13TH INTERNATIONAL RESEARCH CONFERENCE

HOLISTIC APPROACH TO NATIONAL GROWTH AND SECURITY

15TH - 16TH OCTOBER 2020

Basic and Applied Sciences

PROCEEDINGS

General Sir John Kotelawala Defence University

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Ratmalana, Sri Lanka

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Welcome Address

Major General Milinda Peiris RWP RSP USP ndc psc

Vice Chancellor, General Sir John Kotelawala Defence University

Honurable Minister of Education, Professor G L Peiris, the Chief Guest , Keynote Speaker, Secretary to the Ministry of Education, Professor Kpila Perera, Secretary to the Ministry of Foreign Affairs, Admiral Prof. Jayanath Colombage, Deputy Vice Chancellor (Def & Admin) Brig. Nanda Hathurusinghe, Deputy Vice Chancellor (Academic) Prof. Jayantha Ariyarathne, Deans of the respective Faculties, Directors of Centres, Academics, Senior Military Officers, Administrative Staff, Students and all distinguished guests who are connected with us in the cyber space.

First and foremost, let me very warmly welcome our chief guest, Hon Professor GL Peiris, Minister of Education for very kindly accepting our invitation and for gracing this occasion as the chief guest of this inaugural session of our international research conference 2020.

Sir, we consider your presence here this morning, as one of the most renowned scholars the country has ever produced in the field of Law, as a great honour to KDU. Let me also warmly welcome our keynote speaker, Prof Kapila Perera, Secretary to the Ministry of Education, who is having a very close affinity with KDU as an illustrious member of our alumni association.

Then I also welcome Admiral Professor Jayanath Colombage, Secretary to the Ministry of Foreign Affairs, and other distinguished guests and invitees participating on line as well. KDU, from its inception, was instrumental in handing down the core values of security to the development paradigm in Sri Lanka.

This year's theme 'Holistic Approach to National Growth and Security" highlights the importance of maintaining a harmonious blend in security and development in all national projects. As you are aware, this year's conference is taking place amidst very challenging circumstances, so much so that, it becomes a landmark event of KDU in terms of its resolution to ensure the continuity of events at KDU even under the most trying circumstances. And this conference is also significant because the year 2020 marks 40 years of existence of KDU since its inception in 1980.

KDU, initially established as a tri-service academy known then as KDA or Kotelawala Defence Academy, marked a significant diversion in 2008 with its renaming as General Sir John Kotelawala Defence University. Since then, with the guidance and vision of His Excellency the President Gotabaya Rajapakse, as the then Secretary to the Ministry of Defence and the Chairman of our Board of Management, KDU kept a giant leap forward to become a fully-fledged university with nine academic faculties and a University Hospital with state-of-the-art facilities. With this phenomenal change, KDU began expanding its horizon to provide its high-quality higher educational opportunities to civilian students, thereby reducing the burden on other state universities of the country in supplying for the higher educational demand in the country. Today, the University is ready to march forward steadfastly contributing to the national needs combining the national security domain with higher educational needs of the country.

Ladies and gentlemen, KDU international research conference has been attracting local and foreign presenters, participants and more importantly renowned scholars and professionals of the highest caliber both locally and internationally. However, in this year, the global pandemic situation has restricted having them physically present at KDU. But many of our invitees will join us on line to enrich the deliberations through this novel experience of having the conference on a virtual platform.

I reckon that this is a blessing in disguise for us to travel on untrodden paths for new discoveries. KDU IRC has been instrumental in establishing and strengthening the much needed research culture not only at KDU but also in the whole country.

We have been attracting papers from almost all universities, from many research institutions and other organizations representing even Batticaloa and Jaffna, which I reckon is a very encouraging sign. And the impact of the growing research culture was evident during the first breakout of Covid 19 earlier this year, where our staff and students were researching day and night for creating various products and inventions of our own to help the fight against Corona. So, it is heartening to note that in this year's conference, there are many research papers reaching the conference secretariat, which involve the student community of our nine faculties.

Therefore, we are proud that we have created a platform for emerging researchers and scientists for showcasing their research outcomes at KDU research conference. And it is our fervent belief that inculcating and fostering the research culture and enhancing the quality and quantity of research in various disciplines in the country can raise the resilience levels of society and the nation as a whole.

This year's conference has attracted six hundred and fifty plus paper submissions, which I believe is a very clear indication of the right enthusiasm growing in the country towards research, particularly in development and security domains. So we are proud as a university to be able to stand up resolutely to fulfill the needs of the nation, especially at a time when such efforts are very much needed. I believe the efforts of security-based education aiming at strengthening national development should be more cooperative in the future and KDU has always facilitated any research efforts that strengthens the national security of our nation. We urge the academic community of Sri Lanka to join hands with us in all our future endeavours to support the nation especially through productive research in diverse disciplines.

The organizers of the KDU international research conference intend to set the tone to initiate more collaborative research at national and global levels. This research conference is an ideal platform to make connections. I hope that authors of KDU and various other local and international universities will take the opportunity to interact and develop friendly relationships, establish networks and to explore win-win situations.

I wish all the very best for the presenters and hope you will enjoy every moment of this academic fusion taking place on two whole days.

Finally, let me once again welcome our chief guest and the keynote speaker on behalf of all KDU staff. I wish that presenters and participants would have all the courage to continue their pursuits with determination to link up with the international community and work towards national growth and development through their research.

Thank you.

Chief Guest's Speech

Prof. GL Peiris

Honourable Minister of Education, Government of Sri Lanka

Major General Milinda Peiris, Vice Chanceller of the Sir John Kotelawala Defence University of Sri Lanka, Admiral Professor Jayanath Colombage, Secretary to the Ministry of Foreign Affairs, Professor Kapila Perera, Secretary to the Ministry of Education, Deputy Vice Chancellors, Deans of Faculties, Heads of Department, members of the staff and students of this university, friends well wishers, ladies and gentlemen. I am delighted to be present with you on this occasion for the 13th International Research Conference. I am no stranger to these surroundings. I have been consistently associated with your work during the progress of your university until you have reached the stature that we all are proud of at this time. There is no doubt that with the nine fully-fledged faculties that you already have and your plans further to expand this university particularly bearing in mind the priorities of this country at this moment. I am particularly happy about your plans for the establishment of a Faculty of Criminal Justice. I think that is certainly an area that is worthy of focus and attention. So you have always assessed, evaluated very accurately the needs and priorities of our country in the field of Higher Education. And you have been very quick to respond to those needs. That innovative approach is much to be admired. And these are among the reasons why I have particular pleasure in joining you in these deliberations. There is one another matter that I would like to mention. It is this that you are having this conference for the 13th consecutive time. It is our experience in this country that many good things are planned and inaugurated. It is much more difficult to follow through. So the fact that you have been able to do this without interruptions for 13 years adding to your

expertise as you go alone improving and expanding towards what you are attempting. It is greatly to be admired the sense of perseverance and determination that is greatly required in this country at this moment and your performance is an inspiring example of what we all need to carry the country forward to even greater heights.

Now the theme that you have chosen for this 13th International Conference is extremely appropriate from many points of view. You have heard representation from many countries as Major General Milinda Peiris, Vice Chancellor explained a moment ago. You are holding this conference in exceedingly challenging circumstances. Again you have been to adapt to difficult circumstances. You are resorting to modern technology to include and involve foreign participants in these deliberations even though they are unable to present with us physically on this occasion. The topic that you have chosen is the holistic approach to national growth and security. I think that is extremely relevant to present day needs in Sri Lanka today.

The first point I would like to make is that there is an intimate connection between national growth and security. It is fanciful to talk of any kind of national growth without the assurance of security. Security is a necessary and indispensable foundation. Without security it is impossible to achieve growth in any sector of the economy. The celebrated Political Scientist the late Professor Harold Laski of the London School of Economics said that the basic duty of a state is to provide security for its people. That is the ultimate reason for the existence of the nation state. The theory of the Social

Contract which has been developed by writers like Lock and Rousseau emphasizes the fact that the public have given the authority to state principally for the reason to create conditions in which life can go on in an orderly and frank manner so that the citizens of that state can realize their fullest potential as human beings, develop themselves and develop the community in which they live. In order to do this the essential condition is security. Without it nothing at all can be accomplished. Now we have seen empirical evidence of this in the recent past of our country through the 30-year conflict with the Liberation Tigers of Tamil Eelam. It was impossible to attract substantial investment into this country. Every facet of Sri Lanka's economy suffered grievously during that period. How can you attract investors into a country which has been thrown asunder by a ferocious war? Investment, international trade all this was affected by the ongoing conflict. I would also like to make a reference to the concept of reconciliation which became very relevant and important after the end of the war in 2009. There was then naturally the feeling that we have to leave the pain and anguish of the war behind us. We have to emphasize unity and the solidarity and bring together all the people of our cherished land irrespective of caste, creed, ethnic or religious identity to emphasize the oneness of the nation. That was the pith and substance of the concept of reconciliation. But it all went wrong during the *Yahapalana* administration of 2015 to 2019. And it is worth examining in an objective spirit the reasons why that endeavour failed so miserably. I think the basic reason is that the authorities at that time forgot the sentiments, the feelings and aspirations of the majority community. Reconciliation of course bases emphasis on minority aspirations to make them comfortable, to convey to them in definite terms the impression, the conviction that they are very much part of the country. They

belong, the sense of belonging so that confidence should be imparted to minorities, and at the same time, it is absolutely necessary to carry the majority community with you. If you lead them behind if you engender in the lines of the majority community that they are not important, they can be sidelined, they do not matter, such an exercise in reconciliation is doomed to failure as empirical experience in those 4 years convincingly demonstrated. What happened during that period? I think the most alarming spectacle that we are seeing in this country today is evidence that is transpiring in daily basis before the Presidential Commission that is going into the catastrophic phenomenon of the Easter Sunday Attack. Evidence has been given by one witness after another, the Inspector General of Police, the Secretary to President, the Secretary of Defence, all these people. Their evidence emphasizes the total breakdown of this security apparatus in the country. It is not mere debilitation or weakening of security apparatus it was total collapse of it. There was no security apparatus functioning in this country at all in any realistic sense. So it led to the loss of 265 valuable lives of this country and crippling of many other citizens of our land. Why did this happen?

When the present President, His Excellency Gotabaya Rajapaksa was Secretary to the Ministry of Defense, there was a very close collaboration between the intelligence arm and immigration. Whenever an application was made by a foreign preacher somebody who wants to come and teach in this country, when visa was requested a very thorough background check was done. As Admiral Professor Jayanath Colombage would bear witness the antecedent of the person applying for the visa was thoroughly examined. And if there was anything unsavory in the past of that person, if he has been involved in any activity which led to

disharmony among communities, then the immigration authority in close consultation with the intelligence arm would turn down such a request for visa in this country. That whole apparatus was consciously and deliberately dismantled. It did not happen unwittingly or inadvertently. It was deliberate government policy. So intelligence personnel were made to feel that they were in embarrassment. The less that heard from them, the less they were seen the better. That was the environment which prevailed at that time.

Surely, if you are talking of national growth and security, the first thing to ensure is that funds that are coming from abroad had to be brought into the country through proper channels. We have in this country such an established conduit. The conduit is the External Resources Department of the Central Bank of Sri Lanka. Of course resources are welcome. But they must come through the External Resources Department. We must know the source, the origin of these fundsand where are these funds coming from? We must know the purpose for which these resources are going to be applied, who is going to manage these resources? There must be an auditor accounts. All of these were dispensed. You had a situation where a university was built. What is the purpose for a university to come up in Kattankudy. The facilities, the buildings that are constructed, they are better than the buildings that you have here at the Kotelawala Defence University. They are superior to the quality of the infrastructure in the universities of Colombo and Peradeniya. If you go to Kattankudy blindfolded if the blindfold is taken off when you get there, you will feel that you were in the Middle East. The Palmyra trees, the architecture the overall environment. The sums of money involved are colossal. There is no exposure, visibility or accountability. It is that brought about a situation that culminated in the total collapse

of this security establishment. Madrasas can be all over the country. There are no Sunday Schools. They are providing many of them on daily basis. Nobody examines the curricula. There is no regulatory mechanism at all. So the seeds of racial hatred are sown by those institutions. Of course there must be freedom with regard to imparting instruction. But clearly there must be some supervision, some control, some regulation. That was totally lacking. So the country then paid the supreme price for the neglect of security in pursuit of narrow and particent and political objectives to placate aggressive minorities, not law abiding members of minority communities, but people who were intent on the destruction of the very social fabric of the country. So that was our sad experience.

