
1 **Influence of Sole and Combined Application Of NPK (15:15:15) Fertilizer and**
2 **Poultry Manure on Growth and Yield of Okra (*Abelmoschus Esculentus* L.)**
3 **Varieties in Aliero, Kebbi state, Nigeria**

4 **ABSTRACT**

5
6 Field trials were conducted at the University Orchard Aliero, Kebbi state University of Science
7 and Technology Aliero, during the 2017 and 2018 dry seasons, to study the Growth-growth and
8 Yield-yield of Okra (*Abelmoschus esculentus* L. Moench) Varieties-varieties Influenced
9 influenced by Sole-sole and combined application of NPK (15:15:15) and Poultry manure. The
10 treatments consisted of a factorial combination of three Okra varieties: LD88, NHAE47-4 and
11 Dogo; and three level of nutrients: 800kg NPK (15:15:15) ha⁻¹, 100%PM ha⁻¹ equivalent to 6.6t
12 ha⁻¹ and 50%NPK+50%PM ha⁻¹ (400kg of NPK [15:15:15] + 3.3t of PM ha⁻¹) and the untreated
13 control, each designed to supply the recommended dose of 120kg N ha⁻¹ using a compound
14 fertilizer NPK (15:15:15) and poultry manure and cow dung. Results revealed that plant height,
15 number of leaves, number of pods per plant, mean pod weight (g), mean pod length (cm), pod
16 fruit yield per hectare were significantly increased when the recommended N dose of 120kg N
17 ha⁻¹ was applied using only NPK (800kg NPK [15:15:15 ha⁻¹]) or a combination of NPK+PM at
18 50:50 ratio in conjunction with variety NHAE47-4. Based on the results of this study, it could be
19 concluded that the integration of organic and inorganic fertilizers in form of NPK fertilizer and
20 poultry manure at 50:50 ratio in conjunction with variety NHAE47-4, could be adopted for
21 higher pod yield.

22 **Keywords:** Okra; *Abelmoschus esculentus* L. Moench, NPK, Poultry manure, Okra pod yield.
23 Nigeria

24 **1. INTRODUCTION**

25 Okra (*Abelmoschus esculentus* (L.) Moench) is an important vegetable crop consumed worldwide. It is a
26 member of the *Malvaceae* family, widely cultivated in the tropics and subtropics for its immature edible
27 green fruits which are consumed as a vegetable (Iyagba *et al.*, 2013). In Nigeria, okra is usually grown
28 in home gardens and fields both during the wet and dry seasons, with the dry season production being
29 carried out under irrigation (Wamanda, 2007). It has a great demand because it forms an essential
30 part of the human diet. It is grown mainly for its young tender fruits and can be found in most
31 markets in Africa (Rahman *et al.*, 2012). It is produced and consumed all over the country for the

32 mucilaginous or “draw” property of the fruit that aid easy consumption of the staple food
33 products. Nutritionally, tender green fruits of okra are important sources of vitamins and
34 minerals such as vitamins A, B₁, B₃, B₆, C and K, folic acid, potassium, magnesium, calcium and
35 trace elements such as copper, manganese, iron, zinc, nickel, and iodine (Lee *et al.*, 2000), which
36 are often lacking in the diet of people in most developing countries. On the average, young green
37 ~~pod-fruit~~ contains 86.1% moisture, 9.7% carbohydrate, 2.2% protein, 0.2% fat, 1.0% fibre and
38 0.8% ash (Saifullah and Rabbani, 2009). Its importance ranked above most other vegetables
39 including cabbage, amaranths, and lettuce (Kolawole *et al.*, 2008).

40 Vegetable crop producers in the tropics are bedeviled with the problem of maintaining soil
41 fertility. This is because the native fertility of most agricultural soils in this region is low and
42 cannot support suitable crop production over a long period without the use of fertilizers. This
43 problem is compounded by the scarcity and high cost of inorganic fertilizers which has forced
44 farmers to make use of fertilizers rates that are lower than the optimum with its resultant
45 reduction in yield. The scarcity of inorganic fertilizer associated with high cost, has created a lot of
46 problems in arable crop production in Nigeria. In the past, farmyard manure has been used to improve and
47 supplement soil nutrients (Adeleye *et al.*, 2010), but with the advent of inorganic fertilizer, there was a
48 reduction in the use of organic manure by farmers as source of plant nutrients and soil improvement,
49 because of relative ease of application and quick results with inorganic fertilizer application. On the other
50 hand, organic manures generally improve the soil physical, chemical and biological properties along with
51 conserving the moisture holding capacity of soil and thus resulting in enhanced crop productivity along
52 with maintaining the quality of crop produce (Singh *et al.*, 2015).

