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Effect of Nano Fertilizers and Various Nutrient Sources on Growth Parameters of Maize (*Zea mays* L.)

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ABSTRACT

A field investigation was carried out during *kharif* season at Crop Research Centre-1, School of Agriculture, ITM University to study the effects of nano fertilizers and various nutrient sources on the growth and growth parameters of maize. The experiment was laid out in a randomized block design with three replications. The experiment consists of twelve treatments *viz.*, T_1- Control, T_2 - 100 % RDF through chemical fertilizer (120:60:30 NPK kg ha^{-1}), T_3 - 100 % RDF through chemical fertilizer + nano fertilizer @ 1 g l^{-1} of water, T_4 -100 % RDF through chemical fertilizer + nano fertilizer @ 1.5 g l^{-1} of water, T_5- 100 % RDF through chemical fertilizer + nano fertilizer @ 2 g l^{-1} of water, T_6 - 100 % RDF through chemical fertilizer + nano fertilizer @ 2.5 g l^{-1} of water, T_7-125 % RDF through chemical fertilizer, T_8- 75% chemical fertilizer + 25% vermicompost, T_9- 75% chemical fertilizer + 25% vermicompost + nano fertilizer @ 1 g l^{-1} of water, T_{10} - 75% chemical fertilizer + 25% vermicompost + nano fertilizer @ 1.5 g l^{-1} of water, T_{11}- 75% chemical fertilizer + 25% vermicompost + nano fertilizer @ 2 g l^{-1} of water, T_{12} - 75% chemical fertilizer + 25% vermicompost + nano fertilizer @ 2.5 g l^{-1} of water. The results of the experiment revealed that application 75% chemical fertilizer + 25% vermicompost + nano fertilizer @ 1 g l^{-1} of water significantly influenced the growth attributes. This treatment recorded higher values of growth parameters like plant height of green leaves, leaf area per plant, dry matter accumulation, Leaf area index, Crop growth rate, and Relative growth rate The lowest values were recorded in the control.

***Key words**: Chemical fertilizers, Growth of maize, Manures, Maize, Nano fertilizers.*

Introduction

Maize (*Zea mays L.*) belongs to the family Gramineae, it is an annual crop and a monoecious plant. It is one of the most agro-climatically adaptable crop. The term "Queen of Cereals" refers to maize's status as the cereal with the greatest genetic potential. It accounts for 39% of world grain output and is grown on 213 million hectares in 170 nations, with a wide range of varieties, soils, temperatures, biodiversity, and management practices. Approximately 36% of the world's total production of maize is produced in the United States, making it a critical pillar of the maize's economy. In India, maize is grown all year long. Because of its higher yields and versatility in a variety of climates, maize has long been a popular cereal. It is grown primarily for grain and secondarily for fodder. The crop also sustains starch, oil, and dextrose industries.

Maize is the most important cereal crop in the world (*Zea mays L.*). It offers nutrients as well as phytochemicals. "Maize has a high nutritional value since it includes a variety of nutrients protein, 8.5% dietary fiber, 4.8% fat, 3.0% added sugar and 1.7% ash". Chronic disease can't be prevented without phytochemicals. To name just a few of the

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phytochemicals found in it, there are carotenoids, flavonoids, and phytosterols. To counteract HIV, researchers believe that Galanthus nivalis lectin (GNA lectin), or GNA-maize, can be beneficial. A tablespoon of maize oil provides all the fatty acids that a healthy child or adult should consume on a daily basis. For bladder issues, nausea, vomiting, and stomach ailments, a decoction of maize silk, roots, leaves, and cob is provided. The alcohol-soluble prolamine zein, found in the endosperm of maize, has potential applications in medicine and nutrition. Resistance starch (RS) from maize lowers the risk of colon cancer, atherosclerosis, and obesity-related diseases (Shah *et al.,* 2016).

There is scope for increasing the land under maize cultivation in non-traditional areas. Better production and productivity per unit time or season will require the application of better technology particularly the use of nano-fertilizers, organic and inorganic fertilizers. The use of farmyard manure (FYM) become more imperative when the cost of fertilizers is escalating and fear is expressed from many corners that continuous and heavy use of fertilizers particularly nitrogen may cause environmental pollution. So, using modern technology-based materials such as nano-fertilizers plays a major role.

