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Okra (*Abelmoschus esculentus* L.) yield influenced by *Albizia* leaf mould and banana peel with half dosage of NP chemical fertilizers

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Abstract

Dried *Albizia* leaf mould (10 mt/ha) and banana peel (0.1-0.5 mt/ha) with reduced level of NP chemical fertilizers were applied on the production of okra (*Abelmoschus esculentus* L.).The experiment was carried out in a randomized complete block design with seven treatments. The result revealed that the combined application of 10 mt/ha leaf mould and 0.1 mt/ha banana peel with 50% NP chemical fertilizer as basal and 50% N as top dressing (T6) exhibited higher yield than recommended 100% NPK chemical fertilizer alone (T2). Plants treated with fertilizers showed significant influences ($P<0.05$) in the growth parameters such as leaf area, length, fresh and dry weight among treatments. Remarkable differences ($P>0.05$) in number of fruits per plant were obtained. Among the treatments, considerable variations in fruit diameter, fresh and dry weight of fruit ($P<0.05$) were observed. An increase in the fresh weight of fruit per plant by approximately 8.5% was obtained in T6 when compared with the control (T2). The marketable fruit yield per m^2 was 654.71 g in T6 and 603.61 g in the control. It was also noted that combined use of organic (leaf mould with banana peel) and chemical fertilizers increased fruit yield when compared to the application of organic fertilizer (leaf mould with banana peel) alone as basal application. From this study, it could be concluded that *Albizia*leaf mould (10 mt/ha) and banana peel (0.1 mt/ha) with 50% NP chemical fertilizers as basal and also 50% N chemical fertilizer as top dressing could be used for obtaining high fruit yield in okra cultivation.

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Introduction

Okra (*Abelmoschus esculentus* L.) is an annual, erect herbaceous plant which is a warm season vegetable crop grown in the tropics and propagated through seeds. It is known as lady's finger, a popular vegetable in Sri Lanka as well as in other countries of the world. It is widely cultivated in wet, intermediate and dry zones on a wide range of soils. The optimum soil temperature for growth is 24-32°C. Tender pods of okra are used as a vegetable in human diet. It is a good source of protein, carbohydrate, vitamin C and calcium (Kahlon *et al.,* 2007; Arapitsas, 2008). Okra has several medicinal values and also contains a large amount of fiber. The leaves, stems and fruits are also economically important in paper and pharmaceutical industries (Dilruba *et al.,* 2009).

In vegetable crop cultivation, application of fertilizers are important to improve soil fertility and crop nutrition. Okra requires sufficient N and K for regular fruiting and subsequent pickings (Premsekhar and Rajashree, 2009). The chemical fertilizers, NPK are widely used by farmers to improve soil fertility and increase crop production. However, the continuous and indiscriminate use of chemical fertilizers reduces nutrient uptake (Agarwal, 2003) and also causes to

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the environment and human health problem. Further, most of chemical fertilizers mainly contain NPK but crop needs macro and micro nutrients for its better growth and development. Thus, combined use of chemical and organic fertilizers in soil amendments increases crop production (Olaniyi *et al*., 2010, Imthiyas and Seran, 2017; Prradhiepan *et al*., 2018)

Organic manure improves the soil physical, chemical, biological properties and also it is an alternative source to the inorganic fertilizers. Further, it helps in improving public health and conservation of resources (Kurdali and Al-Shamma'a, 2010). Locally available organic manures are inexpensive and environment friendly they could be used to enhance the soil fertility and crop production (Shahardeen and Seran, 2013; Viharnaa and Seran, 2013). Amalgamation of leguminous crop residues to soil could increase the nutrients, particularly N which is a vital nutrient to determine the crop production of okra in sandy soils. Leguminous tree biomass such as *Gliricidia sepium, Albizia lebbeck, Albizia zygia, Leucaena leucocephala* and *Azadirachta indica* can be utilized as amendments to improve the soil fertility (Damian *et al.,* 2015). In addition, most of the fruit peels are good source of nutrients like potassium, calcium, iron and vitamins which boost the crop growth. Potassium is the main nutrient in banana peels. Mercy *et al.* (2014) stated that fruit peel extract enhance the growth and yield. Anbukkarasi and Sadasakthi (2017) reported that fruit yield of okra can be increased by *A. lebbeck.* Therefore, the objective of the experiment was to study the effect of combined use of *Albizia* leaf mould (*Albizia lebbeck* (L.) Benta) and banana peel powder with reduced level of NP chemical fertilizers on marketable fruit yield of okra. Through this experiment it was also aimed to determine the optimal level of banana peel for obtaining high okra yield.

Materials and methods

The experiment was carried out during 2018-2019 at the Crop farm of the Eastern Universitylocated in the Eastern Province of Sri Lanka. The latitude is between 81˚34' and the longitude is between 7˚48'. The study area has an elevation of 100 m msl. The texture of soil is sandy regosol. The annual rainfall ranges from 1800-2100 mm and annual mean temperature is 31±3˚C. The experiment was laid out in poly bags following randomized complete block design (RCBD) design with 7 treatments and 8 replications. The polybagswere prepared by using black polythene with 30 cm diameter and 30 cm length. After making holes for the drainage, each polybag was filled with soil and basal fertilizers according to the scheme of the treatments (Table I). The polybags were arranged in the field at the space of 60 cm between rows and 60 cm within rows as recommended by Viharnaa and Seran (2011) in sandy regosol.