This is true not only within the country, but also in the conduct of our foreign relations. What happened there? Sri Lanka is unique among the nations of this world in committing to a resolution in 2015 in the UN Human Rights Council. Sri Lanka became a co-sponsor of a resolution in condemning its own armed forces accusing its armed forces of the gravest crimes under international law and under the international humanitarian law because the preamble to resolution 13/1 of the 1st of September 2015 acknowledged with appreciation the report of the High Commissioner for Human Rights. And the High Commissioner's report makes the most damaging allegations against the armed forces of this country. And the government of Sri Lanka endorsed all of them and called for a thorough investigation at the international level. The resolution gave responsibility to the Human Rights Council and to the Commissioner for Human Rights to keep Sri Lanka under constant review. So here was a government which consciously, voluntarily, deliberately submitted the country to adjudication and assessment in respect of its armed forces to international tribunals

where justice considered the inanity of what happened. There were pledges given. In resolution 13/1 and 34/1 which are clearly contrary to the highest law of this country, the constitution of Sri Lanka operating para 6 of the first resolution 13/1 recommended that foreign judges of Commonwealth and other foreign judges should be entrusted with the task of judging our armed forces and of course, members of the civilian population. This is not possible under Sri Lanka's constitution because foreigners cannot exercise judicial power in respect of our citizens. And then the High Commissioner for Human Rights, Prince Hussein publicly conceded that in respect no other country has a Human Rights Council based in Geneva adopted so intrusive approach – so intrusive, interfering directly with domestic policy in that country. To what extent did this go? The resolutions involved matters which are clearly within the domain of the Sri Lanka's parliament not the business of foreigners. It called for constitutional reform. It called for devolution of greater powers to provincial councils. It called for thorough overhaul of Sri Lanka's armed forces and the police. It called for the repeal of the prevention of terrorism Act and its replacement by alternative legislation. Members of the Sri Lankan armed forces and the Sri Lankan police force were to be subjected to special criteria when they applied to join UN Peacekeeping forces abroad and even to enroll for programmes of training. So this is the extent to which national dignity and pride was compromised in order to placate foreign interests whose aims and objectives were incompatible with the well-being of this nation.

So this attitude which destroyed the very foundations of our national security manifested itself both in respect to domestic policy and the conduct of country's foreign relations during that period 2015 to 2019. In such a situation you cannot possibly have

national growth. You cannot have economic advancement because security has broken down entirely.

Just one another point I want to make before I conclude, and that is the reference to militarization in the current political discourse. Non-governmental organizations and elements of the opposition as well as some prejudiced and biased foreign commentators are finding fault with the role of the military in the conduct of national affairs in Sri Lanka at this time. But no objective observer of the Sri Lankan scene can doubt the fact. When it came to the control of COVID-19, this country could not possibly have achieved what it did without the vigorous involvement and cooperation of the armed forces, particularly the intelligence arm. We were able to control the pandemic because the armed forces were able to identify those who have been infected, first the immediate circle and then the outer periphery. That is still being done, yesterday today it is being done. And the role of the armed forces is indispensable. Without them the situation would be far worse than it is. Why is there this kind of hostile attitude towards armed forces? I think people who subscribe to that point of view failed to distinguish between the culture of east and west in this regard. Cultural attitudes, assumptions and values are in critical significance in this area. The attitude in this country, the attitude of the public, of ordinary people, to the armed forces is not what prevails in some western countries. The armed forces are not looked upon with fear. They are not regarded as instruments of oppression. On the contrary, after the war ended in 2009, it is in effect the armed forces, they got involved very intimately, very vigorously in uplifting the social conditions in the people affected in areas. They built houses. They made water available. They played a role in restoration of agriculture. And I know personally because I have seen in

my own eyes that armed forces of this country even helped in the constructions of latrines, of toilets in that part of the country. These are not regular functions of the armed forces. But because of the culture of our country the social morals the value system based upon empathy and compassion which is the hallmark of Sri Lanka's culture. That was the nature of the role that was performed by the Sri Lankan military. It is this fundamental fact that is not taken into account. In critiques of the present scene who find fault with the armed forces forget their involvement in national activity on broader scale.

So these are some of the remarks that I would like to make to you on this occasion. I am very happy that you are having this 13th International Research Conference. I am very happy that you have chosen a topic that is extremely appropriate. You have chosen a more relevant topic for this time. As the Minister of Education also with the responsibility for higher education in this country, I am very proud of the achievements of your institution, what you have been able to accomplish within so brief a time span. The needs of higher education in this country are very urgent when more people are clammaering for access to higher education, in our ministry, with the active system of Professor Kapila Perera who is rendering a yeoman service in that regard, we are trying to bridge the gap between education and employment opportunity. We are talking to the major Chambers of Commerce they provide the jobs in the private sector to ascertain from them the employment opportunities that will be available in their institutions during next three or four years, what are the skills which we are looking for? Because they are telling me it is not that we

do not have jobs to offer. We have jobs. But when we interview people we find that they don't have the skills which we want in our institutions. So we don't want to enhance a reservoir of angry and frustrated young people. We want to ensure that there is a co-relation between the education that is imparted in our institutions and the skills for which there is an identifiable demand in the market place. So these are some of the adventures that we have embarked upon. We are also looking critically at our curricula which are obsolete and anachronistic. They have not been revisited for a very long period. There must be in line with the needs of our society methods of teaching. There is far too much emphasis on rote learning in memory that students have required to commit their notes to memory, retain in the memory and reproduce it at the examination that is antithetic of the education. Education comes from Latin words '*educate*' which is draw out not to force in vast volume of actual material into mind of the students. So purpose of the education is to develop the analytical and the critical faculty of the student to encourage him or her to think for himself or herself and apply that volume of knowledge to face the challenges of life. So in the midst of all of this, in confronting the formidable challenges, I am very confident that your institution, Sir John Kotelawala Defence University will render an invaluable service. So I congratulate to you on your achievements of the past and I wish you well for the future. I know that you will continue to do your country proud. And I thank you sincerely for the honour that you have bestowed upon me by inviting me as the Chief Guest for these deliberations.

Thank you

Keynote Speech

Prof. Kapila Perera

Secretary, Ministry of Education, Government of Sri Lanka

Ayubowan! Wanakkam! Assalamu Alaikum! The Vice Chancellor of General Sir John Kotelawala Defence University, Major General Milinda Peiris, the Chief Guest today my honorable Minister, Ministry of Education, honorable Professor G.L. Peiris, Deputy Vice Chancellors, Deans of the Faculties, Heads of the departments, the Secretary to the Ministry of Foreign Affairs, Professor Admiral Jayanath Colombage, all the foreign participants who are joining this 13th International Research Conference at KDU, all the presenters, moderators, session chairs and all the distinguished invitees. Thank you very much for inviting me to deliver the Keynote Speech under the theme 'Holistic Approach to National Growth and Security.' I am indeed honored and privileged to be here having witnessed the very first one 13 years ago, and it happened to be General Milinda Peiris who was the Vice Chancellor then as Major General and we witnessed the presence of the Chief Guest as the Ministry of Higher Education, Ministry of Research and Technology.

I would like to start with this quote from the Chief Guest, "We do not want to have a reservoir of angry uncontented people." I was one who had gone through in 1971, of course not in the country in 1988 -1989 and then in then 1983 as a university student, and many times during my academic career where there were disruptions to education, holding back the desire to fulfill or acquire knowledge with my colleagues, peers and the rest of the people due to the lack of security. I know how I felt then as a student. I think I was in grade 4 in 1971, and then in 1983 in my second year at this very same premises, the education of ours were disrupted. And the feeling of those delays due to the lack of security, and the Cheif Guest elaborated in deep sense of comprehension how security is important for the national growth. If I look at what is this traditional approach that is often based on defensive security policies as we had during my time at different ages. We had always defensive security policies. However, the persistence of strong security measures generates inecure feelings. I hope you agree with me. If there are strong security measures that generate insecure feeling as it reveals the presence of threats. So these are some of the things that people quote. Then again the democracy, well-being and freedom are some of the elements that we feel that we reduce this feeling of insecurity by reducing both threats and activities that we feel. Even if you take a house if you feel this insecureness due to lack of security this might not allow you to think, generate analytical skills. You are always worried about the security. How to provide security to your children and for yourself? And then it hinders and it slows down entire process of nurturing, acquiring knowledge. And then that it is halting the growth. so you start from the small households or individuals then if you take as a whole family, a village, a township and then provinces as a country, it basically retards the national growth. So, therefore, we need to have this thinking of holistic approach to national growth and as you and I understand there are necessary and essential conditions when we learn mathematics for certain things. The Cheif Guest emphasized repeatedly the essential elements and in our academic mathematics there are sufficient and necessary conditions or essential conditions for forming mathematical theories there are certain

things. Likewise, it is essential to have security for national growth.

When it comes to economics, always and even for decades, the GDP strongly criticizes the measure of development. Still the role of economic systems neglecting the goal of global capabilities and expansion holds this economic growth or national growth. But the concession of development based on the glorification of individual success and the pushed capital accumulation hardly allows reducing insecurity and increasing freedom. So security becomes an individual good and relies upon ineffective defensive policies that we have practiced in the past unlike in the present. So development, well-being, security and freedom are strictly interrelated. Individual capabilities imply collective capabilities. Even in free market economies often human needs such as food, housing, employment, health care, family policies, fresh water, security and safety can be put in a market under regulation or collective governance, and those things even the Chief Guest highlighted. The need for water, need for food, how the security-- food security and water security ensure the getting this national security when you combine all these types of security the national growth under war conditions. So these goods are often under political debate as they are critical for development and social cohesion. The more they are shared among the large part of the population the less we experience social conflict and political instability. Security hardly is achievable individually. It is the result of more holistic thinking. Individual security and freedom implies the security and freedom of all. As I mentioned before these are interrelated. And if you look at or if you study research and in future research all these studies can help in understanding human capabilities and pathways towards collective security and enhance development. So instances of participation in

definition of security needs would make citizens able to feel at the center of development goals. So therefore, unlike in the past where we did not think holistically and the interrelations between the security and the national growth. Then we will fail. Even the theories in the literature highlights this one.

As far as Sri Lanka is concerned the contemporary security concerns that we face as an Indian Ocean country are broader and more complex, that need not be elaborated, than any state in our history. This will continue to exist. We can't say that this will stop today, tomorrow, next year or in ten years' time because the geopolitics and the race for the arms business and economic development, all these things will continue to grow, sometimes exponentialy. So therefore, national security cannot be neglected and cannot be just let it go as the Cheif Guest mentioned, even in a fraction of a second, it is very important. Otherwise there won't be any growth. As the Secretary to the Education, in the present context the role played by ensuring a secure environment for the student to go and sit the examination. They are not in a position to concentrate on answering the questions if the place is not secure. So if we are not able to hold the exams and continue to postpone, then we cannot achieve and we cannot predict national growth. So in this context the role played by the national security is to be commended as the Ministry of Education. I know personally the quick response to ensure secure examination centers for all of us for the future of Sri Lanka. Under these conditions even the identification of COVID origin in the recent past, you have to have peace of mind to concentrate on everything. That is basically if you only think of one place, one center out of 2,646 examination centers, then there will be lack of security in different centers. So therefore, you have to think holistically. Only the one aspect of securing

one place will not enable for us to continue this one and therefore the results will come in future in terms of national growth. So the range that concerns arise from threats to system that allows society to control intergroup and interpersonal conflict to more recently reorganized concerns associated with threats to social and economic systems. Once these events start to influence the policy and the economy of a country with a national resilience, that country will perish. One way of addressing this emerging situation is by promoting more and more research and development.

KDU, boasting with diverse nine faculties and through two new faculties to come, the Faculty of Criminal Law and the Faculty of Technology, is going to expand and provide opportunities and platforms for you to think, ponder in a military environment and inviting day-scholars giving the signal that is very important for you to mix each other understand the role of the military or security for the civilians, 22 million people in this country, how important the national security and the training in a military set up to achieve the common goal of national growth. So the KDU is at the forefront of researching the development and security related problems holistically. A holistic approach is needed to understand contemporary complex situations and circumstances. University education could inculcate co-values of security and development such as human dignity, integrity, democratic participation, sustainable development, economic equity, mutual understanding and respect and equality of opportunity. The three flags that are behind bring all three forces together, thanks to the KDA then, and how important this mutual understanding in the war was understood and it helped to coordinate things in a better manner. You trained officer cadets together and they understand the security roles in the air, at sea, on land. I am

sure that it could have been the catalyst then. Now you bring the third aspect the day-scholars. So this is holistic thinking. Like I started at the beginning it was not there then. We had three academies that did not know each other, but how had it come during the time when the national security was at risk. So ultimately the beneficiary is national growth. The honorable Minister, the Cheif Guest mentioned how difficult it was for Sri Lanka to attract foreign direct investments. As I think Minister of Enterprise Development, Foreign Minister, Foreign Secretary. If you don't have security and thrust, nobody would come. But when you train together military and civilians with hand and hand, it would provide an ideal platform. The importance of civil-military relations and how KDU is instrumental in developing the above mentioned areas is to be commended. By promoting civil-military relations through education, a country could raise the resilience levels, like I mentioned, of communities. Honorable Minister spoke at length and elaborated that you have to have a strong commitment and the political will to ensure the security of this country. If these elements, instruments fail, the first thing that is going to effect is the education of the future generations. Even for me, the Oxford graduate, Rohdes scholar, I am a pupil. And this has provided opportunities and the responsibility to the government to ensure the security. So all spheres of activity will simultaneously grow ultimately culminating in national growth.

These are the few thoughts that I have to share with you. I would like to extend my gratitude on behalf of the Ministry of Education for having me and inviting me to deliver the Keynote address and set the platform for the next two day deliberations. And I wish all the success in the deliberations and creating more networks and have future directions for years to come in this context of national security that you have chosen today.

Whatever that you are going to do, base national security at the forefront. So divided we lose together we win. And I wish all the very best and thank you very much for all the participants and the people who have submitted papers, presenters, moderators, and session chairs. You are plying a very important role in this context of national security and the national growth.

Thank you very much!

Vote of Thanks

Dr. L Pradeep Kalansooriya

Conference Chair, 13th International Research Conference,
General Sir John Kotelawala Defence University

It is with deep appreciation and gratitude that I present this vote of thanks on behalf of the organizing committee of the 13th International Research Conference of the General Sir John Kotelawala Defence University.