The nano-fertilizer is made to deliver its nutritious content gradually. A further benefit of these formulations is that they are timed to coincide with the nutritional needs of crops. Ferrous, silica, titanium dioxide, Nano-zinc, Nano-nitrogen, Nano-potassium, core-shell gold nanorods, and other materials are present. The usage of nano-fertilizer improves the effectiveness of the nutrient taken up by the crops.

Materials and Methods

A field experiment was conducted at Crop Research Center-1, School of Agriculture, ITM University, Gwalior during *kharif* (2021-22). The soil was sandy loam in texture with pH 7.93, EC 0.40 dS m^{-1}, low available N,P and high available K (163.4, 19.4 and 416.8 kg ha^{-1} respectively). The experiment was laid out in randomized block design (RBD) with three replication and twelve treatments *viz.,* T_1- Control, T_2 - 100 % RDF through chemical fertilizer (120:60:30 NPK kg ha^{-1}), T_3 - 100 % RDF through chemical fertilizer + nano fertilizer @ 1 g l^{-1} of water, T_4 - 100 % RDF through chemical fertilizer + nano fertilizer @ 1.5 g l^{-1} of water, T_5- 100 % RDF through chemical fertilizer + nano fertilizer @ 2 g l^{-1} of water, T_6- 100 % RDF through chemical fertilizer + nano fertilizer @ 2.5 g l^{-1} of water, T_7-125 % RDF through chemical fertilizer, T_8- 75% chemical fertilizer + 25% vermicompost, T_9- 75% chemical fertilizer + 25% vermicompost + nano fertilizer @ 1 g l^{-1} of water, T_{10}- 75% chemical fertilizer + 25% vermicompost + nano fertilizer @ 1.5 g l^{-1} of water, T_{11}- 75% chemical fertilizer + 25% vermicompost + nano fertilizer @ 2 g l^{-1} of water, T_{12}- 75% chemical fertilizer + 25% vermicompost + nano fertilizer @ 2.5 g l^{-1} of water.

The form of Nano-fertilizers used was NPK composition of 19:19:19 percent. Nano N-P-K was sprayed twice at an interval of 15 days. First spray at 30 DAS and second at 45 DAS stage of the crop. At a seed rate of 20 kg ha^{-1}, the maize hybrid Kaveri Minchu was planted. A spacing of 60 cm row to row and 25 cm plant to plant was kept at the time of sowing.

Results and Discussion

Growth Parameters

The various treatments showed a significant difference on the growth attributes of maize. Among them application of 75% chemical fertilizer + 25% vermicompost + nano fertilizer @ 2.5 g l^{-1} of water (T_{12}) obtained significantly highest plant height (236.09 cm) at harvest stage, no. of leaves (18.40) at 90 DAS, leaf area per plant (7703.58 cm^2) at 90 DAS, dry matter accumulation (377.74 g $plant^{-1}$) at harvest stage over control and found on par with 75% chemical fertilizer + 25% vermicompost + nano fertilizer @ 2 g l^{-1} of water (T_{11}), 75% chemical fertilizer + 25% vermicompost + nano fertilizer @ 1.5 g l^{-1} of water (T_{10}) and 75% chemical fertilizer + 25% vermicompost + nano fertilizer @ 2.5 g l^{-1} of water (T_9).

This might be due, to the increased availability of nutrients as the treatments were applied by nano fertilizers, chemical fertilizers, and vermicompost. As the application of nano fertilizers will increase the microbial activity the nutrients in the soil are converted to readily available form quickly. The importance of these nutrients in promoting plant development is explained by the increase in plant height, dry matter, and dry matter accumulation caused by the application of nano fertilizers and RDFs. These nutrients are necessary for the plant to develop in a healthy and optimum manner and finish its life cycle.