53 Although the organic manures contain plant nutrients in small quantities as compared to the inorganic
54 fertilizers, the presence of growth promoting principles like enzymes and hormones, besides plant
55 nutrients makes them fertility soil enhancers and productivity (Onyango *et al.*, 2012). Despite the
56 beneficial qualities of poultry manure, a high rate may be required to ensure adequate soil coverage
57 especially in fields with low fertility and those that have been subjected to inorganic fertilization for many
58 years (Olaniyi *et al.*, 2010). A lot of work has been done with okra and other related vegetables but not
59 much has been reported on the influence of NPK (15:15:15) and poultry manure on the development of
60 Okra varieties. Therefore, the objective of this study was to assess the performance of okra varieties under
61 the sole and combined application of NPK (15:15:15) and poultry manure in Aliero, on the Kebbi state of
62 Nigeria.

63

64 2. MATERIALS AND METHODS

65 2.1 Experimental site

66 The research was carried out in two dry seasons of 2017 and 2018 at Kebbi state University of
67 Science and Technology Aliero, Orchard (lat. 12°18.64'N; long. 4°29.85'E; 262 above sea level).
68 Aliero is located at in Sudan Savanna ecological zone of Nigeria. The area has a long dry season
69 that is characterized by cool dry air (harmattan) that prevails from November to February; and
70 hot dry air extending from March to May. The locations were used for cultivation of vegetable
71 and cereal crops.

72 2.2 Land Preparation and Field Layout

73 The site was ploughed and harrowed to obtain good tilth. The soil was levelled and constructed
74 into seed beds; water channels were constructed to facilitate free and efficient water movement
75 and uniform distribution on the plots. The plot size was 2.5 x 3m (7.5m²). Space measuring 1.5m
76 was left between blocks and 0.5m between plots. The net plot area consisted of the two middle
77 rows (2.5 x 1.0m = 2.5 m²). Organic manures (Poultry manure and Cow dung) was then applied
78 evenly into the seedbed according to treatment in order to improve its fertility status and then
79 watered. The seed bed left for 5 days with daily watering to stimulate the release the nutrients
80 from manure applied.

81 2.3 Plant Materials

82 Two varieties of okra (LD88, and NHAE47-4) were sourced from the National Horticultural
83 Research Institute (NIHORT) Bagauda sub-station, Kano. While a variety of *Dogo* was out
84 sourced locally from Jega.

85 2.4 Soil and Organic manure Analysis

86 Soil samples were randomly collected from the depth of 0-30 cm across the experimental sites.
87 The samples were bulked to form a composite sample and sub-samples about 200g were
88 collected using coning and quartering method. The samples were air dried, grounded, sieved and

89 analyzed for physical and chemical properties (Table 1). Poultry manure sample was collected
90 and analyzed for chemical characteristics (Table 2).

91 **2.5 Treatment and Experimental Design**

92 The treatments consist of three (3) okra varieties (LD 88, NHAE47-4 and Dogo variety) and
93 three (3) levels of Organic and Inorganic fertilizers, each designed to supply 120 kg N ha⁻¹ using
94 NPK (15:15:15) and poultry manure. The treatments were: 800kg NPK (15:15:15) ha⁻¹;
95 100%PM ha⁻¹ equivalent to 6.6t ha⁻¹; 50%NPK+50%PM ha⁻¹ (400kg of NPK [15:15:15] + 3.3t of
96 PM ha⁻¹) and the untreated control. The experiments were laid out in a Factorial Randomized
97 Complete Block Design (FRCBD) with three (3) replications. Pl. clarify in methods it is FRCB
98 here RCBD?

99 **2.6 Seed treatment and Sowing**

100 Prior to sowing, the seeds were treated with Apron star at the rate of 10g of the chemical per 4.0
101 kg of seed, to protect the seeds from soil-borne diseases and pests. Seeds were dibbled at an intra
102 and inter row spacing of 50 x 50 cm.

103 **2.9 Pesticide Application**

104 Okra plants were protected against insect pests and diseases by regular spraying of an
105 appropriate mixture of *Cypermethrin* plus dimethoate at the rate of 4ml L⁻¹ of water at 10 days
106 interval prior to flowering and 5 days interval continuously after flowering till maturity.

107

108 **2. 7 Irrigation**

109 Water pump machine was used to draw water from the source (tube-well) to the experimental
110 field through the constructed water channels. Irrigation was scheduled at 3 - 4 days interval
111 depending on the crop's need.

112 **2.8 Weeding**

113 Weeds were controlled manually using hand hoe at 3 and 6 WAP please expand and occasional
114 hand pulling when necessary to ensure weed-free plots.

