EFFECTS OF UREA AND POULTRY MANURE ON GROWTH OF AMARANTHS (Amaranths *cruentus*) IN JALINGO, NORTH EASTERN NIGERIA.

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ABSTRACT

A two year field experiment was conducted on the Teaching and Research Farm, Taraba State University, Jalingo, to compare the cultivation of Amaranths cruentus using urea and poultry manure (PM) and the combinations of the two fertilizers. The experimental design was Randomized Complete Block Design replicated three times. The treatments applied include three levels of urea, poultry manure and their combinations. Using standard methods, plant height, leaf area, number of leaves and stem diameter (girth) were measured at two, four and six weeks after emergence (WAE). The soil texture of the study area was sandy loam, moderately acidic pH, medium organic carbon and low total nitrogen. Significant effects of the application were recorded at 2, 4 and 6 WAE. Highest result recorded were 71.43cm for plant height, 133.03mm^2 for leave area, 34.83 for number of leaves and 7.50cm for stem diameter on plots amended with 75kg urea in combination with 7.5t/ha poultry manure could be recommended for the cultivation of A. cruentus on sandy loam soils of Jalingo.

Key word: Amaranth *cruentus*, sandy loam soils, savanna agro-ecological zones

INTRODUCTION

Amaranths *cruentus* is a leafy vegetable commonly cultivate in Nigeria and many parts of Sub-Saharan Africa (Muhammad *et al*., 2017), it belongs to the family *Amaranthaceae* and consists of 60 species (Achigan-Dako, *et al.,* 2014). Amaranths are grown for their leaves and grains which are good source of minerals and vitamins (Assad *et. al*., 2017). Despite their importance in human diets, production of Amaranths in Nigeria is low (Arowosegbe *et al*. 2018). The main factors that prevents adequate cultivation of amaranths is believed to be poor soil fertility and scarcity of fertilizers for soil fertility management (Olaniyi *et al*., 2008).

Nigerian soils are highly degraded due to unsustainable management techniques and absence of appropriate soil fertility restoration practices (FMARD, 2022). Soil fertility management using inorganic fertilizers proved to be difficult since inorganic fertilizers are costly and scarce (Shehu, *et al*., 2019). Poultry manure if applied on soil provides essential nutrients for cultivating crops and improves soil quality as well (Ainika and Amans, 2011). Application of organic amendments along with inorganic fertilizers is a common practice by vegetable farmers in many parts of Nigeria (Ahmad *et al*., 2019). According to Oyedeji *et al*. (2014) application of inorganic fertilizer combined with poultry manure improved the growth and yield of amaranths in south western Nigeria. To derive maximum benefits of sole and combined application of organic and inorganic fertilizers, it is necessary to assess the soil fertility of an area. Unfortunately, there are some information gaps regarding the appropriate combination levels of organic and

inorganic fertilizers on growth of A. *cruentus* in many parts of Nigeria (Matthew, 2020).This study was therefore conducted to assess the effects of different levels urea, poultry manure and their combinations on the growth of Amaranths *cruentus* in order to recommend appropriate application rates on the sandy loam soils of Jalingo, North Eastern Nigeria.

MATERIALS AND METHODS

Experimental Site

The Experiments were conducted at the Teaching and Research Farm of Taraba State University, Jalingo. The area is located between latitudes $11^{0}52^{1}$- $11^{0}57^{1}$N and longitudes $11^{0}19^{1}$ - $11^{0}26^{1}$E. The mean annual rainfall of the area is about 1250 mm and Mean annual temperature is between 34^{0}C to 37^{0}C; relative humidity is between 50 to 80%. The length of growing season ranged between 150 to 210 days. The soil of the area closely fit in the order Alfisols (Ezeaku *et al.* 2022). Common crops cultivated include maize, cowpea, groundnut, rice, Guinea corn, millet, cassava and yam (Ojanuga, 2006).

