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Review Article

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Maximum Okra (*Abelmoschus Esculentus* l. Moench) Productivity through Integrated Organic Nutrient Management

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Abstract

This is a compilation on integrated organic nutrient management (OINM) in productivity of okra. Review showed that physico-chemical properties of OINM materials such as sheep and goat (S&G), poultry (PD), cattle (CD) and kitchen wastes (KW) used in OINM have varied nutrient concentrations of dry matter (DM), organic matter (OM), ash (As), crude protein (CP), nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sodium (Na), manganese (Mn), iron (Fe), cupper (Cu) and zinc (Zn) in the range of DM (PD > CD > S&G), OM (CD > PD > S&G), As (S&G > PD > CD), CP (PD > S&G > CD), N (PD > S&G > KW > CD), P (S&G > PD > KW > CD), K (CD > PD > S&G > KW), Ca (PD > S&G > KW > CD), Mg (PD > S&G and KW > CD), Na (S&G > PD > CD), Mn (PD > CD> S&G) Fe (S&G > CD > PD), Cu (PD > S&G > CD) and Zn (CD > PD > S&G). Okra growth and yield attributes due to OINM revealed that taller plants in okra with significantly higher number of leaves were obtained in PD (though at par with S&G), followed by CD-sourced OINM. Application of PD and CD-OINM sources at 18 and 12 as well as 60 t/ha of KW gave tall okra plants with much leaves and leaf areas. Increasing PD grade up to Mt/ha level, significantly affected fresh and dry matter (FDM) accumulation in leaves, roots and stems of okra. Significantly higher means of okra FDM were obtained with PD at 4 Mt/ha (except fresh at 0-2 Mt/ha and dry at 2-4 Mt/ha of root weights). However, reproductive characters of okra (days to 50% flowering, number of fruits, weight of fruits and fruits yield) had significant effect with OINM materials. These characters were significantly increased by rates of KW, SOM, PD, CD and S&G-OINM sources (except fruit yield in SOM at 2285 and between 3428 and 4000 kg/ha) and number of fruits and fruit yield in PD (0 and 5 t/ha) as well as PD, CD and S&G at 18 t/ha. More so, okra pod length and diameter and fresh pod weight and yield with OINM materials and rates of farm yard manure (FYM) as another OINM-source led to a significant (P = 0.05) increase on these reproductive attributes of okra (except pod length and diameter with source of OINM and pod diameter with rate of FYM). Fresh pod weight and yield were significantly higher with PD and 15 t/ha of FYM. Leaf nutrient contents and fruit yield of okra increase with increasing levels of PD up to 4 Mt/ha. It is therefore recommended that application of OINM sources are very critical in okra productivity, particularly PD from 10 t/ha up to 4 Mt/ha, CD and S&G at 12-18 t/ha, KW at 60 t/ha with SOM at 2857 kg/ha and FYM at 15 t/ha due to inherently low fertility nature of tropical soils and the ever increasing need of improving carrying capacity of soils under tropical conditions.

Keywords: *Maximum okra productivity; Integrated organic nutrient; Management*

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Introduction

Integration of nutrients on the basis of soil texture, fertility level and ecological conditions is of great economic importance. Exhaustive agriculture with incredibly elevated nutrient revenue in soil plant environment attached to small and imbalanced fertilization resulted in worsening of native soil fertility and posed a stern hazard to extended sustainability of crop production (Muddukumar, 2007). Studies on various cropping systems had noticeably showed that sole application of organic or synthetic fertilizers could not maintain towering yield of crops in intensive cropping systems. The integrated use of organic or inorganic fertilizers could help to uphold crop yield strength through alleviation of deficiencies of nutrients, increasing the applied nutrients efficiency and offering the favorable soil atmosphere (Muddukumar, 2007).

The use of organic manures which were traditionally important nutrient resources declined substantially. Added to this, excessive and continuous use of a few inorganic fertilizers in unbalanced proportion resulted in the deficiency of micronutrients besides diminishing soil fertility and resulting in unsustainable crop yield. Despite the fact that the chemical inputs in farming is unavoidable to congregate the mounting demand for foodstuffs, there are chances in chosen crops and niche areas where organic production can be supported to tape the domestic and export food needs (Karmakar., *et al*. 2007). Therefore, integrated nutrient management (INM) is very critical in crop production. Many crop production problems (increasing costs and declining yields) can be traced to improper and inefficient use of nutrients (Dantata., *et al*. 2016 a and b).

