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Nitrogen management through organic and inorganic sources in popcorn (*Zea mays everta*)

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Abstract
The field studies was carried out at the College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand (Gujarat) with a view to study the "Nitrogen management through organic and inorganic sources in popcorn (*Zea mays everta*)" during *rabi*season of the year 2017-18. The experiment was laid out in a Randomized Block Design with four replications. Sustainable agricultural productivity might be achieved through a wise use of INM. Integrated use of chemical and organic fertilizer on yield and yield components of maize is very crucial for assurance of food security though improvement of the stock of plant nutrients in the soils and the rapid uptake of plant nutrients, thus, limiting losses to the environment thus reduce inorganic (fertilizer) input cost. Different kinds of organic materials such as FYM, animal manures, green manures, crop residues, composts, and industrial wastes have been used in maize systems. Hence an attempt has been made in this review to elaborate the effects of INM on various growth parameters, nutrient uptake and yield of maize based on the available literature. The present experiment results revealed that significantly higher value of quality parameters *viz*. protein content and popping percent of grains was found in treatment receiving 75% N through Urea + 25% N through vermicompost. Similarly, higher value of chemical parameters *viz.* available N, P_2O_5 and K_2O of soil after harvest, N, P and K content in grain and stover was found in treatment with 75% N through Urea + 25% N through vermicompost.

Keywords: Popcorn, FYM, vermicompost, castor cake, popping and protein content

Introduction
Maize (*Zea mays* L.) is one of the most important cereal crops in the world's agricultural economy, both as a food for human consumption and as a feed for livestock. It is known as a "queen of cereals" because of its maximum yield potential among the cereals. It has higher level of industrial utilization than any other cereal grains because of it's diversified by products, higher production potential and wider adaptability. Globally, maize is grown in area of 179 million hectares with total production of 967 million tons and productivity of 5.5 t/ha (Anno., 2014). Further, maize contributes nearly 9 per cent in the national food basket. Maize is grown in area of 9.26 million hectares with total production of 23.67 million tons and productivity of 2557 kg/ha (Anon., 2016a) [1]. It is predominantly a *kharif* crop cultivated in nine states *viz*. Karnataka, Andhra Pradesh, Tamil Nadu, Rajasthan, Maharashtra, Bihar, Uttar Pradesh, Madhya Pradesh and Gujarat account for 85 per cent of country's maize production and 80 per cent of area under cultivation (Anon., 2014). In Gujarat, maize is an important traditionally grown crop of tribal areas. Maize is grown over an area of 387000 hectares with an annual production of 571000 tons and productivity of 1478 kg/ha (Anon., 2016b) [2].
There are two types of popcorn grown *i.e.* pearl and rice. Pearl popcorn has round kernels, while rice popcorn kernels are elongated. Popcorn is a special type of flint corn that was selected by Indians inearly western civilizations. Popcorn plant has some distinctive characters compared to normal corn. The plant type is lanky *i.e*. thin and tall. The tassel is highly branched and branches are droopy *i.e*. hanging downward. The ear placement is higher up as compared to normal corn. The rice type popcorn kernels are typically beaked *i.e*. long and pointed at the tip and white in color. Pearl type of popcorn has smooth, round and yellow kernels and is more commonly grown. Based on the shape of flake produced on popping, popcorn is further classified as butterfly and mushroom types. The butterfly popcorn is preferred for eating, while mushroom popcorn is used in confectionary products. At present, the cultivation of popcorn is concentrated in outskirts of big cities and metropolis. The increased demand for popcorn products has made a profitable outlet for those who desire to

grow popcorn on a commercial scale. In popcorn's case, antioxidants are found in hull and are called polyphenols. According to the American Journal of Clinical Nutrition, polyphenols possess numerous health benefits, including prevention of degenerative diseases such osteoporosis, cardiovascular disease, cancer, neurodegenerative diseases and diabetes. Nitrogen is the key element in achieving consistently high yields in cereals. It is a constituent of many fundamental cell components such as nucleic acids, amino acids, enzymes and photosynthetic pigments. It impart green color to plants and also encourage vegetative growth like shoot elongation, tillering and governs to a considerable degree of utilize potassium, phosphorus and other elements in plant. Integrated nutrient supply/management (INM) aims at maintenance or adjustment of soil fertility and plant nutrient supply to an optimum level for sustaining the desired crop productivity through all possible sources of plant nutrients in an integrated manner which include; maintenance or enhancement in soil productivity through a balanced use of fertilizers combined with organic and biological sources of plant nutrients and maintain soil health. However, no single source of nutrients is capable of supplying nutrients in adequate and balanced proportion. A very large number of evidences confirm that judicious combination of organic and inorganic fertilizers bring about favorable as well as desirable results in terms of yield, quality of crop produces and soil fertility (Rao *et al*., 2009).