First of all, I convey my heartiest thanks to Professor G.L. Peiris the Minister of Education, a distinguished academic who spared his valuable time with us on this occasion. Sir, your gracious presence amidst busy schedules is truly an encouragement and it certainly added the glamour and value to this important event.

Professor Kapila Perera, the Secretary to the ministry of Education, also a distinguishable academic and a senior military officer is a proud product from our own institute. Sir, I greatly appreciate your willingness without any hesitation to be our Keynote speaker today.

I would also like to take this opportunity to extend my appreciation and gratitude to the Vice Chancellor, Maj. General Milinda Peiris for all his guidance and assistance provided throughout the event and this event wouldn't have been a reality and a great success without your courageous leadership under the current challenging situation today.

I would be falling my duties if I don't mention the exceptional support and assistance provided by the two Deputy Vice Chancellors who were there behind the team guiding us through a difficult time. I also would like to thank the Deans of all the faculties who shared the responsibilities and guided their staff amidst their very busy schedules.

This year's conference has attracted six hundred and fifty plus paper submissions, which is a very clear indication of the right enthusiasm growing in the country towards research, particularly in development and security domains. I take this opportunity to thanks all authors share their studies on National Growth and Security in our conference. I also greatly appreciate our panel of reviewers on the valuable time spent to review this large number of papers. I'm sure that your valuable resnses would tremendeously supports to authors on enhancing their research studies.

Ladies and Gentlemen, as you witnessed, this was a new experience in the new normal, after the present pandemic, and therefore it was huge challenge to organize, coordinate and conduct research conference of this magnitude on virtual platform enabling a wider participation of both local and foreign participants. I thank all our participants attending the conference online despite numerous difficulties encountered due to the present situation.

Further, it is with great pleasure that I acknowledge the tremendous support and assistance provided by academic staff of all the faculties with all the Heads of Departments going beyond their regular duties to make this event a success. Similarly, I take this opportunity to appreciate the contribution of the administrative and non-academic staff whose commitment was essentially required in achieving the overall success.

Our sponsors, the financial support given by our Platinum Sponsors, People's Bank and

Bank of Ceylon and Co-sponsor, Abans Private Limited is highly appreciated.

Last but not least the officer cadets and day scholars who formed a very virtual component of the organizing teams in every sphere and I believe that it was a great learning experience and exposure which would help them tremendously in similar undertakings in the future.

Finally, I have no doubt that all of those attending the two days seminar will make the best use of the opportunity to enhance their horizons and establish new bonds and networking while sharing their own knowledge and experience in a friendly learning environment.

In conclusion, let me take this opportunity to profusely thank my co secretaries, who stood alongside me throughout extending unexplainable support and assistance with exceptional commitment.

Thank you so much. I wish you good luck and all the best.

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Technical Sessions

Identification of Wolbachia like endosymbiont DNA in Setaria digitata genome and phylogenetic analysis of filarial nematodes

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Abstract - Setaria digitata is a Wolbachia-free filarial parasite that causes cerebrospinal nematodiasis in non-permissive hosts such as goats and sheep, leading to substantial economic losses in animal husbandry. Therefore, there arises a considerable need for the development of new interventions to disease control and eradication of this filarial parasite. Owing to the limited knowledge on S. digitata genome, it's host-parasite relationship and the potential impact of the Wolbachia endosymbiont in filarial nematodes, this research was focused on the generation of the draft genome of S. digitata; identification of Wolbachia like endosymbiont DNA in S. digitata genome; phylogenetic analysis as well as functional annotation and metabolic pathway analysis of the genome. A draft genome of 78.8 Mbp size with a GC% of 31.45% was generated for the S. digitata worms collected from the peritoneal cavity of slaughtered cattle, using NGS Illumina platform. FASTA36 sequence similarity analysis was able to identify homologous sequences of coxA and gatB Wolbachia MLST genes within the S. digitata genome, while phylogenetic analysis using Geneious Prime Software revealed that S. digitata is more closely related to the filarial nematodes with Wolbachia endosymbiont than Wolbachia-free filarial nematodes. Furthermore, BLAST2GO analysis was able to identify 6055 annotations and 95 metabolic pathways within the S. digitata genome. Based on FASTA36 and phylogenetic analyses, it can be concluded that ancestors of S. digitata were colonized with Wolbachia in the distant past, and suspected gene transfer may have brought Wolbachia DNA into the S. digitata nuclear genome prior to endosymbiont loss.

Keywords - Setaria digitata, Wolbachia, NGS

Introduction

S. digitata is an ivory-color slimy filarial parasitic-worm with a coiled tapering tail. It is classified under class Secernentea, order Spirurida and family Setariidae. S. digitata resides in the peritoneal cavity of grazing hoofed animals (Shiny et al., 2011; Shin et al., 2002) and cause cerebrospinal nematodiasis, a neuropathological disorder that causes dysfunction of the central nervous system. It leads to lumbar paralysis and eventual death of non-permissive domesticated hosts such as goats, sheep and horses, which cause substantial economic loss in animal husbandry in Asia and the Far East. However, infection of natural hosts such as cattle and buffalos by the S. digitata cause mild disease conditions such as mild fibrinous peritonitis and not considered as parasitic in their natural hosts. Human infections are also reported

causing allergic reactions, eye lesions, abscesses, enlarged lymph nodes and lung inflammation (Taylor and Hoerauf, 1999; Gunawardene and Dassanayake, 2015; Sundar and Souza, 2015)

Most of the filarial nematodes mutually associate with Wolbachia and without Wolbachia, such filarial nematodes cannot survive (Werren et al., 2008). The reason is that the genome of Wolbachia carries the genes required for the metabolism of heam, riboflavin, FAD, glutathione and nucleotides whereas its filarial host does not (Fenn et al., 2006). However, S. digitata does not harbor Wolbachia endosymbiont, but undergo biosynthetic pathways of heam, riboflavin and nucleotides. The genes of those pathways should be present in its genome itself (Voronin et al., 2015). There are two possible explanations for the independent survival of S. digitata. It can be hypothesized that either the ancestors of S. digitata were colonized with Wolbachia in the distant past and horizontal gene transfer (HGT) may have brought Wolbachia DNA into the nuclear genome of S. digitata prior to endosymbiont loss, or the endosymbiotic relationship between Wolbachia and its filarial host is dispensable. Studies showed that Wolbachia free filarial nematode Loa loa evolved own DNA sequences to code heam and riboflavin biosynthesis pathways. For some pathways, they have gained partial gene sequences from Wolbachia, and this indicates the horizontal gene transfer within Loa loa and Wolbachia at some point during the evolution (Desjardins et al., 2013). Therefore, independent survival of S. digitata also can be explained by horizontal gene transfer of Wolbachia gene fragments to the S. digitata genome and/or evolution of their own DNA sequences to code those pathways (Mcnulty et al., 2010). Therefore, identification of Wolbachia like endosymbiont DNA in S. digitata genome and phylogenetic analysis of S. digitata and other filarial nematodes, are important to understand the potential impact of the endosymbiont and to gain insight into the host-parasite relationship.

S. digitata also considered as a model organism for human lymphatic filariasis (HLF), due to their close resemblance to Wuchereria bancrofti, the primary causative agent of HLF, in morphology, histology and antigenic properties (Gunawardene and Dassanayake, 2015). Hence, generation of a draft genome of S. digitata and complete functional analysis and metabolic pathway reconstructions of S. digitata will have a huge impact on the development of novel drugs and/or vaccines for human filariasis and other filarial diseases.

Methodology

Adult worm samples of S. digitata were collected from the peritoneal cavity of cattle (Bos taurus) from the western province. S. digitata worms were washed thoroughly in PBS and preserved in 80% ethanol at −20°C before analysis. Genomic DNA of adult S. digitata worms was extracted by DNA Micro kit, QIAGEN. Confirmation of extracted S. digitata DNA was done by carrying out a series of PCRs using S. digitata ARV1 specific primers.

After performing quality control (QC), the passed sample was proceeded with the Next Generation Sequencing (NGS) library construction. Sequencing libraries were constructed from the extracted DNA using the TruSeq™ DNA PCR-Free Kit. Purified libraries were loaded into an Illumina HiSeq4000 for paired-end sequencing. Sequenced data (base call files) were converted to raw FASTQ files using the sequencer soon after the initial sequencing. The reads were filtered before assembly such that for a pair of PE reads each read should have more than 90 % of bases with base quality greater than or equal to Q20. Generated 150bp reads were analyzed for K-mers using JELLYFISH. Once the optimum k-

mer size is identified, a de novo draft assembly was built using SOAPdenovo2.

In order to identify Wolbachia like endosymbiont DNA in S. digitata genome, FASTA file containing 2075 S. digitata contigs was blasted against several Wolbachia specific reference sequences such as Wolbachia surface protein (WSP), Wolbachia-specific 16S rRNA and Wolbachia MLST genes (coxA, gatB, fbpA, ftsZ, and hcpA) using FASTA36 program.

Later, using Wolbachia marker sequences (gatB, coxA, ftsZ, fbpA, hcpA, WSP and 16S rRNA), BLASTx was performed against S. digitata, Loa loa, Brugia malayi, W. bancrofti, Onchocerca volvulus and Wolbachia endosymbiont of B. malayi (wBm) protein sequences available on the NCBI non-redundant (NR) protein sequence database. Resulted best hit for each organism for each marker gene was recorded, and the aligned region was obtained. Those aligned sequences of each organism for each marker gene were used to generate a phylogenetic tree using Geneious Prime software. Firstly, sequences were loaded into the program and alignment was done using MUSCLE algorithm and the phylogenetic tree was generated using the Neighbor-joining (NJ) method. Wolbachia endosymbiont of B. malayi (wBm) was used as the out-group.

Lastly, BLAST2GO BASIC software was used for downstream annotations and metabolic pathway reconstruction.

Results and Discussion

After the initial sequencing using the Illumina platform, a total of 97,586,942 reads were obtained with a GC percentage of 31.67% and a Q20 value of 96.09%. Q20 value gives the percentage of bases called that have a quality score of 20 or above. Phred quality score is a numerical value that expresses the accuracy of each nucleotide. Higher the Q number will be higher the accuracy. After the quality control and pre-processing, a total of 79,292,174 reads were obtained with a GC percentage of

31.77% and a Q20 value of 99.18%. A draft genome of 78,774,594 bases belongs to a total of 2,075 contigs was generated after the assembly. The percentage of guanine-cytosine base pairs (GC%) in the assembled draft genome is 31.45%. In a typical random library, it is expected to see a roughly normal distribution of GC content where the central peak corresponds to the overall GC content. An unusually shaped distribution could indicate a contaminated library or some other kinds of a biased subset. Here, the obtained histogram showed a normal distribution and therefore, it can conclude that there is no contamination.

Five Wolbachia marker gene sequences were selected for identification of Wolbachia like endosymbiont DNA in S. digitata genome because of their presence in the Rickettsiales order. These marker genes have a single copy, a wide spatial distribution and a strong stabilizing selection within the Wolbachia genome. Homologous sequences were found only for coxA and gatB. For coxA, homologous sequence was found in the S. digitata contig_633 and for gatB, homologous sequences were found in the S. digitata contig_915 and contig_724, among which contig_915 has the higher similarity. Sequence identity was higher than 50% and e-value was smaller than 10-4, and therefore it can be considered that sequence similarity is accountable.

After performing BLASTx against protein sequences of S. digitata, Loa loa, Brugia malayi, Wuchereria bancrofti, Onchocerca volvulus and wBm available on the NCBI NR protein database using the Wolbachia marker sequences (gatB, coxA, ftsZ, fbpA, hcpA, WSP and 16S rRNA), only coxA gave hits for all six organisms. Therefore, best hit of each organism for coxA was used and aligned using MUSCLE algorithm to create the phylogenetic tree (Figure 1). Neighbor-joining (NJ) method was used here because it is ideal for phylogeny construction from the sequence data, it is rapid, and it does not assume an equal rate of

evolution amongst all lineages. The resulted tree is simply an estimate and is unlikely to represent the true evolutionary tree of these organisms (Figure 2). Resulted tree was a rooted tree with 6 taxa and 11 nodes. The nodes are where lineages diverge, representing a speciation event from a common ancestor. The root node represents the most recent common ancestor of all of the taxa represented on the tree. Wolbachia was used as the outgroup because it has contrasting characteristics relative to the other included taxa. Wolbachia is a bacterium and all other taxa are nematodes. Several clades can be seen in the resulted phylogenetic tree. W. bancrofti and B. malayi forms a clade while O. volvulus and S. digitata form a separate clade. These four taxa all together form a clade that is related to the L. loa, a Wolbachia-free filarial nematode.

According to the evolutionary distance between taxa based on the sum of the branch length (patristic distance), S. digitata is closely related to the O. volvulus, a filarial nematode with Wolbachia endosymbiont while most distance taxon is Wolbachia. It was expected to be closely related to the L. loa since it also a Wolbachia free nematode just like S. digitata. Based on the generated phylogenetic tree, it can be suggested that Wolbachia genes have been laterally transferred into S. digitata genome since S. digitata is more closely related to the filarial nematodes with Wolbachia endosymbiont than Wolbachia-free filarial nematode, and since S. digitata and all other Wolbachia containing nematodes form a clade separately from Wolbachia-free L.loa.

Out of 2075 total contigs put through the BLAST2GO pipeline, 530 contigs did not generate a BLAST hit. Here BLASTx was performed against the NCBI non-redundant database with a cut-off of 1e-3. Out of 1545 BLAST hit generated contigs, 110 contigs generated a BLAST hit without further downstream Gene Ontology (GO) annotation.