115 **2.10 Harvesting**

116 Harvesting was done by picking fresh tender pods. Pods were snapped off or cut with sharp
117 knife.

118 **2.11 Data Collection**

119 Data were collected on the following yield parameters:

120 **2.11.1 Plant Height (cm)**

121 Plant height of 5 tagged plants was recorded at 6 and 8WAP. This was achieved by measuring
122 the plant from ground level to the tallest growing point using a measuring tape. The mean was
123 thereafter determined and recorded.

124 **2.11.2 Number of leaves**

125 Number of leaves of 5 tagged plants was counted and the mean number per stand was recorded
126 for each plot at 6 and 8WAP

127 **2.11.3 Pods plant⁻¹**

128 The number of green pods per plant was counted at every picking day from 5 randomly selected
129 and tagged plants in each plot. The total number of pods obtained from the selected plants was
130 divided to get the average number of pods per plant.

131 **2.11.4 Mean pod weight (g)**

132 Average fresh pod weights from 5 randomly taken pods from each net plot area were measured
133 using a digital balance and the mean was recorded.

134 **2.11.5 Pod mean length (cm)**

135 The lengths of 5 fresh pods collected from sample plants were measured and the mean was
136 recorded.

137 **2.11.6 Pod yield (t ha⁻¹)**

138 Fresh pods weight per plot was extrapolated to tons per hectare.

139 **Data Analysis**

140 The data collected were subjected to analysis of variance (ANOVA). The treatment means were
141 separated using Duncan's Multiple Range Test (DMRT) at 5% level of significance.

142 **3. RESULTS AND DISCUSSIONS**

143 **3.1 Varietal Response**

144 Results revealed a significant effect ($P \leq 0.05$) in relation to height and variety, 6 and 8 weeks
145 after planting, in both years (Table 3). Dogo variety presented-exhibited the highest plant height
146 (36.16cm and 43.90cm) in 2017 season at 6 and 8WAP respectively which was followed by
147 LD88. A similar trend was also observed in 2018 season. The higher values obtained from Dogo
148 variety could be due to genetic factor as Dogo is a characteristically tall okra variety. These
149 results correspond with the findings of Ojo *et al.* (2012) that Dogo variety produced taller plants
150 than the improved variety. NHAE47-4 had the lowest plant height at both 6 and 8WAP (Ojo et
151 al., 2012).

152 A significant effect ($P \leq 0.05$) of variety was observed as regards to the number of leaves
153 produced at 6 and 8WAP (Table 3). At 6WAP, Dogo variety and LD88 presented-produced the
154 highest number of leaves (18.62 and 18.25) while NHAE47-4 presented-had the lowest numbers
155 of leaves (12.72) in 2017 season. At 8WAP, LD88 also recorded the highest number of leaves
156 (25.60) followed by Dogo variety (23.61) whereas NHAE47-4 recorded the lowest number of
157 leaves (15.40). A similar trend was maintained during 2018 season. The higher number of leaves
158 produced by LD88 and Dogo variety could be attributed to their genetic make-up. This is in line
159 with the assertion by Ayoub and Afra (2014) who reported that differential growth of crops
160 under similar environmental conditions is normally the result of differences in the genetic make-
161 up of the crops.

162 | A significant effect ($P \leq 0.05$) of variety as regards to number of ~~Pods-fruits~~ per plant was
163 | observed (Table 5). Dogo variety produced the highest number of pods (13.12) which was
164 | followed by LD88 (11.98) and NHA47-4 (11.73) in 2017 season. In 2018 season, NHA47-4
165 | (13.82) and Dogo variety produced a significantly higher number of pods per plant whereas
166 | LD88 produced the lowest number of ~~fruitspods~~. The higher number of pods obtained from
167 | NHA47-4 could be because it is an improved variety and improved varieties are more efficient
168 | converters of photosynthetic materials into yield. Ojo *et al.* (2012) reported a similar trend on the
169 | okra varieties they worked with. Also, the higher number of pods obtained from Dogo variety;
170 | ~~disagreeing with Ojo *et al.* (2012), that report~~ that's said improved varieties are more efficient
171 | converters of photosynthetic materials into yield.

172 | A significant effect ($P < 0.05$) of variety was observed as regards to mean ~~fruit pod~~-weight (Table
173 | 5). NHA47-4 had the highest ~~fruit pod~~-weight (19.48g) and (20.44g) followed by Dogo variety
174 | [(16.47g) and (17.55g)] and LD88 [(14.32g) and (17.97g)] for 2017 and 2018 dry seasons
175 | respectively. The higher pod weight recorded by NHA47-4 could be because it is an improved
176 | variety therefore, more efficient in the utilization of photosynthetic materials. This result is in
177 | accordance with the findings of Ojo *et al.* (2012), who observed that Dogo variety produces
178 | lighter ~~fruit pods~~-compared to NH 47-4(an improved variety).