Experimental Layout and Treatments

The experiment was laid out using Randomized Complete Block Design with three replications. The three replicates consisted of three levels of urea (50, 100 and 150kg/ha), poultry manure (5, 10 and 15t/ha) and combinations of urea and poultry manure. The controlled plots had no application of urea or poultry manure. The poultry manure was applied one week before planting, while urea was applied one day after the emergence (Abayomi, and Adebayo, 2014).

Soil Sampling and Analysis

Soil samples were collected using auger at depth of 0-20cm before the experiment for routine analysi. Soil texture was determined by the Bouyoucos hydrometer method (Jaiswal, 2003). Soil pH was measured using pH meter in a 1:2.5 soil-water suspension (Jones, 2001). Organic carbon and total nitrogen were determined by Walkey-Black oxidation and Micro-Kjeldahl distillation methods, respectively (Motsara and Roy, 2008). Available P was determined by Bray 1 method (Carter and Gregorich, 2008). Exchangeable cations were determined by EDTA (diethylene triamine penta acetic acid) titrimetric method (Motsara and Roy, 2008).

Land Preparations and Measurement of Parameters

The Amaranths *cruentus* seeds used were obtained from the Taraba Agricultural Development Program (TADP) office, Jalingo. Prior to planting, the experiment field was sprayed with glyphosate and A. *cruentus* seeds were sown at a distance of 30 cm × 30 cm and later thinned to one plant per stand, two weeks after emergence. Weeding was done manually after every two weeks. To control insect pest, dimethoate 400 gL^{-1} emulsifiable concentrate (Dimethoate 400 EC) was applied at the concentration of 1.5 L ha-1 at the 2^{nd} and 4^{th} weeks after emergence (Bako *et al*., 2021). Using standard methods, plant height, leaf area, number of leaves and stem diameter (girth) were measured at 2, 4 and 6 weeks after emergence.

The poultry manure used was obtained from Teaching and Research Farm, Taraba State University, Jalingo. Data collected were subjected to Analysis of Variance (ANOVA) using Statix 10.0, (2022). Significant means were separated using Duncan's Multiple Range Test (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Soil properties of the Study

Physical and chemical properties of the soil study area (Table 1) indicates that the surface

soil was predominantly sandy (87.50%). Silt and clay particles were 7.29 and 5.21% respectively, while textural class was sandy loam. The sandy nature of the surface soil of the area agrees with what was earlier reported for the soils of Jalingo, North Eastern Nigeria (Osujieke, *et al*., 2018; (Ezeaku *et al.* 2022)). Surface soil dominated with sand particles could lead to low water-holding capacity, organic matter content, cation exchange and generally poor soil fertility.

The soil reaction (pH) was moderately acidic (Hazelton and Murphy, 2007). Moderate soil reaction provides appropriate medium for maximum microbial activities with higher rate of bio-recycling of organic materials (Alexandra and Jose, 2005). Electrical conductivity was also low and has less tendency for excess salts accumulation on the surface soil (Alhassan *et al*., 2018). The soils contain medium organic carbon, available phosphorus, exchangeable calcium, magnesium and potassium, but low in total nitrogen and effective cation exchange capacity (Bapetel *et al*., 2021).

Plant Height

The application of urea and poultry manure (PM) had significant effects on the heights of A. *cruentus* during the six weeks experiment (Table 2). At first two weeks, tallest height of 17.00cm was recorded in 2019 cropping season on plots where 100kg was applied. While tallest height of 17.90cm was recorded in 2020 cropping season on plots where 150 urea/ha was applied. For the fourth week of the two seasons, tallest heights of 31.20 and 41.00cm were recorded on plots amended with 50kg urea + with 5.0t/ha PM and 75kg urea + 7.5t/ha PM, respectively. At the sixth week of the two seasons, tallest heights of 65.97 and 71.43cm were also recorded on plots amended with 5.0kg urea + 5t/ha PM and 75kg urea + 7.5tons PM/ha, respectively. For the combined mean at the sixth week of the experiment, tallest A. *cruentus* height of 68.70cm was recorded on plots amended with 50kg urea/ha + 5.0tons PM/ha, followed by height of 67.40cm recorded on plots amended with poultry manure at rate of 150t/ha. The result indicates taller A. *cruentus* heights were produced on plots amended with combination of urea and poultry manure compared to the sole applications of either of the two fertilizers. The result is consistent with what was earlier by reported Tongos, (2016). In another experiment, Kahu *et al*. (2019) reported that application of poultry manure combined with NPK fertilizer had significant effects on growth of A. *caudatus* and A. *cruentus* compared to single application of either poultry manure or NPK fertilizer. The taller heights of A. *cruentus* recorded could be attributed to release of nutrients from the combined fertilizers which resulted high nutrient availability and uptake with the ultimate production of taller amaranths, which is also consistent with earlier reports of Olowoake and Ojo, (2014), Abayomi, and Adebayo (2014) as well as Ahmad *et al*., (2019). Taller heights of A. *cruentus* observed in the second season experiment is also consistent with findings of earlier reported by Bako, *et al*. (2021).