Growth Analysis

The various treatments showed a significant difference on the growth analysis of maize. Among them application of 75% chemical fertilizer + 25% vermicompost + nano fertilizer @ 2.5 g l^{-1} of water (T_{12}) obtained significantly maximum Leaf area Index (5.14) at 90 DAS, Crop growth rate (CGR) (41.11 g day^{-1}) at 60-90 DAS and Relative growth rate (RGR) (74.77 mg g^{-1} day^{-1}) at 30-60 DAS stage over control and found on par with 75% chemical fertilizer + 25% vermicompost + nano fertilizer @ 2 g l^{-1} of water (T_{11}), 75% chemical fertilizer + 25% vermicompost + nano fertilizer @ 1.5 g l^{-1} of water (T_{10}) and 75% chemical fertilizer + 25% vermicompost + nano fertilizer @ 2.5 g l^{-1} of water (T_9).

The importance of these nutrients in promoting plant development is explained by the increase in plant height, dry matter, and dry matter accumulation caused by the application of nano fertilizers and RDFs. These nutrients are necessary for the plant to develop in a healthy and optimum manner and finish its life cycle. It participates in a variety of physiological processes that are essential for plant growth and development. These processes include the pro-

Table 1. Effect of Nano Fertilizers and Various Nutrient Sources on Plant Height (cm) and No. of Leaves.

Treatments	Plant height (cm)				No. of leaves			
	30 DAS	60 DAS	90 DAS	at harvest	30 DAS	60 DAS	90 DAS	at harvest
T_1	40.59	148.07	163.12	165.13	7.03	10.05	11.56	7.88
T_2	41.44	182.07	193.44	196.30	7.91	11.26	12.94	9.06
T_3	44.52	195.67	204.36	206.89	8.04	11.84	13.18	9.13
T_4	44.95	198.90	205.25	207.21	8.48	12.25	14.53	9.59
T_5	45.24	200.80	208.08	210.35	8.56	12.90	14.89	9.97
T_6	46.07	202.37	212.35	215.47	8.67	13.23	15.77	11.41
T_7	45.99	194.17	201.88	203.74	8.32	12.70	15.36	9.87
T_8	46.27	186.13	198.44	200.73	8.11	13.29	15.46	11.13
T_9	46.45	214.80	220.25	221.89	8.54	13.52	15.84	11.74
T_{10}	47.68	216.60	223.45	225.97	8.88	14.20	16.51	12.34
T_{11}	47.90	219.30	228.30	230.21	8.99	14.51	17.13	12.92
T_{12}	48.21	222.20	233.44	236.09	9.10	15.61	18.40	13.87
SEm ±	2.30	9.21	9.94	10.31	0.50	0.71	0.83	0.73
$CD_{(P=0.05)}$	NS	27.00	29.17	30.24	NS	2.1	2.43	2.16

Table 2. Effect of Nano Fertilizers and Various Nutrient Sources on Leaf Area Per Plant (Cm^2) and Dry Matter Accumulation (g $plant^{-1}$)

Treatments	Leaf area per plant (cm^2)				Dry matter accumulation (g $plant^{-1}$)			
	30 DAS	60 DAS	90 DAS	at harvest	30 DAS	60 DAS	90 DAS	at harvest
T_1	1852.20	4056.35	5258.21	2481.84	11.91	70.82	183.85	202.29
T_2	1935.06	4316.19	5676.62	2761.01	12.31	96.89	239.33	263.92
T_3	1953.42	4407.49	5812.85	2860.42	13.15	104.32	249.18	274.07
T_4	2146.98	4630.05	6152.37	3084.80	14.13	112.95	266.05	292.79
T_5	2247.61	4696.47	6567.39	3367.04	14.34	121.13	280.94	310.39
T_6	2304.65	4881.21	6731.02	3507.17	15.18	127.35	291.74	324.14
T_7	2166.92	4596.62	6255.17	3210.87	13.63	104.51	254.28	285.42
T_8	2248.90	4723.44	6516.80	3363.24	13.95	120.02	282.63	314.57
T_9	2317.04	4946.69	6829.09	3519.45	14.46	130.21	298.46	334.08
T_{10}	2374.14	5058.27	6970.35	3641.11	14.97	136.50	304.21	339.39
T_{11}	2460.15	5275.54	7289.29	3859.16	14.53	141.94	317.57	355.67
T_{12}	2506.88	5548.36	7703.58	4141.00	16.13	152.54	337.56	377.74
SEm±	143.51	222.22	301.98	212.50	0.83	8.04	13.74	15.05
$CD_{(P=0.05)}$	NS	651.74	885.66	623.25	NS	23.58	40.32	44.14

Table 3. Effect of Nano Fertilizers and Various Nutrient Sources on Crop Growth Rate (g day^{-1}), Relative Groth Rate (mg g^{-1} day^{-1}).

