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IMPACT OF INTEGRATED NUTRIENT MANAGEMENT PRACTICES ON HYBRID MAIZE

Balasubramanian A.*, Yuvaraj K., R. Gobi, P. Stalin, S.R. Vinoth Kumar and M. Saravana Perumal

Department of Agronomy, Faculty of Agriculture, Annamalai University,
Annamalai Nagar -608 002 (Tamil Nadu) India.

Abstract

Field experiment was conducted at the Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar during the period of March to June, 2018 to study the impact of integrated nutrient management on growth and yield of hybrid maize. The field experiment was laid out in Randomized Block Design (RBD) with three replications. The treatments were consisting of T_1 - Control, T_2 - 100% RDF (250:75: 75 kg NPK ha^{-1}), T_3 - 75% RDN + 100% of P and K, T_4 - 100% RDN + Bio-fertilizer (*Azotobacter* @ 2 Kg ha^{-1}), T_5 - 75% RDN + Bio-fertilizer (*Azotobacter* @ 2 Kg ha^{-1}), T_6 - 100% RDN + FYM @ 12.5 t ha^{-1}, T_7 - 75% RDN + FYM @ 12.5 t ha^{-1}, T_8 - 100% RDN + EFYM @ 750 kg ha^{-1}, T_9 -75% RDN + EFYM @ 750 kg ha^{-1}, T_{10} - 100% RDN + Bio-fertilizer (*Azotobacter* @ 2 Kg ha^{-1}) + FYM @ 12.5 t ha^{-1}, T_{11} - 75% RDN + Bio-fertilizer (*Azotobacter* @ 2 Kg ha^{-1}) + FYM @ 12.5 t ha^{-1}, T_{12} - 100% RDN+ Bio-fertilizer (*Azotobacter* @ 2 Kg ha^{-1}) + EFYM @ 750 kg ha^{-1}, T_{13} - 75% RDN + Bio-fertilizer (*Azotobacter* @ 2 Kg ha^{-1}) + EFYM @ 750 kg ha^{-1}. The growth and yield components of hybrid maize *viz.,* plant height, leaf area index, dry matter production, number of grains cob^{-1}, grain yield and stover yield were recorded. Among the treatments, application of 100% RDN+ Bio-fertilizer (*Azotobacter* @ 2 Kg ha^{-1}) + EFYM @ 750 kg ha^{-1} (T_{12}) favourably influenced the growth and yield parameters and this treatment was on par with application of 100% RDN + Bio-fertilizer (*Azotobacter* @ 2 Kg ha^{-1}) + FYM @ 12.5 t ha^{-1} (T_{10}). The results evidently proved that the integrated application of 100% RDN with Bio-fertilizer (*Azotobacter* @ 2 Kg ha^{-1}) and EFYM @ 750 kg ha^{-1} in maize resulted in higher grain and stover yield.

Key words: INM, *Azotobacter,* EFYM, maize, growth and yield.

Introduction

Maize (*Zea mays* L.) is the third most 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 environment. Since the crop has very high genetic yield potential, it is called as "Queen of Cereals", besides being a potential source of food for human being, it is used as feed for cattle, poultry and raw material for industries for the production of starch, syrup, alcohol, acetic acid, lactic acid etc. It is an effective 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 9.50 million hectares with a production of 24.50 million tonnes and with the productivity of 2.58 t ha^{-1}. In Tamil Nadu, it is cultivated over an area of 0.31 million hectares with production of 0.95 million tonnes with the productivity of 3026 kg ha^{-1} and also it occupies fourth position in Indian maize production (AICRP, 2017).

***Author for correspondence :** E-mail: drabalu1975@gmail.com

It is well known that maize is a heavy feeder of nutrients. Nitrogen is the most important nutrient for plant growth and development. It is key component in many biological compounds and plays a major role in photosynthetic activity and crop yield (Cathcart and Swanton, 2003). Variation in nitrogen availability can affect plant development and grain production in maize.

Integrated nutrient management (INM) involving the best combination of available nutrient management technologies would facilitate in achieving the required productivity and sustainability by the efficient use of soil and applied plant nutrients. Thus INM is a strategy for advocating judicious and efficient use of chemical fertilizers with matching addition of organic manures (Chittaranjan Reddy and Ruazuddin Ahmed, 2009).

Increasing level of nitrogen fertilizers led to increase in grain yield and its component. Increasing nitrogen fertilizer rate from zero to 250 kg N ha^{-1} increased the plant growth, yield components and yield (Bakht *et al*., 2006).

