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Combination of Mineral and Bio Fertilization and Their Effects on Growth and Nutrient Uptake by Fodder Maize

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Abstract: Application of biofertilizers became of great necessity to get a yield of high quality and to avoid the environmental pollution. A pot experiment was carried out to replace a part of chemical fertilizers by bio-fertilizers treatments and their effect on growth and chemical composition of maize fodder plants. The treatments were (T1) 100% 0f recommended NPK ; (T2) 300 ml of bio-fertilizers/pot ; (T3) 25% NPK +225 ml of bio-fertilizers; (T4) 50% NPK + 150 ml bio-fertilizers; (T5) 75% NPK + 75 ml bio-fertilizers; (T6) 75 ml of bio-fertilizes + one foliar spray of NPK compound (19:19:19) ; (T7) 150 ml bio-fertilizer as NPK + Two foliar sprays of NPK compound and T8) 225 ml bio-fertilizer as NPK + Three foliar spray of NPK compound. Data showed that application of NPK with biofertilizers significantly, increased growth parameters in the first and Second harvests compared with adding NPK and biofertilizers alone to maize plant. Also, data showed that application of recommended rates of mineral fertilizers (NPK) stimulate the nitrogen concentration in plant maize in first harvest. However, bio fertilizers added at rates 100% of the recommended decrease nitrogen concentration by about 8% in plant. Results also show that application of P in both forms of (mineral + bio fertilizer) applied as soil treatments e.g. T3, T4 and T5 (25% NPK 75 ml/pot bio-fertilizers), (50% NPK + 150 ml/pot bio fertilizer) (75% NPK + 75 ml bio fertilizer) stimulate the concentration of phosphorous content in maize plant. Maximum concentration noticed in T4 by about 55% as compared with the control one followed by T5 and T 3. Results observed that application of chemical and bio- fertilizer stimulate the concentration of nutrient content particularly in the rhizosphere; application of 300 ml/pot bio fertilizer/pot gradually decrease K- concentration in maize plant. Whereas soil application of combination between mineral and bio fertilizers progressively increment K- concentration in leaves of maize plants and more pronounced effect than soil or foliar treatment separately. Data showed that microbiological counts in the rhizosphere samples after 65 days from sowing affect the total count of bacteria, fungi, actinomyces, azotobacter, phosphate dissolving bacteria and potassium silicate. Application of 50 % recommended NPK in combination with 150ml/pot bio fertilizer gave the highest counts of total bacterial, Azotobacter and phosphate dissolving bacteria.

Key words: Mineral-bio fertilization · Methods of application · Growth parameters · Pigments · Chemical constituents · Maize plants

INTRODUCTION

Maize (*Zea mays* L.) is one of the major cereal crops, it is ranks the third following wheat and rice in world production as reported by Food and Agriculture Organization [1]. It is considered as an important cereal crop for feeding humans, poultry and livestock [2]. Maize is grown for forage purposes. Fodder maize the most important forage after grass compared to other cereal crops. Its rapid growth and taste is palatable to the animal with a high dry matter production and relatively and high-energy content and considerable protein compared

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to other cereal crops. It is therefore directly fed to farm animals as fresh or silage [3-5]. Biofertilizer is a natural input that can be used as a complement or substitute for chemical fertilizer in sustainable agriculture.Biofertilizers are soil organisms or as metabolic products of these organisms that is used in order to provide plant nutrients to an agronomic ecosystem Studies conducted on medicinal plants in natural and agronomic ecosystems indicate that use of biofertilizers provide the necessary conditions for high yield with good quality [6].

