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Effect of integrated nitrogen management on the growth and yield components and yield of hybrid maize [*Zea mays* L.]

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Abstract
A field experiment was conducted at Thanthai Roever Institute of Agriculture and Rural Development, Perambalur, Tamil Nadu on black cotton soils during Kharif season of 2016 to study the Integrated Nitrogen Management on the growth and yield of Hybrid Maize (NK 6240). The experiments were laid out in randomized block design with ten treatments and three replications. The growth and yield components of hybrid maize *viz,* plant height (92.60, 160.92 and 210.87 cm at 30, 60 DAS and harvest), leaf area index (4.61 at 60 DAS), dry matter production (5080.01, 12352.23 and 17500.38 kg ha^{-1} at 30, 60 DAS and harvest), number of cobs per plant (1.40) and number of grains per cob (460.70), hundred grain weight (28.98 g) and yield (7450.70 kg ha^{-1}) were favourably influenced by the application of 75% N through inorganics + 25% N through Poultry Manure + 100% P&K through inorganics (T4). It was followed by T6 (75% N through inorganics + 25% N through Goat Manure). The least growth and yield components and yield was noticed under the control treatment (T1).

Keywords: maize, nitrogen management, inorganic nutrients, organic manures

Introduction
Maize (*Zea mays*) is one of the most versatile emerging crops having wider adaptability under varied agro-climatic conditions. Globally, maize is known as queen of cereals because it has the highest genetic yield potential among the cereals. Maize serves as staple food to large proportion in world (Tagne *et al*., 2008) [1]. It is cultivated in nearly 150 m ha in about 160 countries having wider diversity of soil, climate, biodiversity and management practices that contributes 36 per cent (782 MT) in the global grain production.

The United States of America (USA) is the largest producer of maize contributes nearly 35 per cent of the total production in the world and maize is the driver of the US economy. The USA has the highest productivity (> 9.6 t ha-1) which is double than the global average (4.92 t ha^{-1}). Whereas, the average productivity in India and Tamil Nadu are 2.43 t ha^{-1} and 6.50 t ha^{-1} (Anonymous, 2014) [2].

In India, maize is the third most important food crop after rice and wheat. According to advance estimate it is cultivated in 8.7 m ha, mainly during Kharif season which covers 80 per cent area. Maize in India, contributes nearly 9 per cent in the national food basket and more than Rs. 100 billion to the agricultural GDP at current prices apart from generating employment to over 100 million man-days at the farm and downstream agricultural and industrial sectors.

All though, chemical fertilizers are playing a crucial role to meet the nutrient requirement of the crop, persistent nutrient depletion is posing a greater threat to the sustainable agriculture. Therefore there is an urgent need to reduce the usage of chemical fertilizers and in turn increase in the usage of organics which is needed to check the quality levels. Use of organics alone does not result in spectacular increase in crop yields, due to their low nutrient status. Therefore the aforesaid consequences have paved way to grow maize using organic manures along with inorganic fertilizers.

India has made spectacular break through in production and consumption of fertilizers during the last four decades. But consumption of non-renewable form of energy ie. Chemical fertilizers will be quite a limiting factor of agricultural production in future. Because of escalating energy cost, chemical fertilizers are not available at affordable price to the farmers. Moreover the imbalance and continuous use of chemical fertilizers has adverse effect on soil

physical, chemical and biological properties there by affecting the sustainability of crop production, besides causing environmental pollution. Nitrogen (N) is the most critical element of plant growth and plays a key role in many metabolic and physiological functions (Balasubramaniyan and Palaniappan, 2001) [3]. Deficiency of N is usually the most limiting factor in maize production for early growth and grain filling (Zeidan *et al*., 2006) [4]. Organic manures are the cheap and could substitute the chemical fertilizers (Delate and Camberdella, 2004) [5]. It has the potential to improve the soil fertility and quality.

