

Original Research Article

EFFECT OF POULTRY MANURE AND UREA ON SOIL CHEMICAL PROPERTIES, NODULATION AND YIELD OF GROUNDNUT (*Arachis hypogaea*) IN AKANU IBIAM FEDERAL POLYTECHNIC, UNWANA AFIKPO EBONYI STATE

ABSTRACT

The investigation was carried out in the Teaching and Research Farm of the Department of Horticulture and Landscape Technology to evaluate the influence of the integrated application of poultry manure and urea on soil nutrient properties, nodulation, growth and yield of groundnut (*Arachis hypogaea*) in Akanu Ibiam Federal Polytechnic, Unwana Southeastern Nigeria. The layout was a factorial in Complete Randomized Design (CRD) and treatments comprised of three rates (0, 1 and 2 tons/ha) poultry manure and three rates (0, 1 and 2 tons/ha) urea with three replications. Results showed that poultry manure and urea when applied as both single and combined treatments significantly ($P < 0.05$) improved almost all the soil nutrient properties investigated. Best results in the values of Soil fertility induced ~~ices~~ such as soil pH, available phosphorus, total nitrogen, organic C carbon, TEB, ECEC were obtained in the pots that had treated with 2 tons/ha poultry manure and 1 ton/ha urea. Similarly, poultry manure integrated with urea significantly ($P < 0.05$) improved both the number of leaves and number of pods. However, while the lone application of urea without poultry manure led to corresponded increase in the increased number of leaves, single application of, while poultry manure and its integration with urea had the best results in terms of the improved number of pods with the treatment combination of when treated with poultry manure (2 ton/ha) x (2/ha) poultry manure and urea (1 ton/ha) x (1/ha) urea having the largest number of leaves and number of pods. It was also observed, that inverse relationship existed between the rate of urea application and number of nodules. However, lone application of poultry improved the number of nodules and hence the rate of nodulation. The highest number of nodules was obtained in the pot that had the treatment combination of 2/ha poultry manure and 0/ha urea while the lowest number of nodules was obtained in the pot that had only 2t/ha urea. It is therefore recommended that large amount of urea should not be used in groundnut production; rather poultry manure should be incorporated to enhance nodulation and thus, nitrogen economy availability in soils of Unwana Southeastern Nigeria. The conclusion is not crystal clear what poultry manure did ????? and how the urea improved the soil and crop production.

Key words: Poultry manure, urea, nodulation and groundnut.

INTRODUCTION

Crop production in Nigeria is hindered by several factors such as low soil fertility as well as restricted access to mineral fertilizer (Nyanabgara and Nyaguambo, 2010). In Nigeria, farmers are always faced with the problem of soil fertility decline which has been considered the most important biophysical constraints to crop yield and productivity (Odendo *et al.*, 2004).

Developing soil fertility management options for increasing productivity of stable food crops is a challenge in most part of Nigeria, where soils are constrained by the major mineral element such as potassium, nitrogen and phosphorus deficiencies (Jemo *et al.*, 2010). Nitrogen, Phosphorus and potassium are among the limiting nutrients

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for legumes production (Christianson and Vieck, 1991). Adequate supply of nitrogen is beneficial for carbohydrates and protein metabolism, promoting cell division and cell enlargement (Shehu *et al*, 2010).

In order to ensure sustained crop production in the inherently low fertility status of tropical soils, several nutrient and fertility management options have been developed by many researchers and these include the addition of organic and inorganic fertilizers, conservational tillage, mulching and crop rotation (Brady and Weil 2008). Integration of inorganic manures such as urea and poultry manure into the farming system can be a cheaper alternative to alleviating low soil fertility and erosion problems (Odendo *et al*, 2004).

Poultry manure is a nutrient source of crop production (Soremi *et al*, 2011) and its addition to the soil has been shown to increase soil nutrient indices. Similarly, incorporation of poultry manure into soil promotes transformation and mineralization of less labile inorganic and organic phosphorus into labile phosphorus in the rhizosphere, which results in higher root phosphorus concentration and higher total phosphorus uptake by plants (Waldrip *et al*, 2011). Therefore, poultry manure could be a valuable fertilizer and could serve as a suitable alternative to chemical fertilizer in Nigeria.

