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INTEGRATION OF DIFFERENT GRANULAR ORGANIC MANURES WITH INORGANIC FERTILIZERS FOR INCREASING THE GROWTH ATTRIBUTES OF HYBRID MAIZE (*ZEA MAYS* L.)

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Abstract

Field investigation was conducted at Annamalai University Experimental farm, Annamalainagar to formulate an integrated nutrient management system involving granular form of organic manure granules *viz*., pressmud, seaweed extract granules and Azophos in combination with graded levels of inorganic fertilizers for increasing the growth attributes of hybrid maize during July-November, 2017. The experiment was laid out in a Randomized Block Design (RBD) with nine treatments. All the treatments significantly influenced the crop yield components and yield of hybrid maize. Among the treatments, 75 percent RDF + Azophos @ 4 kg ha^{-1} + Pressmud based organic manure granules @ 150 kg ha^{-1} + Seaweed extract granules @ 20 kg ha^{-1} (T_5) resulted in enhanced values of various growth components *viz*., plant height (99.15, 234.32 and 277.51 cm), leaf area index (3.96 and 8.28) and dry matter production (3958, 7857 and 11,426 kg ha^{-1}). This was closely followed by application of 75 percent RDF + Azophos @ 4 kg ha^{-1} + Pressmud based organic manure granules @ 150 kg ha^{-1} (T_3) and Recommended Dose of Fertilizer (RDF) alone (250:75:75) kg NPK ha^{-1} (T_1) and they were on par with each other. Application of 50 percent RDF + Azophos @ 4 kg ha^{-1} (T_6) resulted in least values of the growth components of hybrid maize.

Key words : Pressmud, organic manures, inorganic fertilizer, *Zea mays*.

Introduction

Maize (*Zea mays* L.) is the third most important crop next to rice and wheat in the world. Maize has the high production potential compared to any other cereal crop and adaptability to wide range of environments. There is no cereal on the earth which has so immense potentiality and that is why it is called as "Queen of cereals". Maize occupies an important place in food production. Maize is a wonder crop, because it can be used at any stage of crop growth. Early stage as succulent green fodder, very early cob stage as baby corn, little later stage as green cob and at fully matured stage as maize grain. Because of this ability it is also called as "Contingent crop". In Worldwide, maize is grown over an area of 185.54 million hectares with a production of 1074.76 million tonnes and with the productivity of 5.79 $t.ha^{-1}$. In India, maize occupies an area of 9.60 million hectares with a production of 26.26 million tonnes and the productivity of 2.74 $t.ha^{-1}$ (USDA, 2017). In Tamilnadu, it is cultivated in an area of 0.36 million hectares with production of 2.38 million tonnes and a productivity of 6.5 $t.ha^{-1}$ and also it occupies fourth position in Indian maize production (AICRP, 2016). Maize being a C_4 plant has higher yield potential which also depends on nutrient supplying capacity of the soil. India occupies the second lowest position in productivity. It is well known that maize is a heavy feeder of nutrients. Maize crop has better response to synthetic inorganic fertilizers. Use of inorganic fertilizers for increasing food grain production is inevitable in the present circumstances where food security and livelihood issues of the people have attained national priority. However, indiscriminate prescriptions of inorganic fertilizers alone in long term deleterious to soil health resulting in drastic yield reduction.

Continuous use of inorganic fertilizers leads to deterioration of soil physical, chemical properties and biological activity in soil. Many efforts are being exercised to combat the adverse consequences of chemical farming. The use of synthetic nitrogenous fertilizers is not only polluting the water resource rather which is toxic to human as well as for animal life (Cheema *et al*., 2010). Moreover, sole use of chemical fertilizers is causing deterioration in soil physico-chemical and biological