179 | Significant effect ($P \leq 0.05$) as regards to mean pod length was observed among the varieties in
180 | both years (Table 5). Dogo variety and LD88 recorded significantly ~~the highest fruit pod~~-length
181 | [(6.32cm) and (7.21cm)] and [(5.97cm) and (7.18cm)]. NHA47-4 had the lowest ~~fruit pod~~
182 | length [(5.40cm) and (5.76cm)] in 2017 and 2018. The longer ~~fruit pod~~-length obtained from the
183 | LD88 could be as a result of its improved nature. These results are in agreement with the
184 | findings of Jamala *et al.* (2011) in their work with local and improved varieties of okra, they
185 | ~~reported~~ that local variety had the shortest ~~fruit pod~~-length. Also, the longer ~~fruit pod~~-length
186 | obtained from the Dogo variety could be due to genetic factor as Dogo is a characteristically tall
187 | okra variety and this disagreed with the findings of Jamala *et al.* (2011).

188 | A significant effect ($P \leq 0.05$) of variety as regards to ~~fruit pod~~-yield of okra was observed (Table
189 | 5). NHA47-4 promoted the highest ~~fruit pod~~-yield [(5.62t ha⁻¹) and (6.80t ha⁻¹)] in 2017 and
190 | 2018 followed by Dogo variety [(5.28t ha⁻¹) and (5.61t ha⁻¹)] whereas LD88 produced the lowest
191 | ~~fruit pod~~-yield [(4.77t ha⁻¹) and (5.31t ha⁻¹)]. The highest pod yield was recorded in NHA47-4

192 which was significantly higher than the yield produced by Dogo and LD88. This result proved
193 the superiority of the improved cultivars over the local. Jamala *et al.* (2011) had reported a
194 similar observation.

195 3.2 Response of NPK (15:15:15) and Poultry Manure

196 There was a significant effect ($P < 0.05$) of fertilization in terms of plant height as observed during
197 2017/2018 dry seasons (Table 3). In 2017, the height of the plant, in dry season, at 6WAP, was
198 tallest with the application of 50%NPK+50%PM (33.28cm) followed by the application of
199 100%NPK (32.69cm) and 100%PM (32.04cm). Shortest plants were recorded by the control
200 (23.90); but at 8WAP, plant height was similar irrespective of fertilizer levels, except the control,
201 which gave significantly shorter plants (37.39cm). A similar trend was maintained during 2018
202 dry season. The increase in plant height resulted from improved soil nutrient, as a result of the
203 combined application of organic manure (poultry manure) with inorganic fertilizer. This finding
204 has buttressed the report of Bairwa (2009) that, mineralization of manures aids in soil nutrient
205 buildup that in turn leads to improved nutrient availability to the growing okra.

206 Results indicated a significant effect ($P < 0.05$) of fertilization in relation to number of leaves. In
207 2017 trial, at 6WAP, application of 50%NPK+50%PM promoted, significantly, the production of
208 more leaves (18.08) than the application of 100%PM (17.68) and 100%NPK (17.06). The lowest
209 number of leaves was by control (12.72). At 8WAP, all the fertilizer levels gave significantly a
210 similar number of leaves which was higher than the untreated control (15.98). A similar trend
211 was maintained during 2018 trial. The beneficial effect of application of organic manures along
212 with inorganic fertilizers reflected in enhanced vegetative growth of plant. This may be attributed
213 to the synergistic effect of organic manure in making available more plant nutrient by improving
214 the soil physical and chemical condition and solubilising the nutrients. Moreover, organic
215 manures are also significant sources of macro and micronutrients needed by plants (Tyagi *et al.*,
216 2016). Similar results have been reported by Sharma *et al.* (2015) in okra.

217 | A significant effect ($P < 0.05$) of fertilization-fertilisation as regard to number of fruit pods per
218 | plant was observed (Table 5). Application of 50%NPK+50%PM [(14.13) and (15.49)] and
219 | 100%NPK [(14.30) and (15.57)] promoted the highest number of fruits pods in 2017 and 2018
220 | trials respectively followed by application of 100%PM [(13.08) and (14.11)], higher than the

221 control [(6.94) and (8.98)]. This could be attributed to the significant role played by NPK in the
222 improvement of soil fertility, and them, in the enhancement of crop yields. NPK fertilizers have
223 been reported to cause significant effects on fruit weight, fruit number and yield of okra (Sarkar
224 *et al.*, 2003). This also ~~shows~~ showed that poultry manure was readily available and in the best
225 form for easy absorption by the plant roots, for this there was a boost in the growth of the plant.