The INM takes into consideration the nutrient cycle involving soils, crops and livestock, nutrient deficiencies, organic recycling, conjunctive use of organic manures or mineral fertilizers and biological nitrogen fixing potential (Kumar and Sreenivasulu, 2004). The INM looks for to augment agricultural production and preserve the atmosphere for upcoming generation. It is an approach through which organic or inorganic nutrient elements are applied jointly to soil for superior crop production and soil deprivation prevention without jeopardizing future food supply requirements (Gruhn., *et al.* 2000). Proper fertilization and application methods such as incorporation in splits at phenological phases of crop, slow released and coated fertilizers, combined application of organic and inorganic fertilizers as well as use of indigenous sources are all important for enhanced crop production. Long-term fertilizer experiments have revealed that the efficiency of P and K increased appreciably when both were applied in conjunction, suggesting their positive interactions (Mahajan., *et al*. 2003; Kumar and Sreenivasulu, 2004).

Combined application of 50, 100 and 150% of recommended rates of inorganic nitrogen, phosphorus and potassium with farmyard manure and zinc improved crop yields compared to straight fertilizers (Roy., *et al*. 2001). The INM system aims at achieving efficient use of plant nutrients. For instance, long term fertilizer trials involving intensive cereal- based cropping systems revealed a declining trends in productivity even with the application of recommended levels of N, P and K fertilizers (Mahajan., *et al*. 2002; Mahajan and Sharma, 2005). However, the same crop productivity increases with combined application of these inorganics and organic manures. Such combinations contributed immensely to the improvement of physical, chemical and biological properties including soil organic matter and nutrients status of the cereal-based cropping environment.

Considering the above facts, the current work was embarked upon to explore okra response under organic INM. As growth and yields in okra depends on soil- nutrients availability which is related to choice of organic sources or types and judicious application rates of organics (Dantata, 2011; Ekinya, 2013; Dantata, 2016b). Organic nutrients may be applied through two or more sources viz (Dantata, 2011); manures (cow dung, poultry litter, farm yard manure, kitchen wastes) and organo-mineral fertilizers (microbial culture, vermi-compost, oil cake pellets, and processed municipality wastes). These are very important. Because increased use of inorganic fertilizers in crop production causes health hazards, creates problems to the environment with pronounce air, water and soil pollution. Continuous use of inorganic mineral fertilizers particularly affects soil texture, structure, color, aeration, water holding capacity and soil microbial activities badly (Dantata, 2011).

A good soil has an organic matter content of more than 3%. But soils in most regions have less than 1.5% organic matter. For continuous cropping, organic manures applied to the crop fields through poultry, sheep and goats and cattle droppings as well as kitchen wastes or farmyard manures and are grossly insufficient (See concentrations in Table 1). Gradual deficiency in soil organic matter and reduced okra crop yields are alarming factors and burning issues for the farmers. All effort should be made to develop consciousness of the farmers about the importance of soil organic matter in the long term maintenance of soil productivity. In recent years livestock's farming (poultry, sheep and goats, cattle) are increasing. Meaning droppings like poultry litters, sheep, goats and cow dungs are becoming more readily available. Different manures contain different amounts of nutrients in different proportions and their mode of nutrients release are not same. So, different manures may influence the productivity of okra differently (Dantata, 2011).

Considering the above facts, the present work was under taken with the objective of supplying information on agronomic rates of organically INM (balanced organic plant nutrients) which would support and match the increasing demand for okra in Nigeria. Already, many farmers have gone into large scale production (Edet and Etim, 2010) using all forms of plant nutrients from various sources (Dantata, 2011); primarily as a means of income and employment. It is therefore important to undertake a major review of certain key areas of the crop cultural requirements such as in IONM to ascertain its appreciable levels especially in the tropics, where soils are inherently low in fertility (Dantata, 2016a) and increasing grades of IONM materials are highly required to improve soils structure and carrying capacity under tropical conditions (Dantata, 2011 and 2016b). More so, to avoid any thresholds that might be associated with release of phytotoxic quantities of NH_3, NO_3 and salts possibly due to use of supra optimal grades which might be very uneconomical and unbeneficial to plants (Weil and Kronje, 1979), animals and humans and also to provide a platform for continuous researches and developments in okra.