The dried leaves of *Albizia* sp. were collected from the fallen leaves in Eastern province and leaf mould was made at crop farm. Banana peels were collected from fruit shop and home. The peels were washed thoroughly with tap water to remove the unwanted material. The washed peels were cut into small pieces (5 cm) and air dried in sunlight for 5 days. The dried fruit peels were powdered, sieved and stored at room temperature. The leaf mould (3.15% N, 0.98% P_2O_5, 0.27% K_2O) and banana peel powder (0.16% N, 2.34% P_2O_5, 72.6 K_2O) were applied to the soil two weeks before seeding while chemical basal fertilizers were added two days before seeding. For okra cultivation, 100% chemical basal fertilizers recommended by the Department of Agriculture, Sri Lanka was used only for T2 treatment (150, 200 and 75 kg/ha of urea, TSP and MP, respectively). The *Albizia* leaf mould and banana peel were applied as basal fertilizer application as shown in Table I.

Germination percentage of seeds was counted in the laboratory conditions. It was 85% percentage. Okra seeds of Haritha variety were soaked overnight and planted in the polybags in June 2018. Three seeds were put into each hole in the 2 cm depth. After 2 weeks of seeding, excess seedlings were thinned out in order to maintain two plants per bag. Irrigation is done twice a day until germination and then every day according to the weather conditions. It was done manually at two weeks' interval. Top dressing was applied after 30 days of seeding, before flower initiation. For T1 treatment (no fertilizer), any chemical fertilizer was not applied as top dressing. For T2 treatment, 100% recommended chemical fertilizers (150 kg/ha of urea and 75 kg/ha of muriate of potash) were applied as a top dressing and for T3-T7 treatments, 50% of recommended urea (75 kg/ha of urea) was applied as top dressing (Table I). No pesticide was used because of less pest attacks. Aphids, Leaf eating caterpillar and shoot and fruit borer were observed at the last few harvesting periods.

Plant height and leaf length were measured by using ruler at the two weeks interval and number of leaves per plant was counted every two weeks from the 2nd week of seeding. Chlorophyll content of leaves was measured by using chlorophyll meter (SPAD 502 plus, Konica Minolta Inc., USA) at the flowering stage and 1st picking time. Chlorophyll content was measured in the 2nd and 3rd leaves and average chlorophyll content was taken. Leaf area of leaves per plant was measured by using portable leaf area meter (LI-3000C, LI-COR Inc. USA) at the 1st harvesting

Table I. Treatments (T1-T7) used in the study

	Fertilizer application	
Treatments	Basal fertilizer	Top dressing
T1	No fertilizer	No fertilizer
T2	Recommended NPK chemical fertilizers (urea-150 kg/ha, TSP-200 kg/ha, MOP-75 kg/ha).	Recommended NK chemical fertilizers (urea-150 kg/ha, MOP-75 kg/ha)
T3	*Albizia* leaf mould (10 mt/ha)	50% of N fertilizer (urea-75 kg/ha)
T4	Albizia leaf mould (10 t/ha) + Bananapeel powder (0.1 t/ha)	50% of N fertilizer (urea -75 kg/ha)
T5	*Albizia* leaf mould (10 t/ha) + Banana peel powder (0.5 t/ha)	50% of N fertilizer (urea -75 kg/ha)
T6	*Albizia* leaf mould (10 t/ha) + Banana peel powder (0.1 t/ha) + 50% NP chemical fertilizer	50% of N fertilizer (urea -75 kg/ha)
T7	*Albizia* leaf mould (10 t/ha) + Banana peel powder (0.5 t/ha) + 50% NP chemical fertilizer	50% of N fertilizer (urea -75 kg/ha)

time. Fresh weight of leaves per plant was measured by using electrical balance (SKX622, Ohaus Corporation, USA) at the time of 1st harvesting and dry weight of those leaves was measured by oven at 105˚C over night. Length of each tender green fruits was measured by using string and ruler at the time of each picking. Diameter of each fruit was measured by using string and ruler. Number of fruits per plant was counted at the time of each harvesting in the two days' interval. From each plant, fruits harvested in five pickings were used to calculate the marketable fruit yield. Fresh and dry weight of fruits per plant was calculated at each picking. The fresh weight of fruits was measured by using electrical balance. It was done immediately after picking to avoid drying. After taking the fresh weight, the samples were dried in an oven at 105 ˚C over night and dry weight of fruits was recorded. All the collected data was analysed by ANOVA using SAS 9.1 statistical software package. The mean was compared by Tukey's test at 5% significant level.