properties. The applied N is not all taken by crop plant; a large proportion is lost due to ammonia volatilization, denitrification and leaching (Zhang *et al*., 2009). There are various approaches to be used to enhance the crop productivity, one of them is integrated application of fertilizers with granulated organic manures. Considering these facts, it is important to identify the best type of available organic resources which can be used as a substitute for inorganic fertilizers. Besides NPK supply they make unavailable nutrients and micronutrients into available form. It is also the fact that optimum yield level of maize production cannot be achieved by only using organic manures because of their low nutrient content (Baradhan and Suresh Kumar, 2018). Efficacy of organic sources to meet the nutrient requirement of crop is not as assured as mineral fertilizers. But, the combined use of chemical fertilizers along with various organic sources is capable of improving soil quality and higher crop productivity on long term basis. Therefore, suitable combination of chemical fertilizers and organic manures need to be developed for particular cropping system and soil (Shilpashree *et al*., 2012). As far as organic manures concerned, the main function of them is to provide plant nutrients to the applied soil.

Powdered organic manures are featured with light relative density which is easily blown away by the wind when applying to the crops. After granulation compared with powdered organic manures, granules are compact and dry. Thus they are easily handled and applied to the crops. Granulated organic manures will absorb the moisture slowly and it results in slow release of nutrients thus results in increased nutrient efficiency (Suresh Kumar and Baradhan, 2018). Microbiological fertilizers are important to environment friendly and sustainable agricultural practices (Bloemberg *et al*., 2000). Biofertilizers are carrier based preparations containing mainly effective strains of microorganisms in sufficient numbers which are useful for nitrogen fixation in plants, solubilization and uptake of phosphorus and synthesis of growth promoting substances like hormones and auxins. A composite biofertilizer inoculum containing both *Azospirillum* and Phosphobacteria is known as Azophos. The main advantage of this single biofertilizer containing both "N" fixer and phosphate solubilizer and it is less expensive, easy to use and also better efficacy of both organisms in mixed culture.

Pressmud as bio compost used to maintain soil fertility and enhance crop production because it is rich in sugar and contains appreciable amount of essential plant nutrients *viz*., organic carbon, nitrogen, phosphorus, potassium, calcium and magnesium along with traces of micronutrients *viz*., Zn, Fe, Cu and Mn, so the beneficial effect of this bio compost for enhancing the soil fertility and thereby improving the crop productivity is well established. Pressmud can serve as a good source of organic manure and an alternate source of crop nutrients and soil ameliorates. By applying pressmud, soil influenced due to continuous and excessive application of chemicals are brought under control *i.e*. such lands can be made good by treating it with added phosphate solubilizing bacteria and decomposing fungi, which are eco-friendly so it nourishes plants and promotes plant growth, protect the plants from various soil borne diseases. Pressmud based organic manure granules contains NPK and important micronutrients and has established its importance in improving fertility, productivity and other physical properties of the soils. As the cost of chemical fertilizers is increasing day by day and not affordable by farmers, pressmud has promise as a most economic source of plant nutrient for sustainable crop production and improvement in the physical (structure, texture, aeration, water-holding capacity and porosity), chemical (pH, EC, CEC) and biological (microbial dyanamics) properties of the composts amended soil.

Marine bioactive substances extracted from seaweed are currently used in organic farming, in order to avoid excessive application of fertilizers and improving the uptake through the roots or leaves (Mugnai *et al*., 2008). Khan *et al*., (2009) presents the possible mechanisms by which the extracts from seaweed extracts have beneficial effect on agriculture: increased photosynthetic efficiency and carbon assimilation, delayed senescence, antimicrobial, anti-feedent and insect repellent, reduced transpiration, enhances stomatal conductance, modulation of root exudates, efficient water and nutrient uptake. Marine algal seaweed species are often regarded as an underutilized bio resource, many have been used as a source of food, industrial raw materials and in therapeutic and botanical applications for centuries. Moreover, seaweeds and seaweed-derived products have been widely used as amendments in crop production system due to the presence of a number of plant growth-stimulating compounds. Seaweed extract is used to enhances the germination of seeds, increases uptake of plant nutrients and gives resistance to frost and fungal diseases. Seaweed extract is effective for increasing shelf-life of the produce, improves the quality of produce and serves as an excellent soil conditioner (Zodape, 2001).