Remaining 1435 BLAST hit generated contigs were mapped to retrieve GO terms. Out of 1435 mapped contigs, only 1280 contigs generated GO annotations while 155 contigs were only mapped.
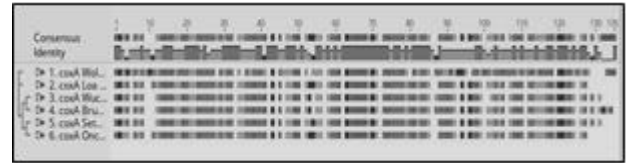

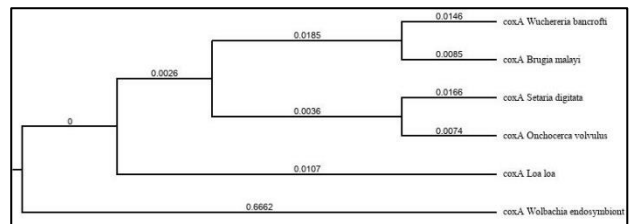*Figure 1. Six coxA BLAST hits after alignment using Geneious Software. Source: Geneious Software*

Figure 2. Phylogenetic tree constructed using Neighbour joining method for coxA sequence data. Source: Geneious Software

Majority of the BLAST hits were belong to filarial nematodes with Wolbachia, like Brugia malayi (4998 hits), Wuchereria bancrofti (3311 hits), Brugia pahangi (1940 hits) and Onchocerca ochengi (1673 hits). In here 6055 number of total GO annotations have been done. Overall, 1280 of 1435 (89.1%) mapped BLAST hits were annotated by at least one of the three categories of the GO function classification. The 1280 mapped contigs could be annotated to 6055 GO terms, among which 2297 (grouped in 9 subcategories), 2206 (grouped in 8 subcategories) and 1552 (grouped in 5 subcategories) GO terms could be grouped to the biological process category, molecular function category and the cellular component category, respectively.

As an alternative method of categorizing contigs/sequences by biochemical function, sequences were assigned to biological pathways using the KEGG database. Total of 246 contigs had been clustered into 95 pathways, in which the most over-represented pathways are Biosynthesis of antibiotics (22genes), Phosphatidylinositol signalling

system (11 genes) and Purine metabolism (10genes).

Conclusion

According to the BLAST results of the BLAST2GO functional analysis, the majority of the S. digitata sequences have a higher sequence similarity to Wolbachia containing filarial nematodes like Brugia malayi, Wuchereria bancrofti, Brugia pahangi and Onchocerca ochengi than Wolbachia free filarial nematodes like Loa loa and Onchocerca flexuosa. Based on this result it can be concluded that S. digitata is more closely related to Wolbachia containing nematodes than Wolbachia free nematodes. Phylogenetic analysis also revealed that S. digitata is more closely related to the Wolbachia containing nematodes.

According to the FASTA36 and BLASTx sequence similarity analysis, partial sequences of Wolbachia marker genes (coxA and gatB) were found within the S. digitata genome. This result provided the bioinformatics evidence for the presence of Wolbachia like DNA sequences in the S. digitata genome.

Therefore, based on the BALST results, phylogenetic analysis and the sequence similarity analysis, it can be concluded that as 90% of the filarial nematodes studied up to date contain the Wolbachia, ancestors of S. digitata may have colonized with Wolbachia in the distant past, and HGT may have brought Wolbachia DNA into the nuclear genome prior to endosymbiont loss.

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Identifying Factors for Sustaining the Zero Accident Vision: A Case of Tire Company in Sri Lanka

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Abstract— Zero Accident Vision (ZAV) encourages the vision that accidents are preventable. The objective of this study is to identify the factors which enable, and impede ZAV in a tire industry. Behaviour-based safety may be affected by providing good safety training, building a safe and healthy work environment, offering safety incentives, and developing safety empowerment based on the literature. Primary data were gathered by distributing the questionnaire. The sample size was 98 among 120 population of the company shop floor members who are the most aware of the work environment and risking accidents. Descriptive analysis and multiple regression analysis were used by SPSS-22. Descriptive analysis was helped to identify the response patterns of employees. Multiple regression analysis identified factors and its impact on sustaining ZAV. Pearson correlation was used to analyse the relationship between variables. All independent variables, safety training, work environment, safety incentives, and safety empowerment significantly affected ZAV. Safety training and safety incentive were enabling factors which should be continued and, safety empowerment and work environment were impeding factors which should be developed further to sustain ZAV.

Keywords— Zero Accident Vision, Safety, Behaviour

Introduction

Workplace safety is critical for the continued functioning, survival, and optimal performance of organizations (Ashour et al, 2018) such as tire industry. Improving the safety of complex industrial systems and preventing serious injury or death is a difficult task (Zwetsloot et al., 2013). Safety is a major concern for organizations as they are a source of significant direct and indirect costs. Direct cost accrues in the form of medical and health bills, claims for deaths and permanent incapacitation, penalties, damage of work equipment, litigation expenses, and related encumbrances. Indirect costs are increasing insurance costs, product losses, pain, suffering, grief, increased staff turnover, and related issues (Ashour et al., 2018).

Occupational accidents threaten to physical and mental safety of workers, enterprises, and communities. Hazards to physical safety of workers include mechanical/machine hazards, slips and falls from heights, ergonomic hazards such as repetitive motion, awkward posture, and excessive force, flying fragments that could injure an eye or risk of a work-related motor vehicle crash. Psychosocial hazards in the workplace affects physical safety directly or indirectly. The impact of accidents is not always easy to recognize and quantify. When someone is injured, colleagues face emotional issues that may impact heavily on the company, particularly in the case of worker death. All

workplaces exist in communities and societies. The community or society in which the enterprise exists has a great impact on employee health and the success of the enterprise (Mealifft, 2010). So, the occupational accident is an issue.

The International Labour Organization (ILO) estimates that 2.3 million women and men worldwide suffer from occupational accidents or illnesses every year. From that, 6000 death occurs every single day. According to ILO, it is concerned about the increase in accidents and ill health (International Labour Organization, 2011). World Health Organization (WHO) estimates that 160 million new cases of work-related illnesses occur every year. It stipulates that workplace condition accounts for over a third of back pain, 16% of hearing loss, 10% of lung cancer and 8% of the burden of depression. The total cost of such accidents and health matters are estimated at 4% of the world's Gross Domestic Products (GDP), (Mealifft, 2010).

In Asia and Pacific, more than 1.1 million people die due to occupational accidents or work-related illnesses each year. Asia was the largest contributor, accounting for about two-thirds of global work-related deaths (International Labour Organization, 1996).

There are about 4,000 occupational accidents in Sri Lanka annually and it is estimated that the number of working days lost due to accidents is about 600,000 each year. In Sri Lanka, occupational safety and health considerations were limited to mining and related machinery from 1896 to 1950. Now, it has been extended to factories under the Factories Act. The deficiencies in the formal sector occupational safety and health coverage are a major concern, as Occupational Safety and Health (OSH) statutory provisions cover only 30 percent of the workforce (International Labour Organization, 1996).

Occupational safety is an important sector which industries should pay attention to. The selected tire company is facing challenge of achieving ZAV. According to the preliminary data gathered through observations, employees' ideas, it was revealed that the safety training, work environment, safety incentive and safety empowerment have been a major contribution for sustaining the ZAV. The main research problem addressed in this study is whether safety training, work environment, safety incentive and safety empowerment have an impact on the sustainability of ZAV in the company and identify enabling and impeding factors to sustain ZAV.

Methodology and Experimental Design

Details of Data Collection

This research has used primary data. The distributing questionnaire was the data collection method. The sample was selected from the company shop floor members who are the most knowing about their work, work environment, and also most subjecting to accidents. The sample size was 98 among 120 populations.

Conceptual Framework

The research project has based on the foundation of the conceptual framework. The conceptual framework of the research project is presented in Figure 1. According to the conceptual model, the dependent variable is "Sustain the ZAV". There are four independent variables. They are "Safety training", "Work environment", "Safety incentive" and "Safety empowerment".
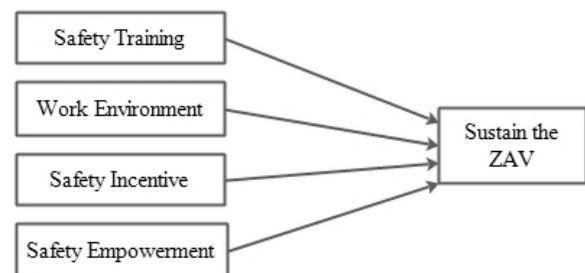

Figure 1. Conceptual Framework

Hypothesis

Various ways are followed for safety training like a formal orientation program and on-going capacity building programs. And, organization use these ways as safety performance indicators (Ashour et al., 2018). Safety training is an important tool for determining general organizational success and the success of occupational health and safety programs (Ashour et al., 2018). Researchers have examined the relationship between safety training and safety performance that give outcomes like recognizing injuries, accidents, incidents, and fatalities. Therefore, this research is proposed the following hypothesis.

Hypothesis 1 - H_1: There is a significant relationship between safety training and sustaining the zero accident vision (ZAV)

A better work environment of a good work environment is related to several organizational performance indicators. Creating a stable work environment is very important to increase an employee's job satisfaction and the ability to work safely. (Dai et al., 2014, cited in Ashour et al., 2018). Work environment effects on health and survival (Hemstrom, 2001, cited in Ashour & Hassan, 2019). Work pressure which includes excessive workload, mandatory workplace and time pressure (Diaz and Cabrera, 1997, cited in Fernández-Muñiz et al., 2012) probably leads to increased psychological stress among workers (Karasek & Theorell, 1990, cited in Fernández-Muñiz. et al., 2012) which may increase the tendency of engaging in unsafe behaviors or errors. Work environment-related stressors including role ambiguity, role conflict, heavy workload, pressure, and physical discomforts are adversely affected their safety and health (Lundstrom et al., 2002). Organizational factors affect the criteria of the work environment. A positive perception of employees that their work environment is well-placed for them to work safely is led to

comply with safety activities and committed to achieving ZAV. And also they tend to reduce risk-taking behaviours (Ashour & Hassan, 2019). Therefore, this study proposes the following hypothesis.

Hypothesis 2 – H_2: There is a significant relationship between work environment and sustaining the zero accident vision (ZAV)

Giving incentives or feedback for the number of positive outcomes and all similar studies is successful in improving safety conditions or in reducing accidents. Bonus is not necessarily a monetary incentive but it can be praise, positive comment for the worker's good behaviour towards their safety or other's safety or firm's safety. A safety incentive program can be designed as informal (feedback, self-recording), social (praise, recognition) and tangible reinforces (trading stamps, cash bonuses) (Vredenburgh, 2002). Appreciation of safety behaviour is a psychological approach that was required (Saracino et al., 2015). An incentive program can be offered recognition which can help modify behaviour. Safety incentive program must be directed to prevent accidents, not punishment after an accident. It should be based on measurable safety activities and behaviours can motivate to improve safety performance (Fell-Carlson, 2004) of the whole company. To sustain the ZAV is also the safety performance of the company. Therefore, this research is proposed the following hypothesis.

Hypothesis 3 – H_3: There is a significant relationship between safety incentive and sustaining the zero accident vision (ZAV)

Employee involvement is contributing to ensure workplace safety. It is a behaviour-based technique. Employee involvement can be as empowering to the decision making process, participating in safety committees, empowering to affect the changes needed in all safety-related issues, empowering to design and implementation, monitoring, and follow-up of the safety management process.

Because of that employee empowerment, employees will have a sense of ownership of the programs and those programs will eventually lead to preventing accidents and injury rates (Ashour & Hassan, 2019). Employees are the only people who sense the condition of their work. And they can clearly understand their critical role in promoting safety. Safety empowerment includes having an important voice in the safety decisions, having the power to initiate and achieve safety improvements, considering them to be responsible for their actions and concerning about their organization's safety performance (Fernández-Muñiz et al., 2012). Employee's positive and supportive safety attitudes is a prerequisite to proactive safety management (Hsu et al., 2008) and support their organization's objectives and goals. Therefore, this research is proposed the following hypothesis.

Hypothesis 4 – H_4: There is a significant relationship between safety empowerment and sustaining the zero accident vision (ZAV)

Results

Reliability Analysis

It looked for a score of over 0.7 for high internal consistency. In this case, α=0.902, 0.855, 0.730, and 0.772 for all categories of safety training, work environment, safety incentive, and safety empowerment respectively which show the questionnaire is reliable. The Cronbach's Alpha for the entire mode is 0.934. Then, the whole questionnaire is reliable.

Validity Test

To check the validity of data, factor analysis was used. The validity of the dimensions was explained using KMO value and significance level. In the factors analysis test, below conditions are applied for validity.

KMO value>0.5

Significance<0.05

Table 1. Summarized of KMO value and significance level

Variable	Degrees of freedom	KMO value	Sig.
Safety training	45	0.881	.000
Work environment	45	0.847	.000
Safety incentive	28	0.738	.000
Safety empowerment	21	0.719	.000

Table 1, shows the validity of the data. Since KMO value each variable is above 0.5 and the significance of each variable is below 0.05, it can be assured that the research data is valid.

