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Effect of Soil Management Practices on Growth and Grain Yields of Soyabean in Makurdi, Benue State, Nigeria

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ABSTRACT
Field experiments were carried out at the Teaching and Research Farm of the University of Agriculture, Makurdi, South Core (Latitude 7°46' – 7°50'N and Longitude 8°36' – 8°40'E) during the 2018 and 2019 cropping seasons. The experiment was setup to assess the effects of soil management practices on growth and grain yields of soyabean in Makurdi under rainfed conditions. The experiment was a factorial experiment in randomized complete block design (RCBD), with three tillage methods (zero tillage, ridge tillage and surface hoeing) and four soil amendments (control, 15 t/ha moringa, 10 t/ha poultry dropping and 120 kg/ha SSP) replicated three times. Tillage treatments constituted the main plots with soil amendments in the sub-plots, resulting in total of twelve (12) treatment combinations. Growth parameters of soyabean such as the plant height and number of branches at 3, 6 and 9 weeks after planting (WAP), number of pods at 8 and 10 WAP and grain yields (1000 grain weight and total grain weight) at harvest were taken to evaluate the effect of these management practices on soyabean performance. Results on growth parameters of soyabean such as plant height, number of branches and pods, and grain yields showed significant ($p<0.05$) difference among the treatments in both seasons. Higher values of yield parameters of soyabean were obtained under ridge tillage x 10 t/ha poultry manure followed by ridge tillage x 15 t/ha moringa and other treatment combinations compared to control plots (no amendments).
Keywords: Soil management, tillage, soil amendments, factorial, yields

INTRODUCTION
Sustainable agriculture integrates three main goals – environmental health economic profitability, social and economic equity. Sustainability rests on the principle that we must meet the needs of the present without compromising the ability of the soil to produce its optimum in future. The soil is viewed as a fragile and living medium that must be protected and nurtured to ensure long term productivity (Lal, 1995). Agricultural productivity of tropical soils is hindered by soil fertility constraints and deteriorating nutrient status (Olatunji and Ayuba, 2011). Many interrelated factors, both natural and managerial cause soil fertility decline (Olatunji and Ayuba, 2011). This decline may occur through leaching, soil degradation are serious threat to successful agricultural enterprise in Nigeria (Olatunji and Ayuba, 2011). The application of inorganic fertilizer has been found to increase crop performance and chemical properties of soil such as pH, total nutrient content and nutrient availability (Ojeniyi, 2000). Its continuous use could cause nutrient imbalance and soil acidity (Olatunji and Ayuba, 2011). Moreso, heavy fertilization in crop production systems could exceed what plants are able to utilize and can be a major source of excessive nitrate leaching (Hong *et al.*, 2007; Cui *et al.*, 2008). Olayinka (1990) therefore, suggested that organic manures should be applied to arable soils to increase crop productivity.
Declining crop yield has being a major concerned among farming communities in the world. Among the factors that contribute to the low yield in crop is low soil fertility status and inadequate use of fertilizers (Obatulo, 1995; Dantata *et al.*, 2006; Dantata and Oseni, 2009; Dantata *et al.*, 2011). Soil fertility decline is one of the main land degradation processes. Organic manures application is one of the technologies being exploited to restore such low fertility and degraded soils (Togun *et al.*, 2004; Dantata *et al.*, 2011). Soil physical properties such as texture and water holding capacity which favours root growth and increase drought tolerance of crops, can be improved (Joshua *et al.*, 1998).

Crop growth and yield in relation to application of agro wastes had been widely reported (Togun *et al*., 2004). For instance, significant higher yield of soyabean and maize have been reported by Ogbuehi and Agbim (2018) and Mbah and Onweremadu (2009) respectively. Similarly, yield increase in Amaranthus, maize, okra and tomato, when grown on soil fertilized with organic manure than without has been reported (Akanbi, 2002; Togun *et al*., 2003; Dantata *et al*., 2011). In most of these studies organic manure application was observed to have positive effects on soil physical, chemical and biological properties (Dantata *et al*., 2011), these aid crop growth and development thereby improving the economic parts.