Apart from the addition of both mineral and organic nitrogen fertilizers, there is another viable and ecologically friendly strategy for improving nitrogen content of soils. This process which is called biological nitrogen fixation is specifically reserved for leguminous crops (Brady and Weil 2008). A relatively small amount of nitrate or ammonia is produced by lightening, some are produced industrially by the Haber-Bosch process, but the major conversion of Nitrogen (N₂) to ammonia and hence protein is achieved by microorganisms that inhabit the root nodules of legumes in the process of nitrogen fixation (Sorensen and Sesitch, 2007). The process of biological nitrogen fixation in legume nodules is an important soil fertility improvement strategy especially nitrogen economy in many tropical ecosystem (Frankow-Lindberg and Dahlin, 2013). Legumes offer the potential of fixing nitrogen to the soil through biological fixation process which provides a more sustainable nutrient recycling that can enhance crop yields and improve soil fertility, with the ability to fix nitrogen (Amba *et al*, 2013). Almost all the fixed nitrogen goes directly into the plant, however, Walley *et al*, (1996), stated that most of the nitrogen eventually returns to the soil when vegetation of legume dies and decomposes and this can be made use of by non-leguminous crops

Groundnut is an edible legume which serves as one of the main sources of income for small holders and commercial farmers. It is mainly grown for its edible seed, and is widely grown in tropics and subtropical regions as grain legume. Because of its high oil content, it has also been classified as oil crop. The seeds contain sufficient quantities of protein (19%, carbohydrate (63%), fat (6.5%) and essential amino acid such as lysine, cysteine and methionine (Lineman 1988; Brough and Azam Ali, 1992). It is cultivated in altitude ranging from 0-1550m and is generally intercropped with cereals, cassava, yam and cow pea. By fixing atmospheric nitrogen, groundnut improves the soil supply of nitrogen that is of benefit to other crops (Mukurumbia 1985). In Nigeria, the cultivation of groundnut is done majorly in the northern regions, characterized by yellow ferratitic soil, with low fertility due to sandy structure (Duchaufor, 1976). Since the nitrogen requirement is met through nitrogen fixation, interest has been developed in

77 cultivation of groundnut for its tremendous potentials both as food and in soil fertility maintenance (Somasegaran *et*
78 *al.*, 1992).

79 Even though several literatures have stated that leguminous crops can derive their maximum nitrogen requirement
80 from biological nitrogen fixation and therefore require no external nitrogen fertilizer application, there is still need to
81 practically investigate the effect of different fertilizer sources on nodulation of groundnut. This study was therefore
82 designed to evaluate the effect of poultry manure and urea on soil chemical properties, nodulation and yield of
83 groundnut (*Arachis Hypogea*) in Unwana, south eastern Nigeria.

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85 MATERIALS AND METHODS

86 The study was carried out ~~in the at~~ Horticultural Farm of Akanu Ibiam Federal Polytechnic Unwana. Unwana is
87 located within the South Eastern ecological zone of Nigeria and lies at latitude 5° 48N and longitude 7° 55E (Njoku
88 Okpara, 2006). The climate ~~ic condition~~ and vegetation types are generally humid tropical rain forest with mean
89 annual rainfall of about 3,500mm and mean daily temperature ~~range of 32°C to 21°C 21°C to 32°C~~ (Odurukwe,
90 1989).

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91 SOIL SAMPLE COLLECTION

92 Soils sample ~~were was~~ collected ~~from~~ 0 – 20cm depth, air dried, sieved through a 2mm sieve after which 5kg ~~of sub-~~
93 ~~samples were weighed into 10 litre capacity buckets perforated at the bottom.~~

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94 POT EXPERIENCE

95 Appropriate weights of poultry manure and urea were added to each pot. ~~The treatment comprised of three rates~~
96 ~~(0,1and 2t/ha) poultry manure and three rates (0, 1 and 2t/ha) urea arranged factorially in a CRD with 3 replications,~~
97 ~~giving a total of 27 observational units. Four groundnut seeds were sown in each pot after one month of treatment~~
98 ~~application and later thinned down to two seeding per bucket after germination. Adequate watering was observed~~
99 ~~throughout the growing period.~~