Materials and Methods

The present investigation was conducted during *kharif* season of 2016 at Thanthai Roever Institute of Agriculture and Rural Development, Perambalur, Tamil Nadu on black cotton soils to study the Integrated Nitrogen Management on the growth and yield of Hybrid Maize (NK 6240). The experiment farm is geographically situated at 11° 8' N latitude, 78°8'E longitude and an altitude of 150 m above mean sea level. The soil nutrient status of the experimental site was low in nitrogen, medium in phosphorous and high in potash. The experiment comprised of 10 treatments laid out in randomized block design with three replications *viz.,* T_1 - Control (No fertilizer and manure), T_2 - 100% RDF (Recommended Dose of Fertilizer), T_3 - (75% N through inorganics + 25 % N through Farm Yard Manure) + 100% P&K through inorganics. T_4 - (75% N through inorganics + 25% N through Poultry Manure) + 100% P&K through inorganics. T_5 - (75% N through inorganics + 25% N through Vermicompost) + 100% P&K through inorganics. T_6 - (75% N through inorganics + 25% N through Goat Manure) + 100% P&K through inorganics. T_7 - (50% N through inorganics + 50% N through Farm Yard Manure) + 100% P&K through inorganics. T_8 - (50% N through inorganics + 50% N through Poultry Manure) + 100% P&K through inorganics. T_9 - (50% N through inorganics + 50% N through Vermicompost) + 100% P&K through inorganics. T_{10} - (50% N through inorganics + 50% N through Goat Manure) + 100% P&K through inorganics.

The crop was sown at a spacing of 60cm x 25cm. The recommended dose of fertilizer 250:75:75 kg of N, P_2O_5 and K_2O per ha^{-1} was applied in the form of urea, diammonium phosphate and muriate of potash. Poultry manure, farm yard manure, goat manure and vermicompost were applied as per the treatment schedule and incorporated into the soil before ploughing. The seeds were soaked overnight in cold water and dibbled @ 1 seed/hole at a depth of 2 cm. The experimental plots were irrigated immediately after sowing. Nitrogen was applied as per the treatment schedule. 25 per cent of inorganic N and full dose of P and K fertilizers were applied as basal. Remaining 50 per cent of N was top-dressed at 25 Days After Sowing (DAS) and 25 per cent of N was top-dressed at 45 DAS.

Results and Discussion

The result shows that the integrated nitrogen management had significant influence on growth characters like plant height, leaf area index and DMP in maize at all stages of crop growth due to application of 75% N through inorganics + 25% N through Poultry Manure) + 100% P&K through inorganics) (T4) viz., plant height (92.60, 160.92 and 210.87 cm at 30, 60 DAS and harvest), leaf area index (4.61 at 60 DAS), dry matter production (5080.01, 12352.23 and 17500.38 kg ha^{-1} at 30, 60 DAS and harvest) and it was followed by T6 (Table I). However, the lowest growth characters were attained in T1 treatment (control). Korsaeth *et al*., (2002) [6] reported that use of organic and chemical fertilizers played a significant role in increasing the growth and development of a plant due to incorporation of organic manures in the soil by improving physical properties and then application of synthetic fertilizers made the soil productive. Similarly, Ayoola and Makinde (2008) [7] and Iqbal *et al.,* (2010) [8] reported that combined application of urea and Poultry Manure increased the plant height in maize.

Higher values of yield characters were recorded due to application of 75% N through inorganics + 25% N through Poultry Manure) + 100% P&K through inorganics) (T4) viz., number of cobs per plant (1.40) and number of grains per cob (460.74) and hundred grain weight (28.98 g) (Table II). It might be owing to supply of N at different stages of crop due to combination of the different N application methods and N sources. Mahajan *et al.,* (2004) [9] also reported that organic and synthetic fertilizer application of N proved more useful and economical to the crop. It was followed by T6 (75% N through inorganics + 25% N through Goat Manure).

Higher grain yield (7450.70 kg ha^{-1}) (Table II) was produced from the plots which received 75% N through inorganics + 25% N through Poultry Manure) + 100% P&K through inorganics. The results are in accordance with Deksissa *et al*., (2008) [10] observed that corn productivity could be positively increased by combined use of mineral N and Organic manures. Negassa *et al.,* (2001) [11] who found that corn yield was 35 per cent increased by integrated N management. The increase in grain yield was mainly due to maximum number of grains per cob as well as, number of cobs per plant. The present result is also in line with the findings carried out by Tamayo *et al*., (1997) [12]. Lower grain yield (1547.77 kg ha^{-1}) was recorded in control plot.

Conclusion

From the results, it could be concluded that application of 75% N through inorganics + 25% N through Poultry Manure) + 100% P&K through inorganics recorded significantly higher growth and yield components and yield of maize that other treatments. It was followed by T6 (75% N through inorganics + 25% N through Goat Manure). The least growth and yield components and yield were noticed under the control treatment (No fertilizer and manure).