Results and discussion

Plant height

Data values in Figure 1 show the plant height in each treatment. According to the statistical analysis, there was not significant ($P<0.05$) difference in average height of plant among the treatments. The maximum plant height (30.47 cm) at 6th week after seeding was recorded in T6 (leaf mould, banana peel and 50% NP fertilizers) followed by T2 (chemical fertilizers alone as control). But there was no remarkable difference between T2 and T6. The minimum value of 23.64 cm was attained by T1 (no fertilizers). The highest plant height recorded in T6 may be probably due to sufficient amount of nutrients taken up by crop from mineralization of the fertilizers. The result obtained in this study confirmed the work of Akanbi *et al*. (2004) who reported that growth of okra was remarkably increased by use of organomineral fertilizer. Plant height is a significant trait associated with the biological and economic yield.

It was noted that there was reduction in plant height when applied relatively high rate (0.5 mt/ha) of banana peel, but it was not significantly influenced. Hence, optimal amount of banana peel has considerable effects on crop growth. Lee *et al*. (2010) stated that banana peel extract contains high vitamins, flavonoids and K element which are essential for plant growth. Second highest plant height was recorded in T2 among the treatments. It is obvious that application of inorganic fertilizers releases nutrients rapidly as a result, plant nutrients are readily available in soil during vegetative growth. The result is consistent with the finding of Datt *et al.* (2003) in vegetable pea. Minimum plant height was recorded by T1. It is confirmed the report of Gholizadeh *et al*. (2009) that any deficiency of the NPK primary nutrients will inhibit good plant growth.