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100 DATA COLLECTION

101 At full bloom (50 days after planting) number of nodules per plant was determined from one plant in each pot. ~~The~~
102 ~~number of nodules was determined by carefully uprooting the seedlings and washing the adhering soil particles from~~
103 ~~the root as outlined~~ The seedlings was carefully uprooted and washed, all the soil particles was removed and then
104 the nodules were counted by (Faizah, (1980;) and Osodeke, (2002). At full maturity, the other plant in each pot was
105 uprooted and both the number of leaves and pods were obtained by counting.

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106 Post-harvest soils samples were collected from each pot and analyzed for routine chemical properties according to
107 standard laboratory procedures. Particle size distribution was determined using the Bouyocous hydrometer method

as describe by Benton (2001). The pH was determined in soil to water and soil to CaCl₂ at a ratio 1:2 soil water and soil CaCl₂ respectively using glass electrode P^H meter (Udo *et al*; 2009).Organic carbon was determined by the wet oxidation method according to Pansu and Gautheyrous (2006) and converted to organic matter by multiplying by 1.792. Available P was determined using the Bray II method of Bray and Kurtz (1945) as described by Udo *et al*; (2009). The total nitrogen determination was done by the macro Kjeidahl digestion method (Simmone *et al.*, 1994). Exchangeable acidity was determined by the nikel extraction procedure as described by Kamprath (1967). Exchangeable basic cations (K⁺, Ca²⁺, Mg²⁺, Na⁺) were determined by the ammonium acetate method (Carter and Gregoich, 2008). Ca and Mg in the extract were determined using the atomic absorption spectrophotometer, while K and Na were determined using the flame photometer. Effective cation exchange capacity (ECEC) was obtained by summation of all the exchangeable cations and exchangeable acidity as described by Udo, *et al*; (2009). The base saturation was obtained mathematically with BS (%) =
$$\frac{\text{Total_cation}}{\text{ECEC}} \times \frac{100}{1}$$

119

120 STATISTICAL ANALYSES

121

122 Data from yield parameters, number of nodulation and soil chemical properties were subjected to analysis of
123 variance (ANOVA) as outlined by Steel and Terrie (1980) and the means separated using FLSD 0.005.

124 RESULT AND DISCUSSION

125 Table 1. Physical and Chemical Properties of the Soil used for the Study

126 Properties	values
127 Sand %	40.13
128 Silt %	21.56
129 Clay %	38.31
130 Texture	clayey-loam
131 PH (H ₂ ⁰)	4.27
132 PH (cac _l ₂)	3.78
133 Organic carbon %	1.90
134 Organic matter %	3.29
135 Total Nitrogen %	0.25
136 Available Phosphonis (mg/kg)	5.62
137 Ca (cmol/kg)	3.18
138 K (cmol/kg)	0.06

139	Mg (cmol /kg)	1.00
140	Na (cmol/kg)	0.02
141	TEA (cmol/kg)	4.10
142	ECEC (cmol/kg)	8.27
143	B.S %	51.51

144

145 The physical and chemical properties of the soil used for the study is presented in Table 1 above. The result showed
146 that the sand, silt, and clay percentages were 40.13, 21.56 and 38.31% respectively. The textural class of the soil was
147 a clayey – loam. This finding is in agreement with the result of Azu *et al* (2017), who reported a clayed – loam soil
148 in some soils of Ebonyi State. Soil P^H values both in H₂O and CaCl₂, showed that the soil was acidity, which suggest
149 the need for liming in order to improve the soil productivity. Several other researchers (Onwuka et al 2007; Eneje
150 and Azu 2009) have also reported acidity in most soils of South – Eastern Nigeria. Both organic carbon and organic
151 matter were moderately low (1.90 and 3.29%) respectively. The total nitrogen was also low (0.25%). The available
152 phosphorus was also low (5.62mg/kg) indicating high fixation and hence low phosphorus availability. The value of
153 phosphorus was lower than the critical value of 15mg/kg suggested by Osodeke and Ubah (2005), for tropical crops.
154 Calcium was relatively high (3.18cmol/kg). The Total Exchangeable Acidity (TEA) was high (4.01cmol/kg)
155 indicating the influence of aluminum and iron oxides in this soil as noted by Azu *et al*; (2017). The Effective Cation
156 Exchange Capacity (ECEC) was moderate (8.27cmol/kg) and Base Saturation (BS) was also relatively moderate
157 (51.51%). Most studies conducted across Southeastern Nigeria showed that most soils are acidic, low in soil organic
158 carbon (SOC), available N, and available P, K and S contents and some micronutrients (Azu *et al.*, 2017;Eneje and
159 Azu 2009). These nutrient deficiencies can affect not only plants but also soil microbes including rhizobia
160 populations (Brady and Weil, 2008) and its activities such as N₂ fixation (Osodeke. 2002).