Discussion

The physico-chemical properties which specify the various nutrients concentrations (NCs) of organic manures (sheep & goat [S&G], poultry [PD], cattle [CD] & kitchen wastes [KW]) used in the integrated organic nutrient management (IONM), are shown in Table 1. The NCs of dry matter (DM), organic matter (OM), ash (As), crude protein (CP), nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sodium (Na), manganese (Mn), iron (Fe), cupper (Cu) and zinc (Zn) follow the order of DM (PD > CD > S&G), OM (CD > PD > S&G), As (S&G > PD > CD), CP (PD > S&G > CD), N (PD > S&G > KW > CD), P (S&G > PD > KW > CD), K (CD > PD > S&G > KW), Ca (PD > S&G > KW > CD), Mg (PD > S&G and KW > CD), Na (S&G > PD > CD), Mn (PD > CD> S&G) Fe (S&G > CD > PD), Cu (PD > S&G > CD) and Zn (CD > PD > S&G).

Content	Droppings			Kitchen wastes
	Sheep and goat	Poultry	Cattle	
Dry matter (g)	29.9	105.2	38.2	-
Organic matter (g)	1.0	1.6	2.1	-
Ash (g)	4.0	3.4	2.0	-
Crude protein	18.14	22.18	14.06	-
Nitrogen (gkg^{-1})	2.903-105.2	3.548-117.5	2.25-41.6	63.4
Phosphorus (gkg^{-1})	0.990-2.9	1.613-2.600	0.63-1.7	1.8
Potassium (gkg^{-1})	1.43-20.7	0.688-23.8	0.4-28.2	16.5
Calcium (cmol kg^{-1})	1.002-1.6	1.9-2.820	0.294-1.5	1.7
Magnesium (cmol kg^{-1})	0.431-1.5	0.578-1.7	0.255-1.4	1.5
Sodium (cmol kg^{-1})	4.200	3.900	0.885	-
Manganese (cmol kg^{-1})	0.040	0.051	0.049	-

Iron (cmol kg^{-1})	0.842	0.527	0.735	-
Cupper (cmol kg^{-1})	0.004	0.005	0.003	-
Zinc (cmol kg^{-1})	0.039	0.077	0.13	-

Table 1: *Physico-chemical properties of IONM materials.*

IONM materials (mostly agricultural by-products of crop or animal origins) added to soils are known to supply the essential nutrients required by plant for growth and development (Akande., *et al*. 2010) as well as improves the biological and physical conditions of the soil (soil aggregates improvement). This occurs through stimulating activities of soil living organisms which increase microbial production of a variety of linear organic polymers that bind soil particles into micro and macro aggregates thereby enhancing capillary of air, water and nutrients through the soil body (Dantata, 2011). The manorial value of the different IONM materials vary widely [Table 1]. However, richest IONM materials reported is in the order of PD > CD > S&G > Swine & Horse dungs (Komolafe, 1980; Ekinya, 2013).

Table 2, showed reports of plant height, number of leaves, number of branches and leaf area of okra as influenced by source and rates of IONM such as the PD, S&G and CD. Significantly taller plants with higher number of leaves comparable to control treatment were obtained in PD (though at par with S&G) followed by CD -sourced IONM treated okra. This revealed that PD-sourced IONM had significant influence on plant height and number of leaves due to the benefits of the available high macro (N, P, K & Ca) and micro (Mg, Na, Mn, Fe, Cu & Zn) nutrient elements compared to other IONM- source (CD and S&G) and the control (Without IONM source) where least responses were recorded. Application rates of PD-IONM source at 0-18 t/ha significantly increase plant height, number of leaves and leaf area of okra, especially 18 t/ha PD rate. This trend was observed in rates of S&G and CD-IONM sources with the exception of number of leaves in rates of CD-IONM source where 12 t/ha CD rate gave significantly higher number of leaves.

Treatments	Plant height	No. of Leaves	No. of branches	Leaf area (cm^2)	References
IONM source					
Without source	39.8b	7b	5	-	
PD	46.4a	8a	5	-	Olubode., *et al.* (2015)
S&G	43.2ab	8a	5	-	
CD	41.2b	7b	5	-	
LS	*	*	Ns	-	
SE±	1.3	0.33	0.27	-	
Rates of IONM materials					
PD (t/ha)					
0	47d	20c	-	72.5c	
6	62.16c	24.12b	-	90b	
12	71.12b	24.3b	-	92.2b	
18	83.14a	28.41a	-	98.1a	
LS	*	*	-	*	
SE±	0.41	0.39	-	0.4	
S&G (t/ha)					
0	47d	19c	-	69.8c	