226 There was a significant effect ($P < 0.05$) of fertilization in terms of mean fruit pod-weight (g) as
227 observed during 2017/2018 dry seasons (Table 5). Maximum fruit pod-weight was recorded with
228 the application 50%NPK+50%PM [(19.26g) and (20.86g)] and 100%NPK [(19.11g) and
229 (21.38g)] followed by the application of 100%PM [(17.59g) and (19.31g)] in both 2017 and
230 2018 trials. The minimum fruit pod-weight was obtained from the control [(9.66g) and (12.28g)].
231 This observation also agreed with that of Mal *et al.* (2013) who also observed better growth
232 performance of crop with inorganic fertilizers of locally compounded NPK.

233 Significant effect ($P < 0.05$) of fertilization in terms of mean fruit pod-length (cm) was observed
234 during 2017/2018 dry seasons (Table 5). In 2017 trial, highest mean fruit pod-length was
235 obtained from the application of 100%NPK (7.07cm), while the lowest mean fruit pod-length
236 was recorded by the control (4.48cm). In 2018 trial, plants submitted in application of 100%NPK
237 (7.91cm) and 50%NPK+50%PM (7.91cm) presents significantly highest mean fruit pod-length
238 than the application of 100%PM (6.83CM) which in turn was higher than the control (4.88cm).
239 This could be attributed to the consistent release of nutrients from both poultry manure and NPK.
240 Similar results have been reported by Sharma *et al.* (2015) in okra.

241 There was a significant effect ($P < 0.05$) of ~~fertilization~~ fertilisation in terms of fruit pod-yield (t
242 ha^{-1}) as observed during 2017/2018 dry seasons (Table 5). Application of 50%NPK+50%PM
243 [(6.40t ha^{-1}) and (7.04t ha^{-1})] and 100%NPK [(6.40t ha^{-1}) and (7.04t ha^{-1})] gave a significantly
244 higher fruit pod-yield in both 2017 and 2018 trials, followed by the application of 100%PM
245 [(5.65t ha^{-1}) and (6.38t ha^{-1})] while the control recorded the lowest yield [(2.30t ha^{-1}) and (3.22t
246 ha^{-1})]. This could be attributed to the significant role played by NPK in the improvement of soil
247 fertility, nutrient uptake and enhancement of crop yields and poultry manure was readily
248 available and in the best form for easy absorption by the plant roots, hence there is a boost in the
249 growth of the plant. NPK fertilizers have been reported to cause significant effects on fruit
250 weight, fruit number and yield of okra (Sarkar *et al.*, 2003).

251 3.3 Effect of interaction

252 Significant interaction effect ($P \leq 0.05$) between variety and ~~fertilization~~ ~~fertilisation~~ was observed
253 as regards to plant height at 6WAP during 2017 trial (Table 4). The highest value was obtained
254 with Dogo variety across all the levels of nutrients, while NHAE47-4 in conjunction with the
255 application of 100%NPK and 100%PM, promoted shorter plants. This has clearly indicated the
256 interdependence and complimentary role of fertilization and variety in influencing the
257 manifestation of the potentials of okra cultivars in terms of growth and development as reported
258 by Jamala *et al.* (2011).

259 Significant interaction effect ($P \leq 0.05$) between variety and fertilization was observed on number
260 of pods per plant during 2017 trial (Table 6). The highest number of ~~fruits~~ ~~Pods~~ per plant was
261 obtained from the application of 100%NPK and 50%NPK+50%PM across NHAE47-4 (14.62
262 and 14.25) and Dogo variety (14.98 and 14.63) while NHAE47-4 in conjunction with the
263 application of 100%PM (12.46) promoted a lower number of ~~fruits~~ ~~Pods~~ per plant. This might be
264 due to quickly mineralized and higher N content of PM (Appendix 2) and abundant availability
265 of nutrients from both NPK and PM that enhanced the growth and development of okra by
266 increasing the rate of plant metabolic processes like photosynthesis and respiration, which helped
267 to build the plant tissue. Similar results were reported by Olaniyi *et al.* (2010) and Akande *et al.*
268 (2010).