Descriptive Analysis

It is mentioned that all variables were tapped on a five-point scale. From the results, it may be seen that most of the respondents have agreed with all the statements of independent variables since the mean of all independent variables is over average on the five-point scale. That means safety training; work environment, safety incentive, and safety empowerment have in somewhat standards. But, it can be found that what are the variables which should be emphasized further develop as a company. The mean on safety incentive is rather low (3.0485 on a five-point scale), as is the mean on safety empowerment (3.5306 on a five-point scale), safety training as somewhat enriched (3.6888 on a five-point scale) and work environment have the largest mean (3.7847 on a five-point scale). The mean of 3.4286 on a five-point scale for the dependent variable (sustaining ZAV) indicates that most of the respondents are satisfied with the current situation of sustaining ZAV in the company.

Multiple Regression Analysis

3) Correlation Analysis

Table 2. Summary of the correlation matrix

Hypotheses	Pearson correlation	P-value	Results
Hypothesis 1	0.722	0.000	Accept H_1
Hypothesis 2	0.692	0.000	Accept H_2
Hypothesis 3	0.627	0.000	Accept H_3
Hypothesis 4	0.675	0.000	Accept H_4

There is a strong positive relationship between sustaining the ZAV and all four independent variables as shown in Table 2. P-values are less than 0.05. Hence, there is statistical evidence to claim that there is a significant relationship between sustaining the ZAV and safety incentives. The hypothesis is accepted.

4) Model Fitting

Table 3. Coefficient table

Factor	VIF	B	P-value
(Constant)		0.233	.333
Safety training	2.586	0.305	.001
Work environment	2.363	0.192	.028
Safety incentive	1.553	0.241	.000
Safety empowerment	2.189	0.172	.046

Significance of coefficient

Significance level: $\alpha = 0.05$, p value: 0.001, 0.028, 0.000 and 0.046 for safety training, work environment, safety incentive and safety empowerment respectively as shown in Table 3.

It can be rejected by the null hypothesis since p-value $< \alpha$. At the 5% significance level, there exists enough evidence to conclude that slopes of safety training, work environment, safety incentive, and safety empowerment are not zero and hence, safety training, work environment, safety incentive, and safety empowerment are useful as a predictor of ZAV.

The coefficients table (Table 3) shows that all b coefficients for the model are statistically significant.

It is,

Predicted ZAV = 0.233 + 0.305*Safety training + 0.192*Work environment + 0.241*Safety incentive + 0.172*Safety empowerment

5) The Model Summary

The coefficient of multiple determinations (R^2 value) is 0.667. Therefore, about 66.7% of the variation in the dependent variable is explained by safety training, work environment, safety incentive and safety empowerment for effecting to sustain the ZAV.

6) Multicollinearity

Based on the coefficients table (Table 3), obtained VIF value of 2.586, 2.363, 1.553, 2.189 meaning that the VIF value obtained is between 1 and 10 and tolerance values are greater than 0.2. Therefore, it can be concluded that there are no multicollinearity symptoms.

Discussion and Conclusion

The main objective of this study was to identify the factors which enabling and impeding to sustain ZAV. The multiple regression analysis identified the model for the sustaining ZAV.

Sustaining the ZAV = 0.233 + 0.305*Safety training + 0.192*Work environment + 0.241*Safety incentive + 0.172*Safety empowerment

From this equation, it can be said that safety training, work environment, safety incentive, and safety empowerment sustain ZAV. The multiple regression equation gives constant values as a combination of all parameters. Safety training and safety incentive are highly impacted by the dependent variable. These factors should be kept continuously as those enabling-factors that sustain ZAV. Safety empowerment and work environment are fewer impacts on the dependent variable. These factors should be improved more to sustain ZAV as these are impeding factors in sustaining ZAV.

Because safety training was becoming an enabling factor, it can be ascertained that the factor provided to personnel is adequate to enable them to assess hazards in their work areas. Adopting new members to the work environment is one of the parts of the safety training program. Two recommendations can be made. One is using a buddy system to help orient new employees in the safety and health and quality systems. Other is instituting of a system of continual re-education and retraining of employees in current safety and health issues.

Another enabling factor is safety incentives. Then it can be ascertained that the current safety incentive program can be motivated to improve safety performance. It can be recommended to continue the safety incentive program, using feedback as a safety incentive. One of the powerful feedbacks is model behaviours.

Current safety empowerment was becoming the most impeding factor to sustain the ZAV. Current safety empowerment is not at a significant level. More emphasis is needed on higher team work and reporting system quality with added team member collaboration, coordination, and information sharing. Improving employee decision making strength can lead to increased safety performance in the plant.

The current work environment of the company was becoming the next more impeding factor to sustain the ZAV. The risk factors must be identified to create a safe work environment with regard to occupational diseases and injuries. Hazards must be recognized, assessed, and controlled to prevent exposure to hazards and the resulting diseases and injuries through eliminating or substituting, engineering controlling, administrative controlling, and personal protective equipment. It fulfils health, safety and well-being concerns in the psychological work environment rendering greater job satisfaction. The company should start to recognize, assess and control psychological hazards through an eliminating or modifying it at the source, lessening the impact on the worker and helping the worker protect him from its effects. Safety will increase employee job satisfaction.

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Author Biographies

The paper originates from the original dissertation work of my BSc Degree in Industrial Management, and Statistics and Mathematics at Department of Industrial Management, Faculty of Applied Sciences at the Wayamba University of Sri Lanka.

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Enhancement of growth and yield of Maize (*Zea mays* L.) using co-compost pellets with biochar

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Abstract— Waste generation and complexity is increasing due to urbanization and absence of proper solid waste management system in developing countries. Co-composted organic fractions of Municipal Solid Waste (MSW) with Dewatered Fecal Sludge (DFS) has a high potential to use as an agricultural resource in Sri Lanka. Oil palm Empty Fruit Bunches (EFB) has become a rising environmental and economic problem and it is a potential source for biochar feedstock. This study was focused on utilization of EFB as a biochar in amending sandy loam soil and evaluating performance of maize (Zea mays L.) fertilized with co-compost pellets (CCP). The experiment was carried out at the Sustainable Agriculture Research and Development Centre, Makandura. The growth and yield characteristics of maize plants were used to assess the effect of pelletized forms of different CCP. Randomized completely block design with four blocks and seven treatments namely MSW+DFS CCP with 30% available Nitrogen (T2) and 100% available Nitrogen (T3), MSW+DFS+biochar CCP with 30% available Nitrogen (T4) and 100% available Nitrogen (T5), MSW+DFS+Mineral enriched CCP (T6) and MSW+DFS+Biochar+Mineral enriched CCP (T7) were compared with mineral fertilizer recommendation by Department of Agriculture (DOA) of Sri Lanka (T1) as control. Significantly higher yield could be obtained under stress weather conditions with T2 against the control. The yield was increased by 22% over current mineral fertilizer recommendation of DOA. It could be concluded that harvest of 4.5 to 6.3 tons ha-1 could be achieved by amending soil with 42 tons ha-1 of MSW+DFS CCP with 30% available Nitrogen.

Keywords**—** Biochar, Co-compost, Pellets, Zea mays L.

Introduction

Waste generation is increasing due to the population growth and urbanization in Sri Lanka. It has been reported that around 6,400 tons of Municipal Solid Waste (MSW) is generated daily whereas waste collection is only about 3,740 tons day^{-1} (Anon, 2020a). MSW compost is produced in 120 compost sites island-wide under the Pilisaru project (Anon, 2008).

The term, MSW usually applies to a heterogeneous collection of wastes produced in urban areas. Improperly managed solid waste poses a risk to human health and the environment, including contamination of water, attracting insects and rodents and increasing flooding due to blockage of drainage canals or gullies. In addition, it may result in safety hazards from fires or explosions and also increases greenhouse gas (GHG) emissions, which contribute to climate change (Karunarathne, 2015).

Biochar is a carbon-rich material obtained from thermochemical conversion of biomass in an oxygen limited environment (Trupiano et al., 2017). Biochar enhances soil properties in many ways such as by holding carbon and making soils more fertile by means of reduced nitrogen leaching into the ground water, reduced nitrous oxide emissions, and increased cation-exchange capacity, as well as by increased pH, increased water retention and increased number of beneficial soil microbes (Anon, 2020b).

Oil palm plantations currently spread in Southern part of the country. Planted area has reached to 4,719 ha by 2012 (Anon, 2012) and production mills generate a large amount of solid wastes such as extracted oil palm fibers, palm shells, palm stone and empty fruit bunches (EFB). Most of these wastes, including EFBs, are dumped in the mill area due to high production rate associated with limited utilization and application. The utilization of oil palm EFBs as biochar feedstock is a way of managing the waste problem. The presctise may decrease the emission of methane (CH_4) and nitrous oxide (N_2O) from the degradation of EFBs (Shariff et al.,2014).

Co-composting is the controlled aerobic degradation of organic materials, using more than one feedstock such as Dewatered Faecal Sludge (DFS) and organic fractions of MSW. DFS has carbon (C), nitrogen (N), phosphorus (P) and potassium (K) as well as micronutrients while biodegradable MSW is rich in organic carbon and show good bulking properties. By combining two, the benefits of each can be used to optimize the process and the product (Anon, 2019c).

Urea is the most widely used N source in the world which represents 21% of total fertilizer N. Granular urea has note worthy characteristics, including less tendency to stick and cake than NH_4NH_3, no risk of explosion, and less corrosiveness towards handling and application equipment.

Substantial savings in handling, storage, transportation, and application costs are possible because of urea's high N content (Havlinet al., 2014).

Maize (Zea mays L.) is the second most important cereal crop grown in Sri Lanka. It is widely used in food and feed industries and consumed as green cobs (Malaviarachchi et al., 2007) as well. There are number of traditional and hybrid Maiz varieties which have been recommended for Sri Lankan conditions as Bhadra, Ruwan, Aruna, Muthu, MI Hybrid Maize 01, MI Hybrid Maize 02 (Anon, 2013). MI Hybrid Maize 02 has cylindrical shape pod. The average yield is 5.5 - 6.5 t h^{-1} (Anon, 2019d).

Therefore, this study focussed on the impact on plant growth, yield quality and quantity when co-compost is added as a 100% organic, and in combinations with mineral fertilizer. The general objectives are the determination of optimum application rate of co-compost for maize cultivation using MI/M/Hybrid 02 and the possibility of using EFB as biochar, DFS and MSW in organic cultivations that can minimize environmental issues and public health.

Methodology and Experimental design

Experimental Site

The experiment was carried out at the Center of Excellence for Organic Agriculture, Makandura, Gonawila (NWP), Sri Lanka. It is situated in IL1a Agro Ecological Zone where maximum and minimum temperatures were 35.6 ^{0}C and 20.8 ^{0}C respectively. Soil type is sandy loamy which consists of alluvial soil as a top layer.

Tested Fertilizer Combination

Seven types of fertilizer combinations were used for the experiment as given in Table 1. 100% available N in T_2 and T_4 signifies the assumption that all N added is absorbed into the plant. In T_3 and T_5 30% available N

signifies the assumption that 30% of added N is absorbed into the plant.

Preparation of Biochar

Oil palm empty fruit bunches (EFB) wereused as a feedstock biochar was made using a pyrolyzer (Pushpakumara et al., 2016).

Preparation of Co-Compost pellets

Co-composting of dewatered fecal sludge , municipal solid waste and biochar weredone at the Kurunagala municipal council compost station operating under the Pilisaru project. Pellets were produced by using pellatizer machine (Grauetal., 2017).

Crop Establishment and Maintenance

Co-compost pellets were applied two weeks before seed sowing. Amount of co-compost necessary for the soil amendment (per plot) was calculated according to its percentage of nitrogen. Co-compost requirement of maize (per plot) was calculated using the urea

pest and disease control and other cultural practices were performed according to DOA recommendation. Thinning out was carried out three weeks after seed germination leaving one well grown, vigorous, healthy and uniform seedling per planting hole.

Experimental Design

Seven treatments were arranged in a Randomized Completely Block Design (RCBD) with four blocks.

Data Recording

Following vegetative and reproductive data were collected from six randomly selected plants from each treatment from each block.

Vegetative Parameters

Plant height, blade length (7th leaf), chlorophyll content (SPAD), leaf area and fresh weight of the rootswere taken as vegetative parameters.

Table 1. Tested fertilizer combination

Code	Treatment	Basal dressing kg/ha			Top dressing kg/ha		
		Urea	TSP	MOP	Urea	TSP	MOP
T_1	Mineral fertilizer	162.5	50	25	162.5	50	25
T_2	FS-MSW-pellet 100% available N	12650					
T_3	FS-MSW-pellet 30% available N	42133					
T_4	FS-MSW-Biochar-pellet 100% available N	13599					
T_5	FS-MSW-Biochar-pellet 30% available N	45366					
T_6	FS-MSW-Mineral-Pellet	1875					
T_7	FS-MSW-Biochar-Mineral-Pellet	1875					

T_1- Mineral fertilizer(control), T_2- Fecal sludge + Municipal Solid Waste Compost Pellets 100% available Nitrogen, T_3- Fecal sludge + Municipal Solid Waste Compost Pellets 30% available Nitrogen, T_4- Fecal sludge + Biochar+ Municipal Solid Waste Compost Pellets 100% available Nitrogen, T_5- Fecal sludge + Biochar+ Municipal Solid Waste Compost Pellets 30% available Nitrogen, T_6- Fecal sludge + Mineral fertilizer +Municipal Solid Waste Compost Pellets, T_7- Fecal sludge + Biochar+ Mineral fertilizer +Municipal Solid Waste Compost Pellets.

requirement (325 kg ha^{-1}) of maize as recommended by DOA (Anon, 2019d).