Integrated use of biofertilizers provides a cheaper, more intensive and environmentally friendly way to boost farm productivity [7, 8, 9]. The utilization of biofertilizers has become very important in agriculture. Biofertilizers usually contain microorganisms having specific function such as phytostimulators, Azospirillum to fix nitrogen and P solubilizing bacteria to solubilize P from the soil and fertilizer to be available to the plants [10, 11, 12] found that the application of Supernitroplassasbiofertilizer with Phosphate Barvar2 treatment had the highest seed yield (7.6 ton / ha) compared with the non-application of biofertilizer treatment with the lowest seed yield (6.3 ton / ha). They also suggested that increases in grain yield and biomass yield were reported with the use of significant biofertilizers [13, 14]. Suggested that the effect of nitrogen and phosphate biofertilizers were evaluatedpositively, by increasing in plant height, ear weight and number of grain / cob, grain yield and biomass yield. Increasing yield was attributed to the plant growth promoting substances by root colonizing bacteria more than the biological nitrogen fixation stated that yield increased due to promoting root growth which in turn enhancing nutrients and water uptake from the soil. Darzi [15] reported that positive and synergistic interactions between mycorrhizal inoculation and phosphate biofertilizers on N concentration, phosphate biofertilizers on P concentration. Biofertilizers might be a better eco-friendly option to maintain soil fertility. Addition of both nitrogen and phosphorus fertilizers is necessary to attain the maximum yield [16]. Application of nitrogen base on soil test and inoculated with 2 kg/ha bacteria, produced the highest number of grains /row, the total number of grains / corn, 1000 grains weight, harvest index and grain yield [17]. Azotobacter significantly enhanced biofertilizer through increase in plant growth and yield of maize [18]. Highest yield may be due to maximum leaf area, highest weight of leaf and highest chlorophyll content. In addition, highest biomass and greatest harvest index were recorded over other treatments Laxminarayana, [19] stated that inoculation of maize grains with Azotobacter and Azospirillum produced more yield as compared with fertilizer application alone. Therefore, this work was carried out to replacepart of chemical fertilizers by bio-fertilizers treatments and their effect on growth and chemical composition of maize fodder plants.

MATERIALS AND METHODS

A pot experiment carried out to examine the possibility of using biofertilizers to reduce the recommended soil mineral fertilizers applied to maize plants (*Zea mays* L.). A representative soil sample was taken before the addition of any fertilizers to determine the chemical and physical characteristics (Table 1). Plastic pots having of 40 cm internal diameter and50 cm depth were used. Each pot with 40 kg soil. Eight treatments and three replications following Complete Randomized Block Design with three replications according to [20].

The treatments were as follow:

T1: Recommended rate of chemical fertilizers NPK 100%.
T2: 300 ml of bio-fertilizer only.
T3: 25% of recommended rate of NPK +225 ml of bio-fertilizers.
T4: 50% of recommended rate of NPK + 150 ml bio-fertilizers.
T5: 75% of recommended rate of NPK + 75 ml bio-fertilizers.
T6: Three foliar spray of NPK compound* + 75 ml of bio-fertilizes
T7: Two foliar spray of NPKcompound+ 150 ml bio-fertilizer as NPK
T8: One foliar spray of NPK compound +225 ml bio-fertilizer as NPK

The used compound of chemical fertilizer were 19- 19 -19 (N-P-K-), spraying was after 30, 40, 50 for T6, 30 and 40 for T7 and 30 days from sowing.for T8 at a rate of 5%..Four maize grains were sown in each pot, thinned to be two seedlings 15 days later. The recommended NPK fertilizers according toMinstry of Agriculture are 8g/pot single super phosphate 15.5% P_2O_5, 14g/pot ammonium nitrate 33.5%N and4g /pot potassium sulphate 48% K_2O. According to experiment treatments, two methods of applied mineral fertilizers were used, first was applied as soil application at the rates of 100, 75 and 50% of the recommended NPKwhile the second was added as foliar spray using compound 19-19 -19 (N-P-K), spraying was after 30, 40, 50 days for T6, 45 and 50 days for T7 and 30

Table 1: Some chemical and physical characteristics of the investigated soil.