6	59.1c	23.1b	-	77.1b	
12	65.4b	24.1ab	-	80a	Ekinya (2013)
18	80a	26.12a	-	81.12a	
LS	*	*	-	*	
SE±	0.41	0.39	-	0.4	
CD (t/ha)					
0	46.1d	19.14d	-	71.5b	
6	57c	24c	-	79ab	
12	69.12b	36.12a	-	82.1b	
18	79.3a	28.13b	-	84.12a	
LS	*	*	-	*	
SE±	0.41	0.39	-	0.4	

In a column, means followed by same letter are not significantly different at 5% probability level by DMRT

LS. Level of significance NS. Not significant at 5% level *Significant at 5% level

Table 2: *Effect of IONM source and rates of IONM materials on plant height, number of leaves, numbers of branches and leaf area of okra.*

Growth attributes of okra represented by plant height, number of leaves and leaf area were also affected by rates of kitchen wastes (KW)-IONM source from 0-60 t/ha [Table 3]. Plots treated with 60 t/ha KW rate gave the tallest plants with much leaves and leaf areas. This pattern of vegetative growth response displayed by okra in the current work may not be unconnected with the physico-chemical properties of the organic material documented in Table 1. The KW-IONM source material contains appreciable amounts of N (63.4 gkg^{-1}), P (1.8 gkg^{-1}), K (16.5 gkg^{-1}), Ca (1.7 cmol kg^{-1}) and Mg (16.5 cmol kg^{-1}). These important nutrient elements are known to elicit vegetative development in crops, especially the vegetables. Increasing rates of PD from t/ha to Mt/ha significantly influenced fresh and dry matter accumulation in leaf, root and stem of okra [Table 4]. Higher and significant okra fresh and dry weights were recorded with application of PD at 4 Mt/ha, except fresh (at 0-2 Mt/ha) and dry (at 2-4 Mt/ha) root weights. Kim., *et al*. (1997) obtained increased dry matter yield by amending soil with CD mixed with rice husk/sawdust.

KW-IONM (t/ha)	Plant height (cm)	No. of leaves	Leaf area (cm^2)
0	46.0d	12.0c	70.1d
20	50.1c	23.0b	72.1c
40	59.1b	28.0a	76.0b
60	66.0a	28.0a	81.1a
LS	*	*	*
SE±	0.41	0.39	0.4

Source: Ekinya (2013)

In a column, means followed by same letter are not significantly different at 5% probability level by DMRT

LS. Level of significance *Significant at 5%

Table 3: *Rate of KW-IONM material on plant height, number of leaves and leaf area of okra.*

PD-IONM (Mt/ha)	Fresh weight (g plant^{-1})			Dry weight (g plant^{-1})		
	Leaf	Root	Stem	Leaf	Root	Stem
0	57.5c	10.7b	18.7c	8.14c	2.19b	3.20c
2	64.0b	11.2b	20.3b	11.7b	3.19a	9.57b
4	68.3a	14.7a	30.6a	14.6a	4.07a	14.2a

Source: Omotoso and Shittu (2008)

Means with same letter in each column are not significantly different (P = 0.05) by DMRT

Table 4: *PD-IONM material on fresh weight and dry matter accumulation in okra.*

Report on the reproductive development of okra as in days to 50% flowering, number of fruits, weight of fruit and fruit yield as influenced by source of IONM materials are presented in Table 5. Sources of IONM sources had no significant effect on days to 50% flowering. This indicated that sources of IONM did not affect days to 50% flowering as they were at par. This may be attributed to the inherent genetic trait of the cultivated okra crop variety, so that with or without IONM sourced material, the crop flowers at about the same age range. Confirming to the findings made by Ibrahim (1989) and Faraqi and Damrany (1994). These workers associated days to flowering in okra to variety. However, flower bud induction as a reproductive growth response in plants is further mediated by many other factors such as seasonal variations and moisture (Albrigo and Sauco, 2004) including growing temperatures and adequate nutrients availability. Davenport (1990) showed that lower moisture availability from low moisture stress is a contributory factor of flower bud induction mechanism in most tropical climates. S&G-IONM source gave significantly greater number of fruits, heavier fruits and higher fruit yield than other IONM sources such as PD and CD put together. This confirmed the report of Chen and Avnimelech (1986) who said that IONM materials have the potential to increase crop yields.