161 **Table 2: Characteristics of the Poultry manure used for the Study**

162	Properties	Values
163	pH (H ₂ O)	8.22
164	pH (CaCl ₂)	8.02
165	Av.P (PPM)	0.95
166	Nitrogen (%)	1.88
167	Calcium (%)	5.70
168	Magnesium (%)	1.90
169	Potassium (%)	0.51

170 Sodium (%) 0.069

171 Organic carbon (%) 4.07

172

173 Mean Effect of Poultry Manure and Urea on Soil Chemical Properties

174 Result of the effect of poultry manure and urea on soil fertility properties is shown in Table 3. Relative to control,
175 the application of poultry manure as lone treatments generally resulted in increase on soil P^H both in water and in
176 salt. The observed increase was proportional to the rate of amendment. There were consistent decline in soil pH with
177 increasing addition of urea as lone treatment. This observation may be attributed to the fact that poultry manure
178 being an organic material contains large amount of basic cations which factored in the reduction of soil acidity.

179 **Table 3. Mean effect of Poultry manure and urea on soil chemical properties**

180	PM +UR pH		Aval. P	Org. C	Total N	Exc. Bases	Exc. Acidity	ECEC	BS	
181	(t/ha)	H ₂ O	CaCl ₂	(mg/kg)	(%)	(%)	(Cmo1/kg)	(Cmo1/kg)	(Cmo1/kg)	%
182	Control	4.13	3.85	4.68	0.89	0.19	4.17	2.97	7.14	58.40
183	0 + 1	4.00	3.69	4.99	0.76	0.23	5.00	3.23	8.23	60.75
184	0 + 2	3.79	3.44	5.55	0.90	0.29	4.94	3.60	8.54	57.85
185	1 + 0	5.40	4.71	5.63	2.60	0.21	6.63	2.21	8.84	75.00
186	1 + 1	5.64	5.08	6.02	2.60	0.28	8.92	2.33	11.25	79.29
187	1 + 2	4.32	4.24	5.10	1.99	0.39	8.71	2.42	11.13	78.26
188	2 + 0	6.07	5.65	7.15	3.02	0.34	9.76	1.00	10.76	90.71
189	2 + 1	6.08	5.76	7.39	2.93	0.42	10.81	1.09	11.90	90.84
190	2 + 2	5.59	5.09	6.48	2.77	0.44	9.54	1.11	10.65	89.58
191	Mean		5.06	4.59	5.89	2.05	0.31	7.61	2.22	9.83
192	75.63									
193	SD(0.05)U.	0.126	0.0055	0.192	0.127	0.019	0.0022	NS	NS	NS
194	SD(0.05)PM	0.121	0.0203	0.192	0.127	0.019	0.0030	0.00014	NS	2.114
195	SD (U XPM)	0.237	0.334	0.371	0.260	0.038	0.0065	0.0177	0.135	3.008