Physical properties				Chemical properties						
Sand	Silt	Clay						N	P	K
%--------			Texture	pH	ECdSm^{-1}	$CaCO_3$%	OM%	(ppm)		
73.34	23.00	3.66	Sandy loam	8.13	0.67	2.66	0.89	208.3	2.76	457

days from sowing for T8 at a rate of5%as mentioned before.Two weeks later after the last spray (65 days from sowing) the plants were harvestedto determineplant height, stem diameter, leaves number /plant, length of leaves, width of leaves, fresh and dry matter of leaves /plant. First and second vegetativesamples were taken after 35 and 65 days of sowing.

Chemical Analysis: Chlorophyll a, b and total carotenoids in leaves were determined using the method described by [21].

- Total N, P, K, Ca and Mg in fresh and dry matter of leaves and roots were determined according to the methods of the [22].
- The physical and chemical properties of the soil were determined according to the method described by [23].

Biological Properties: Bio-fertilizers consisted of high efficient strains of Azotobacterchrococcum (a free-living nitrogen fixing bacteria), Bacillus megaterium var. phosphaticum (phosphate dissolvers) and Bacillus sp (potassium dissolvers) obtained from the culture collection of the Agricultural Microbiology Department, National Research Centre, Dokki Giza. The selected three bacterial strains were propagated in sterilized proper nutrient broth media and incubated on a rotary shaker (180 rpm) at 28°C for 5 days. Turbidity, as bacterial growth indicator, of the cultures was adjusted calorimetrically to optical density of 1.6 at wave length of 420 nm to give $5x10^9$ viable cells/ ml, respectively for Azotobacter after 6 days. phosphste and potassium dissolvers after 4 days incubation at 28-30°C. Bio-fertilizers were added to soil at rates of 75, 150, and 225 ml/pot ml as soil application.

Microbiological Analyses: Microbiological analyses of the rhizosphere sample after 80 days from sowing were conducted using the standard dilution, [24] for total bacteria count. Phosphate dissolving bacteria count (PDB) was determined using methods described by [25]. In order to count the living microbes in rhizosphere after 80 days, it is required that dilution is carried out to a level where the microbes can be counted correctly and accurately as specified by each methodology and the rhizosphere sample must be distributed thoroughly and homogeneously in the diluent as much as possible. The quantity of rhizosphere sample to be used for each analysis depends on the homogeneous characteristic of the sample used. In general, the sample should not be less than 10 g.

RESULTS AND DISCUSSION

Effect of Bio- and Chemical Fertilizers and Their Combination:

Growth Parameters: Data presented in Table (2) Biofertilizer is a biological product that can be used to ameliorate the fertility of soil, additionally enriching soil with microorganisms, producing organic nutrients, which reduce the plant diseases. Biofertilizers can be a better eco-friendly option to maintain soil fertility [26]. Results showed that 75% of NPK +75 ml/pot bio fertilizers gave the highest increments in all studied growth parameters. Wani [18] reported that Azotobacter enhanced bio fertilizer and has the significant increase in plant growth and yield of maize. It can be also noticed that both treatments T2 and T6 (300 ml/pot bio fertilizers and three foliar spray of NPK compound +75ml/pot bio fertilizers) gave the lowest values. The highest yield may be due to maximum leaf area, highest weight of leaf and highest chlorophyll content. Laxminarayana, [19]. Reported that, highest biomass and greatest harvest index were recorded over other treatments. Inoculation of seeds with Azotobacterand Azospirillum produced more yield compared to fertilizer application alone [27]. Several researchers reported that bio fertilizers are being used due to their recognized roles in growth, yield and nutritional quality of various crops including- maize, bean, cucumber and tomato [28, 29, 30]. Harman, [31] reported that stimulating

Table 2: Effect of bio- and chemical fertilizers and their combinationon growth parameters of maize plants.