Co-compost pellets were applied only as a basal dressing, while mineral fertilizer were applied as both basal and top dressing. Mineral fertilizer basal dressing was applied two days before seed sowing in the field. Top dressing was applied four weeks after seed sowing. Earthing up was carried out four weeks after seed sowing. Manual weeding,

Plant height was measured from soil surface to tip of the fully emerged leaf sheath from four randomly selected plants and data were recorded two weeks after the seed sowing and continued within two weeks interval.

Blade length was measured from end of leaf sheath to tip of the leaf from two randomly selected plants and data were recorded one month after seeds sowing.

Chlorophyll content was measured from the middle part of the fully emerged leaves by using SPAD-502 Plus (Konica Minolta) chlorophyll meter and data were recorded two weeks after the seeds sowing and continued once in two weeks.

Leaf area and fresh weight of the roots were measured at harvesting (50 days after seeds sowing) from one randomly selected plant and data were recorded.

Yield Parameters

Pod diameter, pod length, number of pods and yield were taken as yield parameters.

Pod diameter was measured by using Vernier caliper from two randomly selected plants and data were recorded 20 days after pod emergence.

Pod length was measured from two randomly selected plants and data were recorded 20 days after the pod emergence.

Number of pods were counted at 75 days after the seed sowing.

Predicted grain yield was taken at harvesting. One randomly selected pod and number of seeds were recorded for each treatment 25 days after the pod emergence. Total number of seeds per plot was calculated using number of pods per plot. Predicted grain yield was calculated using the weight of 1000 seeds (241.9 g) and the plot size of 4.64 m^2.

Statistical Analysis

Data were analysed by analysis of variance using SAS Statistical software (version 9.4).

Results and Discussion

Vegetative Parameters

Mean values of quantitative vegetative parameters are given in Table 2. The highest plant height was recorded with T_2 while the lowest was recorded with T_6. Even though the highest plant height was demonstrated by addition of MSW co-compost (T_2), addition of mineral fertilizer into FS-MSW co-compost

(T_6) tend to lower the plant height according to the results of T_6 and T_1 (mineral + pellet is significantly lower than the control). This may be due to the stress conditions prevailed during the research period.

Table 3. Mean values of quantitative yield parameters

T	Yield (g m^{-2})	Pod diameter (cm)	Pod length (cm)
T_1	443.94[b]	4.18[bc]	26.19[a]
T_2	501.97[ab]	4.25[bc]	24.94[a]
T_3	542.42[a]	4.78[a]	27.13[a]
T_4	417.43[bc]	4.33[b]	25.50[a]
T_5	468.81[ab]	4.76[a]	27.31[a]
T_6	232.49[e]	4.25[bc]	26.50[a]
T_7	323.28[d]	4.00[c]	25.50[a]
p	0.0001	0.0012	0.1024

T-Treatment, T_1- Mineral fertilizer, T_2- Fecal sludge + Municipal Solid Waste Compost Pellets 100% available Nitrogen, T_3- Fecal sludge + Municipal Solid Waste Compost Pellets 30% available Nitrogen, T_4- Fecal sludge + Biochar+ Municipal Solid Waste Compost Pellets 100% available Nitrogen, T_5- Fecal sludge + Biochar+ Municipal Solid Waste Compost Pellets 30% available Nitrogen, T_6- Fecal sludge + Mineral fertilizer +Municipal Solid Waste Compost Pellets, T_7- Fecal sludge + Biochar+ Mineral fertilizer +Municipal Solid Waste Compost Pellets, p-significant probability value

The highest mean value (Table 2) of the leaf bade length was recorded with T_2 while the lowest was recorded with T_7. However T_2 and T_3 had no significant difference. Even though the leaf bade length growth was increased by the addition of MSW co-compost in T_2 and T_3, addition of mineral fertilizer+biochar into MSW co-compost (T_7) tend to lower the leaf bade length. It was found that T_7 and T_6 have no difference with T_1. This may be also due to the stress conditions prevailed during the research period that can reduce the effect of mineral ferti

Table 2. Mean values of quantitative and vegetative parameters

Treatment	Plant height (cm)	Leaf blade length (cm)	Chlorophyll content (SPAD)	Leaf area (cm²)	Root fresh mass (g)
T_1	98.59^e	41.86^c	51.68^{ab}	13619.5^a	131.75^b
T_2	136.50^a	53.61^a	43.36^e	13063.7^a	137.25^b
T_3	132.42^{ab}	50.60^{ab}	53.41^a	13809.0^a	184.75^a
T_4	116.76^{cd}	47.48^b	45.32^{de}	16116.7^a	148.75^{ab}
T_5	122.25^{bc}	47.45^b	53.13^a	16032.0^a	156.25^{ab}
T_6	82.75^f	41.60^c	48.07^{bcd}	15671.3^a	184.00^a
T_7	95.66^e	41.23^c	46.55^{cd}	11647.3^a	125.00^b
P	<0.0001	<0.0001	0.0025	0.1212	0.0437

T_1- Mineral fertilizer, T_2- Fecal sludge + Municipal Solid Waste Compost Pellets 100% available Nitrogen, T_3- Fecal sludge + Municipal Solid Waste Compost Pellets 30% available Nitrogen, T_4- Fecal sludge + Biochar+ Municipal Solid Waste Compost Pellets 100% available Nitrogen, T_5- Fecal sludge + Biochar+ Municipal Solid Waste Compost Pellets 30% available Nitrogen, T_6- Fecal sludge + Mineral fertilizer +Municipal Solid Waste Compost Pellets, T_7- Fecal sludge + Biochar+ Mineral fertilizer +Municipal Solid Waste Compost Pellets, p-significant probability value

The highest mean value (Table 2) of the chlorophyll content (SPAD) was recorded with T_3 while the lowest was recorded with T_2. Even though the highest Chlorophyll content was demonstrated by MSW co-compost 30% available nitrogen (T_3), addition of MSW co-compost 100% available nitrogen (T_2) tended to lower the chlorophyll content. However T_5 was not significantly different with T_3 probably due to the addition of excess amount of nitrogen than the requirement of the plant. Further results indicated that addition of mineral fertilizer to MSW co-compost pellet tended to lower the chlorophyll content. Leaf area among all treatments was unchanged (Table 2).

The highest mean value (Table 2) of the root fresh mass was recorded with T_3 while the lowest was recorded with T_7. However T_3 and T_6 was not significantly different. Even though root fresh mass was increased by addition of MSW co-compost and MSW co-compost + mineral fertilizer (T_3, T_6), addition of mineralfertilizer + biocharinto MSW co-compost (T_7) lowered the root fresh mass. This may also be due to the stress conditions prevailed during the research period and cultivation under irrigation water.

Yield Parameters

Mean values of quantitative yield parameters are given in Table 3. Pod lengths were not different among all treatments suggesting no effect of the treatments.

The highest mean value (Table 3) of the pod diameter was recorded with T_3 while the lowest was recorded with T_7. Even though the highest pod diameter was achieved by MSW co-compost (T_3), addition of mineral fertilizer + biochar into MSW co-compost (T_7) tended to lower the pod diameter according to the results. However T_1, T_6 and T_2 were not significantly different with T_7. This may also be due to the stress conditions prevailed during the research period as observed with plant height and blade length.

Mean values (Table 2) of the highest predicted yield was recorded with T_3 while the lowest was recorded with T_6. Even though the highest predicted yield was demonstrated by addition of MSW co-compost (T_3), addition of mineral fertilizer into MSW co-compost (T_6) lowered the predicted yield. Mineral fertilizer with MSW co-compost (T_6) was not significantly different with mineral fertilizer with MSW co-compost treatments (T_7). This may also be due to the stress conditions prevailed during the

research period and cultivation under irrigation water. (Malaviarachchi et al., 2007)

The results show significant treatment effect in both vegetative and yield parameters. Mineral fertilizer and mineral fertilizer with MSW co-compost had lower values for vegetative and yield parameters. The FS-MSW pellets 30% available Nitrogen fertilizer (T_3) showed significantly better performance than mineral fertilizer recommendation of DOA (5.1 to 6.2 t ha^{-1}). However, under the study conditions (irrigated water and average day time temperature of 33 ^{0}C) the yield recorded with mineral fertilizer recommendation was 4.0 to 5.2 t ha^{-1}.

Conclusions

When the co-compost is used as a fertilizer with maize, optimum yield could be obtained with the application of excess amount of co-compost. FS-MSW pellets with 30% available Nitrogen could increase the yield by 22% over current mineral fertilizer recommendation of DOA. FS-Biochar-MSW pellets with 30 % available Nitrogen also increased the yield by 6 % over the current mineral fertilizer recommendation. However co-compost with biochar showed lower yield than co-compost. A better understanding of the behavior of co-compost pellets and biochar can be obtained by conducting the same trial under normal rain fed conditions in same soil.

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Performance evaluation of coconut estates: developing an index to evaluate performance of coconut estates managed by Kurunegala Plantations Ltd

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Abstract — Coconut industry plays a vital role in the economy of Sri Lanka and in rural livelihood. Over 497,000ha of lands are cultivated with coconuts in Sri Lanka. Estate sector accounts for 25% of the land area for coconut cultivation and it contributes 40% of the national production. However the rest, 60%, is from smallholders' sector. Coconut production by both smallholders and estates managed by plantation companies show high variation in their performance. In this study, the performance evaluation of coconut estates was done by developing an index. It facilitated comparison of the performance at seven area-coconut estates of Kurunegala Plantations Ltd (KPL) which holds mature coconut area of 3,124.60ha. Ten variables were identified as the most vital pertning to estate performance. Weights for each variable was finalized through direct interviews with five plantation experts at KPL. Ten year data for each variable were collected and the average values were taken for analyses. Results revealed that Narammala area estates have excellent performance in profit per ha, field works, agronomic and other management practices, and immature coconut extent. The estate has done well in density per ha, net sales average, cost of production and progress in office work. Even though the estate has done good in many variables, yield per ha and nuts per palm were only at satisfactory level. Its yield per ha was the 2nd highest among all area estates. With all performances, Narammala area-estates ranked no. 1 in KPL, but needed to improve in diversification, yield per ha and nuts per palm.

Keywords— Coconut, Estate sector, Performance Index

Introduction

Coconut (Cocos nucifera L.) is extensively cultivated in all tropical regions of the world (Somasiri et al., 1994). It is grown in more than 86 countries worldwide, with a total production of 61 billion nuts per annum (Arancon, 2009). In the Asian continent, it grows well in Indonesia, Malaysia, India, Philippines, Thailand, Sri Lanka, Burma and Cambodia. Among them, Indonesia, India, Philippines, and Sri Lanka play a major role contributing 76% of the global coconut production (Krishna, 2011). Coconut is a rain-fed perennial crop that plays a major role in Sri Lankan

economy (Pathiraja et al., 2015). It spreads over 400,000 ha of land area in all administrative districts of Sri Lanka except those at elevations beyond 750 m msl (Somasiri et al., 1994; Central Bank of Sri Lanka, 2019). Every part of the coconut tree has its own commercial value. The coconut trunk can be used for building material, coconut fronds can be turned into brooms, coconut fibre can be turned into cushion,

coconut shell can be used to produce activated carbon and coconut flesh can be used to produce coconut milk. (Md Akhir et al., 2009). The main coconut growing areas in Sri Lanka consist of three administrative districts namely, Kurunegala, Puttalam and Gampaha and called the "Coconut Triangle". This region represents 57% of the total coconut extent. The remaining coconut land is distributed throughout the country except for the central hills where coconut is not grown due to low temperatures. It is cultivated in all three agro-climatic zones of Sri Lanka as 30% in the wet zone, 50% in the intermediate zone and 20% in the dry zone. Coconut is considered as a crop of multipurpose use; providing food, shelter, oil, medicine, fuel, building materials and beverage. Therefore, coconut is interwoven and highly attached with the lives of local people and considered as the "tree of life". The annual nut production was 3,056 million in the year 2015 (Central Bank of Sri Lanka, 2019). Coconut production has reduced in recent years due to lower amount of rainfall received in major coconut growing areas, increase of average temperature more than 32°C (Ranasinghe, 2012), and inefficiency in utilization by farmers.

The annual coconut production is mainly influenced by the productivity of estate sector. The estates of more than nine ha. represents 40% of the total bearing extent. The productivity of a coconut estate is determined by its land suitability classes for coconut, when other biotic factors are nonlimiting (Somasiri, et. al, 1994). An analysis of past data indicates that the gap between the potential and the actual coconut yield of the estate sector has been widening over the years in spite of the advances in agricultural technology and considerable efforts on subsidy programs of coconut. Based on the population growth rate of 1% per yearand the annual consumption rate of 110 nuts per head (Sri Lanka Coconut Statistics, 1998), the requirement for domestic consumption in the year of 2005 would be 2185 million nuts. Sri Lankan coconut sector is monitored by the Coconut Research Institute (CRI), Coconut Cultivation Board (CCB) and the Coconut Development Authority (CDA). Coconut cultivation is dominated by the smallholders' sector accounts for 75% of the area (917,307 acres) and contributes 60% to the national production (Central Bank of Sri Lanka, 2016). Estate sector (RPCC & State Agency) accounts for 25% of the area (178,675 acres) and contributes 40% to the national production (Central Bank of Sri Lanka, 2016). Chilaw Plantations Limited and Kurunegala Plantations Limited play a prominent role in the estate sector.

Kurunegala Plantations Limited is fully government owned public company with limited liability. The companies core business interests continue to be in cultivation, production, processing and sale of coconut, rubber and ancillary crops with a portfolio of seven Area Estates which span varying agro climatic zones in the four district of Kurunegala, Gampaha, Matale and Anuradhapura. KPL doesn't have a criteria to evaluate the performances of Area Estates. Need to identify a method to evaluate the maximum usage of inputs, management, resources and to identify most important variables which affects the performances of estates. To develop an index for performance evaluation of Area Estates in order to rank them based on different variables.