269 Significant interaction effect ($P \leq 0.05$) between variety and fertilization was observed on ~~fruit~~
270 ~~pod~~-yield during 2017/2018 trials (Table 7). In 2017 trial, higher ~~fruit~~ ~~pod~~-yield was obtained
271 after application of 50%NPK+50%PM ($7.12t\ ha^{-1}$) to NHAE47-4 and 100%PM to Dogo variety
272 ($5.28t\ ha^{-1}$). A similar trend was maintained in 2018 trial. The ~~fruit~~ ~~pod~~-yield generally
273 optimized with the application of NPK+PM at 50:50 ratio and NPK only across all the varieties
274 (Prasad and Naik, 2013). This could be due to quick decomposition of PM and consistent release
275 of nutrients by both PM and NPK, leading to higher yield (Yadav *et al.*, 2006).

276 4.0 CONCLUSION

277 The variety of NHAE47-4 should be combined with the application of 50:50 ratio of NPK and
278 PM for enhanced Okra and other varieties production in the study area.

279 5.0 RECOMMENDATION

280 It is therefore recommended that combination of NPK fertilizer and poultry manure at 50:50
281 ratios with NHA47-4 could be adopted for higher Okra fruit pod-yield, considering the
282 complimentary role of poultry manure in improving the structure, chemistry, and biological
283 activity in the soil.

284

UNDER PEER REVIEW

Table 1: Physical and Chemical Properties of Soil of the Experimental site during 2017/2018 dry session.

Physical and Chemical Properties	2017	2018
	0-30cm depth	
Particles size Analysis		
pH	6.60	6.11
Organic Carbon %	1.04	0.87
Organic Matter %	1.79	2.01
Total N %	0.084	0.093
P mg/kg	0.93	1.05
Ca Cmol/kg	0.50	0.78
Na Cmol/kg	0.52	0.62
Mg Cmol/kg	0.80	0.74
K Cmol/kg	1.95	2.56
CEC Cmol/kg	8.40	8.94
Sand %	63.3	61.7
Silt %	24.9	28.2
Clay %	11.8	10.1

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Table 2: Chemical Composition of poultry manure (PM) during 2017/018 dry season

Character	Poultry manure	
	2017	2018
Organic carbon (gkg ⁻¹)	3.11	3.26
pH	6.20	5.94
Total N (mg kg ⁻¹)	1.76	1.83
Na (mg kg ⁻¹)	140	138
K (mg kg ⁻¹)	2500	2500
Ca (mg kg ⁻¹)	0.44	0.55
P (mg kg ⁻¹)	7.83	8.04

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Table 3: Plant Height and Number of leaves of Okra varieties as Influenced by NPK (15:15:15) and Poultry manure during 2017/2018 dry season

Treatment	Plant Height (cm)				Number of leaves			
	2017		2018		2017		2018	
	6WAP	8WAP	6WAP	8WAP	6WAP	8WAP	6WAP	8WAP
Fertilizer								
Control	23.90c	27.39b	28.39b	32.64c	12.72c	15.98b	13.90b	16.76c
800kgNPK(15:15:15) ha ⁻¹	32.69ab	43.73a	37.72a	49.16ab	17.06b	22.80a	18.29a	24.55ab
100%PM	32.04ab	42.98a	36.73a	48.61ab	17.68ab	22.92a	18.26a	23.94ab
50%NPK+50%PM	33.28a	44.75a	38.06a	50.65a	18.08a	23.89a	18.66a	26.12a
SE±	0.448	1.127	0.841	0.961	0.293	0.844	0.541	0.864
Variety								
LD88	28.84b	42.15a	30.99b	47.56b	18.25a	25.60a	20.80a	31.79a
NHAE47-4	27.60c	36.18b	30.87b	38.63c	12.72b	15.40c	13.63c	17.13c
Dogo variety	36.16a	43.90a	44.92a	52.61a	18.62a	23.61b	17.65b	20.32b
SE±	0.292	0.739	0.551	0.629	0.192	0.553	0.354	0.566
Interaction								
Fert x Var	*	NS	NS	NS	NS	NS	NS	NS

Means followed by the same later (s) in a treatment group are not significantly different at 5% level using DMRT

Table 4: Interaction of Variety and Fertilizer on Plant Height at 6WAP during 2017 dry season.

Fertilizer	Variety		
	LD88	NHAE47-4	Dogo
Control	25.63d	21.48e	24.61de
800kgNPK(15:15:15) ha ⁻¹	30.33b	28.95cd	38.82ab
100%PM	29.42c	28.64cd	38.05ab
50%NPK+50%PM	31.21b	29.37c	39.26a
SE±	0.775		

Means followed by the same later (s) are not significantly different at 5% level using DMRT

Table 5: Fruit Pods-plant⁻¹, fruit Pod-mean weight, fruit Pod-mean length and fruit Pod-yield of Okra varieties as Influenced by NPK (15:15:15) and Poultry manure during 2017/2018 dry season