	First sample (35 days)							Second sample (65 days)						
Treatments	Plant height	Stem diameter	leaves No /plant	Length of leaves	Width of leaves	F.M gm plant^{-1}	DM gm plant^{-1}	Plant height	Stem diameter	Leaves No /plant	Length of leaves	Width of leaves	F.M gm plant^{-1}	D.M gm plant^{-1}
T1	81.75	0.61	7	57.3	4.93	62.26	10.97	112.78	0.87	8	74.33	5.27	113.55	14.28
T2	73.20	0.47	6	49.7	4.17	57.38	9.56	94.92	0.72	7	63.76	4.97	98.17	12.03
T3	91.12	0.90	8	69.0	5.13	80.62	17.84	116.31	1.38	11	84.00	5.73	123.09	19.44
T4	99.80	1.30	9	70.7	5.63	97.74	19.88	135.34	1.56	12	92.67	6.40	159.85	24.05
T5	110.03	1.73	11	88.0	6.63	133.30	21.81	154.49	2.07	13	94.00	7.20	186.41	27.74
T6	74.43	0.83	7	60.0	5.17	85.24	14.15	118.32	1.15	9	88.67	5.33	153.29	21.38
T7	92.91	1.03	9	63.7	5.63	94.45	15.27	124.84	1.23	10	100.0	5.87	195.58	27.52
T8	122.79	1.44	9	82.7	6.57	113.17	18.26	149.51	1.80	12	105.00	6.90	208.78	33.46
LSD 5%	4.55	0.10	1.64	4.8	0.30	7.37	0.90	6.44	0.10	1.71	4.49	1.03	9.86	1.56

effects of Trichoderma on maize plants growth, however negative effects were observed by [32, 33] stated that pathogenic isolates of Trichoderma spp on maize stimulated the plants growth El-Hoseiny [34] found that bacterization of maize with Azotobacterdisposed to animate the growth of treated plants as indicated by advancing of both root and shoot lengths Nieto, [35] noticed that plant height and internodes length of the corn stalks gradually increased by using bacterium Azotobacterwhich produce cytokinin and its originator Mirza, [36] attributed the efficiency of application of bio fertilizers itself through nitrogen fixation, caused the production of auxin that increase nutrients, availability and therefore, improves plant height. Hajieghrari, [37] demonstrates that application of bio fertilizers gradually stimulated and enhancement leaves growth and also decreasing theroot-shoot ratio of maize may be due to Trichoderma inoculation. Similarly were observed by [38, 39] reported that inoculation treatment gradually increase the production of phytohormones due to by bio fertilizers application and therefore, improving the availability of nutrients status. Shafeek, [40] reported that bio-fertilizer significantly increased all plant growth characters of broad bean plants as compared with control one [41] explain these distinction, which may be directed to the microorganisms inoculation itself, particularly in the first place, supporting rhizosphere with these bacteria. Furthermore, promoted plant growth each precisely, by achievement plant hormones and advancement nutrient uptake, or backhanded, by fluctuating microbial equation in rhizosphere in advancement of the beneficial microorganisms. N bio-fertilizer bacteria (Piogen) enhancements plant growth particularly in the plowed soil and perform some growth hormone, as gibberellins, auxins and Cytokinins [42] currently, its advantageous achievement was convenient with those obtained by several researchers [43, 44, 45].

Data in Table (2) showed that application of biofertilizers stimulate the fresh and dray matter yield of maize plant, results indicated that soil application of bio fertilizers reduced the FM, DM of maize plant by about 8-13%. However, the combination of both inorganic and biofertilizers gradually increase both FM, DM of maize plant. Data also showed that soil application of biofertilizers stimulated the FM and DM. T5 treatment (75%NPK+ 75 ml/pot bio fertilizer) gave the maximum increased. Average of increases was 29, 57 and 114% for T3, T4 and T5, respectively. Combination of inorganic + Foliar of bio cementT6, T7 and T8 respectively.Data revealed that application of mineral of NPK or combined with NPK bio fertilizers in both two methods of application (soil and foliar application) observed same trend as shown in the first harvest. Application of recommended rate of NPK gradually increased the FM and DM of the maize plant as compared to the first harvest. Maximum increased was observed in the treatments of T6, T7 and T8 as compared with the first one. Shafeek, [46] stated that bio fertilizers and phytostimulators dominate secondary advantageous enforcement that would increase their hopeless as bio inoculants, microorganisms such as Rhizobium and Glomus spp. have been also play a role in reducing plant diseases.

