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ASSESSING THE IMPACT OF CULTIVATION METHODS AND FERTILIZERS ON THE YIELD OF OKRA

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Abstract. Experimental design is an effective statistical tool widely used in agricultural research. In a typical agricultural case, the factors that could presumably influence the outcome variable are tested using a predefined experimental design model. Taking from this tried and tested trend, a field experiment was conducted at Madras Christian College farm from January to March 2019 to evaluate the effect of fertilizers and cultivation methods on the yield of Okra crop. For the purpose of study vermicompost and mixture of vermicompost with synthetic fertilizer was used as fertilizers. Similarly mulching sheet, grow bag and flat bed were considered for cultivation methods. A split-plot design with three replications was conducted and treatments were laid as randomized block design having fertilizers as main plot treatment and cultivation methods as sub plot treatment respectively. Pre-harvest and Post-harvest readings were recorded. R software was used for performing ANOVA. Pursuant to the analysis, it has been observed that there is significant increase in the number of leaves, height of the plant and number of pods for mulching sheet compared to other cultivation method during the pre-harvest phase. Similarly the post-harvest study reveals a significant difference in the weight, length and number of pods for mulching sheet and grow bag over the conventional flat bed cultivation method. However, with respect to the application of fertilizers, the vermicompost only option had an impact in the pre-harvest and in the first stage of the harvest. Later the synthetic fertilizer mixture seemed to provide similar results in the subsequent harvest. As the fertilizer mixture did not show any significant advantage over the option, the study recommends the use of organic fertilizer for Okra farming.

1. Introduction

Okra is an important fruit vegetable crop belongs to the family of Malvaceae. It is fast maturing and easy to grow vegetable. Okra (Abelmoschusesculentus L) which is also known as bhindi, grows in tropical and sub-tropical parts of the world. Okra has many nutritional values. It is a good source of vitamin A, B, C and also rich in protein, carbohydrates, fats, minerals, iron, and iodine. Fruits of okra contain a mucilaginous substance that thickens the soup and stews. The roasted seeds of okra are also used as a substitute for coffee. The growth and yield of okra are influenced by wide range of factors.

Many research experiments have been done to improve the growth and yield of okra plants. In the recent studies scientific methods are applied to study the factors

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of interest.Odeleye et al (2007) studied the effect of sowing depth on emergence, growth, and yield of okra. The experiment involved a factorial combination of 5 sowing depths (1, 2, 3, 4, 5) in cm in two varieties of okra. The plot was arranged in a randomized completed block design with four replications. The study shows that good seedling emergence were obtained at 1 cm and 2cm sowing depth but 3cm depth appears to be the optimum sowing depth for okra, as the highest yield and overall best performance of okra were attained at this depth. Also the two varieties of okra responded similarly to all depth of sowing.

Growth performance and pod dry matter yield of local and improved varieties of okra was discussed byChigbund et al (2007). The experiment was laid out in a randomized completed block design. The treatments consist of five varieties of okra replicated four times. The result shows that there is a significant difference in growth characteristics and yield of okra due to varieties. The study also shows that with higher pod dry matter yield, okra contains more nutritional component than others

The soil amendments compost organic fertilizer, NPK, Glomus, Mosseae mycorrhiza and control group on the nutritional quality of okra have been discussed in literature by Adewole and IIesanmi (2011). The experiment was performed as a randomized complete block design with four replications. The Study revealed that high-quality okra pods could be effectively produced with no soil amendment when planted in soil with high fertility, such as those treated with sewage sludge. It result also shows that the organic-based fertilizers enhanced the bio-availability and mobility of plant nutrients and the usage of compost organic fertilizer enhanced the uptake of nutrients more than any of the other soil amendments.

Jamala et al (2011) observed a great diversification in the yield of okra by considering three main varieties of okra (improved, serial, and local). The experiment was laid out in a randomized complete block design with three replications. It was observed that an improved variety of okra responded well with respect to the yield.

Allah BakhshGulshan et al (2013) point out that the effect of animal manure on the growth and development of okra. The experiment was conducted as a complete randomized block design with 5 replications and 3 treatments (control group, 125 gms. animal manure and 250 gms. animal manure). The data was recorded for 6 harvests and the results showed that the growth of okra had a significant response with more concentration of animal manure. Moreover the germination of weeds was significantly high with the concentration of animal manure.