The application of enriched FYM is superior to conventional FYM and on par with recommended mineral fertilizers on maize grain yield (Tolessa and Friesen, 2001). Bio-fertilizers have emerged as an important component of the integrated nutrient supply systems and hold a great promise to improved crop yields through environmentally better nutrient supplies. The aerobic bacteria *Azotobacter chrococcum* is known to fix considerable quantity of nitrogen in the rhizosphere of non-leguminous crops. The bacterium produces growth promoting substances *viz*., indole acetic acid, gibberellins, pantothenic acid, thiamine and niacin which promotes root proliferation and improve the plant growth and yield. It increases the rootlet density and root branching resulting in the increased uptake of mineral and water (Zothanmawii *et al*., 2018). Keeping the above facts, the present study was coined to evaluate a suitable integrated nutrient management on growth and yield of hybrid maize.

Materials and Methods

Field experiment was conducted in the Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar during the period of March to June, 2018 to study the impact of integrated nutrient management on growth and yield of hybrid maize. The experimental site is situated at 11°24' N latitude and 79° 41' E longitude with an altitude of +5.79 meters above mean sea level. The soil was clay loam in texture with a pH of 7.9. The soil was low in available nitrogen (190.30 kg N ha^{-1}), medium in available phosphorus (18.30 kg P_2O_5 ha^{-1}), high in available potassium (320 kg K_2O ha^{-1}) and low in organic carbon (0.37%). The field experiment was laid out in Randomized Block Design (RBD) with three replications. The treatments were consisting of T_1 - Control, T_2 - 100% RDF (250:75: 75 kg NPK ha^{-1}), T_3 - 75% RDN + 100% of P and K, T_4 - 100% RDN + Bio-fertilizer (*Azotobacter* @ 2 Kg ha^{-1}), T_5 - 75% RDN + Bio-fertilizer (*Azotobacter* @ 2 Kg ha^{-1}), T_6 - 100% RDN + FYM @ 12.5 t ha^{-1}, T_7 - 75% RDN + FYM @ 12.5 t ha^{-1}, T_8 - 100% RDN + EFYM @ 750 kg ha^{-1}, T_9 -75% RDN + EFYM @ 750 kg ha^{-1}, T_{10} - 100% RDN + Bio-fertilizer (*Azotobacter* @ 2 Kg ha^{-1}) + FYM @ 12.5 t ha^{-1}, T_{11} - 75% RDN + Bio-fertilizer (*Azotobacter* @ 2 Kg ha^{-1}) + FYM @ 12.5 t ha^{-1}, T_{12} - 100% RDN+ Bio-fertilizer (*Azotobacter* @ 2 Kg ha^{-1}) + EFYM @ 750 kg ha^{-1}, T_{13} -75% RDN + Bio-fertilizer (*Azotobacter* @ 2 Kg ha^{-1}) + EFYM @ 750 kg ha^{-1}.

Inorganic fertilizers and organic manures were applied as per recommendation given in the treatment schedule. The N, P and K were applied through urea, Di-ammonium phosphate and muriate of potash, respectively. Phosphorus and potassium were applied to the plots as per treatments at the time of sowing. Half dose of N was applied basal and remaining half dose was applied in two splits as per treatments. The observations on growth parameters *viz.,* plant height, leaf area index, dry matter production were recorded at 30, 60 and at harvest. The yield parameters *viz*., number of grains per cob and grain yield and stover yield were also recorded.

Results and Discussion

Impact of INM on growth components

Data presented in table 1 indicated that the plant height was significantly influenced by integrated nutrient management practices. Among the treatments, application of 100% RDN+ Bio-fertilizer (*Azotobacter* @ 2 Kg ha^{-1}) + EFYM @ 750 kg ha^{-1} (T_{12}) recorded higher plant height (80.6 cm, 168.8 cm and 215.9 cm at 30DAS, 60 DAS and at harvest, respectively). This treatment was on par with the application of 100% RDN + Bio-fertilizer (*Azotobacter)* + FYM @ 12.5 t ha^{-1} (T_{10}). Adequate nitrogen application increased the cell division, cell elongation, nucleus formation and the shoot growth. The cumulative effect of nitrogen fertilizer with EFYM increased the plant height. This might be due to the increased nitrogen content in soil which was responsible for all round enhancement of growth, increased metabolic activities, assimilation rate and cell division within the plant. The results are in accordance with the report of Zothanmawii *et al.,* (2018).