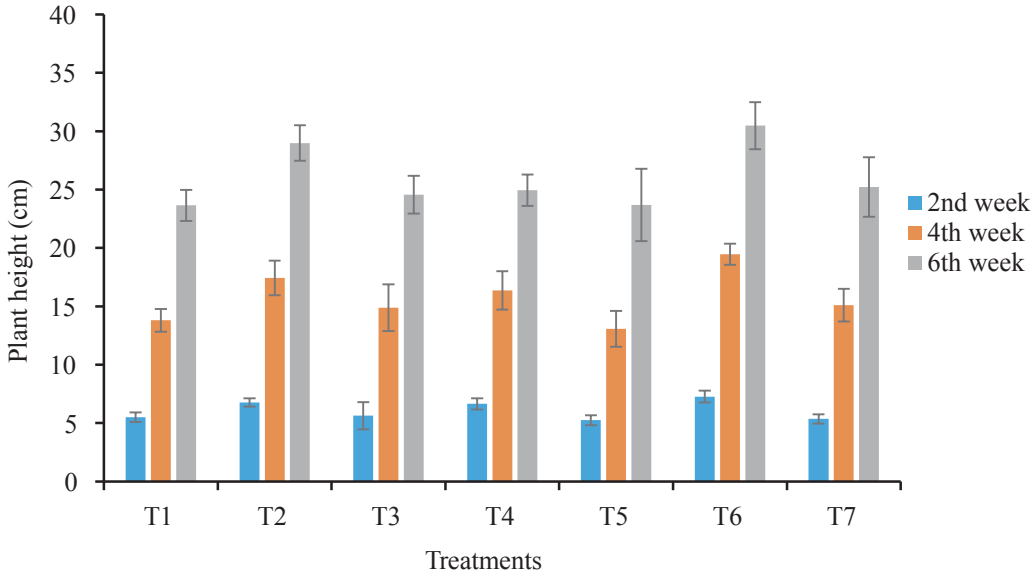

Fig. 1. The average plant height of okra at two weeks interval

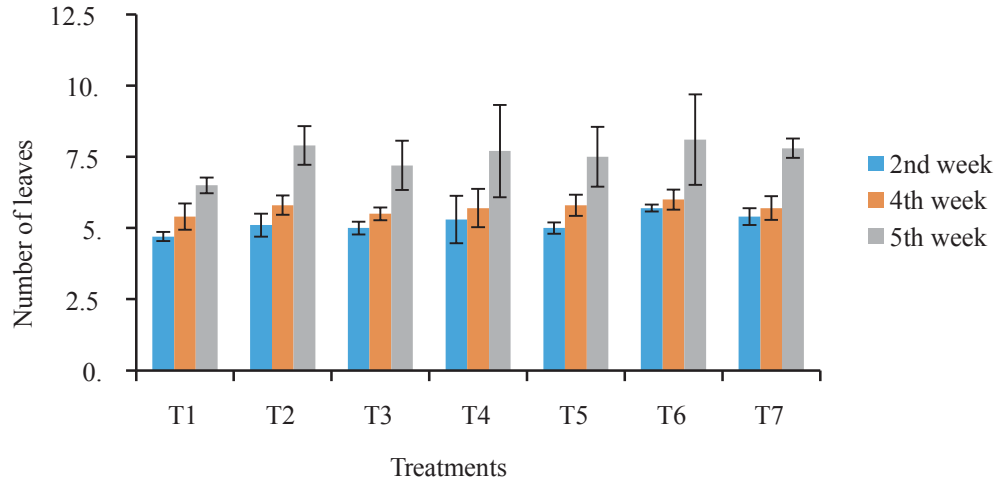

Fig. 2. The average number of leaves per okra plant at two weeks interval

Number of leaves

Statistically analyzed data shows that there was no significant difference (P>0.05) in average number of leaves per plant at the 6th week after seeding. The highest number of leaves (8.1) was recorded in T6 (Fig. 2). Lowest value of 6.5 was attained in T1. The reason may be due to gradual decomposition of organic matter and slow release of nutrients especially K. Ojo *et al*. (2014) also revealed that higher number of leaves related attribute due to sustaining release of nutrients from the organic manure over NPK fertilizers. At the first two weeks, highest number of leaves was obtained from the combination of the organic and inorganic treatments (T6, T7) as compared to T2 and T3. There was increased number of leaves with time. In this experiment, T6 showed comparatively higher number of leaves than T7 treatments. It may be due to the high rate of potassium present in the banana peel fertilizer. This result is similar with the findings of Hari *et al.* (2007) who mentioned that number of leaves of *Capsicum annuum* L. was not increased by the application of muriate of potash at the higher rates.

Leaf length

Application of fertilizers to okra plants had significant effect (P<0.05) on leaf length after seeding (Table II). According to that, the leaf length was high (13.19 cm) in T6 at the sixth weeks and leaf length ranged from 8.66 cm (T1) to 13.19 cm. At the fourth and sixth weeks, remarkable difference in leaf length was not observed among the treatments except T1. The fertilizer containing NPK nutrients has substantial impact in crop growth and yield. Banana peel is rich in proteins, essential amino acids and potassium (Emaga *et al*., 2007). In general, organic manures enhance the organic matter content of soils in addition to supply of plant nutrients that improve the soil properties for better plant growth. Adewale *et al*. (2011) reported that application of organic manure boost in garlic plant growth as a consequence of releasing considerable amount of N and Mg for plant use through the process of mineralization.

Table II. The average leaf length of okra plant at two weeks interval

	Leaf length (cm) at different weeks		
Treatments	2nd week	4th week	6th week
T1	3.95±0.41b	07.35±0.58b	08.66±0.21b
T2	4.73±0.59ab	10.22±0.88a	11.64±0.57a
T3	4.46±0.48ab	08.47±0.45ab	09.63±0.51ab
T4	5.09±0.41ab	08.60±0.60ab	09.82±0.31ab
T5	4.65±0.42ab	08.70±0.57ab	09.75±1.08ab
T6	6.03±0.11a	11.82±0.36a	13.19±1.59a
T7	4.81±1.17ab	09.50±1.41ab	10.97±1.03ab
F test	P<0.05	P<0.05	P<0.05

Value represents mean± standard error of replicates. Means are followed by the same letter in each column are not significantly different according to Tukey's test at 5% level.

Chlorophyll content

Statistically analyzed data showed that there were no remarkable differences (P>0.05) in chlorophyll content of leaves at 50% flowering and 1st picking time among treatments except T1. The chlorophyll content was high in leaf mould added treatments than that in plants treated with chemical fertilizer alone at 1st picking (Figure 3). The reason for high value of chlorophyll content is due to leaf mould incorporated to soil which contains high nitrogen. The similar finding is supported by Premsekhar and Rajashree (2009) who reported that the application of organic sources of nutrients may improve the chlorophyll content in the leaves of okra. Yong *et al*. (2010) also stated that foliar application of fertilizer enhanced the leaf chlorophyll content of *Jatropha* plant. Nitrogen is a chlorophyll component and is responsible for leaf greenness. Chlorophyll absorbs sun light hence its content is a very important for effective photosynthesis process. The high chlorophyll content directs to high rate of the photosynthesis. Nitrogen content of leaves is closely associated with yield of okra (Khandaker *et al*., 2017).

Leaf area

Application of different doses of fertilizer had significant influence (P>0.05) on the leaf area of the plant among the treatments. The highest average leaf area (458.56 cm^2) was recorded in T7 however, no remarkable difference was found between T2 and T7 treatments. Minimum value (255.55 cm^2) was recorded in T1 (Table III). Leaf area was high in the treatments with fertilizer application. Increased leaf area implies higher light interception and dry matter product which consistently boosts plant growth (Ofosu-Anim and Leitech, 2009). Further, it was noted that combined use of leaf mould, banana peel and inorganic fertilizers showed high leaf area than that in the other treatments. This result is supported the findings of Imayavarambani *et al*. (2002) who mentioned improvement in the crop performance due to the combined application of different nutrient sources.