Despite the potential of organic wastes such as poultry manure and moringa leaf extract as fertilizers against the inorganic sources which is characterized by scarcity, high cost and inappropriate knowledge for uses, particularly in soyabean, there is need to test the suitability of these organic materials as fertilizers for optimum development of crop vegetative and reproductive phases in soyabean under different soil management practices. Very few data are so far available on the use of organic manures (poultry manure and moringa leaf extract) in soyabean production in the northern Nigeria particularly Benue State. Hence, the aim of the research was to assess the effects of tillage practices and soil amendments (organic and inorganic fertilizers) on growth and grain yields of soyabean in Makurdi area of Benue State.

MATERIALS AND METHODS

Experimental Site

The experiment was carried out at the Teaching and Research Farm of the University of Agriculture, Makurdi, South Core (Latitude 7°46' – 7°50'N and Longitude 8°36' – 8°40'E) during the 2018 and 2019 cropping seasons. The experimental area is characterized by warm tropical climate with distinct wet and dry season. The wet season starts from April to October with an annual rainfall of about 1137 mm although the amount and duration vary annually.

The soils are underlain with Makurdi sandstone and are moderately deep to deep. The soils are coarse textured; especially in the surface horizons, with variable texture in the surface layers. The soils are well drained to moderately well drained (Agber and Anjembe, 2012).

Land Preparation

The land was cleared manually with cutlasses and hoes. The mapping was done using pegs, lines and measuring tape into a total plot size of 17 m x 66 m.

Experimental Treatments and Design

Total plot size of 17 m x 66 m was used. The experiment was a factorial experiment in randomized complete block design (RCBD), with three tillage methods (zero tillage, ridge tillage and surface hoeing) and four soil amendments (control, 15 t/ha moringa, 10 t/ha poultry dropping and 120 kg/ha SSP) replicated three times. Tillage treatments constituted the main plots with amendments in the sub-plots, resulting in Total of Twelve (12) treatment combinations of experimental plots of 5 m x 5 m (25 m^2) with 0.5m alley between them.

The treatment combinations were zero tillage x control, zero tillage x 15 t/ha moringa, zero tillage x 10 t/ha poultry dropping, zero tillage x 120 kg/ha SSP, ridge tillage x control, ridge tillage x 15 t/ha moringa, ridge tillage x 10 t/ha poultry dropping, ridge tillage x 120 kg/ha SSP, surface hoeing x control, surface hoeing x 15 t/ha moringa, surface hoeing x 10 t/ha poultry dropping and surface hoeing x 120 kg/ha SSP.

Planting

Soybeans were drilled on ridges and flats depending on the treatment combination at spacing of 5 cm as recommended by Benue Agricultural and Rural Development Authority (BNARDA). For ridges and surface hoeing, the soil was tilled and inverted to the depth of 30 cm using traditional hoes. Soybeans (TGX 1440 -2E) were used as a test crop. Soybeans were manually planted (two seeds per hole) at 5 cm depth and at 0.5 x 0.75 cm spacing. The seedlings were thinned down to one seed per hole, one week after emergence leaving 53,000 plants per hectare. Lost stands were replaced.

Treatments Application

The green manure ie 15 t/ha of moringa (*Moringa oleifera*) and 10 t/ha of poultry droppings were applied one week before planting to allow for decomposition and accompanying heat of decomposition to wear off. Inorganic fertilizer SSP at 120 kg/ha was applied two (2) weeks after planting (WAP), according to the treatment combinations.

Weed Control

Weed control was done manually at 4 and 8 weeks after planting (WAP)

Crop Data

Plant height and number of branches were collected at 3, 6 and 9 WAP. In taking the plant height and number of branches, ten (10) plants in each plot were selected at random and tagged at 2 WAP. Plant height (cm) was measured as the distance from the soil surface to the top most leaf. The average of ten (10) tagged plants was calculated to obtain plant height and number of branches per plot at 3, 6 and 9 WAP. Numbers of pods were taken at 8 and 10 WAP. Seed yields (1000 grain weight and total grain weight) of soyabean measurements were collected at harvest, dried, threshed and weighed to obtain yield data. These were done to evaluate the effect of soil amendments and tillage practices on soyabean performance.