Leaf Area

Application of urea and poultry manure had significant effects on the leaf area of A. *cruentus*. At second week of the first season experiment, largest leaf area of 14.46mm^2 was recorded on plots amended with 25kg urea/ha + 2.5tons PM/ha. For the second season, sole application of 150kg/ha urea produced largest leaf area of 16.21cm^2. At 4th week first season, largest leaf area of 98.80mm^2 was recorded on plots where 100kg urea/ha was applied, while at second season, it was the application of 100kg urea that produced largest leaf area of 98.80mm^2. The application of 100kg urea that produced largest leaf in the second season had

no statistical differences with plots amended with 15tons PM/ha. Similarly the application of 100kg urea does have significant differences with plots amended with 75kg/ha urea + 7.5t//ha PM (Table 3). For 6th weeks of the experiment first cropping season, largest leaf area of 91.60mm^2 was recorded on plots amended with 15tons PM/ha, for the second cropping season, largest leaf area of 133.05mm^2 was recorded on plots amended with 75kg/ha urea + 7.5t//ha PM. For the combined means at 6th weeks of the experiment, largest leaf area of 104.78mm^2 was recorded on plots amended with 75kg urea/ha + with 7.5tons PM/ha, followed by leaf area of 80.50mm^2 recorded on plots amended with 150tons PM/ha. The smallest leaf area (58.52mm^2) was recorded from the controlled plots, where neither urea nor amendments were applied. The results show that larger leaves of A. *cruentus* were recorded on plots amended with combined application of urea and poultry manure at higher rates and is similar with the trend earlier observed for the heights of A. *cruentus* and is consistent with earlier reports (Adewole and Dedeke, 2012; Ahmad *et al*. 2019). The larger leaf area recorded could be attributed to release of nutrients and higher nutrient uptake in urea combined with poultry manure. Larger leaves are expected to increase the ability of A. *cruentus* for higher sunlight absorption, thereby facilitating higher photosynthetic activity which might be accompanied with fast assimilates production (Richard *et al*., 2019). Larger leaves could also mean more weight value with likely higher income for producers (Kahu *et al*., 2019).

Number of Leaves

The significant effects of the treatments were also observed on leaves number of leaves of A. *cruentus*. Application of 75kg urea/ha + 7.5tons PM/ha produced highest leaves number of 6.33, 7.33 and 6.83 for the first season, second season as well as the combined means. At fought week of the experiment, application of 50kg/ha urea + 5.0t/ha PM produced highest t leaves number of 19.17, 22.27 and 20.72 for the two seasons and their combined mean, respectively. For sixth week of the experiment during the first cropping season, the highest leaves number of 28.27 was recorded on plots amended with sole application of poultry manure at the rate of 15tons/ha. During the second season, highest leaves number of 34.83 was recorded on plots amended with 75kg/ha urea + 7.5t//ha PM (Table 4).