Table I: Effect of integrated nitrogen management on the growth components of hybrid maize

Treatment No	Treatment details	Plant height (cm)			Leaf Area Index	Dry Matter Production(kg/ha)		
		30 DAS	60 DAS	Harvest stage	60 DAS	30 DAS	60 DAS	Harvest stage
T1	Control (No fertilizer and manure)	33.30	58.41	97.15	1.65	2649.12	5443.75	8431.52
T2	100% RDF	85.60	147.55	196.33	4.16	4758.28	11926.97	16595.36
T3	(75% N through inorganics +25% N through FYM)+ 100% P&K through inorganics.	77.20	131.56	185.54	3.66	4293.45	11293.75	15243.74

T4	(75% N through inorganics +25% N through PM)+ 100% P&K through inorganics.	92.60	160.92	210.87	4.61	5080.01	12352.23	17500.38
T5	(75% N through inorganics +25% N through Vermicompost)+ 100% P&K through inorganics.	83.20	142.58	193.63	4.02	4609.92	11716.97	16144.13
T6	(75% N through inorganics +25% N through Goat Manure)+ 100% P&K through inorganics.	88.56	153.52	203.58	4.41	4910.17	12139.85	17047.64
T7	(50% N through inorganics +50% N through FYM)+ 100% P&K through inorganics.	66.70	111.67	164.34	2.92	3809.38	10656.69	13885.87
T8	(50% N through inorganics +50% N through PM)+ 100% P&K through inorganics.	79.74	135.80	186.82	3.75	4447.65	11503.35	15691.92
T9	(50% N through inorganics +50% N through Vermicompost)+ 100% P&K through inorganics.	70.12	118.06	171.31	3.15	3969.63	10869.07	14338.21
T10	(50% N through inorganics +50% N through Goat Manure)+ 100% P&K through inorganics.	73.20	124.62	178.53	3.4	4132.17	11081.61	14791.30
S.Ed		0.58	1.41	1.53	0.14	80.04	106.47	226.32
CD (p=0.05)		1.40	2.83	3.28	0.34	160.62	213.83	454.54

RDF: Recommended dose of fertilizer
RDF of Hybrid Maize : 250:75:75 kg ha^{-1} of N, $P2O_5$ and K_2O
FYM: Farm Yard Manure
PM: Poultry Manure

Table II: Effect of integrated nitrogen management on the yield components and yield of hybrid maize

Treatment No	Treatment details	Number of cob $plant^{-1}$	Number of grains cob^{-1}	100 seed weight (g)	Grain yield (kg/ha)
T1	Control (No fertilizer and manure)	1.00	102.35	16.42	1547.77
T2	100% RDF	1.20	383.12	28.41	6183.76
T3	(75% N through inorganics + 25% N through FYM)+ 100% P&K through inorganics.	1.00	290.26	27.87	5663.68
T4	(75% N through inorganics + 25% N through PM)+ 100% P&K through inorganics.	1.40	460.74	28.98	7450.70
T5	(75% N through inorganics + 25% N through Vermicompost)+ 100% P&K through inorganics.	1.20	352.88	28.29	6073.03
T6	(75% N through inorganics + 25% N through Goat Manure)+ 100% P&K through inorganics.	1.40	422.13	28.76	7020.05
T7	(50% N through inorganics + 50% N through FYM)+ 100% P&K through inorganics.	1.20	200.55	26.63	4543.72
T8	(50% N through inorganics + 50% N through PM)+ 100% P&K through inorganics.	1.20	318.87	27.95	6030.34
T9	(50% N through inorganics + 50% N through Vermicompost)+ 100% P&K through inorganics.	1.20	208.47	26.94	4938.76
T10	(50% N through inorganics + 50% N through Goat Manure)+ 100% P&K through inorganics.	1.20	250.56	27.5	5309.11
S.Ed		0.05	3.57	0.11	135.27
CD (p=0.05)		NS	7.14	0.23	270.54

RDF: Recommended dose of fertilizer
RDF of Hybrid Maize : 250:75:75 kg ha^{-1} of N, $P2O_5$ and K_2O
FYM: Farm Yard Manure
PM: Poultry Manure

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