Materials and Methods

The present investigation was conducted in *rabi* season of the year 2017-18 at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand. The soil is locally known as "*Goradu"* soil. The texture of the soil is loamy fine sand. It was suitable for a variety of crops of tropical and sub-tropical origins. Data on soil analysis indicated that the experimental site was low in organic carbon (0.40%) and available nitrogen (230.5 kg/ha), medium in available phosphorus (42.83 kg/ha) and potassium (311.1 kg/ha). There were total 10 treatments like T_1: RDF (120-60-00) NPK kg/ha, T_2 : 100% N through FYM, T_3: 100% N through vermicompost, T_4: 100% N through castor cake, T_5: 75% N through Urea + 25% N through FYM, T_6: 75% N through Urea + 25% N through vermicompost, T_7 : 75% N through Urea + 25% N through castor cake, T_8: 50% N through Urea + 50% N through FYM, T_9: 50% N through Urea + 50% N through vermicompost, T_{10}: 50% N through Urea + 50% N through castor cake. Organic manures were thoroughly incorporated in soil in the furrow as per treatment and fertilizers were applied according to the treatments manually before sowing. Maintain uniform plant population in all treatments and follow all agronomical practices for better crop production. Randomly selected five plant from net plot area and tag it all for further agronomical observations. Find out protein and popping content of popcone maize by standard prescribe methods. The collected data for various parameters were statistically analysed using Fishers analysis of variance (ANOVA) technique and the treatments were compared at 5% levels of significance (Cochran and Cox, 1967) [3].

Results and Discussion

Protein content of grain (%): Data presented in Table-1 indicated that protein content was effected by various organic and inorganic treatments. Proteins are assembled from of unique amino acid sequences. Application of 75%N through urea + 25% N through vermicompost (T_6) recorded significantly higher protein content (10.28). Significantly higher protein content might be explained on the basis of better availability of nutrients in crop root zone and from its solubilization caused by the organic acid produced from the decaying organic matter and also increase uptake by roots and which turn in enhanced photosynthetic and metabolic activity resulting in better partitioning of photosynthates to sinks, which reflected in quality enhancement in terms of protein content of popcorn grains. The positive effect of application of vermicompost on increase in protein content was also noticed by Ramesh *et al*. (2008) and Meena *et al*. (2007) [15, 10].

Popping (%): Popcorn is grown for its tasty, exploding kernels so popping percentage is the most important factor in relation to economic perspective. The analysis of data (Table 1) manifested that different treatments differed significantly among themselves with respect to popping percentage of popcorn. Popping percentage ranged from 90.21 to 95.29 per cent among all the treatments. Treatment receiving 75% N through Urea + 25% N through vermicompost (T_6) showed significantly higher value of popping percentage (95.29%) than rest of treatments.

Table 1: Protein content, Popping, available N, P_2O_5 and K_2O in soil after harvest, N, P and K content of grains and stover as influenced by organic and inorganic sources of nitrogen.