Application of 100% RDN+ Bio-fertilizer (*Azotobacter* @ 2 Kg ha^{-1}) + EFYM @ 750 kg ha^{-1} (T_{12}) recorded higher leaf area index of 2.36 and 5.29 at 30 and 60 DAS. This was on par with the application of 100% RDN + Bio-fertilizer (*Azotobacter)* + FYM @ 12.5 t ha^{-1} (T_{10}). Leaf area influences the interception and utilization of solar radiation of crop canopies. Inoculation of *Azotobacter* along with inorganic fertilizers showed significantly taller plant and higher LAI. This might be due to the growth promoting effect showed by the beneficial microbe *Azotobacter* through free atmospheric nitrogen fixation. Similar findings have been reported by Raies Ahmed Bhat *et al*., (2008).

Dry matter production also higher in the treatment with the application of 100% RDN+ Bio-fertilizer (*Azotobacter* @ 2 Kg ha^{-1}) + EFYM @ 750 kg ha^{-1} (T_{12}) which recorded 4771, 8418 and 11658 kg ha^{-1} at 30, 60 DAS and at harvest stage, respectively. This treatment

Table 1: Impact of integrated nutrient management practices on growth components of hybrid maize.

Treatments	Plant height (cm)			LAI		DMP (kg ha^{-1})		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	30 DAS	60 DAS	At harvest
T_1 - Control	38.9	95.1	140.1	10.91	2.31	2524	3967	5110
T_2 - 100% RDF (250 : 75 : 75 kg NPK ha^{-1})	70.9	151.0	190.0	1.67	4.49	4143	7453	10401
T_3 - 75% RDN + 100% of P and K	66.2	144.3	180.1	1.35	4.19	3929	7127	9935
T_4 - 100% RDN + Bio-fertilizer (*Azotobacter)*	71.6	151.8	191.7	1.69	4.52	4187	7503	10461
T_5 - 75% RDN + Bio-fertilizer (*Azotobacter)*	67.1	145.3	181.1	1.39	4.21	3971	7189	10013
T_6 - 100% RDN + FYM @ 12.5 t ha^{-1}	75.9	159.1	202.0	2.01	4.89	4437	7896	10980
T_7 - 75% RDN + FYM @ 12.5 t ha^{-1}	72.0	153.0	192.2	1.73	4.54	4222	7552	10517
T_8 - 100% RDN + EFYM @ 750 kg ha^{-1}	76.8	162.5	205.2	2.09	4.98	4554	8069	11182
T_9 - 75% RDN + EFYM @ 750 kg ha^{-1}	72.5	153.8	193.0	1.76	4.58	4269	7607	10576
T_{10} - 100% RDN + Bio-fertilizer (*Azotobacter)* + FYM @ 12.5 t ha^{-1}	80.4	167.9	214.1	2.33	5.24	4733	8352	11578
T_{11} - 75% RDN + Bio-fertilizer (*Azotobacter)* + FYM @ 12.5 t ha^{-1}	76.2	160.7	203.1	2.04	4.93	4488	7967	11065
T_{12} - 100% RDN+ Bio-fertilizer (*Azotobacter)*+EFYM @ 750 kg ha^{-1}	80.6	168.8	215.9	2.36	5.29	4771	8418	11658
T_{13} - 75% RDN+ Bio-fertilizer (*Azotobacter)* + EFYM @ 750 kg ha^{-1}	76.6	161.4	204.6	2.06	4.95	4514	8028	11139
S.Ed	1.31	2.60	4.20	0.05	0.09	79.91	129.84	163.86
CD (P=0.05)	2.70	5.36	8.66	0.10	0.19	164.93	267.99	338.20

was on par with the application of 100% RDN + Bio-fertilizer (*Azotobacter)* + FYM @ 12.5 t ha^{-1} (T_{10}) at all the stages. Positive effect in plant dry matter produced by available nitrogen is perceived from function in plant metabolism, which was used in synthesis of proteins, enzymes, coenzymes, nucleic acids, phytochromes and chlorophyll, besides to effect on physiological processes such as leaf expansion, plant growth and intensity of leaf senescence. The result was in accordance with the findings of Ricardo Shigueru Okumura *et al.,* (2011). Application of *Azotobacter* in combination with inorganic source of nitrogen gave higher plant dry weight. This might be due to the supply of nitrogen by *Azotobacter* could be the reason for higher plant dry weight. Similar findings were also reported by Rubina Gill *et al.,* (2018). Enriched farmyard manure has high proportion of available nutrients which significantly increased the dry matter production and more positive growth. This is similar with the findings of Bharathi, (2018).

Impact of INM practices on Yield components and Yield

The yield potential of maize is determined by the resultant values of yield components which are greatly influenced by the growth characters. This is well reflected

Table 2: Impact of integrated nutrient management practices on yield components and yield of hybrid maize.