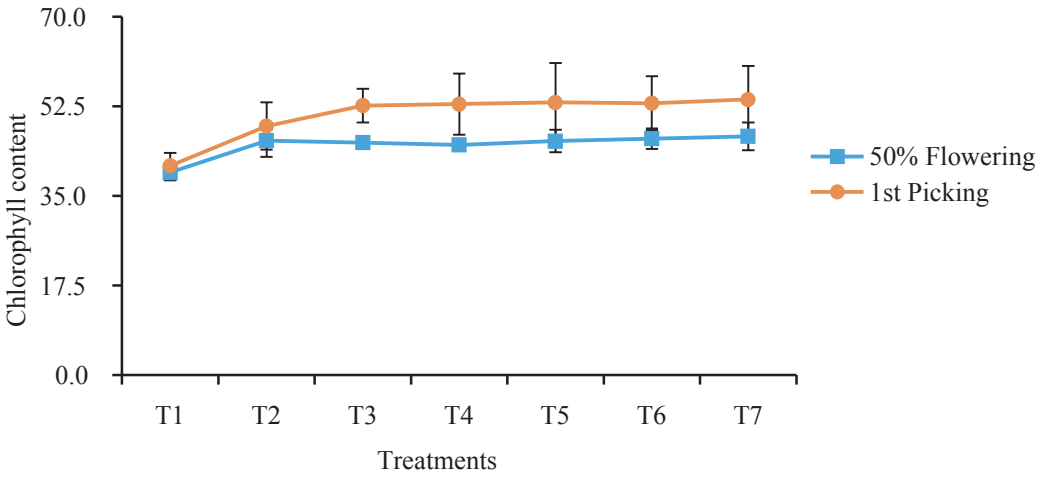

Fig. 3. Chlorophyll content of leaves at 50% flowering and 1st picking of okra

Table III. The leaf area and weight per plant at the 1st picking time

Treatments	Leaf area (cm^2)	Leaf weight per plant (g)	
		Fresh weight	Dry weight
T1	255.55±27.68c	08.20±0.89c	1.24±0.17c
T2	435.85±31.24ab	15.57±0.89a	2.54±0.49ab
T3	300.78±25.49bc	10.20 ±1.29b	1.85±0.35ab
T4	343.39±18.50abc	11.43±1.67ab	1.98±0.49ab
T5	363.87±14.38abc	12.44±1.07ab	2.26±0.12ab
T6	445.64±53.74ab	15.71±0.534a	2.79±0.68a
T7	458.56±41.47a	14.86±0.52ab	2.68±0.63ab
F test	P<0.05	P<0.05	P<0.05

Value represents mean± standard error of replicates. Means followed by the same letter in each column are not significantly different according to the Tukey's test at 5% level.

Leaf weight per plant

A significant difference (P<0.05) was observed in leaf weight per plant among the treatments. The highest (15.71g) fresh weight of leaves was recorded in T6 while minimum fresh weight (8.20 g) was in T1 control (Table III). Further, the highest dry weight (2.79 g) was achieved in T6 and minimum dry weight (1.24 g) was in T1. Organic fertilizer generally releases nutrients slowly to plants but chemical fertilizer release nutrients rapidly. The plants that treated with organic and NP chemical basal fertilizer received ample amount of nutrients during the crop growth to produce high leaf dry matter content. Application of higher rate (0.5 mt/ha) of banana peel does not increase leaf dry weight. This was in line with the report of Akanbi *et al.* (2000) that vegetative growth of tomato plant is determined by the nutrient availability especially nitrogen.

Fruit length and diameter

The highest fruit length (15.09 cm) was recorded in T4 whereas minimum fruit length (9.88 cm) was in T1 at 1st picking (Table IV). There was a remarkable difference in fruit length (P<0.05) among the treatments. However, significant variation was not observed in length of fruits harvested from plants treated with fertilizers (T2-T7) at 1st picking. Further, statically analyzed data shows the significant difference in fruit diameter at 1st picking among

the treatments but it was not significantly different at 2nd picking (Table IV). The maximum fruit diameter (1.61 cm) was attained in T6 and minimum fruit diameter (1.25 cm) was in T1 at 1st picking. Combined use of organic and chemical fertilizers increases crop yield and available N, P and K in soil (Rautaray *et al*., 2003).

fruit number (6.3) was recorded by T6 (Figure 4). Minimum cumulative fruit number (4.5) was noted by T1. Yong *et al*. (2010) indicated that fertilizer application increased the number of pods and seed number in pod of *Jatropha* plant. Plants treated with leaf mould (10 mt/ha) alone (T3) gave lower fruit number than 100% chemical

Table IV. Fruit length and diameter of okra at 1st and 2nd picking time

	Fruit length (cm)		Fruit diameter (cm)	
Treatments	1st picking	2nd picking	1st picking	2nd picking
T1	09.88±0.76b	09.33±0.67	1.25±0.07b	1.34±0.04
T2	12.92±0.47ab	11.73±0.74	1.53±0.06a	1.38±0.04
T3	13.84±1.06ab	12.34±0.99	1.53±0.06a	1.40±0.09
T4	15.09±1.02a	13.10±0.98	1.60±0.05a	1.45±0.06
T5	14.01±1.34ab	12.96±0.87	1.56±0.09a	1.42±0.06
T6	13.33±0.79ab	11.70±0.30	1.61±0.07a	1.48±0.05
T7	11.79±1.25ab	10.11±0.94	1.44±0.07ab	1.35±0.05
F test	P<0.05	P>0.05	P<0.05	P>0.05

Value represents mean ± standard error of replicates. Means followed by the same letter in each column are not significantly different according to the Tukey's test at 5% significant level.