Ufere et al (2013) asserted the relative effect of organic and inorganic fertilizers on the growth of okra. The experiment was conducted with four treatments (control group, cow dung, poultry droppings and NPK) laid in a completely randomized design with three replications. The application of cow dung, poultry droppings and NPK fertilizer had a significant effect when compared with the control group.

The Growth and Yield of okra were investigated by Kibria et al (2013) based on the effect of 6 treatments (control group, poultry manure, kitchen waste compost,

NPK their combinations of NPK with poultry manure and kitchen waste). The treatments were arranged in Randomized Block Design with three replications. The combination of NPK and poultry manure gave best results when compared to other treatments.

AShaEmbrandiri et al (2013) investigated the yield response of okra by applying palm oil waste at various ratio as a bio-fertilizer. The experiment was constructed as a completely randomized design having a ratio of decanter cake (10

Idowu et al (2013) studied the effect of spent mushroom compost (SMC) on the growth and yield response of okra for a greenhouse and field experiment. Both experiments were carried out as a randomized complete block design. For the greenhouse experiment the four treatments (control group, topsoil + SMC (1kg:15t/ha), SMC, topsoil + NPK (1kg: 10 gm)) were considered and replicated four times. The greenhouse experiment showed that topsoil plus NPK gave highest yield per plant though this was not significantly different from topsoil plus SMC applied at 15t/ha. In the field experiment SMC was tested for four levels (0, 5, 10 and 15t/ha) with three replications. The yield of okra on the field experiment increased with an increased level of SMC. Therefore SMC is much suitable for field experiments.

Olabiyi andOladeji (2014) attempted to examine the assessment of four compost types on the nematode population dynamics in the yield of okra. The experimental site consisted of four blocks that were laid out in a randomized complete block design with five treatments, including the control plot. The treatments were neem based, cassava peel based, sawdust basedandtithonia based compost. Each of the compost were prepared throughrapid composting Technology with trichodermaharzianum as decomposer using windrow method. The result indicated that the application of trichodermaharzianum incorporated into neem, cassava, sawdust and tithonia composts had a significant effect on the yield of okra.

Ngbede et al (2014)evaluated the economic application of different rates of poultry manure on okra production. The experimental design was a randomized complete block design with three replicates. The treatments consisted were four rates 0, 4,8,12 t/ha of poultry manure.The study showed that 8t/ha of poultry manure had the optimum rate of producing okra which would be the most profitable and cost-effective rate.

Responses on the growth of okra to various treatment methods of diary wastewater were investigated by Rana et al (2014).The experiment was conducted in a greenhouse with ten plants for each treatment replicated three times. The plants were treated using raw dairy wastewater, chemical treatment, physical treatment, dilution method treatment, and tap water. The result indicated that chemical treatment improved the growth and characteristics of the plant when compared to other treatments.

Owoseni and Adetunji (2014) studied the effect of three levels (60kg, 90kg, and 120 kg) of nitrogen fertilizer on two varieties (V-35 and N47-4) of okra with three

replications using a spilt-plot design. Fertilizers were taken as the main plot treatment and varieties as subplot treatment. The result shows that there is significant difference in the yield for the level of nitrogen fertilizer application.

Influence of Different nitrogen sources on three varieties of okra were discussed by Sinmidele et al (2015). The experiment was laid out as a split-plot design with varieties as main plots (LF, LD88 and Local variety) and different nitrogen sources as subplot (urea, poultry manure and cow dung). The results indicate that the application of urea and poultry manure had a significant effect when compared with cow dung.

Shanika and Premanandarajah (2015)conducted a pot experiment to study the maximum nitrogen intake in okra with locally available organic manures and by minimizing the usage of synthetic fertilizers. 13 treatment combinations were laid out in a completely randomized design each with four replicates. Poultry manure, farmyard manure, Leucaena Leaves, and paddy straw were used as organic nitrogen sources and urea as the inorganic nitrogen sources. The study shows application of Poultry manure, farmyard manure and leucaena leaves showed good result like synthetic fertilizer which indirectly minimizes the use of synthetic fertilizer.

Effect of intercropping and poultry manure rates on the growth and yield of maize and okra crop were observed by Onwuchekwa and Muoneke (2016). The experiment was conducted as a 2x4 split plot arranged as randomized completed block design with three replications. The treatment cropping system (sole maize or sole okra, maize/ okra intercrop) was considered as the main plot treatment and poultry manure rate (0, 5, 10, 15 t/ha) as sub plot treatment. The results shows that poultry manure increased the fresh pod yield of okra and maize up to 10 t/ha application of poultry manure.