Harvesting

Harvesting was done when the pods were sufficiently dried in the field. Soybeans plants were harvested and manually threshed and winnowed to remove plant debris. The pods were manually threshed and the seeds weighed using digital weighing balance.

Statistical Data Analysis

The data collected on growth parameters and grain yield of soyabean were subjected to Analysis of Variance (ANOVA) test based on Randomized Complete Block Design (RCBD) using GenStat Release 10.3DE.

RESULTS AND DISCUSSION

Effect of Tillage Practices on Soyabean Performance

The results of the effect of tillage practices on soyabean plant height, number of branches, number of pods and grain yield are presented in Tables 1 and 2 for 2018 and 2019 cropping seasons respectively. Effect of tillage practices on soyabean growth and grain yield showed high significant ($p<0.001$) difference among the tillage methods. The results indicated that the plots treated with ridge tillage practices significantly ($p<0.001$) had higher growth and grain yield parameters followed by surface hoeing and zero tillage practices with lower parameters. Ridge tillage showed a significant response in growth and grain parameters of soyabean compared to surface hoeing and zero tillage. In the surface hoeing and zero tillage practices, nutrients might have washed away by the rains, soil compaction, low infiltration and slow decomposition of organic matter resulting to non availability of soil amendments to the roots for plant uptake contributed to low soyabean yield parameters. Similar results were observed by Ojeniyi (1993), Lal (1995), Diaz-Zorita (2000), who reported that plant height was significantly higher in the ridge and surface tillage than those under no-tillage. These results are also in agreement with those of Bonari *et al.* (1994), who concluded that grain yield was significantly higher with deep tillage than shallow plowing (surface tillage). Similar results were shown by Albuquerque *et al.* (2001) and Khurshid *et al.* (2006) that plant height, number of leaves, 1000 grain weight and grain weight reduced with no-tillage (zero tillage) as compared with ridge tillage.

Effect of Soil Amendments on Soyabean Performance

The results of the effect of soil amendments on soyabean performance are shown in Tables 3 and 4 for 2018 and 2019 cropping seasons respectively. The results showed high significant ($p<0.001$) difference among the soil amendments. The results indicated that the plots applied with poultry droppings at 10 t/ha significantly ($p<0.001$) had higher growth and grain yield of soyabean followed by 15 t/ha moringa and 120 kg/ha SSP relative to the control plots. Control plots had the least values of growth and grain yields. The values of yield parameters of soyabean in the control plots at various tillage practices reduced or maintained due to insufficient soil nutrients as a result of non application of soil amendments.

Poultry manure in this study significantly ($p<0.001$) increased yield parameters of soyabean such as plant height, number of branches, number of pods, 1000 grain weight and dry grain weight regardless of differences in tillage practices. This increase could be ascribed to the availability of more nutrients by poultry manure compared to moringa extract and SSP fertilizer throughout the growing season. The increases in yield parameters of soyabean were attributed to improvement in soil properties such as reduction in bulk density, increase in both infiltration rates and soil organic matter indicating improved aggregate stability, nutrient release, and moisture availability. Mbah and Onweremadu

(2009), Adeyemo *et al.* (2019) also adduced soil aggregate stability, reduction in soil bulk density, and improved maize yield to increased soil organic matter on ultisol in southeastern Nigeria. The authors indicated that organic amendments are effective in restoring productivity of degraded soils. Mohamed *et al.* (2010) and Timsina (2018) also clarified that the increase in the yield components might be associated with the release of essential micro and macro soil nutrients by the poultry manure. Similar reports were also made by several researchers including Grande *et al.* (2005), Yamoah *et al.* (2002), Smaling *et al.* (2002), and Adeyemo *et al.* (2019) also reported significant increases in the maize yield biomass and other yield components with the addition of organic manure.