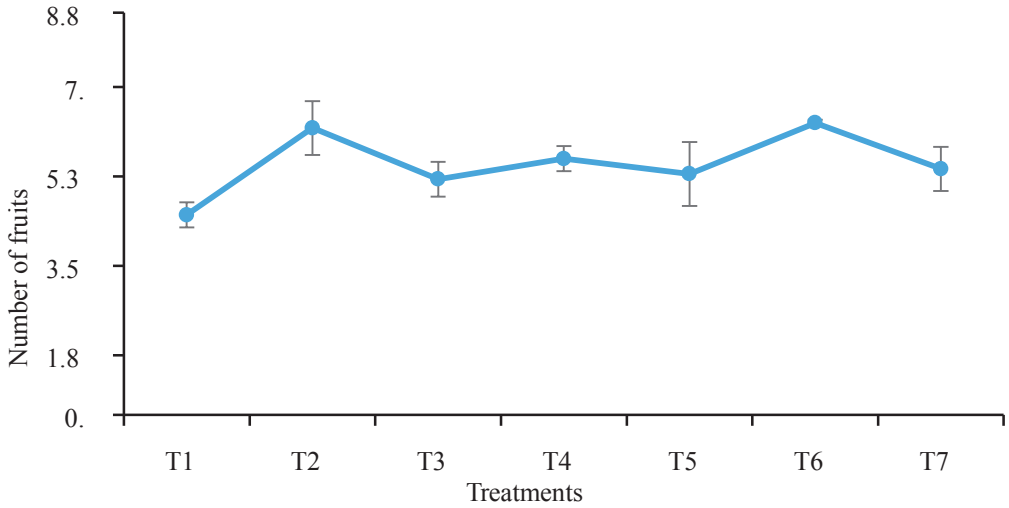

Fig. 4. The cumulative number of okra fruits per plant

Fruit number per plant

Statistically analyzed data shows that there was no significant difference (P<0.05) in number of fruits per plant among treatments except T1. The highest cumulative

fertilizers (T2). Leaf mould and banana peel added treatments exhibited higher fruit number than T1 (no fertilizer) and leaf mould only added treatment (T3). Reason may be the higher nitrogen and potassium availability to plants from the both organic manures. Both

Table V. The weights of fruits per plant and fruit yield of okra

Treatments	Fruit weight (g)		Fruit yield (g/m^2)
	Fresh weight	Dry weight	
T1	36.90±1.61e	11.27±1.07d	205.00±18.97e
T2	108.64±3.93ab	35.22±1.43a	603.61±48.69ab
T3	77.14±5.57d	23.29±1.56c	428.54±30.93d
T4	84.23±5.28cd	24.15±0.70bc	467.97±29.39cd
T5	90.42±5.70bcd	26.99±1.66bc	502.32±31.69bcd
T6	117.85±6.77a	36.32±2.44a	654.71±37.60a
T7	105.38±5.82ab	31.09±1.76ab	585.42±32.34abc
F test	P<0.001	P<0.001	P<0.001

Value represents mean± standard error of replicates. Means followed by the same letter in each column are not significantly different according to the Tukey's test at 5% level

nutrients are essential for photosynthesis to produce more vegetative and reproductive growth of crop. Ananthi *et al*. (2004) stated that increase in the number of chilli pods might be due to the mobility of photosynthetates from the source to sink.

Fresh weight of fruits per plant

Considerable variation was noted in the statistically analyzed data of fresh fruit weight (P<0.05) among the treatments. The highest cumulative fresh weight was recorded by T6 (117.85 g) while the minimum fresh weight (36.90 g) was by T1 (Table V). Combined use of organic and and chemical fertilizer treatment (T6) gave highest fruit weight. This proves finding of Imayavarambani *et al*. (2002) who declared that improvement in the crop performance is owing to application of different nutrient sources. Imthiyas and Seran (2017) also reported that 10 mt/ha compost and half dose of NPK fertilizer as basal application gave high marketable tuber yield of radish than NPK fertilizers.

Dry weight of fruits per plant

There was significant difference (P<0.05) in dry weight of fruits per plant among the treatments. The highest cumulative dry weight 36.32 g was recorded by T6. The minimum dry weight 11.27 g was by T1. Combined application of organic and chemical fertilizers showed an increase in crop growth and yield related attributes of okra. It is probably as a result of ample supply of macro and micro nutrients from soil and better physical soil properties. Agbede *et al*. (2008**)** stated that suitable organic manure added to the soil increases the soil physical and chemical properties consequently it gives direction to obtain high fruit yield.

Marketable fruit yield

There was a remarkable variation in marketable fruit yield between the treatments. Maximum marketable fruit yield was achieved in T6 (654.71 g/m^2) (Table V). When compared to T6 treatment, T7 treatment recorded low yield (585.42 g/m^2). Reason may be the high potassium availability to crop from added banana peel. Excess of potassium may be detrimental to crop growth and yield. Harneet *et al.* (2003) stated that increasing application rates of potassium increased the marketable yield of tomato. T2 treatment gave 603.61 g as marketable pod yield per m^2. In this study, plants treated with organic and inorganic nutrient sources exhibited higher fruit yield. NPK elements are the foremost nutrients required for plant growth and yield but plants require other nutrients too for better crop production. This finding agreed with Imthiyas and Seran (2017), Prradhiepan *et al*. (2018) and Seran (2018) who stated that the combined use of organic and inorganic mineral fertilizers results in high crop yield than inorganic fertilizer alone. In general, proper application of organic manure improves soil properties which result in better nutrient supply to crop. Further, it was noted that minimum fruit yield was recorded by T1 treatment and it was 205 g per m^2. The reason may be due to the availability of low soil fertility.

