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INTEGRATED USE OF ORGANIC AND GRADED LEVELS OF INORGANIC FERTILIZERS FOR HYBRID MAIZE PRODUCTION IN CAUVERY DELTA ZONE

G. Bardhan and S.M. Suresh Kumar

Assistant Professors, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar-608 002 (Tamil Naudu) India

Abstract

Field investigation was conducted at Annamalai University Experimental Farm, Annamalai Nagar, Tamil Nadu to study the effect of integrated nutrient management in maize. The field experiment was carried out during March to June, 2014 and was conducted in randomized block design with three replications. The treatments comprised of 100 per cent recommended dose of fertilizer (RDF) (T_1), 75 per cent RDF (T_2), 100 per cent RDF + enriched FYM @ 750 kg ha-1 (T_3), 75 per cent RDF + enriched FYM @ 750 kg ha^{-1} (T_4), 100 per cent RDF + vermicompost @ 5 tonnes ha^{-1} (T_5), 75 per cent RDF + vermicompost @ 5 tonnes ha^{-1} (T_6), 100 per cent RDF + enriched FYM @ 750 kg ha^{-1} + soil application of *azospirillum* @ 2 kg ha^{-1} (T_7), 75 per cent RDF + enriched FYM @ 750 kg ha^{-1} + soil application of *azospirillum* @ 2 kg ha^{-1} (T_8), 100 per cent RDF + vermicompost @ 5 tonnes ha^{-1} + soil application of *azospirillum* @ 2 kg ha^{-1} (T_9), 75 per cent RDF + vermicompost @ 5 tonnes ha^{-1} + soil application of *azospirillum* @ 2 kg ha^{-1} (T_{10}). Among the integrated nutrient management practices evaluated, 100 per cent RDF + vermicompost @ 5 tonnes ha^{-1} + soil application of *azospirillum* @ 2 kg ha^{-1} resulted in the enhanced values of various growth attributes *viz.,* plant height, leaf area index and dry matter production. Application of 75 per cent RDF alone resulted in the lowest values of the growth components.

Key Words: Hybrid maize, vermicompost, *Azospirillum* and enriched FYM.

Introduction

Maize (*Zea mays* L.) is the third important cereal crop next to rice and wheat in the World. Maize has been an important cereal crop because of its high production potential compared to any other cereal crop and adaptability to wide range of environments. Besides being a potential source of food for human being, it is used for feeding cattle, poultry and industries for the production of starch, syrup, alcohol, acetic acid, lactic acid etc. It is an efficient converter of solar energy into dry matter. Maize occupies an important place in Indian economy as like rice, wheat and millets. In India, maize occupies an area of 8.65 million hectares with a production of 19.78 million tonnes and the productivity of 2.36 t ha^{-1}. In Tamil Nadu, it is cultivated in an area of 0.26 million hectares with production of 0.81 million tonnes and a productivity of 4.5 t ha^{-1} and also it occupies fourth position in Indian maize production (Gangaiah, 2013). Maize being a C_4 plant has higher yield potential depends on nutrient supplying capacity of the soil. However, its potential could not be utilized fully due to lack of proper agronomic management practices like nutrient management, season and variety (Sahrawat *et al*., 2008).

The productivity of maize is largely dependent on its nutrient management. Chemical fertilizers cannot be avoided completely since they are the potential sources of high amount of nutrients in easily available forms. Excessive and continuous use of chemical fertilizers coupled with pesticides and fungicides have damaged the soil health which causes deleterious effects on crop cultivation and productivity (Karthika and Vanangamudi, 2013). But continuous application of chemical fertilizers alone in intensive cropping system is leading to imbalance of nutrients in soil which has an adverse effect on soil health and also on crop yields. However, indiscriminate prescription of inorganic fertilizers alone in long run deteriorates soil health resulting in drastic yield reduction.

On the other hand, application of organics helps to build up soil humus and beneficial microbes besides, improving the soil physical properties. At the same time, application of organic manures alone does not produce required yields due to their low nutrient status. Sustainable yield levels could be achieved only by applying appropriate combination of organic manures and chemical fertilizers (Obi and Ebo, 1995). The rising prices and lack of availability of inorganic fertilizer at right time to the farmers due to poor transport facility necessitates some alternative ways of nutrient supply and the mineral fertilizers alone cannot meet the requirement of crops in a cropping system (Rao Ravi *et al*., 2011).