Treatment	Pods Plant ⁻¹		Pod mean weight (g)		Pod mean length (cm)		Pod Yield (t ha ⁻¹)	
	2017	2018	2017	2018	2017	2018	2017	2018
Fertilizer								
Control	6.94c	8.98c	9.66c	12.28c	4.48d	4.88c	2.30c	3.22e
800kgNPK(15:15:15) ha ⁻¹	14.30a	15.57a	19.11a	21.38a	7.07a	7.91a	6.40a	7.56a
100%PM	13.08b	14.11b	17.59b	19.31b	6.13bc	6.83b	5.65b	6.38c
50%NPK+50%PM	14.13a	15.49a	19.26a	20.86a	6.40b	7.91a	6.40a	7.04b
SE±	0.157	0.813	0.389	0.415	0.214	0.233	0.070	0.110
Variety								
LD88	11.98b	13.06b	14.32c	17.97b	5.97a	7.18a	4.77c	5.31c
NHAE47-4	11.73b	13.82a	19.48a	20.44a	5.40b	5.76b	5.62a	6.80a
Dogo variety	13.12a	13.56a	16.47b	17.55b	6.32a	7.21a	5.28b	5.61b
SE±	0.103	0.173	0.255	0.272	0.140	0.152	0.046	0.073
Interaction								
Fert x Var	*	NS	NS	NS	NS	NS	*	*

Means followed by the same later (s) in a treatment group are not significantly different at 5% level using DMRT

Table 6: Interaction of Variety and Fertilizer on Pods plant⁻¹ during 2017 dry season.

Fertilizer	Variety		
	LD88	NHAE47-4	Dogo variety
Control	7.09ef	6.34f	7.39e
800kgNPK(15:15:15) ha ⁻¹	13.29bc	14.62a	14.98a
100%PM	12.80c	12.46cd	13.97b
50%NPK+50%PM	13.52b	14.25ab	14.63a
SE±	0.271		

Means followed by the same later (s) are not significantly different at 5% level using DMRT

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Table 7: Interaction of Variety and Fertilizer on Yield (t ha⁻¹) during 2017/2018 dry season.
2017

Fertilizer	Variety		
	LD88	NHAE47-4	Dogo variety
Control	1.94e	2.07de	2.89d
800kgNPK(15:15:15) ha ⁻¹	5.86bc	6.75ab	6.58ab
100%PM	5.45c	6.21b	5.28c
50%NPK+50%PM	5.66bc	7.12a	6.44ab
SE±		0.121	
	2018		
Control	2.20f	3.96e	3.51ef
800kgNPK(15:15:15) ha ⁻¹	7.48ab	7.96ab	7.24ab
100%PM	6.30bc	7.29ab	5.54d
50%NPK+50%PM	6.76b	8.17a	6.19bc
SE±		0.192	

Means followed by the same later (s) are not significantly different at 5% level using DMRT

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UNDER PEER REVIEW

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REFERENCES

300

301 Akande, M. O., Oluwatoyinbo, E. A., Makinde, E. A., Adepoju, A. S. and Adepoju, I. S. (2010).
302 Response of okra to organic and inorganic fertilization. *Journal of Natural Science*
303 8(11):261–266

304 Ayoub, Z. E. and Afra, A. A. (2014). Effect of cultivar and sowing date on okra (*Abelmoschus*
305 *esculentus* (L.) Moench) seed yield: *Universal Journal of Applied Science* 2(3): 64-67.

306 Bairwa, H. L., Shukla, A. K., Mahawer, L. N., Kaushik, R. A., Shukla, K. B. and Ameta, K. D.
307 (2009). Response of integrated nutrient management on yield, quality and physico-
308 chemical characteristics of okra cv. Arka Anamika. *Indian Journal of Horticulture*.
309 66(3): 310-314.

310 Iyagba, A. G., Onuegbu, B. A. and Ibe, A. E. (2013). Growth and yield response of okra
311 (*Abelmoschus esulentus* (L.) Moench) to NPK fertilizer rates and weed interference in
312 South-eastern Nigeria. *International Research Journal of Agricultural Science and Soil*
313 *Science*. Vol. 3(9) pp. 328-335.

314 Jamala, G. Y., Boni, P. G., Abraham, P. and Musa, A. M. (2011). Soil status and yield response
315 of different varieties of okra (*Abelmoschus esulentus* (L.) Moench) grown at Mubi
316 Floodplain, North Eastern Nigeria. *Journal of Agricultural Biotechnology and*
317 *Sustainable Development* 3(7): 120-125.

318 Kolawole, G. O., Olapede, A. O., Alade, C. R. and Olaniyi, J. O. (2008). Response of okra
319 (*Abelmoschus esulentus*) varieties to NPK fertilizer in the South Guinea Savanna of
320 Nigeria. *Nigeria Journal of Horticulture*. Sci. 13: 99- 108.