Conclusion

Considering all parameters tested, combined application of 10 mt/ha leaf mould and 0.1 mt/ha banana peel with reduced level (50% NP as basal and 50% N as top dressing) of chemical fertilizer (T6) significantly increased okra fruit yield when compared to other treatments. The Marketable fruit yield was 654.71 g per m^2 in T6 treatment followed by 603.61 g per m^2 marketable fruit yield in control treatment (chemical fertilizer alone). The combined basal application of organic (leaf mould and banana peel) and 50% NP chemical treatments recorded higher yield than sole organic treatments (leaf mould and banana peel). Lowest yield was attained in T1 and it was 205 g $perm^2$. The result proves that organic manure combined with NP chemical fertilizers is a suitable source of nutrients for improving soil fertility and fruit yield of okra. The marketable fruit yield of okra increased by approximately 8.5% in T6 treatment when compared to control treatment in sandy regosal.

References

Adewale OM, Adebayo OS and Fariyike TA (2011), Effect of poultry manure on garlic (*Allium Sativum* L) production in Ibadan, South Western Nigeria, *C J Agric Sci.* **5**(2): 7-11. DOI: 10.5281/zenodo.839967

Agarwal AK (2003), Role of organic enrichers in management of soil salinity, *Agrobios***2**: 21-23.

Agbede TM, Ojeniyi SO and Adeyemo AJ (2008), Effect of poultry manure on soil physical and chemical properties, growth and grain yield of sorghum in southwest, Nigeria, *Am-Eurasian J Sustain Agric*. **2**(1): 72-77.

Akanbi WB, Adediran JA, Togun AO and Sobulo RA (2000), Effect of organic-based fertilizer on the growth, yield and storage life of tomato (*Lycopersicon esculentum* Mill), *Biosci Res Commun.***12**: 439-444.

Akanbi WB, Togun AO, Adediran JA, Olabode OS, Olaniyan AB and Olaniyi JO (2004), Effects of split application of organo-minerals fertilizers on Okra growth nutrient uptake and fruit yield, *Niger J Horti Sci*. **9**(1): 102-109. DOI: 10.4314/njhs.v9i1.3387

Ananthi S, Veeraragavathatham D and Srinirasan K (2004), Comparative efficacy of muriate of potash and sulphate of potash on yield attributes, yield and economics of chilli (*Capsicum annuum L.*), *South IndianHorti.* **52**(1-6): 158-163.

Anbukkarasi V and Sadasakthi A (2017), Effect of leguminous green leaf manures and leaf extract on growth, yield, quality and economics of bhendi [*Abelmoschus esculentus* (L.) Moench] cv. Arka Anamika, *Indian J Agric Res*. **51**(1): 9-16. DOI: 10.18805/ijare.v51i1.7055

Arapitsas P (2008), Identification and quantification of polyphenolic compounds from okra seeds and skins, *Food Chem.* **110**(4): 1041-1045. DOI: 10.1016/j.foodchem.2008.03.014.

Damian TD, Mohammed AR, William JA, Hamza I and Kwame OB (2015), Effect of *Albizia Lebbeck* pods used as soil amendment on the growth of *Solanum Aethiopicum* (garden eggs), *UDS Int J Dev.* **2**(1): 12-19.

Datt N, Sharma RP and Sharma GD (2003), Effect of supplementary use of farmyard manure along with chemical fertilizers on productivity and nutrient uptake by vegetable pea (*Pisum sativum* var arvense) and buildup of soil fertility in Lahaul valley of Himachal Pradesh, *Indian J Agric Sci.* **73**(5): 266-268.

Dilruba S, Hasanuzzaman M, Karim R and Nahar K (2009), Yield response of okra to different sowing time and application of growth hormones, *J Horti Sci Ornal Plants* **1**: 10-14.

Emaga TH, Andrianaivo RH, Wathelet B, Tchango JT and Paquot M (2007), Effects of the stage of maturation and varieties on the chemical composition of banana and plantain peels, *Food chem.* **103**(2): 590-600. DOI: 10.1016/j.foodchem.2006.09.006

Gholizadeh A, Amin MSM, Anuar AR and Aimrun W (2009), Evaluation of SPAD chlorophyll meter in two different rice growth stages and its temporal variability, *Eur J Sci Res.* **37**(4): 591-598.

Hari GS, Rao PV, Reddy YN and Reddy MS (2007), Effect of Nitrogen and potassium levels on yield and nutrient uptake in Paprika (*Capsicum annuum L.*) under irrigated conditions of Northern Telganza zone of Andhra Prades, *The Asian J Horti.* **2**(1): 193-196.