Organic manures particularly FYM, vermicompost and green manures not only supply macronutrients but also meet the requirements of micronutrients besides improving soil health. Boosting yield, reducing production cost and improving soil health are three inter-linked components of the sustainable triangle. Therefore, suitable combination of chemical fertilizer and organic manure culture need to be developed for particular cropping system and soil. The conjunctive use of organic manure and chemical fertilizers can augment the nutrient use efficiency and also enhance the productivity of quality protein maize. Hence the concept of integrated nutrient management is gaining momentum in view of its beneficial effect on physio-chemical soil characteristics, beneficial microbial load and sustainable crop productivity. Imbalanced soil nutrients status as a result of the continuous usage of chemical fertilizers, its escalated costs and pollution hazards to agro-ecological situations are the other factors that weigh in favour of INM.

Use of organic manure to meet the nutrient requirements of crop would be an inevitable practice in the year to come for sustainable agriculture. The factors which indirectly influenced the grain yield are growth attributes like plant height, leaf area index and total dry matter production.

Vermicomposts are products derived from the accelerated biological degradation of organic wastes by earthworms and microorganisms. Earthworms consume and fragment the organic wastes into finer particles by passing them through a grinding gizzard and derive their nourishment from microorganisms that grow upon them. Farm Yard Manure (FYM) is the decomposition of dung and urine of farm animals along with litter and left over material from roughages or fodder fed to the cattle, on an average it contains 0.5 per cent N, 0.2 per cent P and 0.5 per cent K. The traditional farmyard manure (FYM) is becoming a scarce organic input due to drastic reduction in cattle population. Enriched FYM is an alternative source to conventional FYM and further there is a saving of 25 per cent recommended dose of fertilizers. The EFYM will help in arresting the trends of nutrient depletion, reducing application of bulk quantity of organic manure and improving organic matter status, microbial biomass, nitrogen, phosphorus availability and humus content of the soil (Tolessa *et al.,* 2001).

The biofertilizer *azospirillum* is an important free living organism that can fix atmospheric nitrogen into the soil ranging from 20 to 30 kg ha^{-1} (Reddy and Reddy, 2003). In order to sustain soil fertility and productivity and to reap rich harvest of maize, it is important that EFYM and *azospirillum* (biofertilizer) have to be applied in adequate quantity. Due to ever increasing cost of inorganic chemical fertilizers their use in combination with organic sources has become imperative for sustained crop production.

Materials and Methods

The field experimental was conducted to study the influence of inorganic fertilizers and organic granules in yield attributes and yield of hybrid maize at Annamalai University Experimental Farm, Annmalai Nagar, during February – May, 2014. The experimental farm is situated at 11°24' N latitude, 79°44' E longitude and at an altitude of 5.79 m above the mean sea level. The weather at Annamalai nagar is moderately warm with hot summer months. The mean annual rainfall received at Annamalai nagar is 1500 mm distributed over 60 rainy days. The soil of the Experimental Farm is deep clay, low in available nitrogen, medium in available phosphorus and high in available potassium. Ten treatment combinations were studied in RBD with three replications. The maize variety chosen for the experiment was NK 6240 with a spacing of 60 × 30 cm was adopted. The treatments comprised of 100 per cent recommended dose of fertilizer (RDF) ($\mathbf{T_1}$), 75 per cent RDF ($\mathbf{T_2}$), 100 per cent RDF + enriched FYM @ 750 kg ha-1 ($\mathbf{T_3}$), 75 per cent RDF + enriched FYM @ 750 kg ha^{-1} ($\mathbf{T_4}$), 100 per cent RDF + vermicompost @ 5 tonnes ha^{-1} ($\mathbf{T_5}$), 75 per cent RDF + vermicompost @ 5 tonnes ha^{-1} ($\mathbf{T_6}$), 100 per cent RDF + enriched FYM @ 750 kg ha^{-1} + soil application of *azospirillum* @ 2 kg ha^{-1} ($\mathbf{T_7}$), 75 per cent RDF + enriched FYM @ 750 kg ha^{-1} + soil application of *azospirillum* @ 2 kg ha^{-1} ($\mathbf{T_8}$), 100 per cent RDF + vermicompost @ 5 tonnes ha^{-1} + soil application of *azospirillum* @ 2 kg ha^{-1} ($\mathbf{T_9}$), 75 per cent RDF + vermicompost @ 5 tonnes ha^{-1} + soil application of *azospirillum* @ 2 kg ha^{-1} ($\mathbf{T_{10}}$). The growth parameters which were observed during experiment includes plant height at different growth stages, LAI and DMP.

