International Journal of Multidisciplinary Research and Development
Online ISSN: 2349-4182, Print ISSN: 2349-5979
Impact Factor: RJIF 5.72
www.allsubjectjournal.com
Volume 4; Issue 12; December 2017; Page No. 03-08

Characterization of enriched rock phosphate, bio-compost and partitioning study of micronutrient in maize crop under south Gujarat

Asmatullah Durani, Sonal Tripathi, Narendra Singh, Rajkishor, Jiamin R Naik
Department of Soil Science and Agricultural Chemistry, NMCA, Agricultural University, Navsari, Gujarat, India

Abstract
An investigate was carried out with different rate of rock phosphate enriched compost and single supper phosphate fertilizer alone or combined with vascular arbuscular mycorrhizal (VAM) applied to *rabi* maize in the year 2015-16 and 2016-17. Concentration of iron Fe (674.8 mg kg^{-1}) significantly increased the in maize straw in pooled analysis. Manganese (Mn) and zinc (Zn) in maize cover, silk and Zinc content and maize cover and grain significantly higher in 75% P as RP+ AM (T_8) treated plots and also Fe, Mn, Zn and Cu content in the different part of maize numerically increased over control plots which was statistically non-significant. Rock phosphate and SSP alone or combined with AM increased the micronutrients concentration, in the different part of maize.

Keywords: rock phosphate (enriched compost), SSP and AM, Maize, Fe, Mn, Zn and Cu

Introduction

Maize is economically important cereal grain crop after wheat and rice. It is used as staple food for human, livestock and as raw material for industries. Rock phosphate (RP) is mainly composed from apatite minerals. Scientifically managed system of soil mycorrhiza, bacteria plant association is useful in conserving energy by reducing fertilizer requirement of crops and meeting production targets in nutritionally deficient soils. Because of their ubiquitous nature, extensive host range and plant growth benefits, endomycorrhiza, especially VAM type are important to increase the absorption of relatively immobile elements such as P, Cu, Zn etc. in soil. Jakobsen (1983) [8] reported increased dry matter production, P, Zn, Cu uptake by barley inoculated with *Glomus caledonium*. Raju *et al.* (1990) [14] showed that sorghum plant inoculated with VAM recorded higher amount of P, K, Mg, Mn, S, Ca, Fe, Cu and Zn than non-mycorrhizal plants. A RP, which is considered slow releasing P source (Akande *et al.*, 1998) [2], was also applied in combination with various bio-organic sources such P solubilizing fungi and bacteria (Khalil *et al.*, 2002; Cabello *et al.*, 2005) [3, 9] organic manures (Akande *et al.*, 2005) [3] and inorganic substances like (Harry *et al.*, 2002) [7], pyrite (Singh *et al.*, 1993) [17] or different kinds of acids (Basakar and Deg, 1997) [5] to increase release of P and subsequent influence to increased nutrient concentration in the plant. Rock phosphate has mixed some other minerals with like enriched compost which supply micronutrient for plant growth but not very sufficient information about direct application of RP to the plant. Rock phosphate has the capacity to increase the micronutrient concentration in soil as well as in crop growth and yield. Various researchers have worked on direct applications of RP to soil and reported even superior results than commercial fertilizer in some instances (Menkeni *et al.*, 1991; White *et al.*, 1999) [12, 22]. Bashir *et al.*, (2012) [6] study the effect of rock phosphate and micronutrient content in maize. Single super phosphate (SSP) is very common source of P used by farmer community and an ample amount of work is done in this regard. Although some information is available on the influence of phosphate applied as SSP the growth of some crops. There is a dearth of information on the effect of these sources on VAM fungi and their role in the nutrition of crop plants. The enormous variability in agronomic effectiveness of different types of phosphate rock due to variations in physico-chemical and edaphic factors, has made it increasingly difficult to extrapolate results from one location to another. Its effectiveness as sole application is proved by the highest total biomass in soybean (Sharma et al., 2002) maize (Akande *et al.*, 2010) [4], chickpea (Srividya *et al.*, 2009) [18] and cowpea (Akande *et al.*, 2010) [4] compared with RP. Although from the present study Characterization of enriched rock phosphate, bio-compost and partitioning study of micronutrient in Maize crop under South Gujarat