Adekiya (2017) studied the effect of Green manures and NPK fertilizer effects on soil properties, growth, yield, mineral and vitamin C composition of okra. The experiment were carried out during the cropping seasons of 2015 and 2016 to compare the impact of different green manures and NPK 15-15-15 fertilizer on soil properties, growth, yield, mineral and vitamin c composition of okra. The six treatments were arranged in a randomized complete block design with four replications. Pawpaw leaves, Neem leaves, Mesquite leaves, Moringa leaves were used as a green manure, NPK 15-15-15 fertilizer and control grpup. Application of green manure reduced soil bulk density and increased soil OM, N, P, K, Ca, Mg growth and yield of okra compared with the control group. Green manures and NPK fertilizer increased okra minerals and vitamin C contents. The study also concluded that application of Moringa leaves increases the quality of okra fruits and the quantity of okra was increased by applying Mesquite leaves.

It is evident from the past research that many authors have studied the impact of fertilizers and cultivation methods on yield of okra. In this paper attempts had been taken to investigate the impact of conventional and non-conventional methods of cultivation as well as the impact of organic and mixture of organic with synthetic fertilizers on the yield of okra.

2. Materials and Methodology

The study was conducted at Madras Christian College farm during January-March 2019. The experiment was conducted as a split plot design having three replicates and treatments were laid as Randomized Block Design. Two fertilizers (vermicompost(F1), vermicompost+NPK(F2)) were taken as main plot treatment. Three methods of cultivation(Mulching sheet (M1), Grow Bag (M2), Flat bed (M3)) were considered as sub-plot treatment. The layout of the experiment is given in Table 1. The experimental field was plowed, harrowed and the field was marked out. The

TABLE 1. Layout of OKRA Experiment

Replicate 1		*Replicate 2*		*Replicate 3*	
F1	F2	F2	F1	F1	F2
M3	M2	M3	M1	M2	M3
M2	M1	M2	M2	M1	M2
M1	M3	M1	M3	M3	M1

total area used for cultivation was 2700sq.ft. The size of each experimental unit was $(12mx4m)$. Mulching Sheets, Grow bags and flat beds were arranged in rows and randomly placed within each main plot as experimental unit. The seeds were sown on 14 January 2019. Ten seeds of okra were planted in each experimental unit in an average depth of 2 to 3 cm.Seedlings emerged after 4 to 5 days of sowing. The fertilizer variant vermicompost was prepared in house. On the 15th day after sowing the seeds, vermicompost and mixture of vermicompost+NPK (9:9:9) were applied as main plot treatment. Irrigation was done as and when needed. The experiment plot was kept free of weeds by manual weeding at regular intervals. To control the Pests and diseases, necessary plant protection measures were taken. The growth of each plant was monitored every day. Number of Leaves, Height of the plant and number of pods were recorded before first harvest. The pods were ready for the first harvest on February 28, 2019. Harvest was done on alternative days. Length (cm) and weight (grams) of the pod and number of pods were recording during each harvest. The collected data were subjected to analysis of variance for a split-plot design using R software. Post hoc test was carried out for the significant factors under study.

3. Results and Discussion

3.1. Pre-Harvest Analysis. In Pre-Harvest analysis the yield of Okra was studied based on Number of leaves, Height of the plant, and Number of pods. The following tables provide the results obtained by using Analysis of Variance (ANOVA) technique.

In all the above tables(Table 2-4), it is evident that in the pre-harvest phase the sub-plot treatment (methods) was found to be significant as the p-value is less than 0.05.i.e. The number of leaves, the height of the plant and the number of pods significantly differ due to the subplot treatment (methods). Post-hoc test

FIGURE 1. OKRA Experimental Area

TABLE 2. ANOVA Table Based on Number of Leaves

	df	*SS*	*MSS*	*F-value*	$Pr(>F)$
Replicate	2	874.3	437.2	0.3036	
Fertilizer	1	264.5	264.5	0.1837	0.709989
Main Plot Error	2	2880.3	1440.2		
Method	2	13822.3	6911.2	14.3584	0.002254*
Fertilizer Method	2	1914.3	957.2	1.9886	0.199043
Error	8	3850.7	481.3		

was carried out to study the significant difference between the three methods of cultivation. It is evident from the Table 5 that there a significant difference in the number of leaves between method 1 (Mulching sheet) and other two methods. Considering the Height of the plant and the Number of pods produced there was a significant difference between method 3(flatbed) and other two methods.