Chemical Composition in Maize Plant (*Zea mays* L.)

Macronutrients Concentrations (NPK): Data in Table (3) showed that application of recommended rates of mineral fertilizers (NPK) stimulate the nitrogen concentration in plant maize. However, bio fertilizers added Moreover, combination between mineral fertilizers and bio fertilizer significantly increased both N concentration and uptake as compared with mineral fertilizers or bio fertilizers alone. Sanjay Mahato [26] reported that rapid increase in plant height due to top dressing of mineral N- fertilizer causes a reduction and furthermore nitrogen content in plant [47] reported that analysis of

Table 3: Effect of bio- and chemical fertilizers and their combination on NPK concentration and uptakes of maize plants.

	First sample (35 days)						Second sample (65 days)					
	N %	N uptake mg/plant	P %	P uptake mg/plant	K %	K uptake mg/plant	N %	N uptake mg/plant	P %	P uptake mg/plant	K %	K uptake mg/plant
T1	0.64	70	0.22	24	1.74	195	1.37	196	0.26	37	1.84	263
T2	0.59	56	0.16	15	1.45	138	1.18	142	0.21	25	1.57	189
T3	0.78	139	0.27	48	2.40	431	1.61	313	0.34	66	2.76	537
T4	0.92	183	0.34	68	2.68	529	1.65	397	0.40	96	3.09	741
T5	0.88	192	0.30	65	2.31	517	1.54	427	0.37	103	2.59	718
T6	0.68	96	0.29	41	2.20	317	1.43	306	0.36	77	2.43	520
T7	0.81	124	0.36	55	2.33	358	1.50	413	0.47	129	2.60	718
T8	0.77	146	0.35	64	2.15	394	1.43	478	0.42	141	2.30	770
LSD 5%	0.06	17	0.04	7	0.06	19	0.10	35	0.07	15	0.11	43

leaves fertilizedwith either sole organic fertilizer (0.84%) or combined with inorganic fertilizer (0.98%) were lower, relative to N of leaves from sole inorganic fertilizer (1.68%). Several field research reports have indicated that high and sustainable crop yields are only possible with integrated use of mineral fertilizers with organic manure [48], it is also important not only for advancing the ability of the fertilizers, but also in depressing environmental problems that may proceed from their use). Approving appositeness of organic and inorganic fertilizers increases nutrient, simintanously and reduces losses by altering inorganic nitrogen into organic forms [49, 50] stated that indicative lower yield from organic fertilizer application assists the observation that organic fertilizers are better used for supporting continuous cropping for 2 – 3 years than inorganic fertilizers. Results showed that, assimilation of mineral and bio fertilizers progressively increase the nitrogen concentration in maize plant. Results observed that Maximum concentration (44%) were noticed in treatment of (T4) soil application (50% of recommended NPK +150 ml/pot bio fertilizer) as compared with the recommended mineral fertilizer [51] they stated that biological nitrogen fertilizer (BNF) could be deliberated as long-term prospective nitrogen source for low apparent input corn production systems. Data in Table (3) also showed that integration between chemical and bio fertilizers applied to soil and foliar spraying gradually stimulate the nitrogen concentration in maize plant,results noticed 50% of both mineral and bio fertilizers (T7) added as soil and foliar application increased N- concentration in maize plant. Several researchers reported that this increments attributed to bio fertilizers inoculation which producing phytohormones and organic compounds that improving the availability of nutrients by maize plant [38, 39, 41, 52] reported that foliar application of bio fertilizer had a expressive guidance on all growth characters and protein content of leaves. Results noticed that soil application of chemical fertilizer and bio fertilizer were more effective than soil application and foliar spraying separately [53] stated that bio fertilizers responsible for nitrogen fixation, the microbial inoculation stimulate plant growth through execration hormones production, nutrient enhancement by plant uptake and promote the biological status of the rhizosphere.