Treatments	Crop Growth Rate (g day^{-1})			Relative growth Rate (mg g^{-1} day^{-1})		
	30 - 60 DAS	60 - 90 DAS	90 DAS - Harvest	30 - 60 DAS	60 - 90 DAS	90 DAS - Harvest
T_1	13.08	25.11	2.74	59.48	26.53	3.14
T_2	18.79	31.65	3.66	68.54	26.69	3.17
T_3	20.25	32.18	3.70	69.29	27.32	3.21
T_4	21.95	34.01	3.96	69.30	27.60	3.29
T_5	23.72	35.50	4.37	71.04	27.64	3.32
T_6	24.92	36.52	4.80	71.75	28.57	3.65
T_7	20.19	33.27	4.61	67.95	28.11	3.51
T_8	23.57	36.13	4.73	71.33	28.55	3.58
T_9	25.94	37.16	5.13	73.29	28.96	3.75
T_{10}	27.00	37.26	5.23	73.77	29.66	3.77
T_{11}	28.16	39.02	5.75	73.83	30.23	3.79
T_{12}	30.31	41.11	6.05	74.77	31.90	3.85
SEm±	1.76	0.20	0.44	0.94	1.06	0.05
$CD_{(P=0.05)}$	5 16	0.59	1.29	2.75	3.12	0.15

Table 4. Effect of Nano Fertilizers and Various Nutrient Sources on Leaf Area Index.

Treatments	Leaf Area Index (LAI)			
	30 DAS	60 DAS	90 DAS	at harvest
T_1	1.23	2.70	3.51	1.65
T_2	1.29	2.88	3.78	1.83
T_3	1.30	2.94	3.88	1.90
T_4	1.43	3.09	4.10	2.05
T_5	1.50	3.13	4.38	2.23
T_6	1.54	3.25	4.49	2.33
T_7	1.44	3.06	4.17	2.13
T_8	1.50	3.15	4.34	2.23
T_9	1.54	3.30	4.55	2.33
T_{10}	1.58	3.37	4.65	2.42
T_{11}	1.64	3.52	4.86	2.56
T_{12}	1.67	3.70	5.14	2.75
SEm±	0.10	0.15	0.20	0.14
$CD_{(P=0.05)}$	NS	0.43	0.59	0.41

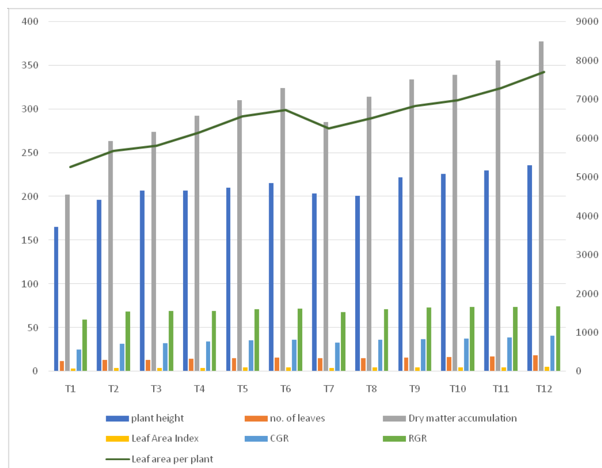

Fig. 1. Effect of Nano Fertilizers and Various Nutrient Sources on Various Growth Factors.

duction of chloroplasts and thylakoids as well as the synthesis of chlorophyll. It also participates in the transmission of energy inside the plant, several enzymatic processes, photosynthesis, respiration, and protein synthesis, and as a result, it is essential for plant development.

Conclusion

Based on the above results, it may be concluded that the application of 75% chemical fertilizer + 25% vermicompost + nano fertilizer @ 2.5 g l^{-1} of water holds promise as an agronomically sound and viable technology for enhancing maize growth and its attributes.

Reference

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