IONM source	*Days to 50% Flowering	No. of fruits	Wt of fruit	Fruit yield (t/ha)	References
Control	-	6	86.9	4.8	Tiamiyu., *et al*. (2013) and Olubode., *et al*. (2015)
Poultry	60.2	6	127.8	7.1	
Sheep and goats	60.2	7	145.7	8.1	
Cattle	60.3	5	79.2	4.4	

*Not significant

Table 5: *IONM source on days to 50% flowering, number of fruits, weight of fruit and fruit yield (t/ha) of okra.*

Rates of KW, SOM and PD [Table 6] as well as PD, CD and S&G [Table 7] as IONM materials affected number of fruits and fruit yield in okra. These reproductive characters of okra were significantly affected by all the different rates of KW, SOM, PD, CD and S&G-IONM sources except fruit yield in SOM (at 2285 and between 3428 and 4000 kg/ha) and number of fruits and fruit yield in PD (0 and 5 t/ha) as well as PD, CD and S&G at 18 t/ha. The results in this work suggests that incorporation of IONM materials into the soil body proved more effective for nutrients supply, availability and uptake. Implying that nutrient uptake at rates of 0-60 t/ha of KW, 2857 t/ha of SOM, 10-12 t/ha of PD with 12 t/ha of CD and S&G were effectively converted to economic yield and consequently adequate for okra productivity. The current observations corroborates findings made by Maerere., *et al*. (2001) and Akande., *et al*. (2010).

Rates of IONM materials	No. of fruits	Fruit yield (t/ha)	Fruit dry weight (g/plant)	References
KW (t/ha)				
0	98	1.52	-	
20	110	1.92	-	
40	128	1.99	-	Ekinya (2013)
60	144	2.00	-	
SOM (kg/ha)				
1000	-	1.34	-	
1714	-	1.49	-	
2285	-	1.47	-	
2857	-	2.36	-	Ojeniyi (2010)
3428	-	2.04	-	
4000	-	2.09	-	
PD (t/ha)				
0	96.0c	1.24b	-	
5	153.0bc	1.81b	-	Awe., *et al.* (2011)
10	184.7a	2.62a	-	
PD (Mt/ha)				
0	-	-	23.34b	
2	-	-	25.12b	Omotoso and Shittu (2008)
4	-	-	27.14a	

In a column, means followed by same letter are not significantly different at 5% probability level by DMR
SOM. Sunshine organic manure.

Table 6: *Rates of IONM materials on number of fruits, fruit yield (t/ha) and fruit dry weight (g/plant) of okra.*

Rates of IONM materials	Number of fruits	Fruit yield (t/ha)
PD (t/ha)		
0	110	1.61
6	182	2.94
12	211	4.60
18	172	2.90
LS	*	*
SE±	4.1	0.01
CD (t/ha)		
0	108	1.66
6	183	2.99
12	201	3.20
18	173	1.96

LS	*	*
SE±	4.1	0.01
S&G (t/ha)		
0	111	1.60
6	180	2.00
12	190	3.99
18	182	2.10
LS	*	*
SE±	4.1	0.01

Source: Ekinya (2013) and Modified by Author LS. Level of significance *Significant at 5%

Table 7: *Rates of IONM materials (PD, CD and S&G) on the number of fruits/plant and fruit Yield (t/ha) of okra.*

These workers reported that when organic manures above agronomic rates are applied, there might be a release of phytotoxic quantities of NH3, NO3 and salts which might be uneconomical and unbeneficial to both plants and humans. Further consideration of okra pod length and diameter as well as fresh pod weight and yield with sources of IONM materials and rate of farm yard manure (FYM) which is another IONM-source revealed a significant (P = 0.05) effect on these reproductive attributes of okra, except pod length and diameter with source of IONM and pod diameter with rate of FYM [Table 8]. This invariably means that various sources of IONM materials and rates of FYM applied did not increase length and diameter of okra pods significantly. This may not be unconnected with the genetic trait of the cultivated crop variety earlier mentioned in days to 50% flowering. Okra pod length and diameter posture are genetically controlled, so that no IONM sources or rates may change it. Fresh pod weight and yield were significantly higher with PD and 15 t/ha FYM producing higher pod weight and yield. CD and S&G with FYM at 0 and 5 as well as 5 and 10 t/ha gave these parameters at par. The reason for increased pod weight and yield could be attributed to mineralization effect of plant nutrients by PD (Table 1) which led to improvement in soils nutrient status. The results concur with that of Tolanur and Badanur (2003) who studied the effect of INM on the productivity of chickpea in Vertisol. They concluded that integration of N nutrient with FYM sustained the productivity of chick pea and significantly improved the organic carbon, available N, P and K status of Vertisol after harvest.