The insignificant differences at plant height, number of branches and grain yields of soyabean in 2018 and 2019 observed between moringa 10 t/ha and SSP 120 kg/ha amendments were as a result of insignificant differences in nutrient composition. The two soil amendments contain high amount of phosphorus as also reported by Chiezey and Odunze (2009), Anyaegbu (2014), Ogbuehi and Agbim (2018).

Effect of Soil Amendments and Tillage Interaction on Soyabean Performance

The results of the effect of soil amendments and tillage interaction on soyabean plant height, number of branches, number of pods and grain yields are presented in Tables 5 and 6 for 2018 and 2019 cropping seasons respectively. These parameters are important determinants of growth and grain yield increased in soyabean (Chiezey and Odunze, 2009). The results indicated significant ($p<0.05$) differences among the treatment combinations. The result showed that the plots treated with ridge tillage x 10 t/ha poultry manure treatment combination significantly ($p<0.05$) had higher growth and grain yield parameters compared to the rest of tillage practices and soil amendments treatment combinations. The results further showed that the plots treated with soil amendments significantly ($p<0.05$) increased plant height, number of branches, number of pods and grain yield of soyabean compared to control plots (no amendments). Interaction between soil amendments and tillage practices indicated that higher growth and grain yields were obtained under plots treated with 10 t/ha poultry manure followed by 15 t/ha moringa, 120 kg/ha SSP amendments and control plots.

Higher yields of soyabean obtained by application of poultry manure and moringa amendments over SSP and control plots had also been reported by several researchers. Chiezey and Odunze (2009) reported that poultry manure increased leaf area index, plant height, nodule dry weight, total dry matter per plant and per hectare, number of pods per plant and grain yield per hectare than phosphorus fertilizer application. Organic manure is a reservoir of nutrients and these nutrients are released during humification, thus supplying the necessary elements for plant growth. The nutrient content of the poultry matter was fair, and the quantity applied must have supplied the important nutrients such as N and P which are critical for soybean growth (Chiezey and Odunze, 2009). According to Chiezey and Odunze (2009) application of phosphorus affected most of the growth and yield parameters. Growth and grain yield parameters were generally increased with application of SSP after poultry manure and moringa. These parameters have been shown to increase with P application, indicating the essentiality of P as a nutrient requirement for soybean (Chiezey *et al.*, 1992; Chiezey *et al.*, 1993). Application of P significantly ($p<0.01$) increased 1000 grain weight over moringa in both seasons. This could be probably because of more rains during the cropping season which helped solubilised the phosphate as also reported by Chiezey and Odunze (2009). Similar results were also reported by Chiezey and Odunze (2009) in 2003 with 26.4 kg P/ha producing the heaviest seeds. The application of poultry manure and phosphorus fertilizer stimulated leaf expansion; hence more light interception for photosynthetic activity and high assimilate accumulation. Chiezey and Odunze (2009) suggested that application of P not exceeding 23.3 kg/ha or applying 1 t/ha of poultry manure will significantly increase grain yield of soybean.

Second higher yields of soyabean were produced from moringa treated plots. Moringa (*Moringa oleifera*) has been reported to provide crop nutritional benefits as reported by Fuglie (2001) where it has been used to promote growth and yield of crop plants in Zambia. Moringa accelerates growth of young plants, strengthens plants, improve resistance to pests and diseases, prolongs life span, increases number of roots, stem and leaves, produces more and larger fruits and generally increases yield by about 20-30% (Fugile, 2001; Abdullahi and Anyaegbu, 2017). These findings have earlier been reported by Price (1999) who observed increase in growth and yield of crops due to use of moringa. Moringa also has been reported to significantly improve soil fertility if used as a green manure when moringa seedlings are ploughed into the soil to a depth of 15 cm at age of 25 days