Data in Table (3) showed that application of recommended rate of chemical fertilizer (NPK) stimulate the concentration of phosphorous concentration in maize plant. Whereas application of NPK - bio fertilizer resulted in a reduction of P concentration, due to high pH value of the investigated soil, since most of phosphorous is in the insoluble fraction and plant cannot uptake it. Results also observed that application of P in both forms of (mineral + bio fertilizer) applied as soil treatments e.g. T3, T4 and T5 (25% of recommended NPK +225 ml/pot bio fertilizer), stimulate the concentration of phosphorous content in maize plant. Maximum concentration noticed in T4 by about 55% as compared with the control one followed by T5 and T 3 [54, 55] reported that dynamics of phosphorous in soil is characterized by sorption-desorption reactions and biological processes. Large amount of P applied as fertilizer enters into the immobile forms through precipitation reaction in acidic condition with highly reactive Al^{3+} and Fe^{3+} and Ca^{2+} in calcareous or normal soils. Efficiency of Phosphorous fertilizer throughout the world is about 10 - 25 % [56] and bioavailability and mobility of Phosphorous is very low (1.0 mg kg^{-1} soil) [56]. Soil microorganisms play an important role in soil P driving and consequently applicability of phosphate to Growing plants [57]. Soil bacteria are accomplished of altering soil Phosphorous to available forms and can absorbs available Phosphorous and prohibit from adsorption or fixation reactions [58]. Data also revealed

Table 4: Effect of bio- and chemical fertilizers and their combination on photosynthetic pigments (mg/g f.w) in fresh leaves of maize

	First sample (35 days)				Second sample (65 days)			
Treatments	Ch a	Ch b	Car	Total	Ch a	Ch b	Car	Total
				(mg/g f.w)				
T1	16.83	3.99	4.30	25.12	16.71	2.66	4.96	24.33
T2	16.46	2.74	4.77	23.96	15.33	2.32	5.28	22.92
T3	17.96	3.72	5.51	27.18	19.79	3.30	6.85	30.42
T4	20.72	4.50	7.45	33.47	18.56	4.88	6.21	29.65
T5	21.94	7.64	7.42	36.81	22.99	4.79	7.57	35.34
T6	18.39	2.92	6.27	27.58	19.41	6.77	4.07	30.24
T7	17.81	2.6	5.96	26.37	17.03	6.18	4.83	28.04
T8	25.28	6.06	8.26	39.58	22.35	4.15	7.84	34.58

Table 5: Effect of bio- and chemical fertilizers and their combination microbiological counts(CFU /g dry soil) after 65 days from planting

Treatments	T $Cx10^6$	T $Fx10^3$	$Actenox10^3$	$Azot\ x10^5$	$Phosx10^5$	$Potax10^5$
T1	135	23	13	48	36	30
T2	137	25	14	50	41	32
T3	147	21	15	58	48	37
T4	150	23	18	80	55	45
T5	139	22	16	70	41	39
T6	142	26	15	70	39	36
T7	149	27	16	55	53	42
T8	145	29	18	50	51	40

that application of mineral and bio fertilizers applied as soil and foliar spraying (T6,T7, T8) gradually increase the P concentration in maize plant. Application of T7 dramatically increased the phosphorous concentration in plant tissues of maize plant by about (64%) followed by T8 (59%) and T6 (32%).The results revealed that application of chemical and bio- fertilizer stimulate the concentration ofnutrient content particularly in the rhizosphere; application of 100% bio fertilizer gradually decrease K- concentration in maize plant. Whereas soil application of combination between mineral and bio fertilizers progressively increased K- concentration in leaves of maize plants and more pronounced effect than soil foliar treatment separately [59, 60], 61indicated that Biofertilizer increased the supply or availability of essential nutrients and promote plant growth.