Material and Methods

The field experiment was conducted at the College Farm, Navsari Agricultural University, Navsari in the year 2015-16 and 2016-17. To study the effect of SSP, RP (enriched compost) alone or combined with AM and micro nutrients content in the different part of maize during 2015-16 and 2016-17. The details treatment combination was given in Table (1) with replicated three times in randomized block design with 42 treatment combination. Soil of the experimental field was clayey in texture, slightly alkaline in reaction (pH 7.8), Electrical conductivity 0.145 (dS/m) at 25 C and low in organic carbon (0.44%) and available nitrogen (206.50 kg ha^{-1}), medium in available phosphorus (31.20 kg ha^{-1}) and high in available potassium (323.18 kg ha-1). Total available micronutrient content iron 4.18 mg kg^{-1}, lower of copper (Cu) 0.049 mg kg^{-1}, zinc (Zn), 0.264 mg kg^{-1} and 6.2

mg kg^{-1} of manganese (Mn). Properties of the bio-compost which applied (15t ha^{-1}) and properties of (RP-enriched compost) bellow in the (Table 2).

Table 1: Treatment details

T1	**:**	**Rabi Fallow**
T2	:	Absolute control (No fertilizer and AM)
T3	:	50% P as RP
T4	:	50% P as RP +AM
T5	:	50 % P as SSP
T6	:	50 % P as SSP+ AM
T7	:	75% P as RP
T8	:	75% P as RP +AM
T9	:	75% P as SSP
T10	:	75% P as SSP +AM
T11	:	100 % P as RP
T12	:	100 % P as RP+ AM
T13	:	100% P as SSP
T14	:	100% P as SSP+ AM

Table 2: Characterization of bio-compost and rock phosphate enriched compost

Properties of Biocompost		
pH	6.32	
EC	0.14	(dS/m)
Available p	45.3	mg kg-1
Available N	122.6	mg kg-1
Available K	274.8	mg kg-1
Iron (Fe)	10.6	mg kg-1
Copper (Cu)	0.67	mg kg-1
Zinc (Zn)	2.32	mg kg-1
Manganese (Mn)	1.34	mg kg-1
Properties of Rock Phosphate		
Total P	0.023	(%)
Available K	175.0	mg kg-1
Available N	97.0	mg ha-1
Iron (Fe)	5.60	mg kg-1
Copper (Cu)	1.30	mg kg-1
Zinc (Zn)	1.52	mg kg-1
Manganese (Mn)	1.10	mg kg-1

Micronutrient Contents in Different Part of Maize

Plant different part (Straw, Silk, Cob, Cover and grain) after harvesting and ground in willey mill to pass through 40 mesh sieve and plant material (0.5g) was digested in di-acid mixture of HNO_3 and $HClO_4$ (3:1) and total Fe, Mn, Zn and Cu form the plant extract after digestion and volume was direct using Atomic plasma emission spectroscopy by Lindsay and Norvell (1978) [11]. The data on various variables were analysed by using statistical procedures and pooled analysis of the preceding *rabi* maize analyzed for two years was worked out as per the method described by (Panse and Sukhatme, 1967) [13].