The plant height was measured from the base of the plant to tip of the last opened leaf. The plant height was measured at 30, 60 DAS and at harvest and expressed in cm. The leaf area was measured on the leaves of the tagged plants at 30 and 60 DAS and the LAI was calculated by using the formula suggested by Francis *et al.* (1969). The plants selected at random in two border rows were cut at 30, 60 DAS and at harvest for estimating DMP. The collected samples were chopped, air dried and then oven dried at 80°C till concordant values were obtained. The dry weight of samples were recorded and expressed in kg ha^{-1}. Statistical analysis was carried out as per the procedure suggested by Panse and Sukhatme (1978).

RESULT AND DISCUSSION

Growth Attributes

The data on maize plant height recorded at 30 DAS, 60 DAS and at harvest are given in table 1. Regarding the nutrient management practices evaluated, application of 100 per cent RDF + vermicompost @ 5 t ha^{-1} + soil application of *azospirillum* @ 2 kg ha^{-1} (T_9) significantly registered the highest plant height of 94.94, 223.67 and 258.25 cm respectively at 30 DAS, 60 DAS and harvesting stage respectively. The other treatments *viz.,* application of 100 per cent RDF + enriched FYM @ 750 kg ha^{-1} + soil application of *azospirillum* @ 2 kg ha^{-1} (**T$_7$**), application of 75 per cent RDF + vermicompost @ 5 t ha^{-1} + soil application of *azospirillum* @ 2 kg ha^{-1} (**T$_{10}$**), application of 75 per cent RDF + enriched FYM @ 750 kg ha^{-1} + soil application of *azospirillum* @ 2 kg ha^{-1} (**T$_8$**), application of 100 per cent RDF + vermicompost @ 5 t ha^{-1} (**T$_5$**), application of 100 per cent RDF + enriched FYM @ 750 kg ha^{-1} (**T$_3$**), application of 75 per cent RDF + vermicompost @ 5 t ha^{-1} (**T$_6$**), application of 75 per cent RDF + enriched FYM @ 750 kg ha^{-1} (**T$_4$**) and application of 100 per cent recommended

Table1: Integrated use of organic and graded levels of inorganic fertilizers for hybrid maize production in Cauvery delta zone.

Treatments	Plant Height (cm)			Leaf area index		Dry matter production (kg ha^{-1})		
	30 DAS	60 DAS	Harvest	30 DAS	60 DAS	30 DAS	60 DAS	Harvest
T$_1$ - Recommended dose of fertilizers (RDF)	74.58	178.62	199.66	2.30	6.16	2919	5128	7293
T$_2$ - 75 per cent RDF	71.12	171.69	193.24	2.14	5.86	2800	4759	6283
T$_3$ - 100 per cent RDF + EFYM @ 750 kg ha^{-1}	82.24	195.37	223.18	2.80	6.97	3261	5936	8602
T$_4$ - 75 per cent RDF + EFYM @ 750 kg ha^{-1}	77.35	184.99	209.27	2.50	6.44	3041	5420	7849
T$_5$ - 100 per cent RDF + vermicompost @ 5 t ha^{-1}	85.62	202.10	231.12	2.95	7.19	3395	6211	9042
T$_6$ -75 per cent RDF + vermicompost @ 5 t ha^{-1}	80.28	190.87	217.15	2.69	6.81	3164	5691	8391
T$_7$ - 100 per cent RDF + EFYM @ 750 kg ha^{-1} + soil application of *azospirillum* @ 2 kg ha^{-1}	92.07	216.87	250.26	3.21	7.60	3662	6926	10027
T$_8$ - 75 per cent RDF + EFYM @ 750 kg ha^{-1} + soil application of *azospirillum* @ 2 kg ha^{-1}	87.30	206.62	237.18	3.04	7.34	3477	6399	9264
T$_9$ - 100 per cent RDF + vermicompost @ 5 t ha^{-1} + soil application of *azospirillum* @ 2 kg ha^{-1}	94.94	223.67	258.25	3.37	7.84	3787	7246	10732
T$_{10}$ - 75 per cent RDF + vermicompost @ 5 t ha^{-1} + soil application of *azospirillum* @ 2 kg ha^{-1}	90.24	212.44	245.15	3.18	7.57	3594	6684	9868
S.Ed	1.14	2.40	3.23	0.05	0.08	52	111	160
CD (p= 0.05)	2.54	5.34	7.19	0.12	0.19	116	246	356

dose of fertilizer (RDF) (T_1) stood next in order of ranking at all the stages of crop growth. The 75 per cent RDF alone (T_2) recorded the lowest plant height of 71.12, 171.69 and 193.24 cm at respective stages of crop growth.