OINM source	Pod length (cm)	Pod diameter (cm)	Fresh pod weight (g)	Fresh pod yield (tha)
CD	7.01	1.46	19.0b	3.22b
S&G	7.01	1.47	20.6b	3.42b
PD	7.15	1.47	21.3a	4.34a
LS	Ns	ns	*	*
SE±	0.04	0.01	0.39	0.15
FYM-OINM rate				
0	6.89b	1.45	17.9c	2.80c
5	7.04b	1.47	20.3b	3.22c
10	7.11a	1.47	20.9b	4.03b
15	7.19a	1.48	23.1a	4.61a
LS	*	ns	*	*
SE±	0.05	0.01	0.40	0.17

Interaction				
OINM source x FYM	ns	Ns	Ns	Ns

Source: Tiamiyu., *et al.* (2013) and Modified by the Author

Means in a column followed by same letter (s) are not significantly different at 5% probability level using DMRT

LS. Level of significance NS. Not significant *Significant

Table 8: *IONM sources and rates on yield and yield components of okra.*

Leaf nutrient composition of okra tends to increase with increasing level of PD [Table 9]. Comparative analysis of PD in it uptake indicated that PD. The robust look of plants in PD plots is indicative of the induced CN ratio. Addition of PD has produced better and healthier growth and thereby improved significantly the growth, yield and nutrient contents of okra. PD at the rate of 4 Mt/ha gave significantly higher yield.

PD (Mt/ha)	**N**	**P**	**K**	**Ca**	**Mg**	**Na**
	%					
0	0.90	1.35	1.36	2.10	0.30	0.70
2	1.27	2.25	2.40	2.90	0.40	1.20
4	1.38	3.40	3.61	3.30	0.60	1.10

Source: Omotoso and Shittu (2008)

Table 9: *Rates of PD-IONM in Mt/ha on nutrient uptake in okra.*

Conclusion

Integrated organic nutrient management (OIONM) materials (S&G, PD, CD, KW and FYM) are adequate in nutrient elements with concentrations of DM, OM, As, CP, N, P, K, Ca, Mg, Na, Mn, Fe, Cu and Zn in the order of DM (PD > CD > S&G), OM (CD > PD > S&G), As (S&G > PD > CD), CP (PD > S&G > CD), N (PD > S&G > KW > CD), P (S&G > PD > KW > CD), K (CD > PD > S&G > KW), Ca (PD > S&G > KW > CD), Mg (PD > S&G and KW > CD), Na (S&G > PD > CD), Mn (PD > CD> S&G) Fe (S&G > CD > PD), Cu (PD > S&G > CD) and Zn (CD > PD > S&G). Taller plant heights with significantly high number of leaves were obtained in PD and S&G followed by CD, PD & CD at 18 and 12 t/ha and KW at 60 t/ha produced tall okra plants with much leaves and leaf areas. Raising PD up to Mt/ha grade level, influenced fresh and dry matter accumulation in leaves, roots and stems of okra.

Reproductive characters of okra (days to 50% flowering, number of fruits, weight of fruits and fruits yield) were significantly increased by rates of KW, SOM, PD, CD and S&G-IONM sources (except fruit yield in SOM at 2285 and between 3428 and 4000 kg/ha) and number of fruits and fruit yield in PD (0 and 5 t/ha) as well as PD, CD and S&G at 18 t/ha. Okra pod length and diameter and fresh pod weight and yield with IONM materials and rates of FYM led to a significant (P = 0.05) increase in the reproductive attributes of okra (except pod length and diameter with source of IONM and pod diameter with rate of FYM). Fresh pod weight and yield were significantly higher with PD and 15 t/ha of FYM. Leaf nutrient contents and fruit yield of okra increase with increasing levels of PD up to 4Mt/ha.

It is concluded therefore that for maximum productivity in okra, application of IONM sources are very critical, particularly PD from 10 t/ha up to 4 Mt/ha, CD and S&G at 12-18 t/ha, KW at 60 t/ha with SOM at 2857 kg/ha and FYM at 15 t/ha.

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