3.2. Post-Harvest Analysis. The yield of okra was studied for five subsequent harvest in terms of the number of pods, weight of the pod and length of pod and number of pods. The recordings were done for each plant to test whether there

TABLE 3. ANOVA Table Based on Height of the Plant

	df	*SS*	*MSS*	*F-value*	*Pr*(> *F*)
Replicate	2	7108	3554	0.6055	
Fertilizer	1	3901	3901	0.6647	0.50056
Main Plot Error	2	11739	5870		
Method	2	130399	65200	37.1996	0.000088*
Fertilizer Method	2	14741	7371	4.2054	0.05647
Error	8	14022	1753		

TABLE 4. ANOVA Table Based on Number of Pods

	df	*SS*	*MSS*	*F-value*	*Pr*(> *F*)
Replicate	2	10.11	5.056	1.2466	
Fertilizer	1	0.89	0.889	0.2192	0.6857303
Main Plot Error	2	8.11	4.056		
Method	2	354.78	177.389	22.2509	0.0005391*
Fertilizer Method	2	1.44	0.722	0.0906	0.9143136
Error	8	63.78	7.972		

TABLE 5. Post-Hoc Test for Three Methods of Cultivation

Dependent Variable	*Methods*		*Mean Difference of Methods*	*Significant Value*
leaves	1	2	61.833	0.002*
	2	3	-6.667	0.894
	1	3	-55.167	0.005*
Height	1	2	62.500	0.188
	2	3	141.0	0.002*
	1	3	-203.500	0.000*
Number of Pods	1	2	-3.500	0.054
	2	3	10.667	0.000*
	1	3	-7.167	0.000*

is any significant difference in methods of cultivation, fertilizers applied and their interaction effect. ANOVA was carried out and the following findings are drawn.

It is observed from Table 6 that, in all the five subsequent harvest cultivation method was found to be significant. Also it is also observed that there was a significant difference in the yield by the application of fertilizer only in the first harvest. Further by multiple comparison test for cultivation method 1 (Mulching Sheet) and method 2 (Grow Bag) had significant difference in weight of the pod when compared to flat bed. The average weight of the pod in the five subsequent harvest where recorded as mulching sheet (30.83, 191, 157.17, 130.33, 158.50), Grow bag (100.67, 88.50, 73.33, 92.50) and flatbed (0, 41.50, 77.33, 72, 37.67).

TABLE 6. ANOVA Table for Harvest based on Weight of the Pods

Date	*Harvest*	*Particulars*	*Df*	*SS*	*MSS*	*F-Value*	*Pr(> F)*
28-02-2019	1	Replicate	2	1606	803.2	113.8346	
		Fertilizer	1	1073	1073.4	152.1339	0.0065091*
		Ea	2	14	7.1		
		Method	2	31922	15961.2	23.8900	0.0004231*
		Fertilizer Method	2	663	331.7	0.4965	0.6262369
		Eb	8	5345	668.1		
02-03-2019	2	Replicate	2	4159	2080	1.5564	
		Fertilizer	1	118	118	0.0880	0.7947206
		Ea	2	2672	1336		
		Method	2	77557	38778	27.0040	0.0002771*
		Fertilizer Method	2	1264	632	0.4401	0.6586470
		Eb	8	11488	1436		
04-03-2019	3	Replicate	2	1576.3	788.2	0.2435	
		Fertilizer	1	1352	1352	0.4178	0.584315
		Ea	2	6472.3	3236.2		
		Method	2	22426.3	11213.2	9.6637	0.007344*
		Fertilizer Method	2	2704.3	1352.2	1.1653	0.359624
		Eb	8	9282.7	1160.3		
06-03-2019	4	Replicate	2	3083.1	1541.6	1.6372	
		Fertilizer	1	0.2	0.2	0.0002	0.98914
		Ea	2	1883.1	941.6		
		Method	2	13307.1	6656.6	7.0422	0.01722*
		Fertilizer Method	2	3293.8	1646.9	1.7431	0.23532
		Eb	8	7558.4	944.8		
08-03-2019	5	Replicate	2	2919	1459.4	0.5103	
		Fertilizer	1	854	854.2	0.2987	0.6395
		Ea	2	5720	2806.1		
		Method	2	43927	21963.4	51.8446	0.00002632*
		Fertilizer Method	2	1284	642.1	1.5156	0.2766
		Eb	8	3389	423.6		