Materials and Methods

Field investigation was conducted at Annamalai

University Experimental farm, Annamalainagar during July-November, 2017. The experiment was laid out in a Randomized Block Design (RBD) with nine treatments comprised of T_1 - Recommended dose of fertilizer (RDF) alone (250:75:75) kg NPK ha^{-1}, T_2 - 75 percent RDF + Azophos @ 4 kg ha^{-1}, T_3 - 75 percent RDF + Azophos @ 4 kg ha^{-1} + Pressmud based organic manure granules @ 150 kg ha^{-1}, T_4 - 75 percent RDF + Azophos @ 4 kg ha^{-1} + Seaweed extract granules @ 20 kg ha^{-1}, T_5 - 75 percent RDF + Azophos @ 4 kg ha^{-1} + Pressmud based organic manure granules @ 150 kg ha^{-1} + Seaweed extract granules @ 20 kg ha^{-1}, T_6 - 50 percent RDF + Azophos @ 4 kg ha^{-1}, T_7 - 50 percent RDF + Azophos @ 4 kg ha^{-1} + Pressmud based organic manure granules @ 150 kg ha^{-1}, T_8 - 50 percent RDF + Azophos @ 4 kg ha^{-1} + Seaweed extract granules @ 20 kg ha^{-1}, T_9 - 50 percent RDF + Azophos @ 4 kg ha^{-1} + Pressmud based organic manure granules @ 150 kg ha^{-1} + Seaweed extract granules @ 20 kg ha^{-1}. All the treatments significantly influenced the crop growth parameters of hybrid maize. The observation on growth parameters was recorded. The growth attributes which were observed during experiment includes plant height, leaf area index and dry matter production. Statistical analysis was carried out as per the procedure suggested by Panse and Sukhatme, (1978).

Results and Discussion

The yield potential of maize is determined by the resultant values of growth components which are greatly influenced by the growth parameters. This is well reflected in the present investigation also. Almost all growth attributing characters *viz.*, plant height, leaf area index and dry matter production of hybrid maize were remarkably influenced by the integration of inorganic fertilizers and organic source of granules. Among the treatments evaluated, 75 percent RDF + Azophos @ 4 kg ha^{-1} + Pressmud based organic manure granules @ 150 kg ha^{-1} + Seaweed extract granules @ 20 kg ha^{-1} (T_5) significantly resulted in the enhanced values of various growth attributes *viz.*, plant height (99.15, 234.32 and 277.51 cm), leaf area index (3.96 and 8.28), dry matter production (3958, 7857 and 11,426 kg ha^{-1}). This was closely followed by application of 75 percent RDF + Azophos @ 4 kg ha^{-1} + Pressmud based organic manure granules @ 150 kg ha^{-1} (T_3) and Recommended Dose of Fertilizer (RDF) alone (250:75:75) kg NPK ha^{-1} (T_1) and they were on par with each other. Application of 50 percent RDF + Azophos @ 4 kg ha^{-1} (T6) resulted in least values of the growth components of hybrid maize.

The result of the field study on maize crop revealed that the growth characters were remarkably influenced by combined application of organic manure granules and graded levels of inorganic fertilizers to evaluate their relative effectiveness. Pressmud is a good source of organic manure with NPK and important micronutrients and has established its importance in improving fertility,

Table 1: Influence of different granular organic manures with inorganic fertilizers in growth attributes of hybrid maize (*Zea Mays* L.).