(Ogbuehi and Agbim, 2018). According to Ogbuehi and Agbim (2018) moringa leaf extract application was able to improve the growth and yield performance of soybean. And that the level of improvement increases with increase in the concentration of the moringa leaf extract applied. It was also observed that protein, carbohydrate and chlorophyll level were influenced by the application of moringa leaf extract leading to increase in yield of soybean (Ogbuehi *et al.*, 2017; Ogbuehi and Agbim, 2018). This could be as a result of effect of moringa leaves is rich in Zeatin and can be used as a natural source of cytokinin as reported by Ogbuehi and Agbim (2018). The leaves also contain ascorbates carotenoids, phenol, potassium and calcium, which will help enhance the synthesis of biochemicals in the soybean plants which have plant growth promoting capability and are being applied as exogenous plant growth enhancers as reported by Foidl *et al.* (2001) and Ogbuehi *et al.* (2017).

The mean weights of grain yield of soyabean per hectare obtained in 2019 were higher than 2018 cropping season in all the treatment combinations. In the first cropping season, there was a delayed in soil amendment and organic matter decomposition, and as a result soil nutrients were not readily available for plant growth and grain yields. But in the second cropping season, soil amendment / organic matter decomposition might have been taken place thereby releasing nutrients to the soil through mineralization for plant use. These are in agreement with those of Chiezey and Odunze (2009) who had higher grain yields of soyabean in their second trial. Under zero tillage x control plots, there was a decreased in grain yield of soyabean by 0.03 t/ha in 2019 (0.54 t/ha) compared to 2018 (0.57 t/ha) cropping season. The decreased in grain yield could be as a result of insufficient soil nutrients due to non application of soil amendments in the control plots. Soil compaction might also been a problem.

CONCLUSION

The study has shown that soil amendments and tillage practices indicated significant ($p<0.05$) differences among the treatment combinations. The plots treated with ridge tillage x 10 t/ha poultry manure treatment combination significantly ($p<0.05$) had higher growth and grain yield parameters compared to the rest of the treatment combinations. The results further showed that the plots treated with soil amendments significantly ($p<0.05$) increased plant height, number of branches, number of pods and grain yields of soyabean compared to control plots (no amendments). Interaction between soil amendments and tillage practices showed that higher growth and grain yields were obtained under plots treated with 10 t/ha poultry manure followed by 15 t/ha moringa and 120 kg/ha SSP amendments relative to control plots.

It is, therefore, recommended that 10 t/ha poultry manure on ridge tillage follow by 15 t/ha moringa application could be viable tools for sustainable soil management practices in Makurdi under rainfall condition. However, the quality of manure must be taken into consideration as the nutrient supplying power depends on the conditions under which the manure was stored.

Table 1: Effect of Tillage Practices on soyabean performance (2018)

Tillage method	Plant height (cm) 3WAP	No. of Branches per plant 3WAP	Plant height (cm) 6WAP	No. of Branches per Plant 6WAP	Plant height (cm) 9 WAP	No. of Branches per plant 9 WAP	No. of pods/plant 8 WAP	No. of Pods/Plant 10WAP	Weight of 1000 grain/plot (g)	Grain yield (t/ha)
T1. Zero Tillage	11.38	2.17	35.63	3.25	41.01	4.25	37.08	39.08	266.0	0.69
T2. Ridge tillage	20.48	3.42	44.98	4.75	54.95	6.17	6.58	69.50	295.8	1.63
T3. Surface Hoeing	16.76	3.00	39.30	4.08	46.13	5.17	47.58	5.67	286.1	1.05
LSD (P<0.01)	0.901	0.415	2.480	0.414	2.478	0.440	2.754	2.912	15.61	0.127

Table 2: Effect of Tillage Practices on Soyabean Performance (2019)