With regard to LAI also, the application of 100 per cent RDF + vermicompost @ 5 t ha^{-1} + soil application of *azospirillum* @ 2 kg ha^{-1} (T_9) significantly registered the highest LAI values of 3.37 and 7.84 respectively at 30 and 60 DAS. The 75 per cent recommended dose of fertilizer (RDF) (T_2) resulted in the lowest LAI values of 2.14 and 5.86 respectively at 30 DAS and 60 DAS. The dry matter production (DMP) of maize was influenced by varied integrated nutrient management practices. In general, the values of DMP showed linear response to advancement in age of the crop. Application of 100 per cent RDF + vermicompost @ 5 t ha^{-1} + soil application of *azospirillum* @ 2 kg ha^{-1} (T_9) significantly recorded the highest DMP of 3787, 7246 and 10733 kg ha^{-1} respectively at 30 DAS, 60 DAS and harvesting stages. The rest of the treatments *viz.,* T_7, T_{10}, T_8, T_5, T_3, T_6, T_4 and T_1 stood next in the order of ranking. The lowest dry matter production (2801, 4760 and 6283 kg ha^{-1}on 30 DAS, 60 DAS and harvesting stages respectively) was recorded with 75 per cent recommended dose of fertilizer (RDF) (T_2).

In general, nitrogen is a vital plant nutrient, being the major constituent of chlorophyll, amino acids and proteins; increase the growth attributes *viz*., plant height, leaf number, leaf area index during growth period (Onasanya *et al*., 2009). Phosphorus being the component of energy compounds *viz*., ATP, NADP and potassium serving as an activator/cofactor for various enzymes involved in photosynthesis and CO_2 fixation, could have promoted satisfactory plant growth and photosynthetic surface (Sahoo and Mahapatra, 2004). *Azospirillum lipoferum*, was found to have not only the ability to fix nitrogen but also the ability to release growth - promoting substrates similar to gibberellic acid and indole acetic acid in the plant rhizosphere, also improved soil properties, such as organic matter and total N-content (Zahiroddini *et al*., 2004) which could stimulate plant growth, absorption of nutrients and photosynthesis (El Ghadban *et al*., 2006 and Mahfouz and Sharaf Eldin, 2007) and increased plant height, (Migahed *et al*., 2004) growth level, dry weight of shoot and root over control (Bhaskara Rao and Charyulu 2005).

Vermicompost is rich source of macro and micro-nutrients and growth hormones, which not only supply essential nutrients to the soil but also improve the physico-chemical and biological properties of the soil and thereby improved the physico-chemical properties and slow release of nutrients over longer periods with the uses of vermicompost might be responsible for better growth of maize with vermicompost application. The improvement in plant height and LAI with the use of organic sources *viz*., vermicompost consequently enhanced the plant growth and dry matter (Meena *et al.,* 2013). Application of 100 per cent RDF + vermicompost @ 5 t ha^{-1} + soil application of *azospirillum* @ 2 kg ha^{-1} could have also contributed to the synergistic effect on crop growth and development due to the presence of growth promoting substances such as NAA, IAA and humic acids which provides numerous sites for chemical reaction and microbial components (Najar and Khan, 2013).

The consistent increments observed with the values of plant height and LAI might have positively reflected on dry matter production. Increments in values of growth attributes of maize through the practice of INM were also reported by Sunitha and Maheswara Reddy (2012) and also distinct improvement in soil physical properties *viz*., texture, structure and porosity and making a suitable environment for root's growing. Higher growth characters predominantly registered in N application and higher growth was due to quicker availability of nutrients from the vermicompost when compared to FYM due to their narrow C: N ratio (Shilpashree *et al*., 2012). Application of 75 per cent of recommended dose of fertilizers (T_2) resulted in the least values of growth parameters, attributable to the absence of beneficial effect of biofertilizer, lesser levels of NPK and vermicompost, which contains nutrients in forms that are readily taken up by the plants such as nitrates, exchangeable phosphorus and soluble potassium, calcium and magnesium. The results are conformity with the findings of Aspasia *et al.*, (2010).

Conclusion

On the basis of results summarized above, It may be concluded that application of vermicompost @ 5 tonnes ha^{-1} + soil application of *azospirillum* @ 2 kg ha^{-1} along with 100 per cent recommended N, P and K holds promise as an eco-friendly and economically viable nutrient management practice for hybrid maize.

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