The effects of applied treatments on leaves number indicates an increase in leaves number with higher rates of the applied fertilizers and also progressively increased with days after sowing. Combined application of the fertilizers also produced higher leaves number compared to the sole application of poultry manure or urea. The findings of this research agrees with the report of Pospisil, *et al.*, (2006). The number of leaves observed in this experiment is higher than what was earlier reported by Tongos, (2016) and Ahmad *et al*. (2019) for the application of single dose of urea and NPK. However, Bako *et al.* (2021) recorded higher leaves number of *Amaranthus hybridus* amended with 500kg/ha solid compost combined with NPK in soils of Jalingo. The increase in number of leaves with the combined fertilizer application of the two fertilizers also confirmed that the combination released more essential nutrients compared to sole application and as such promotes vigorous vegetative growth and larger leaves number of A. *cruentus* due to higher nutrient uptake (Olaniyi, *et al*., 2008).

Stem Diameter (cm)

Application of urea and poultry manure had significant effects on stem diameter of A. *cruentus*. At the first two weeks of the first

season, largest stem diameter of 2.87cm was recorded on plots amended with 50kg urea + 5.0t/ha. For the second season of same two weeks, largest diameter of 3.15cm was recorded on plots amended with 75kg/ha urea + 7.5t/ha PM. At fought week first season of the experiment, largest stem diameter of 3.60cm was recorded on plots amended with 50kg urea + 5.0t/ha and 75kg/ha urea + 7.5t/ha PM, respectively. For the second season, largest stem diameter of 5.33cm was recorded on plots amended with 75kg urea + 7.5t//ha PM. During sixth week of the first season at experiment, largest stem diameter of 6.67cm was recorded on plots amended with 75kg urea + 7.5t/ha PM. For the second season, largest stem diameter of 7.50cm was recorded on plots amended with 50kg urea + with 5.0t/ha PM. For the combined mean at the 6th weeks of the experiment, largest stem diameter of 6.54cm was recorded on plots amended with 75kg urea + 7.5t/ha PM, followed 6.42cm recorded on plots amended with 50kg urea + 5.0 tons PM/ha, respectively (Table 5). Generally, combined applications of urea and poultry manure produced larger stem diameter similar with earlier trends for other growth parameters The result is consistent with earlier reports (Shuaibu *et al*., 2017; Tongos, *et al*., 2018). The larger stem diameter recorded with the combined application at higher rates of the combined fertilizers could be attributed to balance release of nutrients due to the combination of urea and poultry manure (Muhammad *et al.*, 2017).

CONCLUSION

Two years field experiments were conducted on the Teaching and Research Farm of Taraba State University Jalingo, to assess effects of urea, poultry manure and their combination on growth of A. *cruentus.* The experiments were also conducted to determine the appropriate application rates of the combined fertilizers for the sustainable cultivation of the A. *cruentus* on sandy loam soil of the study area. Standard procedures were applied for the laboratory and field data collections and analysis. The result shows that the soil of the study area was sandy loam and moderately acidic in soil reaction, with medium organic carbon, available phosphorus, exchangeable calcium, magnesium and potassium, but low in total nitrogen and effective cation exchange capacity. Significant effects of the applications on the growth parameters were recorded. At the final stage of the experiment (sixth week), tallest height of 71.43cm was recorded on plots amended with urea and poultry manure at the rates of 75kg/ha urea + 7.5t//ha PM. Similarly, largest leaf area of 133.0mm^2 was also recorded on plots amended with 75kg/ha urea + 7.5t//ha PM. The highest leaves number of 34.83 at the same time were recorded on plots amended with 75kg/ha urea + 7.5t//ha PM. Largest stem diameter of 7.50cm^2 was however recorded on plots amended with 50kg urea + 5.0tons PM/ha. On the overall, taller A. *cruentus* heights with larger leave areas and higher leaves number were recorded on plots amended with 75kg urea + 7.5t/ha PM. Largest stem diameter was recorded on plots amended with 50kg urea + 5.0t/ha PM. Based on the result of the experiments, application of 7.5t/ha PM + 7.5t/ha PM could be recommended for the cultivation of A. *cruentus* on the sandy loam soils of Jalingo and soils with similar properties within the savannah agro-ecological zones of Nigeria. Sole application of 15tons/ha poultry manure could also be recommended for organic cultivation of A. *cruentus* in the study area.