Tillage method	Plant height (cm) 3WAP	No. of Branches per plant 3WAP	Plant height (cm) 6WAP	No. of Branches per Plant 6WAP	Plant height (cm) 9 WAP	No. of Branches per plant 9 WAP	No. of pods/plant 8 WAP	No. of Pods/Plant 10WAP	Weight of 1000 grain/plot (g)	Grain yield (t/ha)
T1. Zero Tillage	12.40	2.50	36.47	3.25	42.46	4.16	39.92	42.50	260.0	0.76
T2. Ridge tillage	23.88	3.25	47.77	4.50	57.25	5.66	69.08	71.50	291.8	1.73
T3. Surface Hoeing	20.97	2.83	43.30	4.00	48.23	5.25	48.75	51.42	286.5	1.24
LSD (P<0.01)	1.178	0.358	1.754	0.329	2.776	0.475	2.296	2.576	5.79	0.096

Table 3: Effect of Soil Amendments on Soyabean Performance (2018)

Amendment	Plant height (cm) 3WAP	No. of Branches per plant 3WAP	Plant height (cm) 6WAP	No. of Branches per Plant 6WAP	Plant height (cm) 9WAP	No. of Branches per plant 9 WAP	No. of pods/plant 8 WAP	No. of Pods/Plant 10WAP	Weight of 1000 grain/plot (g)	Grain yield (t/ha)
A1. Control	12.71	2.22	25.342	3.33	33.57	4.44	31.56	33.89	275.7	0.73
A2. Moringa 15 t/ha	16.88	3.11	43.67	4.11	52.24	5.33	54.89	57.33	281.3	1.13
A3. Poultry Dropping	19.13	3.22	47.38	4.78	54.97	6.00	66.33	69.67	289.9	1.50
A4 SSP 120 kg/ha	16.09	2.89	43.40	3.89	48.68	5.00	48.89	51.44	283.7	1.12
LSD (P<0.01)	1.040	0.479	2.863	0.478	2.861	0.508	3.180	3.362	18.03	0.146

Table 4: Effect of Soil Amendments on Soyabean Performance (2019)

Amendments	Plant height (cm) 3WAP	No. of Branches per plant 3WAP	Plant height (cm) 6WAP	No. of Branches per Plant 6WAP	Plant height (cm) 9 WAP	No. of Branches per plant 9 WAP	No. of pods/plant 8 WAP	No. of Pods/Plant 10WAP	Weight of 1000 grain/plot (g)	Grain yield (t/ha)
A1. Control	12.41	2.00	23.41	3.00	32.67	3.88	31.89	34.67	260.6	0.72
A2. Moringa 15 t/ha	20.27	3.11	47.19	4.00	55.17	5.11	56.56	59.56	283.8	1.28
A3. Poultry Dropping	23.44	3.44	52.33	4.88	58.46	6.11	69.33	71.89	294.6	1.68
A4. SSP 120 kg/ha	20.21	2.88	47.13	3.77	50.96	5.00	52.56	54.44	286.8	1.29
LSD (P<0.01)	1.360	0.414	2.025	0.380	3.206	0.549	2.652	2.974	6.68	0.111

Table 5: Effect of Soil Amendments and Tillage Interaction on Soyabean Performance in (2018)