Treatments	Plant height (cm)		LAI	DMP (kg ha^{-1})	
	60 DAS	Harvest		60 DAS	Harvest
T_1 - RDF alone (250:75:75 kg NPK ha^{-1})	224.24	257.36	7.71	7381	10796
T_2 - 75% RDF + Azophos @ 4 kg ha^{-1}	206.39	234.07	6.82	6630	9620
T_3 - 75% RDF + Azophos @ 4 kg ha^{-1} + Pressmud based organic manure granules @ 150 kg ha^{-1}	227.39	262.43	7.88	7508	11020
T_4 - 75% RDF + Azophos @ 4 kg ha^{-1} + Seaweed extract granules @ 20 kg ha^{-1}	216.41	249.38	7.36	7081	10370
T_5 - 75% RDF + Azophos @ 4 kg ha^{-1} + Pressmud based organic manure granules @ 150 kg ha^{-1} + Seaweed extract granules @ 20 kg ha^{-1}	234.32	277.51	8.28	7857	11426
T_6 - 50% RDF + Azophos @ 4 kg ha^{-1}	172.48	202.94	5.64	5485	7963
T_7 - 50% RDF + Azophos @ 4 kg ha^{-1} + Pressmud based organic manure granules @ 150 kg ha^{-1}	202.53	229.46	6.65	6518	9350
T_8 - 50% RDF + Azophos @ 4 kg ha^{-1} + Seaweed extract granules @ 20 kg ha^{-1}	186.63	218.37	6.14	6114	8734
T_9 - 50% RDF + Azophos @ 4 kg ha^{-1}+ Pressmud based organic manure granules @ 150 kg ha^{-1} + Seaweed extract granules @ 20 kg ha^{-1}	214.32	243.53	7.22	6915	10020
S.Ed	2.80	3.52	0.10	116.35	168.69
CD (p=0.05)	5.93	7.46	0.21	246.66	357.62

productivity and other physical properties of the soils. Seaweed and seaweed derived products have been widely used as amendments in crop production system due to the presence of number of plant growth stimulating compounds. 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 (LAI) during growth period. Phosphorus being the component of energy compounds *viz*., ATP, NADP and potassium serving as an activator / co-factor for various enzymes involves in photosynthesis and CO_2 fixation, could have promoted satisfactory plant growth, photosynthetic surface, yield structure and finally to cob yield under adequate and balanced supply of nutrients at higher level (Sahoo and Mahapatra, 2004).

The growth parameters, including plant height and LAI greatly improved with the application of organic manure granules along with inorganic fertilizers. This could be due to optimum and sustained availability and supply of both macro and micro nutrients during the entire growth phases of maize. This is in conformity with the findings of Sankaranarayanan *et al.*, (2010). Among the treatments, application of 75 percent RDF + Azophos @ 4 kg ha^{-1} + Pressmud based organic manure granules @ 150 kg ha^{-1} + Seaweed extract granules @ 20 kg ha^{-1} (T_5) significantly resulted in the highest plant height and dry matter production in maize. The in-time availability of the needed nutrients to the plant at the important growth stage might be the reason for increased growth attributes in this treatment.

Azophos improves liberation of organic acids by proton extrusion mechanism which stimulates the growth and increases the growth attributes of maize. Addition of Azophos might have prevented the fixation of nutrients in the soil and ensure steady supply of nutrients throughout the growth period that helped in better root and shoot growth. The improvement in plant height and LAI with the use of organic sources *viz*., pressmud based organic granules and sea weed granules along with Azophos consequently enhanced the plant growth and dry matter. Similar findings were reported by Azeem Tariq *et al*., (2014) and Rakesh Kumar *et al*., (2015). Dry matter production in maize depends on the plant height, LAI and number of plants m^{-2}. Moreover, the plant dry matter increase is due to better uptake of nutrients and water. 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 integration of organic granules and inorganic fertilizers were also reported by Kamran Azeem *et al*., (2014). This is might be due to distinct improvement in soil physical properties and making a suitable environment for root's growth. Application of 50 percent of recommended dose of fertilizers + Azophos 4 kg ha^{-1} (T_6) resulted in the least values of growth parameters attributable to the absence of beneficial effect of pressmud based organic granules and seaweed extract granules which contains nutrients in forms that are readily taken up by the plants and lesser levels of NPK. The results are conformity with the findings of Aspasia *et al*., (2010).

Conclusion

From the result of the field investigation carried out at Annamalai University Experimental farm, the following conclusion is drawn**.** It may be concluded that application of 75 percent RDF + Azophos @ 4 kg ha^{-1} + Pressmud based organic manure granules @ 150 kg ha^{-1} + Seaweed extract granules @ 20 kg ha^{-1} (T_5) is an eco-friendly and economically suitable nutrient management practice of organic manure granules with graded levels of inorganic fertilizers for enhancing the productivity together with maintenance of soil fertility over a long period of hybrid maize cultivation.

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