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Table 1: Physical and Chemical Properties of the Study Area

Parameters	Ratings
Sand (%)	87.50
Silt (%)	7.29
Clay (%)	5.21
Textural Class	Sandy Loam
pH (Soil Reaction)	5.80
Electrical Conductivity (dS/m)	0.19
Organic Carbon (g/kg)	11.90
Total Nitrogen (g/kg)	0.15
Available Phosphorus (mg/kg)	11.50
Exchangeable Calcium (cmol/kg)	6.10
Exchangeable Magnesium (cmol/kg)	2.80
Exchangeable Potassium (cmol/kg)	0.30
Effective Cation Exchange Capacity(cmol/kg)	10.93

Table 2: Effects of Urea and Poultry Manure on Heights (cm) of Amaranths (*Amaranthus cruentus*) at Jalingo, Taraba State.

Treatments	2Weeks after Sowing			4Weeks after Sowing			6Weeks after Sowing		
	2019	2020	C.M.	2019	2020	C.M.	2019	2020	C.M.
50kg Urea/ha	15.13^{cd}	15.17^{c}	15.15^{f}	29.57^{bc}	31.50^{ab}	30.37^{e}	64.60^{ab}	62.80^{ab}	63.74^{d}
100kg Urea/ha	17.00^{a}	15.73^{bc}	16.37^{cd}	28.17^{de}	33.20^{abc}	30.67^{d}	62.80^{abc}	62.87^{ab}	62.39^{e}
150kg Urea/ha	16.33^{ab}	17.90^{a}	17.12^{a}	29.70^{abcd}	38.67^{ab}	34.19^{b}	60.33^{bcd}	61.97^{ab}	58.82^{f}
5tons PM/ha	16.13^{abc}	16.53^{abc}	16.33^{d}	29.77^{abc}	30.37^{c}	30.07^{f}	58.87^{cd}	57.30^{ab}	59.27^{f}
10tons PM/ha	15.13^{cd}	17.73^{ab}	16.43^{c}	29.20^{bcde}	29.70^{c}	29.45^{g}	64.10^{ab}	59.67^{ab}	61.85^{e}
15tons PM/ha	16.13^{abc}	16.80^{abc}	16.47^{c}	29.57^{bcde}	31.83^{bc}	30.70^{d}	62.63^{abc}	59.60^{ab}	67.40^{b}
25kg Urea/ha + 2.5tons PM/ha	16.14^{abc}	17.13^{abc}	16.64^{b}	30.37^{ab}	29.97^{c}	30.17^{ef}	64.23^{ab}	72.17^{a}	66.68^{c}
50kg Urea/ha + 5tons PM/ha	16.07^{abc}	17.17^{abc}	16.62^{b}	31.20^{a}	34.90^{abc}	30.05^{c}	65.97^{a}	69.13^{ab}	68.70^{a}
75kg Urea/ha + 7.5tons PM/ha	15.47^{bcd}	16.80^{abc}	16.14^{e}	28.80^{cde}	41.00^{a}	34.90^{a}	61.57^{abc}	71.43^{a}	57.90^{g}
Control	14.87^{d}	15.50^{c}	15.19^{f}	28.07^{c}	13.67^{d}	20.87^{h}	56.27^{d}	54.23^{b}	28.14^{h}
S.E.	0.48	1.04	0.05	0.74	3.78	0.11	2.45	7.33	0.23

All values with same letters are not significantly different at 0.05% confidence level according to Duncan Multiple Range Tes t
C.M. = Combined mean

Table 3: Effects of Urea and Poultry Manure on Leaf Area (mm ^{2}) of Amaranths (*Amaranthus cruentus*) at Jalingo, Taraba State.