Harneet K, Thakur JC and Neena C (2003), Effect of nitrogen and potassium on growth, yield and quality of tomato (*Lycopersicon esculentum* Mill.) cv. *Punjab Upma, Haryana J Horti Sci.* **32**(3/4): 286-288.

Imayavaramban V, Thanunathan K, Singaravel R and Manickam G (2002), Studies on the influence of integrated nutrient management on growth, yield parameters and seed yield of sesame (*Sesamum indicum* L.), *Crop res-hisar* **24**(2): 309-313.

Imthiyas MSM and Seran TH (2017), Marketable tuber yield of radish (*Raphanus sativus* L.) as influenced by compost and NPK fertilizers, *Res J Agric For Sci.* **5**(11): 1-4.

Kahlon TS, Chapman MH and Smith GE (2007), In vitro binding of bile acids by okra, beets, asparagus, eggplant, turnips, green beans, carrots, and cauliflower, *Food chem.* **103**(2): 676-680. DOI: 10.1016/j.foodchem.2006.07.056

Khandaker MM, Nor MF, Dalorima T, Sajili MH and Mat N (2017), Effect of different rates of inorganic fertilizer on physiology, growth and yield of okra (*'Abelmoschus esculentus'*) cultivated on Bris soil of Terengganu, Malaysia, *Aust J Crop Sci.* **11**(7): 880-887. DOI: 10.21475/ajcs.17.11.07.pne552

Kurdali F and Al-Shamma'a M (2010), Natural abundances of 15Nitrogen and 13Carbon indicative of growth and N2 fixation in potassium fed lentil grown under water stress, *J Plant Nutr*. **33**(2): 157-174. DOI: 10.1080/01904160903434238

Lee EH, Yeom HJ, Ha MS and Bae DH (2010). Development of banana peel jelly and its antioxidant and textural properties, *Food Sci Biotechnol.* **19**(2): 449-455. DOI: 10.1007/s10068-010-0063-5

Mercy S, Mubsira BS and Jenifer I (2014), Application of different fruit peels formulations as a natural fertilizer for plant growth, *Int J Sci Tech Res*. **3**(1): 300-307.

Ofosu-Anim J and Leitch M (2009), Relative efficacy of organic manures in spring barley (*Hordeum vulgare* L.) production, *Aust J Crop Sci.* **3**(1): 13-19.

Ojo JA, Olowoake AA and Obembe A (2014), Efficacy of organomineral fertilizer and unamended compost on the growth and yield of watermelon (*Citrullus lanatus* Thumb) in Ilorin Southern Guinea Savanna Zone of Nigeria, *Int J Recycl Org Waste Agric*. **3**: 121–125. DOI: 10.1007/s40093-014-0073-z

Olaniyi JO, Akanbi WB, Olaniran OA and Ilupeju OT (2010), The effect of organo-mineral and inorganic fertilizers on the growth, fruit yield, quality and chemical compositions of okra, *J Anim Plant Sci.* **9**(1): 1135-1140.

Premsekhar M and Rajashree V (2009), Influence of organic manures on growth, yield and quality of okra, *Am Eurasian J Sustain Agric.* **3**(1): 6-8.

Prradhiepan T, Seran TH and Hariharan G (2018), Effect of integrated nutrient management on green pod yield of chilli (*capsicum annuum* L.) cv MIPC-01, *Sabaragamuwa Univ J*. **16**(1): 28-33. DOI: 10.4038/suslj.v16i1.7715

Rautaray SK, Ghosh BC and Mittra BN (2003), Effect of fly ash, organic wastes and chemical fertilizers on yield, nutrient uptake, heavy metal content and residual fertility in a rice–mustard cropping sequence under acid lateritic soils, *Biores Tech.* **90**(3): 275-283. DOI: 10.1016/s0960-8524(03)00132-9

Shahardeen RNM and Seran TH (2013), Impact of animal manure EM-bokashi on seed yield and quality of vegetable cowpea (*Vigna unguiculata* L.), *Bangladesh J Sci Ind Res.* **48**(1): 33-38. DOI: org/10.3329/bjsir.v48i1.15411

Seran TH (2018), Effects of inorganic and organic nutrients combindly used on yield and quality of groundnut (*Arachis hypogaea* L.), *Bangladesh J Sci Ind Res.* **53**(4): 289-296. DOI: 10.3329/bjsir.v53i4.39193

Viharnaa S and Seran TH (2013), Pod formation and yield of okra (*Abelmoschus esculentus* L.) as affected by organic manure application. In: Proceeding of 4th International Symposium, Sabaragamuwa University of Sri Lanka held on 11th-12th January, p 29.

Viharnaa S and Seran TH (2011), Effect of plant spacing on fruit yield of okra (*Abelmoschus esculentus* L.). In: Proceedings of the 10th Annual Research Session, Eastern University of Sri Lanka, pp 104-109.

Yong JWH, Ng YF, Tan SN and Chew AYL (2010), Effect of fertilizer application on photosynthesis and oil yield of *Jatropha curcas L*., *Photosynthetica* **48**(2): 208-218. doi:10.1007/s11099-010-0026-3