Thus, this study was conducted with the objective of developing an index for performance evaluation of coconut estates in order to rank them based on their current performance levels and identifying the constraints and suggesting appropriate measures to increase the sustainability. The study also focused on identifying the important variables which affect the overall performances of coconut estates.

Methodology

Ten variables were identified as most important in performance evaluation through direct interviews with five plantation experts in KPL. Gathered 10 years data of each variable for all seven Area Estates and calculated 10 year averages. Scoring criteria was developed by direct interviews with the plantation experts in KPL based on country averages of coconut plantations and KPL norms. Each variable was awarded points according to the scoring criteria. All the variables were given weightages by the experts through questionnaires circulated among five experts of KPL of their importance to the performances of the Area Estates. Accordingly, the Coconut Plantation Performance Index was calculated and each Area Estates was ranked. The model can be specified as given bellow equation.

Coconut Plantation Performance Index (CPPI)

$$= \sum_{i=1}^{n} \left[\frac{W_i L_i}{n} \right]$$

Where, Wi is weightage given by the experts, Li is score for each variables and N is the total Nnmber of variables. When considering the Estates, E_1 is Attanagalla, E_2 is Dambadeniya, E_3 is Dodangaslanda, E_4 is Hiriyala, E_5 is Katugampola, E_6 is Kurunegala and E_7 is Narammala., The variables represented as V_1 for profit & loss per hectare, V_2 for yield per hectare, V_3 for nuts per palm, V_4 for density per hectare, V_5 for net sales average per nut, V_6 for cost of production per nut, V_7 for field works, agronomic & other management practices (Timely application of fertilizer, Application of soil & water conservation methods, Weeding, Pest & disease management etc.), V_8 for percentage of immature coconut extent from total coconut extent, V_9 for percentage of diversified extent from coconut bearing extent and V_{10} for progress of office works (Timely submission of documents, Accuracy of information, Record keeping and maintenance, Correspondence etc.)

Results and Discussion

Narammala araea estate has excellent performance in profit per ha (V_1), Field works, agronomic & other management practices (V_9) and immature coconut extent (V_{10}). The Estate has done good in density per ha (V_4), net sales average (V_5), cost of production (V_6) and progress of office work (V_7). Even though Estate has done good in many variables, yield per ha (V_2) and nuts per palm (V_3) are only in satisfactory level, but yield per ha is the 2 nd highest in all area estates. Percentage of diversified extent (V_8) is very poor. With all performances, Narammala area estates ranks no. 1 in KPL, but need to improve in diversification, yield per ha and nuts per palm. Over the last 15 years, AEIs have been successfully applied in Dutch research, playing, amongst others, an important role in research projects such as 'De Marke', 'Cows and Opportunities' and 'Farming with a future'. Nitrogen Surplus has played by far the most important role in both analysis and communication, being the starting point in most projects and discussions, providing quick but limited insight in N management (Aarts et al., 1999; Schro¨ der et al.,2003). Kurunegala area estates havedone excellent in profit per ha and cost of production, but only has done good in net sales average, the progress of office works and field works, agronomic practices and other management practices. The estate has done satisfactory level in yield per ha, nuts per palm and density per ha, but poor in diversification and immature coconut extent. The estate ranks 2nd in KPL, but need to improve in yield per ha, nuts per palm, density per ha, diversification extent and immature extent. Dodangaslnda Area Estates has excellent performances in profit per ha (V_1) and net sales average (V_5). The estate has done good in cost of production (V_6), progress of office works (V_7) and field works, agronomic practices and other management practices (V_9). The Area Estate has done yield per ha,

nuts per palm, density per ha and immature coconut extent as at satisfactory level, but diversified extent is at a poor level. The Area Estate ranks 3rd in KPL, but need to improve yield per ha (V_2), nuts per palm (V_3), density per ha (V_4), diversified extent (V_8) and immature coconut extent (V_{10}). Although Attanagalla Area Estates has excellent performances in net sales average, cost of production and field works, agronomic & other management practices, only done good in profit per ha and progress of office works

per ha and reduce the cost of production. Dambadeniya Area Estates only done excellent in immature coconut extent and performed good in profit per ha density per ha, net sales average, progress of office works and field works, agronomic & other management practices. The state has performed statisfactorily in nuts per palm and cost of production.

The estate has done poorly in yield per ha. The estate has ranked 6th in KPL and needs to improve nuts per palm, cost of production,

Table 1. 10 Year averaged (2009-2018) statistical data of each variable of seven Area Estates in KPL

Variable	Unit	E₁	E₂	E₃	E₄	E₅	E₆	E₇
V_1	Rs./ha	72,813	69,975	98,958	60,156	70,424	79,788	97,256
V_2	Nuts	3,717	4,632	5,423	3,899	4,289	5,054	5,317
V_3	Nuts	43	38	47	40	38	46	42
V_4	Palms	87	122	115	100	117	110	130
V_5	Rs.	32	2	30	26	30	28	29
V_6	Rs.	17	18	16	20	1	15	16
V_7	Progress	9	8	8	8	7	7	9
V_8	%	11	22	16	21	24	15	23
V_9	%	14	2	10	18	17	6	7
V_{10}	Progress	8	8	8	8	8	7	8

All the other variables are satisfactory or poor. The estates ranks 4th in KPL and need to improve in yield per ha, nuts per palm, density per ha, diversified extent and immature coconut extent. Intercropping enhances soil conservation and the sustainability of coconut lands. Monocrop stands of mature coconuts only partially cover the ground, thereby exposing soils to degradation (Liyanage et al., 1984).

Katugampola Area Estates has excellent performances only in net sales average and immature coconut extent and done wellin only profit per ha, the progress of office worksdiversified extent and field works, agronomic & other management practices. The estate has only done satisfactory level in nuts per palm, density per ha and cost of production, but has poor performance in yield per ha. The estate rank is 5th in KPL and needs to improve yield per ha, nuts per palm, density

yields per ha and diversified extent.

Although Hiriyala Area Estates were done in excellent in diversification and immature coconut extent, good in progress of office works and field works, agronomic & other management practices The estate ranks 7th in KPL, because it has satisfactory performances in profit per ha, nuts per palm, density per ha, net sales average per nut and poor performances in yield per ha and cost of production. All satisfactory and poor performances should be improved in the estate. Considering all the variables, it is observed that Narammala Area Estates has ranked one in KPL and the Hiriyala Area Estates has ranked 7th in KPL.

Table 2. Scoring criteria

Variable	Unit	E_1	E_2	E_3	E_4	E_5
V_1	Rs./ha	<75,000	75,000-63,000	63,000-37,000	37,000-20,000	>20,000
V_2	Nuts	<9,000	9,000-8,000	8,000-5,000	5,000-3,000	>3,000
V_3	Nuts	<60	59-50	49-30	29-20	>19
V_4	Palms	158-140	139-120	119-100	99-80	>79
V_5	Rs.	<30	29-27	26-24	23-21	>20
V_6	Rs.	<15	16-17	18-19	20-21	>21
V_7	Progress	10-9	8-7	6-5	4-3	>2
V_8	%	<20	19-18	17-16	15-14	>13
V_9	%	<18	17-16	15-14	13-12	>11
V_{10}	Progress	10-9	8-7	6-5	4-3	>2

Table 3. Calculation of weighted values

Variable	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Weight average
V_1	4.00	2.50	4.00	5.00	8.65	4.83
V_2	1.20	1.00	1.20	2.00	0.08	1.10
V_3	0.50	0.75	0.70	1.30	0.07	0.66
V_4	0.75	0.60	0.60	0.10	0.06	0.42
V_5	0.10	0.05	0.20	0.02	0.04	0.08
V_6	0.40	0.02	0.50	0.03	0.03	0.20
V_7	2.50	2.00	2.00	1.43	1.00	1.79
V_8	0.05	0.01	0.10	0.01	0.01	0.04
V_9	0.20	3.00	0.30	0.04	0.01	0.71
V_{10}	0.30	0.07	0.40	0.07	0.05	0.18

Table 4. Calculation of scores for each variables of all seven Area Estates, CPPI & ranking estates

	Variables	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	CPPI	Rank
	Weighted Average	4.83	1.10	0.66	0.42	0.08	0.20	1.79	0.04	0.71	0.18		
	Attanagalla	4	2	3	2	5	5	5	1	3	4	**3.75**	**4**
	Dambadeniya	4	2	3	4	4	3	4	5	1	4	**3.46**	**6**
Area Estate	Dodangaslanda	5	3	3	3	5	4	4	3	1	4	**4.04**	**3**
	Hiriyala	3	2	3	3	3	2	4	5	5	4	**3.20**	**7**
	Katugampola	4	2	3	3	5	3	4	5	4	4	**3.64**	**5**
	Kurunegala	5	3	3	3	4	5	4	2	1	4	**4.05**	**2**
	Narammala	5	3	3	4	4	4	5	5	1	4	**4.26**	**1**

Conclusion

As per the weighted values given by the experts of KPL, profit per ha is the most significant variable. Yield per ha, nuts per palm and density per ha is at a low performance level in most of all Area Estates and that directly affects the profit per ha and the company performances are not at the satisfactory level. Performances of net sales average and cost of production are low in few Area Estates and percentage of diversified extent from coconut bearing extent is poor in most of the estates, except Hiriyala and Katugampola Area Estates.

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Effect of vermicompost with biodynamic formulated biochar on Carbon and Nitrogen mineralization in Ultisols and Alfisols

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Abstract— Organic amendments provide good nutritional input to the soil by maintaining environmental sustainability. Availability of nutrients are less due to soil salinization and acidity in Alfisols and Ultisols, respectively.Therefore, this study aims to assess the effect of vermicompost, biochar and biodynamic formulated biochar on C and N mineralization in Alfisols and Ultisols,the main soil types that cover land area in Sri Lanka. Vermicompost and biochar with and without biodynamic formulation were applied to soil types separately according to the specific rates. After incorporating the amendments, pH, EC, nitrate-N, ammonium-N and CO2 evolution were determined up to 63 days. Statistical analysis was done using SAS software. According to the results, the pH of Ultisols with inoculated biochar shows a lowering at the initial stage, however it was not significantly different with the control. Inoculated and non- inoculated biochar with vermicompost in Alfisols decreased the EC significantly ($p<0.05$) in later stages reducing the salinity compared to the control. In Ultisols and Alfisols, nitrate-N increased significantly ($p<0.05$) in both treatments. The evolved CO2 is significantly high ($p<0.05$) in microbial inoculated soil treatments when compared to non-microbial inoculated soil treatments in both soil types. It can be concluded that the N and C mineralization pattern varied among the treatment in Ultisols and Alfisols and the biodynamic formulated biochar with vermicompost showed an impact on mineralization. Soil amendments have both long term and short term effects. Therefore, it is recommended to do further studies to evaluate the long term effect of organic amendments.

Keywords— Biochar, inoculum, vermicompost

Introduction

In agriculture, soil management is essential to get adequate food production (Walpola & Wanniarachchi, 2003) as soil acts as the original nutrient resource. Due to the rapid growth of human population, there will be a problem in future on food accessibility due to poor agricultural practices.

Alfisols covers about 2.5 million hectares in Sri Lanka (Subasinghe, 2004). On the other hand, Ultisols are mostly found in wet zone of Sri Lanka. Due to the salinity, in the Hambantota district soil productivity has been reduced and the land degradation has been increased (Subasinghe, 2004). On the other hand, soil acidity is the main factor which acts as a barrier for amelioration of Ultisols (Li., et al. 2015).

To overcome these problems, applying eco–friendly sustainable organic methods and materials has become a good strategy (Singh and Tiwari, 2017). Further, the organic amendments will increase the nutrient availability by mineralization. This study thus aimed to assess the effect of vermicompost (VC), biochar (BC) and biodynamic formulated biochar (BDF biochar) on C and N mineralization in Alfisols and Ultisols.

Methodology

Alfisols and Ultisols were collected from Bandagiriya Agrarian Service Centre, Hambantota, Sri Lanka and Ultisols were collected from the Faculty of Agriculture, University of Ruhuna, Mapalana, Kamburupitiya, Sri Lanka. Samples were collected from three randomly selected places in each soil type. Meantime, soil samples were obtained for determining the bulk density. Composite soil samples were air dried and sieved by passing through 2mm mesh to make homogeneity. Basic soil properties such as pH, EC, moisture content (MC), bulk density (DB), particle density (pycnometer method) (DP) and texture (hydrometer method) of Ultisols and Alfisols (Bandyopadhyay et al.,2012) were determined at initial stage before mixing soil organic amendments (SOA).

The vermicompost was collected from a vermicomposter in Retreat hotel, Thalalla, Sri Lanka. It was sieved by a 2mm mesh to make homogeneity. BC was prepared by using rice husk at the Faculty premises using the pyrolysis method.

Biodynamic formulation (Jeevamrutha) (BDF) was prepared by mixing 500g cow dung, 250ml cow urine, 100g brown sugar, 100g green gram flour, handful of fertile soil in 10L of water (Jayappa et al., 2010). It was thoroughly mixed using a wooden stick once a day and incubated for 72 hours. Prepared BDF was applied to biochar at the rate of 500L/ acre and kept for 24 hours.
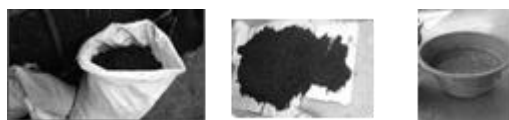

Figure1. Prepared vermicompost, biochar and biodynamic formulation for the experiment

The treatments were prepared by mixing amendments according to the Table 1. with VC and BC and BDF biochar with 2kg of soil sample each and mixed thoroughly. All the treatments were replicated four times, labelled and kept in the laboratory conditions.