Treatments	2Weeks after Sowing			4Weeks after Sowing			6Weeks after Sowing		
	2019	2020	C.M.	2019	2020	C.M.	2019	2020	C.M.
50kg Urea/ha	13.98^{abcd}	13.63^{ab}	13.81^{f}	42.12^{ab}	47.03^{bc}	44.58^{h}	77.23^{ab}	71.59^{c}	74.41^{c}
100kg Urea/ha	13.96^{abcd}	14.69^{ab}	14.33^{c}	46.99^{ab}	98.80^{a}	72.90^{a}	67.42^{b}	21.48^{c}	44.45^{j}
150kg Urea/ha	13.68^{bcd}	16.21^{a}	14.95^{a}	51.39^{a}	49.55^{bc}	50.47^{g}	67.40^{b}	44.02^{bc}	55.71^{i}
5tons PM/ha	14.14^{abc}	13.30^{ab}	13.74^{fg}	43.29^{ab}	40.30^{bc}	41.80^{i}	77.45^{ab}	67.64^{bc}	72.55^{e}
10tons PM/ha	13.66^{cd}	15.86^{ab}	14.69^{b}	46.38^{ab}	50.17^{bc}	48.28^{g}	59.45^{b}	84.20^{ab}	71.83^{g}
15tons PM/ha	13.84^{bcd}	13.49^{ab}	13.67^{g}	47.44^{ab}	94.86^{a}	71.15^{b}	91.60^{a}	69.40^{bc}	80.50^{b}
25kg Urea/ha + 2.5tons PM/ha	14.46^{a}	13.46^{ab}	13.96^{c}	46.90^{ab}	56.05^{b}	51.48^{e}	73.65^{ab}	70.77^{bc}	72.21^{f}
50kg Urea/ha + 5tons PM/ha	14.17^{abc}	14.12^{ab}	14.15^{d}	50.40^{ab}	63.54^{b}	56.97^{d}	67.16^{b}	81.48^{ab}	74.32^{c}
75kg Urea/ha + 7.5tons PM/ha	12.26^{ab}	14.42^{ab}	13.34^{h}	45.16^{ab}	94.90^{a}	70.03^{c}	76.50^{ab}	133.05^{a}	104.78^{a}
Control	13.47^{d}	13.10^{b}	13.29^{h}	43.00^{b}	27.52^{c}	35.26$_{j}$	69.75^{b}	47.29^{bc}	58.52^{h}
S.E.	0.28	1.40	0.04	3.80	6.57	0.06	8.99	26.01	0.04

All values with same letters are not significantly different at 0.05% confidence level according to Duncan Multiple Range Tes t
C.M. = Combined mean

Table 4: Effects of of Urea and Poultry Manure on Number of Leaves of Amaranths (*Amaranthus cruentus*) at Jalingo, Taraba State.

Treatments	2Weeks after Sowing			4Weeks after Sowing			6Weeks after Sowing		
	2019	2020	C.M.	2019	2020	C.M.	2019	2020	C.M.
50kg Urea/ha	5.73^{b}	6.10^{a}	5.92^{e}	18.40^{ab}	19.93^{ab}	19.17^{d}	27.73^{ab}	28.17^{ab}	27.95^{f}
100kg Urea/ha	6.07^{ab}	7.10^{a}	6.59^{bc}	17.40^{bc}	18.63^{ab}	18.02^{f}	27.80^{ab}	29.47^{ab}	28.64^{e}
150kg Urea/ha	6.40^{ab}	7.10^{a}	6.75^{a}	19.13^{a}	20.33^{ab}	19.73^{b}	26.27^{b}	25.80^{b}	26.04^{h}
5tons PM/ha	5.47^{b}	7.57^{a}	6.52^{c}	18.40^{ab}	18.07^{ab}	18.24^{e}	27.27^{ab}	32.43^{ab}	29.85^{c}
10tons PM/ha	6.40^{ab}	6.67^{a}	6.54^{b}	17.20^{bc}	16.67^{bc}	16.94^{g}	27.20^{ab}	30.97^{ab}	29.09^{d}
15tons PM/ha	5.47^{b}	6.50^{a}	5.99^{e}	17.93^{abc}	19.60^{ab}	18.77d	28.27^{a}	27.33^{ab}	27.80^{g}
25kg Urea/ha + 2.5tons PM/ha	6.07^{ab}	7.17^{a}	6.62^{b}	16.87^{c}	15.37^{bc}	16.12^{h}	28.07^{ab}	31.97^{ab}	30.02^{b}
50kg Urea/ha + 5tons PM/ha	6.00^{ab}	7.07^{a}	6.54^{b}	19.17^{a}	22.27^{a}	20.72^{a}	26.80^{ab}	33.27^{ab}	30.04^{b}
75kg Urea/ha + 7.5tons PM/ha	6.33^{a}	7.33^{a}	6.83^{a}	17.27^{bc}	22.33^{a}	19.80^{b}	27.87^{ab}	34.83^{a}	31.35^{a}
Control	6.07^{ab}	6.70^{a}	6.39^{d}	16.87^{c}	11.67^{c}	14.27^{i}	26.47^{ab}	25.63^{b}	26.05^{h}
S.E.	0.45	1.02	0.05	0.66	2.41	0.04	0.88	4.01	0.03