Treatment combinations		Plant height (cm) 3WAP	No. of Branches per plant 3WAP	Plant height (cm) 6WAP	No. of Branches per Plant 6WAP	Plant height (cm) 9 WAP	No. of Branches per plant 9 WAP	No. of pods/plant 8 WAP	No. of Pods/Plant 10WAP	Weight of 1000 grain/plot (g)	Grain yield (t/ha)
1. (T1A1) Zero tillage x control		10.93	1.33	22.63	2.67	29.50	3.67	22.67	24.33	222.3	0.57
2. (T1A2) Zero tillage x moringa	15 t/ha	11.43	2.33	38.97	3.33	44.23	4.33	44.00	45.67	262.0	0.65
3. (T1A3) Zero tillage x Poultry 10 t/ha	dropping	11.67	2.67	41.03	3.67	47.63	4.67	46.33	49.00	276.3	0.77
4. (T1A4) Zero tillage x SSP	120 kg/ha	11.17	2.33	39.87	3.33	42.67	4.33	35.33	37.33	268.3	0.76
5. (T2A1) Ridge tillage x control		15.57	3.00	30.30	4.00	40.03	5.33	41.67	44.33	286.3	0.91
6. (T2A2) Ridge tillage x moringa	15 t/ha	21.77	3.67	47.57	4.67	60.97	6.33	72.00	75.00	302.0	1.73
7. (T2A3) Ridge tillage x poultry 10 t/ha	dropping	24.87	3.67	55.10	6.00	63.70	7.33	86.00	89.67	302.7	2024
8. (T2A4) Ridge tillage x SSP	120 kg/ha	19.70	3.33	46.93	4.33	55.10	5.66	66.67	69.00	292.3	1.64
9. (T3A1) Surface hoeing x	control	11.63	2.33	23.33	3.33	31.17	4.33	30.33	33.00	272.0	0.72
10. (T3A2) Surface hoeing x t/ha	moringa 15	17.43	3.33	44.47	4.33	51.53	5.33	48.67	51.33	290.7	1.01
11. (T3A3) Surface hoeing x dropping 10 t/ha	poultry	20.57	3.33	46.00	4.67	53.57	6.00	66.67	70.33	291.3	1.49
12. (T3A4) Surface hoeing x kg/ha	SSP 120	17.40	3.00	43.40	4.00	48.27	5.00	44.67	48.00	290.3	0.96
LSD (P<0.05)		1.801	0.829	4.959	0.829	4.956	0.880	5.509	5.823	31.22	0.253

Table 6: Effect of Soil Amendments and Tillage Interaction on Soyabean Performance (2019)

Treatment combinations	Plant height (cm) 3WAP	No. of Branches per plant 3WAP	Plant height (cm) 6WAP	No. of Branches per Plant 6WAP	Plant height (cm) 9 WAP	No. of Branches per plant 9 WAP	No. of pods/plant 8 WAP	No. of Pods/Plant 10WAP	Weight of 1000 grain/plot (g)	Grain yield (t/ha)
1. (TIAI) Zero tillage x control	10.00	1.66	19.83	2.67	27.73	3.33	21.33	24.00	248.0	0.54
2. (TIA2) zero tillage x moringa 15 t/ha	11.97	2.66	39.83	3.33	47.23	4.33	45.33	49.33	268.7	0.73
3. (TIA3) Zero tillage x poultry dropping 10 t/ha	15.93	3.00	43.80	3.66	50.77	4.67	52.67	54.67	277.7	0.93
4. (TIA4) zero tillage x SSP 120 kg/ha	11.70	2.66	42.43	3.33	44.10	4.33	40.33	42.00	269.7	0.81
5. (T2A1) Ridge tillage x control	15.03	2.33	29.27	3.33	39.57	4.33	44.61	47.00	264.7	0.88
6. (T2A2) Ridge tillage x moringa 15 t/ha	26.03	3.67	51.50	4.67	63.87	5.66	74.33	77.00	291.0	1.89
7. (T2A3) Ridge tillage x poultry dropping 10 t/ha	28.63	4.00	59.70	6.00	68.40	7.33	87.33	90.33	313.7	2.41
8. (T2A4) Ridge tillage x SSP 120 kg/ha	25.83	3.00	50.63	4.00	57.17	5.33	70.00	71.67	297.7	1.74
9. (T3A1) Surface hoeing x control	12.20	2.00	21.13	3.00	30.70	4.00	29.67	33.00	269.0	0.74
10. (T3A2) surface hoeing x moringa 15 t/ha	22.80	3.00	50.23	4.00	54.40	5.33	50.00	52.33	291.7	1.20
11. (T3A3) surface hoeing x poultry dropping 10 t/ha	25.77	3.33	53.50	5.00	56.20	6.33	68.00	70.67	292.3	1.69
12. (T3A4) surface hoeing x SSP 120 kg/ha	23.10	3.00	48.33	4.00	51.60	5.33	47.33	49.67	293.0	1.30
LSD ($P<0.05$)	2.355	0.717	3.508	0.659	5.553	0.951	4.593	5.151	11.58	0.193

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