From the above Table 7, it is evident that there was a significant difference in the length of pod due to the cultivation method in all the subsequent harvest. Further by comparing the cultivation methods in the five subsequent harvest, the average length of the pod was significantly high in mulching sheet(27.25, 160.75, 125.43, 102.25, 125.42) and grow bag (87.67, 132.92, 78.76, 63.42, 75.92) compared to flatbed (0, 42, 75.58, 60.42,38). While observing from Table 8, the number of pods there was a significant difference in the cultivation method for the first, second and fifth harvest. The number of pods significantly differs in all the three cultivation methods for the first and fifth harvest. The average number of pods by using these cultivation methods were recorded as harvest 1 (2, 7, 0) and harvest 5 (9, 6, 3).

TABLE 7. ANOVA Table for Harvest based on Length of the Pods

Date	*Harvest*	*Particulars*	*Df*	*SS*	*MSS*	*F-Value*	*Pr(> F)*
28-02-2019	1	Replicate	2	725.4	362.7	17.9368	
		Fertilizer	1	506.7	506.7	25.0556	0.0065091*
		Ea	2	40.4	20.2		
		Method	2	24156.4	12078.2	26.3528	0.0003016*
		Fertilizer Method	2	663	316.5	0.6906	0.5288487
		Eb	8	3666.6	458.3	1.4016	
02-03-2019	2	Replicate	2	1920	960.1	1.5564	
		Fertilizer	1	0	0.1		0.9936322
		Ea	2	1370	685	19.2022	
		Method	2	46284	23142.1	0.3679	0.0008833*
		Fertilizer Method	2	887	443.4		0.7032901
		Eb	8	9641	1205.2		
04-03-2019	3	Replicate	2	1281	640.5	0.7035	
		Fertilizer	1	36.1	36.1	0.0397	0.86053
		Ea	2	1821	910.5		
		Method	2	9342.3	4671.2	5.8612	0.02707*
		Fertilizer Method	2	1033	516.5	0.6481	0.54846
		Eb	8	6375.7	797		
06-03-2019	4	Replicate	2	1496.4	748.22	1.8821	
		Fertilizer	1	5	5.01	0.0126	0.9208
		Ea	2	795.1	397.56		
		Method	2	5602.1	2801.06	4.6512	0.0457*
		Fertilizer Method	2	2275.4	1137.72	1.8892	0.2128
		Eb	8	4817.8	602.22		
08-03-2019	5	Replicate	2	2552.1	1276.1	0.9421	
		Fertilizer	1	264.5	264.5	0.1953	0.7017511
		Ea	2	2709	1354.5		
		Method	2	23059.2	11529.6	35.0903	0.0001096*
		Fertilizer Method	2	320.3	160.1	0.4873	0.6313702
		Eb	8	2628.6	328.6		