All values with same letters are not significantly different at 0.05% confidence level according to Duncan Multiple Range Tes
C.M. = Combined mean

Table 5: Effects of Urea and Poultry Manure on Stem Diameter of Amaranths (*Amaranthus cruentus*) at Jalingo, Taraba State.

	2Weeks after Sowing			4Weeks after Sowing			6Weeks after Sowing		
Treatments	**2019**	**2020**	**C.M.**	**2019**	**2020**	**C.M.**	**2019**	**2020**	**C.M.**
50kg Urea/ha	2.40^{b}	3.47^{ab}	2.94^{c}	3.53^{a}	3.90^{abc}	3.72^{c}	5.43^{bc}	6.17^{abc}	5.80^{cd}
100kg Urea/ha	2.71^{ab}	3.27^{ab}	2.99^{bc}	3.57^{a}	3.87^{abc}	3.72^{c}	5.53^{bc}	6.10^{abc}	5.82^{cd}
150kg Urea/ha	2.78^{ab}	3.60^{ab}	3.19^{a}	3.33^{a}	4.67^{ab}	4.00^{a}	5.37^{c}	6.10^{abc}	5.74^{d}
5tons PM/ha	2.57^{ab}	2.87^{ab}	2.72^{d}	3.27^{a}	3.73^{abc}	3.50^{de}	5.43^{bc}	6.07^{abc}	5.75^{d}
10tons PM/ha	2.59^{ab}	3.20^{ab}	2.90^{c}	3.50^{a}	3.53^{abc}	3.52^{d}	5.37^{c}	6.23^{abc}	5.80^{cd}
15tons PM/ha	2.47^{ab}	2.67^{b}	2.57^{e}	3.30^{a}	3.40^{abc}	3.35^{f}	5.30^{c}	5.67^{bc}	5.49^{e}
25kg Urea/ha + 2.5tons PM/ha	2.51^{ab}	2.93^{ab}	2.72^{d}	3.40^{a}	3.47^{abc}	3.44^{e}	5.57^{bc}	7.13^{ab}	6.35^{b}
50kg Urea/ha + 5tons PM/ha	2.87^{a}	3.28^{ab}	3.08^{ab}	3.60^{a}	3.10^{bc}	3.35^{f}	5.33^{c}	7.50^{a}	6.42^{b}
75kg Urea/ha + 7.5tons PM/ha	2.47^{ab}	3.83^{a}	3.15^{a}	3.60^{a}	5.33^{a}	4.47^{a}	6.67^{a}	6.40^{abc}	6.54^{a}
Control	2.57^{ab}	3.33^{ab}	2.95^{c}	3.50^{a}	2.43^{c}	2.97^{g}	5.77^{b}	5.90^{bc}	5.84^{c}
S.E.	0.19	0.55	0.06	0.16	0.90	0.04	0.16	0.75	0.06

All values with same letters are not significantly different at 0.05% confidence level according to Duncan Multiple Range Tes
C.M. = Combined mean