TREATMENTS	Number of grains cob^{-1}	Cob Length (cm)	Cob diameter (cm)	Grain Yield (kg ha^{-1})	Stover Yield (kg ha^{-1})
T_1 - Control	197	11.41	5.11	2090	3642
T_2 - 100% RDF (250 : 75 : 75 kg NPK ha^{-1})	279	17.29	5.88	4731	7586
T_3 - 75% RDN + 100% of P and K	265	16.04	5.49	4342	7210
T_4 - 100% RDN + Bio-fertilizer (*Azotobacter)*	280	17.47	5.94	4776	7639
T_5 - 75% RDN + Bio-fertilizer (*Azotobacter)*	268	16.27	5.54	4397	7267
T_6 - 100% RDN + FYM @ 12.5 t ha^{-1}	294	19.11	6.39	5280	8043
T_7 - 75% RDN + FYM @ 12.5 t ha^{-1}	282	17.79	5.97	4837	7682
T_8 - 100% RDN + EFYM @ 750 kg ha^{-1}	301	19.81	6.51	5401	8163
T_9 - 75% RDN + EFYM @ 750 kg ha^{-1}	284	18.04	6.02	4893	7739
T_{10} - 100% RDN + Bio-fertilizer (*Azotobacter)* + FYM @ 12.5 t ha^{-1}	310	20.72	6.76	5748	8459
T_{11} - 75% RDN + Bio-fertilizer (*Azotobacter)* + FYM @ 12.5 t ha^{-1}	296	19.32	6.42	5321	8081
T_{12} - 100% RDN+ Bio-fertilizer (*Azotobacter)* + EFYM @ 750 kg ha^{-1}	315	20.97	6.78	5818	8508
T_{13} - 75% RDN+ Bio-fertilizer (*Azotobacter)* + EFYM @ 750 kg ha^{-1}	298	19.59	6.47	5364	8126
S.Ed	**3.44**	**0.41**	**0.11**	**94.66**	**135.45**
CD (P=0.05)	**7.10**	**0.85**	**0.23**	**195.36**	**279.55**

in the present investigation too. Almost all yield attributing characters such as cob length, cob diameter and number of grains cob^{-1} has been significantly influenced with the application of 100% RDN + Bio-fertilizer (*Azotobacter)* + EFYM @ 750 kg ha^{1} (T_{12}). This treatment recorded higher number of grains cob^{-1} (315), cob length (2.97 cm) and cob diameter (6.78 cm). This treatment was on par with 100% RDN + Bio-fertilizer (*Azotobacter)* + FYM @ 12.5 t ha^{1} (T_{10}). The increased supply of nitrogen might have stimulated the rate of various physiological processes in plant and led to increased yield attributes and yield. Similar findings were also reported by Pal *et al.,* (2017).

Application of 100% RDN+ Bio-fertilizer (*Azotobacter* @ 2 Kg ha^{1}) + EFYM @ 750 kg ha^{1} (T_{12}) recorded higher grain yield (5818 kg ha^{-1}) and stover yield (8508 kg ha^{-1}). This was on par with the application of 100% RDN + Bio-fertilizer (*Azotobacter)* + FYM @ 12.5 t ha^{1} (T_{10}). This was more likely because the application of organic manures application not only improved soil physical properties but also enhanced microbial activities and provided stable supply of both micro and macro nutrients. Application of *Azotobacter* along with urea (N) significantly influenced the grain and stover yield. This might be due to the interactive effect of biofertilizer along with nitrogen. *Azotobacter* supplied additional nitrogen through atmospheric nitrogen fixation which was taken by the plant led to increased yield attributing characters and yield. Combined application of N fertilizer, Biofertilizer and EFYM resulted in higher yield attributes, yield and harvest index due to the fact that integrated application of nutrients gave proper nutrition and maintenance of soil fertility in field when applied at proper doses replenishing the most deficient macro and micro nutrients which in turn help in getting the higher grain and stover yield in hybrid maize. This was in accordance with the results of Zelalem Bekeko, (2014). Lower grain and stover yield was recorded under control.

Conclusion

The results of the field experiment on hybrid maize revealed that growth and yield characters were significantly influenced by the application of RDN, biofertilizers and organic manures. Among the different treatment used, application of 100% RDN + Bio-fertilizer (*Azotobacter)* + EFYM @ 750 kg ha^{1} recorded higher values of plant height, LAI, DMP, number of grains cob^{-1}, cob length, cob diameter, grain yield and stover yield. Adoption of this technology will be agronomically sound, ecologically safe practice for small and marginal farmers of Tamilnadu.

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