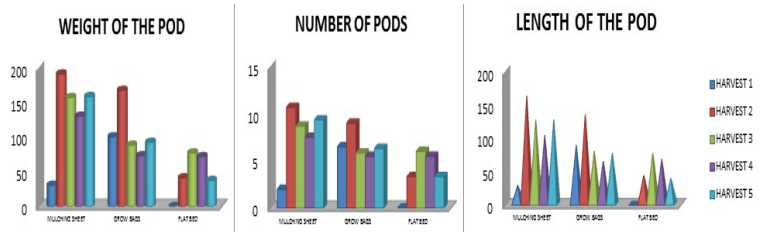

FIGURE 2. Comparison on Effect of Fertilizer in OKRA Cultivation

TABLE 8. ANOVA Table for Harvest based on Number of the Pods

Date	*Harvest*	*Particulars*	*Df*	*SS*	*MSS*	*F-Value*	*Pr(> F)*
28-02-2019	1	Replicate	2	4.333	2.167	39	
		Fertilizer	1	2.722	2.722	49	0.0198039*
		Ea	2	0.111	0.056		
		Method	2	133	66.500	31.500	0.0001612*
		Fertilizer Method	2	3.444	1.722	0.8158	0.475959
		Eb	8	16.889	2.111		
02-03-2019	2	Replicate	2	5.33	2.667	0.9231	
		Fertilizer	1	0.889	0.889	0.3077	0.634852
		Ea	2	5.778	2.889		
		Method	2	177.333	88.667	16.5389	0.001439*
		Fertilizer Method	2	1.778	0.889	0.1658	0.850051
		Eb	8	42.889	5.361		
04-03-2019	3	Replicate	2	10.33	5.1667	1.2740	
		Fertilizer	1	0.056	0.0556	0.0397	0.9175
		Ea	2	8.111	4.0556		
		Method	2	30.333	15.1667	3.7655	0.0704
		Fertilizer Method	2	3.444	1.7222	0.4276	0.6661
		Eb	8	32.222	4.0278		
06-03-2019	4	Replicate	2	1	0.5000	0.4737	
		Fertilizer	1	0.0556	0.0556	0.0526	0.8399
		Ea	2	2.1111	1.0556		
		Method	2	16.0000	8	2.0719	0.1883
		Fertilizer Method	2	12.4444	6.2222	1.6115	0.2582
		Eb	8	30.8889			
08-03-2019	5	Replicate	2	19	9.500	1.3256	
		Fertilizer	1	2	2	0.2791	0.6500729
		Ea	2	14.333	7.167		
		Method	2	108	54	18.5143	0.0009963*
		Fertilizer Method	2	1.333	0.667	0.2286	0.8006916
		Eb	8	23.333	2.917		

4. Conclusion

A field experiment was conducted at the Madras Christian College farm to evaluate the effect of organic fertilizer and its mixture with fertilizer synthetic as well as the cultivation methods to study the yield of okra crop. A Split-plot design laid in a randomized block design with three replications were taken for the study.Analysis of variance and post-hoc test were carried using R software. The significance of cultivation method in okra crop has been established through this study. Amongst the cultivation methods, mulching sheet and grow bags gave good yield more than the conventional flatbed method. It was also observed that flatbed method takes more time to produce the first yield. In the long run, it can be observed that the application of mulching sheet helps to prevent weeds and improves harvest making

it ideal for field experiments. Further application of vermicompost alone gave significant effect in pre-harvest phase and in the first harvest. Later application of mixture of vermicompost with synthetic fertilizer gave similar results. Hence it is suggested that vermicompost can be used instead of synthetic fertilizer as it produces good yield and chemical free. The scope of the study can be widened to include different variants of okra crop and combination of animal manure in the fertilizer mix.