Treatment		Protein content (%)	Popping (%)	(kg/ha)			Content in grains (%)			Content in stover (%)		
				N	P_2O_5	K_2O	N	P	K	N	P	K
T_1	RDF (120-60-00) NPK kg/ha	10.18	94.54	230.63	46.96	339.24	1.661	0.228	0.560	0.544	0.175	1.530
T_2	100% N through FYM	9.61	90.21	196.71	39.74	320.75	1.488	0.207	0.499	0.511	0.152	1.500
T_3	100% N through vermicompost	10.09	92.84	226.09	45.56	335.26	1.635	0.225	0.531	0.529	0.171	1.530
T_4	100% N through castor cake	9.65	90.63	217.65	42.69	331.13	1.498	0.210	0.508	0.519	0.162	1.523
T_5	75% N through Urea + 25% N through FYM	9.62	90.47	212.83	39.93	327.08	1.491	0.209	0.501	0.513	0.159	1.508
T_6	75% N through Urea + 25% N through vermicompost	10.28	95.29	262.42	48.31	344.98	1.694	0.246	0.583	0.565	0.189	1.550
T_7	75% N through Urea + 25% N through castor cake	10.23	95.23	239.76	47.80	340.23	1.676	0.238	0.577	0.564	0.184	1.540
T_8	50% N through Urea + 50% N through FYM	9.92	90.75	221.12	44.76	331.19	1.578	0.212	0.510	0.520	0.168	1.525
T_9	50% N through Urea + 50% N through vermicompost	10.22	94.72	235.97	47.55	339.93	1.674	0.237	0.565	0.549	0.182	1.535
T_{10}	50% N through Urea + 50% N through castor cake	9.93	91.43	225.04	44.90	332.03	1.581	0.220	0.523	0.516	0.169	1.528
	S. Em. ±	0.18	1.43	11.64	2.08	14.86	0.05	0.01	0.02	0.01	0.01	0.04
	C. D. (P=0.05)	0.51	4.14	33.78	6.03	NS	0.157	0.027	0.063	0.041	0.022	0.130
	C. V. (%)	3.55	3.08	10.26	9.27	8.89	6.76	8.36	8.15	5.25	8.88	5.87

The available nitrogen, phosphorus and potash soil nutrient status of was significantly impacted by various treatments. Application of 75% N through urea + 25% N through vermicompost (T_6) recoded significantly higher available nitrogen (262.42 kg/ha) and phosphorus (48.31 kg/ha) but treatment response was found non-significant in case of available potash status in soil. Perusal of data presented in Table-1 indicated that application of 75% N through urea + 25% N through vermicompost (T_6) reported significantly higher nitrogen (1.694%), P (0.246) and K (0.583) content than rest of treatments. Increasing nutrient content in grain was might be due to the benefits of organic manures, which release nutrients slowly for a longer period and make them available to the plant for their uptake which accumulate more nitrogen in the popcorn grains (Vidyavathi *et al*., 2011) [16]. The higher phosphorous content in grains under said treatments might be attributed to additional amount of phosphorous supplied through application of organic manures as well as the beneficial effect of organic matter addition derived in connection with the improvement in physico-chemical properties of the soil as observed by Meena *et al*. (2016) [9]. Further, maize being an exhaustive crop which removes huge quantity of nutrients from soil which increased nutrient content in plant resulted in higher content in grains reported by Prasad *et al*. (2006) [14]. The beneficial effect of addition of organic manure could be attributed to improved better root proliferation, resulting in higher K uptake and might be due to addition potassium in soil its higher availability to plant system, which encourages robust root system resulting in better absorption of water and nutrient from lower layers and thus resulting in higher uptake and hence higher nutrient content (Kumar *et al*., 2003 amd Danilchenko *et al*., 2005) [6, 4].

Application of organic and inorganic sources of provided nutrient in soil for longer time. Treatment (T_6) noted significantly higher nitrogen (0.565%) and phosphorus (0.189%) and potash content (1.550%) stover content. It might be attributed to well establish developed root system, additional nutrients supply by vermicompost and castor cake which facilitate the improvement in soil physical properties, microbial properties and metabolic activity and higher photosynthesis rate, which may have helped in better absorption of nutrients by plant (Parmar *et al*., 2007) [12]. Further compare with applying only chemical fertilizer integration of organic and inorganic fertilizer was found beneficial to the balanced release of nutrients and reduction of nitrogen loss thus, increasing the nitrogen use efficiency (Liu *et al*., 2008) [8]. The higher response to the organic sources might be due to the nature and amount of nutrients present in the vermicompost and castor cake and their decomposition and nutrient release pattern in the soils which translocate into plant (Laxminarayana *et al*., 2011) [7]. Further, well developed root system leads to better absorption of nutrients from the soil, may be the most pertinent reason for higher content of phosphorous with the application of organic manures.

Conclusion

In the light of the present investigation, it is concluded that higher value of quality parameters *viz*. protein content and popping percent of grains was found in treatment receiving 75% N through Urea + 25% N through vermicompost. Similarly, higher value of chemical parameters *viz.* available N, P_2O_5 and K_2O of soil after harvest, N, P and K content in grain and stover was found in treatment with 75% N through Urea + 25% N through vermicompost.

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