196

197 This attribute of poultry manure can be harnessed and used as lime in reducing soil acidic. (Onwunka et al 2007).
198 On the other hand, urea, being a mineral fertilizer with no organic component may have been responsible for
199 increased acidity as observed. This report is consistent with the results of other researcher (Azu *et al.*, 2017). The
200 interaction between the poultry manure and urea showed high significant ($P<0.05$) in improving the soil acidity in
201 consonant with the reports of other researchers (Adediran *et al.*, 1999; Azu *et al.*, 2017., FAO, 1976) who reported
202 better performance in soil acidity when organic and inorganic fertilizers are combined. The pH values ranged from
203 6.08 to 3.79 and the highest value was obtained at the treatment combination of 2t/ha poultry manure and 1t/ha urea.
204 With the exception of ECEC, the lone application of poultry manure was significant ($P<0.05$) in improving the soil
205 nutrient indices, but the lone application of urea was only significant in influencing the P^H , P, C, N and the
206 Exchangeable bases. However, the interaction between the two materials was highly significant ($P<0.05$) in
207 influencing all the nutrient properties studied. The mean table showed that relative to control, the treatments
208 especially their interaction showed greater improvement on soil chemical properties. Other researchers (Eneje and
209 Azu, 2009; Soremi *et al.*, 2017; Adekiya and Agbede, 2016) have reported improvement on soil chemical properties
210 when poultry manure was used as fertilizer.

211 Mean Effect of Poultry Manure and Urea on Number of Nodules

212 With the exception of urea as lone treatments, the number of nodules was observed to significantly ($P<0.05$) differ
213 among the various treatments and their combinations. As shown in Table 4, the addition of poultry manure as lone
214 treatment had significant ($P < 0.05$) increasing effect on the number of nodules relative to control and the increase
215 was proportional to the rate of amendment. This finding is similar to those reported by Panda *et al.*, (2012) who
216 found that poultry manure boosts the effectiveness of *Rhizobium* in cowpea. Consequently, the highest number of
217 nodules (196) was obtained in the pot that had 2t/ha poultry manure. This observation can be attributed to the fact
218 that poultry manure in addition to nitrogen and other elements contains large amount of organic phosphorus which
219 when mineralized enrich the soil with the available forms of phosphorus which factors efficiently in nodulation of
220 legumes as noted by other researchers (Osodeke, 2002; Amba *et al.*, 2013; Thedchanamoorthy and Gurung, 1999;
221 Lomoro, 2008; Naveenkurma *et al.*, 2015). Therefore the nodules produced by the pot that had 2t/ha poultry manure
222 was significantly higher than the other treatment levels considered in this study. Result also showed that the number
223 of nodules was only higher (110.00) in pot that had 1t/ha urea relative to control (84.67) and subsequently, the
224 number of nodules decreased with increased rate of urea application as lone treatments and the least amount of
225 nodules (54.50) was recorded in pot that had 2t/ha urea. Nodulation in legumes has been known to require initial
226 nitrogen to boost the process, after which continuous addition of mineral nitrogen may adversely affect the nitrogen
227 fixing organisms. High amount of nitrogen application have been reported to reduce the rate of nodulation, but little
228 quantity have been reported to enhance early vegetative crop growth without compromising the process of
229 nodulation (Anteneh, 2015, Amba *et al.*, 2013).

230 Mean Effect of Poultry Manure And Urea Number of Leaves.

231 As shown in Table 4 below, the application of poultry manure and urea both as single and combined treatments had
232 significant ($P<0.05$) effect on the number of leaves. Generally, these treatments increased the number of leaves

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relative to the control experiment and the observed increases were directed proportional to the rate of treatment application. Compared to the lone application of poultry manure, the single application of urea gave higher number of leaves. This observation may be due to the quick release of nitrogen by urea in relation to poultry manure which takes longer time to release its nutrient content (Gunri and Nath, 2012). Nitrogen has been known to improve the vegetative growth of plants, therefore, the quicker its release the more the leave growth (Brady and Weil, 2008). It was also observed that the interaction between the two fertilizer materials had better improvement on the number of leaves compared to the single application of either of the materials. This report is in accord with the report of Naveenkurma *et al.*, (2015). The highest number of leaves (110.00) was obtained in the pot that had 2t/ha poultry manure and 2t/ha urea while the least value (55.00) was obtained in the pot that had only 1t/ha urea. The most impressive report on the number of leaves observed in experimental pots that had different combinations of poultry manure and urea agreed with the recent emphasis of supplementation of mineral fertilizers with organic manures for better crop performances and sustainable soil fertility maintenance (Adediran *et al.*, 1999; Azu *et al.*, 2017).