References

1. Adewole M. B and A. O. Ilesami, (2011), Effect of soil amendments on the nutritional quality of Okra (Abelmoschusesculentus [L.] Moench, Journal of Soil Science and Plant Nutrition, 11(3), 45-55.
2. Adekiya A.O., T.M.Agbede, C.M. Aboyeji, O. Dunsin, J.O. Ugbe, (2017), Green manures and NPK fertilizer effect on soil properties, growth , yield, mineral and vitamin C composition of okra (Abelmoschusesculentus (L.) Moench), Journal of the Saudi Society of Agricultural Sciences, 18, 218-223.
3. Allah BakhshGulshan, Hafiz Muhammad Saeed, ShaziaJavid, ToobaMeryem, Muhammad Imran Atta and Muhammad Amin-ud-Din, (2013), Effects Of Animal Manure On The Growth And Development Of Okra (Abelmoschusesculentus L.), ARPN Journal of Agricultural and Biological Science, Vol.8, No:3, 213-218.
4. AshaEmbrandiri, Rajeev Pratap Singh and MahamadHakimi Ibrahim, (2013), Biochemical, morphological, and yield responses of lady's finger plants to varying ratios of palm oil mill waste (decanter cake) application as a bio-fertilizer, International Journal of Recycling of Organic Waste in Agriculture, ISBN: 1186-2251 – 7715-2-7.
5. Chigbundu I. N., S. A. Dialoke, J. O. Ajaero, F. O. Nwosu and I. I.Ibeawuchi,(2007), Growth Performance and Pod Dry Matter Yield of Some Local and an Improved Variety of Okra in Sudan Savannah Zone Nigeria, Journal of Plant Sciences 2(4): 465-469.
6. Idowu, O. O and Kadiri. M, (2013), Growth and yield response of okra (Abelmoschus esculentusMoench) to spent mushroom compost from the cultivation of Pleurotus ostreatusanedible mushroom, Academia Journal of Agricultural Research 1(3): pp: 039- 044, ISSN: 2315-7739.
7. IjoyahM. O., A. U. Usman, N. I. Odiaka, (2015), Yield Response of Cassava-Okra Intercrop as Influenced by Population Densities and Time of Introducing Okra on Makurdi, Nigeria, World Scientific News 18, pp: 133-154, EISSN 2392-2192.
8. JamalaG. Y., P. G.Boni, P. Abraham and A. M. Musa, (2011), Soil status and yield response of different varieties of okra (Abelmoschusesculentus (L.) Moench) grown at Mubi floodplain, North Eastern, Nigeria; Journal of Agricultural Biotechnology and Sustainable Development Vol. 3(7), pp. 120-125.
9. KibriaM.G., N. Hossain, M. J. Ahammad and K. T. Osman, (2013), Effect of Poultry Manure, Kitchen Waste Compost and NPK Fertilizer on Growth and Yield of Ladies Finger, IOSR Journal of Enviromental Science, Toxicology and Food Technology, e-ISSN: 2319-2402,Volume 2, Issue 6, 55 - 60.
10. Ngbede, S. O, U. N. Onyegbule, H. N. Ibekwe, O. A. Uwalaka and S. C. Okpara, (2014), Economic Analysis of Okra (Abelmoschusesculentus l. Moench) Production under Different Rates of Organic Manure in Okigwe, Southern Nigeria, Asian Journal of Agricultural and Food Science (ISSN: 2321-1571), Volume 02, Issue 02, 96 - 99.
11. Niyi S. Omidire, RaymonShange, Victor Khan, Russell Bean, Jewel Bean, (2015), Assessing the Impacts of Inorganic and Organic Fertilizer on Crops Performance Under a Microirrigation- Plastic Mulch Regime, Professional Agricultural Workers Journal,Volume 3: No. 1,6, pp. 1-9.
12. OdeleyeF.O., O. M. O. Odeleye, A. O. Olaleye and F. B. Yakubu, (2007), Effect of sowing depth on emergence, growth and yield of okra (Abelmoschusesculentus (L.) Moench), Journal of Food, Agriculture Environment Vol.5 (1): 205-209.

13. Olabiyi T. I and Oladeji O. O, (2014), Assessment of four compost types on the nematode population dynamics in the soil sown with okra, International Journal of Organic Agriculture Research and Development, Volume 9, 146 - 155.
14. Onwuchekwa-Henry, C. B and C. O. Muoneke (2016), Effect of Intercropping and poultry manure rates on the growth and yield of maize and okra, International Journal of Advanced Research, Volume 4, Issue 4, 28-36.
15. Owoseni DO and Adetunji AA, (2014), Examining effects of different levels of nitrogen fertilizer on varieties of okra (ABELMOSCHUS ECSULENTUS) using Split plot design,Journal of Science, Volume 4, Issue 8, e ISSN 2277 – 3290.
16. Rana Ibrahim Al-Dulaimi, Norli Ismail, Mahamad H. Ibrahim, (2014), Responses of growth of lady's fingers (Abelmoschusesculentus L.) to different treatments methods of diary wastewater, Annals of Agricultural and Environmental Medicine, Vol 21, No 1, 42-48.
17. Shanika W., P. Premanandarajah, (2015), Nitrogen Use Efficiency of Okra (Abelmoschusesculentus (L.)Moench) in Sandy Regosol Amended with Locally Available Organic Manures and Urea Integrations, Journal of Environment Protection and Sustainable Development, Vol. 1, No. 3, pp. 121-125.
18. Sinmidele k. Orundare, Frank D. Owa, Omolola O. Etukudo, Naomi K. Ibitoye- Ayeni, (2015), Influence of Different Nitrogen Sources on the Growth and Yield of Three Varities of Okra (Abelmoschusesculentus) in kabba, Kogi State, Nigeria, Agricultural Sciences, 6,1141-1147.
19. Ufere N. Uka, Kanayo S. Chukwuka and Mary Iwuagwu, (2013), Relative Effect of Organic and Inorganic fertilizers on the growth of okra [ABELMOSCHUS ESCULENTUS (L.) MOENCH], Journal of Agricultural sciences, Vol. 58, No. 3, pp.159-166.

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