Photosynthesis Pigments: Data given in Table (4) show increasing chlorophyll a and b and Carotenoids in shoots (D.M) of maize plants with application of chemical fertilizers as compared with the bio-fertilizers alone. Data indicated that, the highest increments resulted from the application of one foliar spray of NPK compound +225 ml bio-fertilizer as NPK. In addition to that, foliar application of Three foliar spray of NPK compound + 75 ml of bio-fertilizes resulted in marked positive effect on chl. a & b and carotene as compared with control treatment

Microbiological Counts: The development and use of microbial-based fertilizers has recently gained significance due to the recognition of the deleterious effects on the environment generated by the excessive and/or improper application of chemical fertilizers. This was a result of the improved knowledge about the relationships occurring in the rhizosphere, between the plant and all soil microorganisms, as well as due to the immense efforts in isolating and selecting microbial strains showing plant growth promotion capabilities.

Data in Table(5) show that microbiological counts in the rhizosphere samples after 65 days from sowing affect the microbial density in total count of bacteria, fungi, actinomyces, azotobacter, phosphate dissolving bacteria and potassium silicate.Microbial density in the rhizosphere were gradually affected by bio-and chemical fertilization. Bio-fertilizers treatments reflected an increase in the microbial density in the rhizosphere samples. Total bacterial count, fungal, actinomyces and azotobacter as well as phosphate dissolving bacteria and potassium silicate recorded higher counts in the rhizosphere due to bio fertilizers application as comparing with chemical fertilizers treatments. It is obvious that bio-chemical fertilization enriched the rhizosphere by the different microorganisms. Higher values were recorded by treatments of bio-fertilization for total bacterial count, total fungi, actinomyces,

azotobacter and phosphate dissolving bacteria and potassium silicate. The integration between chemical and bio fertilizers at equal dose gave the highest counts of total bacteria and Azotobacter and phosphate dissolving bacteria. Results also showed that chemical fertilization (NPK) alone gave the lower counts of total bacteria, fungi, actinomyces and azotobacter as well as phosphate and potassium silicate. Therefore, whether the microorganism increases the growth of plants by replacing soil nutrients (i.e., by biological N2 fixation), by making nutrients more available to plants (i.e., by solubilization of nutrients) or by increasing plant access to nutrients (i.e., by increasing the volume of soil accessed by the root system), as long as the nutrient status of the plant has been enhanced bythe microorganism [62, 63] stated that application of EM solution gradually increased the overall densities of viable bacteria in the soil, as compared to the control group with sterilized EM (p=0.999) and with the treatment received chemical fertilizer (p=0.987). Only EM bokashi plus EM solution significantly increased the microbial density (435000000CFU) in the soil (p=0.000992). They also reported that treatment with EM bokashi plus EM solution resulted in the maximum biomass of seed pod; it also enhanced the increase of seed yield. Moreover, EM plus bokashi had the highest microbial densities through either a stimulation of the soil micro-flora, or an input of the compost micro-flora or a combination of both.

EM combined with organic matter such as EM bokashi or other compost that is an important source of nutrients usable by microorganisms for improving the plant growth.

Application of microorganisms to the plant or soil enriched the rhizosphere of the maize plant by microorganisms that facilitate solubility, absorption of nutrients by roots and nutrients content of rhizosphere plant might by increased. Increases in nutrients uptake and content of the maize plant may reflect increases in the vegetative growth and photosynthetic activity that might by reflected as increases in total yield. Zaki [64] working on sweet fennel came to similar results.

CONCLUSION

It could be concluded from this study that partialreplacing of chemical fertilizers by bio-fertilizers is effective in increasing fodder yield and improving the nutritive value of fodder maize. Such integration between chemical and bio fertilizers is important for fertilizer rationalizing and increasing forage productivity.

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