Table. 4. Number of Nodules, growth and yield components of Groundnut as affected by the addition of Poultry manure and Urea

PM +UR	No Nodules/plant	Number of Leaves	Number of Pods
Control	84.67	55.00	12.33
0 + 1	110.00	76.67	24.67
0 + 2	54.50	83.00	20.44
1 + 0	172.00	62.67	21.77
1 + 1	120.03	87.00	26.00
1 + 2	87.77	98.40	24.60
2 + 0	196.00	81.00	22.00
2 + 1	133.7	99.60	31.12
2 + 2	92.50	111.00	29.70
Mean	116.80	83.82	23.63
F-LSD(0.05)PM	15.361	11.117	9.854
F-LSD(0.05)UREA	NS	14.339	9.277
F.LSD (PM XU)	7.626	5.016	8.103

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Mean Effect of Poultry Manure and Urea on Number of Pod

Number of pods showed significant ($P<0.05$) response to the application of poultry manure and urea both as single or combined treatments. The mean Table showed that the number of pods ranges from 31 to 12. It was observed that the interaction between the two amendments consistently gave higher values of the number of pods compared to either application of both materials as lone treatments. It was also observed that the increase in the number of leaves did not necessarily have a corresponded increase in the number of pods. Naveenkurma *et al.*, (2015), also made similar observation. This observation can be explained on the fact that, while nitrogen may be responsible for the leave growth, other nutrient element especially phosphorus which is in abundance in the poultry manure might have factored more in the seed formation (Brady and Weil, 2008). Consequently, the pot that had 2t/ha poultry manure and 1t/ha urea had the highest number of pods. Gunri and Nath (2012) have also reported greater yield of pods of groundnut when poultry manure was applied at different rates with a recommended dose of mineral nitrogen fertilizer. Similarly, Lomoro, (2008) reported significant positive effect of poultry manure combined with mineral fertilizer on the number and weight of groundnut pods. . Previous works on organic and inorganic fertilization effect on the soil have found to buildup of essential plant nutrients (i.e., N, P, K, S, Ca, Mg, Zn, Fe, Mn, and B) in the soil (Dotaniya *et al.*2016; Ogundare *et al.*, 2012 Rezig *et al.*2012). This may have led to the substantial increase on the number and weight of groundnut pods observed in this study.

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CONCLUSION

In general, organic and inorganic fertilizer applications are relevant to boost the fertility status of soils and effectiveness of *Bradyrhizobium* for nodulation and yield of groundnut in the degraded sandy-loam soils of southeastern Nigeria. While the combined application of poultry manure and urea is needed to increase the productivity of groundnut in the soils of southeastern Nigeria, increased application of urea may be detrimental to the process of nodulation, which may affect nitrogen economy especially residual nitrogen reserves for subsequent crop. In view of this, heavy mineral nitrogen application for groundnut production should be discouraged, rather continuous addition of poultry manure with little or booster dose of urea should be emphasized in order to not only boost soil fertility and productivity, but also to enhance nodulation processes in groundnut for long lasting fertility effect in terms of nitrogen.

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Page 1: [1] Comment [TA3]	Taufiq Ahmad	27-Oct-17 3:28:00 AM
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With different levels of poultry manure (0, 1 and 2 tons ha⁻¹) and Urea (0, 1 and 2 tons ha⁻¹) replicated three times.

Page 1: [2] Comment [TA4]	Taufiq Ahmad	27-Oct-17 3:32:00 AM
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Results showed that poultry manure applied alone or combined with urea

Page 1: [3] Comment [TA6]	Taufiq Ahmad	27-Oct-17 10:55:00 PM
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What does this mean??? Clarify

Page 1: [4] Comment [TA8]	Taufiq Ahmad	27-Oct-17 11:05:00 PM
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Arrange your introduction in this way; crop introduction, statistical data, nutritional value, importance, problem, importance of material you are using and then objectives. Sorry to say that your introduction is not in proper way arrange it as i discussed. In addition to all these correction also improve your gramatical mistakes.