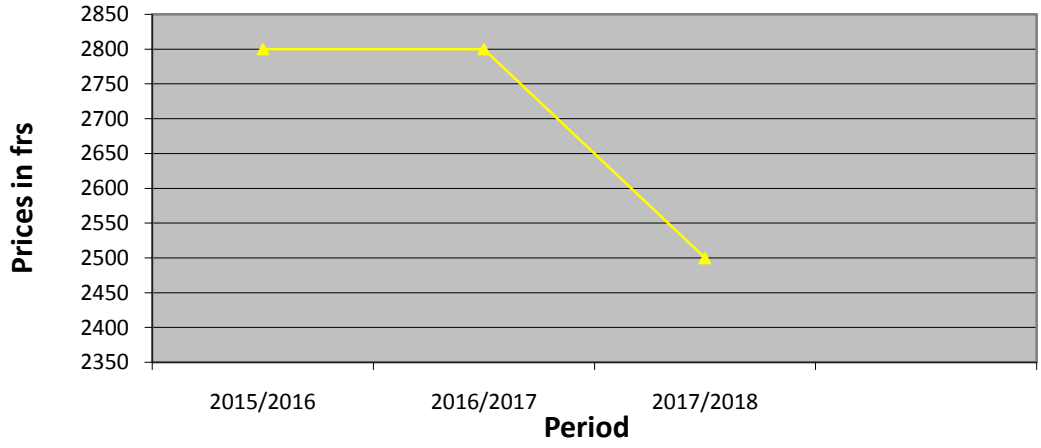

FIGURE 2: Trends in the price of garri in three successive years

3.2.23 Quality Standards during Processing and Packaging

The study revealed that 37.2% of the farmers followed quality standards during processing and packaging of processed cassava roots while 62.8% did not. Farmers expressed the need for proper packaging material which was not readily available, allowing most of the products to be packaged in non-degradable plastic papers and bags. Hypothesis testing showed that all categories of the variables studied, occurred with equal probabilities with one sample Chi – Square test at

0.05% level of significance. This lead us to reject the null hypothesis favouring our assumption to conclude that the availability of improved technologies had impact on the level of propagation and usage among cassava farmers during production, processing and marketing, leading to higher yields and value.

IV. CONCLUSION

The availability, level of propagation and usage of improved technologies among cassava farmers were examined in this work. More women were involved in cassava production, processing and marketing than men. Most of them were married, and have had primary school education. Households with 4-7 persons were highest and mostly households with children. Most of the farmers fell within an active age range of 31 to 50 years and relied on their families for labor, while hired labor was minimal. Findings indicated that the majority of members in each of the households were involved in the cassava value chain activities, attesting that the majority of farmers actually propagated and used improved technologies though some were at minimal levels. The presence of social amenities like local markets, hospitals, portable water, electricity and regular schools were significant, but the insufficiency of good roads, research stations, and mechanized tools need to be addressed. Improved cassava varieties, improved weeding technique using herbicides and fighting of cassava diseases using fungicides, nematicides and insecticides were propagated at minimal levels and needed to be improved. Better preservation and storage methods were limited in the cassava value chain. Quality standards and proper packaging of cassava products also need enhancement, so that cassava products could be upgraded for both local and international markets. Significant increases in yields with the use of improved technologies were achieved by many farmers. Garri being the highest processed cassava product witnessed a drop in quantity produced and price, in three successive years from 2015/16, 2016/17 and 2017/18. This mostly due to the heavy presence of competitive food crops like maize, beans, solanum potatoes, that brought down market prices of local food stuffs. Suggestions made to all actors are to ameliorate the situation by improving on the social amenities, road infrastructure; farm cultivation and processing equipment, seed material, and capacity building of farmers so as to make farmers more self-sustaining.

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