Separately, an incubation study was conducted. The treatments were prepared according to the Table 1 and mixed with 100g of soil. All the bottles were kept in a dark place according to the CRD method with the aim of determination of CO_2 evolution. A bottle without soil and with NaOH and H_2O was kept considering as a control.

Table1. Application amount of amendments according to the rate of application

Vermicompost	Application rate= 10MT/ha	Alfisols	For 2kg	12.55g
			For 100g	5.02g
		Ultisols	For 2kg	18.09g
			For 100g	0.91g
Biochar	Application rate= 5% (w/w) [wet weight basis]	Alfisols	For 2kg	100g
			For 100g	5g
		Ultisols	For 2kg	100g
			For 100g	5g
Biodynamic formulation (*Jeevamrutha*)	Application rate= 500L/acre	Alfisols	For 2kg	1.55ml
			For 100g	0.08ml
		Ultisols	For 2kg	2.24ml
			For 100g	0.12ml

The pH 1:2.5 (w/v soil:water)- (pH meter HANNA), EC 1:5 w/v sil:water)-(EC meter HANNA), Nitrate nitrogen (Salicilic acid method, UV-visible spectrophotometer UV160, Shimadzu, Japan), Ammonium nitrogen (Salicilic acid method, UV-visible spectrophotometer UV160, Shimadzu, Japan), (Markus et al., 1985) were determined in all treatments in days 1, 4, 7, 14, 21, 28, 35, 42, 49, 56, 63, after incorporating amendments. Carbon mineralization (CO_2 evolution method) was determined by incubation study in days 1, 4, 7, 14, 21, 28, 35, 42, 49, 56, 63 after incorporating amendments. The evolved CO_2 was determined by the titration method (Rubio, 2017).

Experimental Design

All the experimental units were kept following CRD method using four replicates for each treatment type. Statistical analysis was conducted using SAS method.

The treatments were prepared according to the rates of amendments described in Table 1 and named from T1 – T6 (Table 2).

Table 2. Treatments for the experimental study

Ultisols	Vermicompost+ Biochar (T1)	Vermicompost+ BDF Biochar(T2)	Control (T3)
Alfisols	Vermicompost+ Biochar (T4)	Vermicompost+ BDF Biochar(T5)	Control (T6)

Results

The physico-chemical characteristics of soils

Soil Property		Ultisols	Alfisols
Moisture content (%)		38.79 ± 3.11	19.59 ± 1.06
Bulk density (g/cm³)		1.11 ± 0.09	1.59 ± 0.07
Particle-density (g/cm³)		2.55 ± 0.08	2.6 ± 0.16
Texture	Sand	67.11 ± 1.63	67.78 ± 0
	silt	21.59 ± 1.63	9.85 ± 1.55
	clay	11.28 ± 0	22.36 ± 1.55
		Sandy Loam	Sandy Clay Loam
pH		6.0 ± 0.10	7.6 ± 0.03
EC (dS/ cm)		0.3 ± 0	5.8 ± 0.68

were obtained before incorporating them with soil amendments (Table 3). When considering the pH values, Ultisols and Alfisols showed 6.0 and 7.6, respectively. Therefore, sampled Ultisols have slight acidic conditions and Alfisols have slight alkaline conditions. When considering EC values, Alfisols have high EC value than Ultisols showing higher soil salinity.

Table3. Physical and chemical properties of Ultisols and Alfisols at initial stage

The physico-chemical properties of soil amendments were given inTable 4.

Table 4. Chemical properties of organic amendments used in the study

Organic amendment	pH	EC (mS/cm)	NO_3^--N nitrogen (mg/kg)	NH_4^+-N (mg/kg)
Vermicompost	6.3	5.43	133.3	5.25
Biochar	7.5	0.38	31	2.7
BDF	4.4	1.0	50	63.6

The analysed results of pH, EC, Ammonium N, Nitrate N, and carbon dioxide evolution of the treatments are given in Figures 2 – 11.
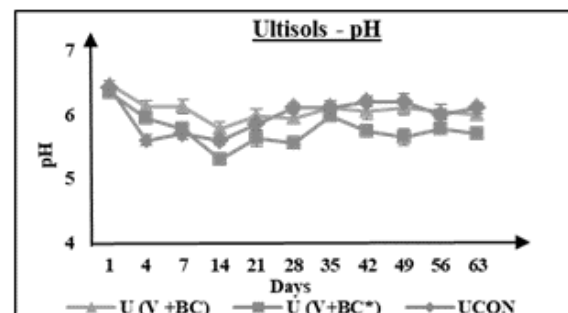

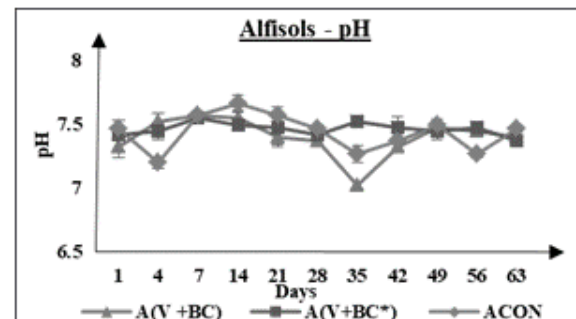*Figure2. Temporal variation of pH values in different treatments of Ultisols*

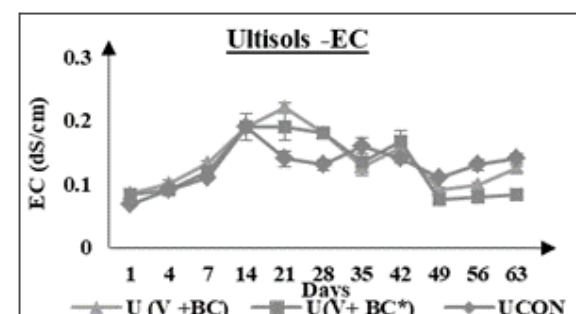*Figure 3. Temporal variation of pH values in different treatments of Alfisols*

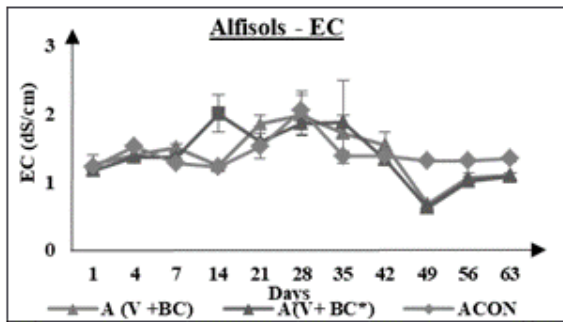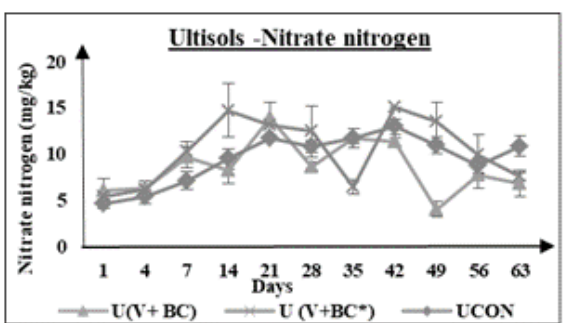*Figure 4. Temporal variation of EC values in different treatments of Ultisols*

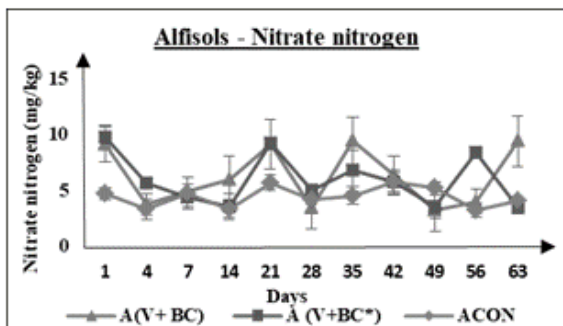*Figure 8. Temporal variation of ammonium nitrogen values in different treatments of Ultisols*

Figure 5. Temporal variation of EC values in different treatments of Alfisols

Figure 9. Temporal variation of ammonium nitrogen values in different treatments of Alfisols

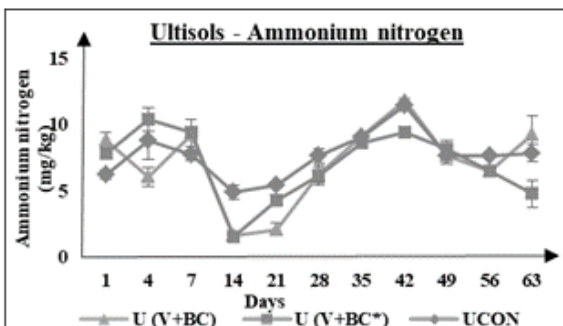*Figure 6. Temporal variation of nitrate nitrogen values in different treatments of Ultisols*

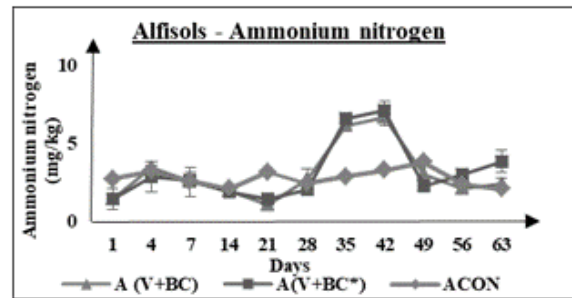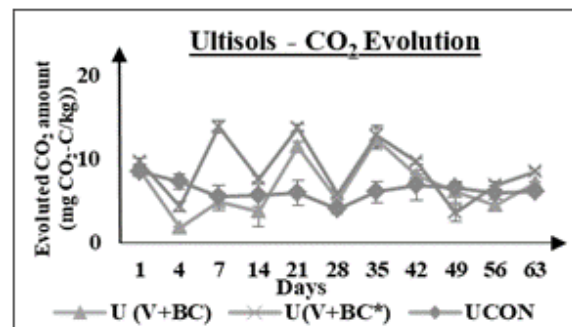*Figure 10. Temporal variation of carbon dioxide evolution in different treatments of Ultisols*

Figure 7. Temporal variation of nitrate nitrogen values in different treatments of Alfisols
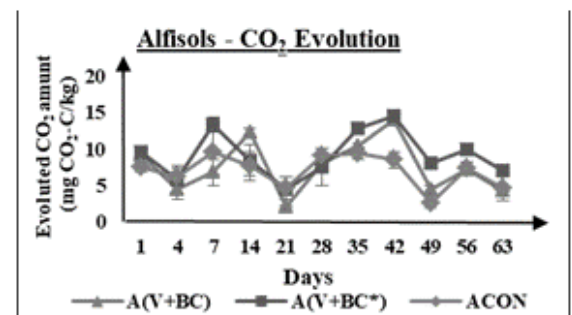

Figure 11. Temporal variation of carbon dioxide evolution in different treatments of Alfisols

Discussion

When considering pH, Ultisols with inoculated biochar and vermicompost [U(V+BC*)] showed a lower value compared to other treatments and the control (Figure 2). This may be due to microbial reactions. Further, microbial inoculated biochar and vermicompost [A(V+BC*)] in Alfisols have shown a stable pH value during the study period (Figure3). There was no significant difference between inoculated and non

inoculated treatments in both soils amended by vermicompost.

When considering EC in Ultisols, it has no significant change in the initial stage, however the EC increased gradually from day 14 and decreased in both treatments (Figure 4). However, inoculated and non inoculated biochar with vermicompost in Alfisols decreased the EC significantly (p<0.05) in later stages reducing the salinity compared to the control (Figure 5). This shows that the incorporation of amendments may be effective at later stages than early stages during the mineralization.

When considering the nitrate-N in Ultisols and Alfisols, inoculated soil [U(V+BC*)] had a higher nitrate level compared to the control, however fluctuated with the time (Figure 6 & 7). However, the impact of biodynamic formulation was not observable clearly.The mineralization is lesser in Alfisols than the Ultisols. This may be due to the saline conditions in the soil.

When considering the ammonium-N in both soil treatments, the highest concentration was observed in day 42. Similarly, mineralization rate was low in Alfisols (Figure 9).

When considering the CO2 evolution in both Ultisols and Alfisols, with biodynamic formulation [U(V+BC*)] and [A(V+BC*)] have shown high CO2 evolution compared to other treatments. However, compared to Ultisols, Alfisols showed less amount of CO2 evoution due to salinity effect which may retard the microbial activity.

Conclusion

Based on the results, it can be concluded that, nitrogen mineralization pttern varied among the treatments of Ultisols and Alfisols. Ultisols and Alfisols showed lowering of pH with treatments.With both inoculated and non-inoculated biochar with vermicompost decreased the EC of Alfisols in later stages of the experiments. N mineralization showed

higher effect in both treatments (inoculated and non-inoculated) of Ultisols than the Alfisols. This may be due to the Microbial activity which is higher in inoculated biochar and vermicompost treatment in Ultisols than Alfisols.

Recommendations

Further studies may be required with extending the time period to evaluate the long term effect of biochar, vermicompost, biodynamic formulated biochar on the enhancement of the overall soil quality in Ultisols and Alfisols.

Acknowledgement

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