321 Lee, K. H., Cho, C. Y., Yoon, S. T. and Park, S. K. (2000). The effect of nitrogen fertilizer, plant
322 density and sowing date on the yield of okra. *Korean Journal of Crop Science* 35: 179-
323 183.

- 324 Mal, B., Mahapatra, P., Mohanty, S. and Mishra, H. N. (2013). Growth and yield parameters of
325 okra (*Abelmoschus esculentus*) influenced by diazotrophs and chemical fertilizers.
326 *Journal of Crop and Weed* 9(2): 109-112.
- 327 Ojo, G. O. S., Richard, B. I. and Jorlamen, T. (2012). Evaluation of Okra (*Abelmoschus*
328 *esculentus* (L.) Moench) cultivar for dry season ecology of Nigeria. *International*
329 *Journal of Agronomy and Agricultural Research* pp 13-18.
- 330 Olaniyi, J. O., Akanbi, W. B., Olaniran, O. A. and Ilupeju, O. A. (2010). The effect of organo-
331 mineral and inorganic fertilizers on the growth, fruit yield, quality and chemical
332 composition okra. *Journal of Animal and Plant Science*. 9(1): 1135-1140.
- 333 Onyango, C. M., Harbinson, J., Imungi, J. K., Shibairo S. S. and Van Kooten. O. (2012). Influence of
334 organic and mineral fertilization on germination, leaf nitrogen, nitrate accumulation and yield
335 of vegetable amaranth. *Journal Plant Nutrition*. 35(3): 342-365.
- 336 Prasad, P. H. and Naik, A. (2013). Effect of varying NPK levels and bio-fertilizers on growth
337 and yield of okra [*Abelmoschus esculentus* (L.) Moench] under sustainable condition.
338 *Journal of Bioscience*. 6(2): 167- 169.
- 339 Rahman, K., Waseem, M., Kashif, M. S., Jilani, M. and Kiran, G. (2012). Performance of
340 different okra (*Abelmoschus esculentus* L.) cultivars under the agro-climatic conditions
341 of Defra Ismail Khan. *Pakistan Journal of Science* 64: 316-319.
- 342 Saifullah, M. and Rabbani, M. G. (2009). Evaluation and characterization of okra (*Abelmoschus*
343 *esculentus* L. Moench.) genotypes. *SAARC J Agric* 7: 91-98.
- 344 Sarkar, S., Singh, S.R. and Singh, R.P. (2003). The Effect of Organic and Inorganic Fertilizer on
345 Soil Physical Condition and the Productivity of Rice-Lentil Cropping Sequence in
346 India. *Journal of Agricultural Science* 140 (4): 419-425.
- 347 Sharma, I. J., Samnotra, R. K., Kumar, V., Rai, A. P. and Dhotra, B. (2015). Effect of organic
348 and inorganic fertilizers on the growth and yield of okra under sub-tropical region. *Ann.*
349 *Plant and Soil Res*. 17(2): 215-218.

- 350 Singh, K. V., Anuj, K., Kumar, M., Soni, S., Kumar, A. and Singh, M. K. (2015). Response of
351 different organic and inorganic fertilizers on growth and yield of okra (*Abelmoschus*
352 *esculentus* (L.) Moench). *Ann. Hort.* 8(1): 107-109.
- 353 Sylvester, R., Nuga, B. O., Lale, N. E. S. and Osayi, R. N. (2014). Effect of organic and
354 inorganic fertilizers on okra (*Abelmoschus esculentus* (L.) Moench) production and
355 incidence of insect pests in the Humid Tropics. *Journal of Agriculture and Veterinary*
356 *Science.* 7(4): 25-30.
- 357 Tyagi, S. K., Shukla, A., Mittoliya, V. K., Sharma, M. L., Khire, A. R. and Jain, Y. K. (2016).
358 Effect of integrated nutrient management on growth yield and economics of okra under
359 nimar valley condition of Madhya Pradesh. *International Journal of Tropical*
360 *Agriculture.* 34(2): 415-419.
- 361 Wamanda, D. T. (2007). Inheritance studies in collected local okra (*Abelmoschus esculentus* L.
362 Moench) cultivars. In: Combining ability analysis and heterosis on diallel cross of okra.
363 *African Journal of Agricultural Research* 5: 2108-2155.
- 364 Yadav, P., Singh, P. and Yadav, R. L. (2006). Effect of organic manures and nitrogen levels on
365 growth, yield and quality of okra. *Indian Journal of Horticulture.* 63(2): 215-217.

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