Results and Discussion

Influence of Bio-Compost on Micronutrient Content in Different Parts of Maize Crop

Fe (mg kg^{-1}) Content in Maize Straw, Cob, Silk and Grain

Iron (Fe) content in the years 2015-16 and 2016-17 analysis among different treatments tried in experimental plot was found to be non-significant but the average of pooled analysis was found significant and results revealed that 75% P as RP+AM (T_8) recorded significantly higher iron (Fe) content in maize straw and lower was observed (354.2 mg kg^{-1}) in control (T_2). The iron (Fe) content in maize straw (674.8 mg kg^{-1}) in pooled analysis it was significantly higher than with control (T_2), 50%P as RP+AM (T4), 50 % P as SSP (T_5), 75% P as SSP +AM (T_{10}) 100% P as SSP (T_{13}) and 100% P as SSP+ AM(T_{14}). However, it was at par with 50% P as RP (T_3), 50 % P as SSP+ AM (T_6), 75% P as RP (T_7) 75% P as SSP (T_9) 100 % P as RP (T_{11}) and 100 % P as RP+ AM (T_{12}) treated plots. The pooled data among different treatments of both the year revealed that, 75% P as RP+AM (T_8) recorded non-significantly higher iron (Fe) content in maize cover and lower was observed in control (T_2). Whereas, in case of maize cob, the iron (Fe) content was 125.4, 125.7 and 125.5 mg kg^{-1}, respectively with the application of 75% P as RP+AM (T_8) treated plot in the both two years of the experiment 2015-16, 2016-17 and average of the pooled analysis and it was non-significantly, increased over other phosphorus fertilizer treated plots. The iron (Fe) content in maize cob 2015-16 and pooled varied from (100.8, 77.0 and 88.9 mg kg^{-1}) in control (T_2) to 149.4, 95.7, 122.5 mg kg^{-1} with application of 50 % P as SSP+ AM (T_6). It was noted that application of phosphorus in soil either though SSP, RP or SSP, RP with AM increased non-significantly iron (Fe) content in maize cob than control (Table 3). In the years 2015-16 and pooled analysis among different treatments tried in experimental plot, 75% P as SSP+AM (T_{10}) recorded non-significantly higher iron (Fe) content in maize silk and lower was observed in control (T_2). The iron (Fe) content in maize silk was showed 756.6, 759.0 and 757.8 mg kg^{-1} with the application of 75% P as SSP+AM (T_{10}) treated plot in the both two years of the experiment 2015-16 and average of the pooled analysis and it was non-significantly, increased over other phosphorus fertilizer treated plots. Whereas, in case of maize grain, the iron (Fe) content was In the years 2015-16 and pooled analysis among different treatments tried in experimental plot, 75% P as RP+AM (T_8) recorded non-significantly higher iron (Fe) content in maize grain and lower was observed in control (T_2). The iron (Fe) content in maize grain was showed 319.7, 317.0 and 323.4 mg kg^{-1} with the application of 75% P as RP+AM (T_8) treated plot in the both two years of the experiment 2015-16 and average of the pooled analysis and it was non-significantly, increased over other phosphorus fertilizer treated plots. In generally among the treatment that combined application of different phosphorus fertilizer along with AM showed numerically higher iron (Fe) content which was statistically not significant. Similar results were obtained by Li *et al.*, (1991) [10]; showed that sorghum plant inoculated with VAM recorded higher amount of P, K, Mg, Mn, S, Ca, Fe, Cu and Zn than non-mycorrhizal plants. Similarly results were obtained before by Akande *et al.*, (1998) [2]. Tiwari (2005) [21] studied the response of soybean to basal application of P_2O_5 and K_2O. They observed a significant increase in micronutrient of Ca, Mg, Fe, Zn, Cu and Mn in the plants.

Table 3: Effect of different treatments on Fe (mg kg^{-1}) in the different part of maize crop (Pooled data of 2015-16 and 2016-17)

	Straw Fe		Pooled	Cover Fe		Pooled	Cob Fe		Pooled	Silk Fe		Pooled	Grain Fe		Pooled
	2015	2016		2015	2016		2015	2016		2015	2016		2015	2016	
T1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T2	366	341	354	84	59	71	100	77	88	283	286	285	76	83	79
T3	663	534	599	146	99	123	175	93	134	502	505	503	90	97	93
T4	513	427	470	122	93	108	110	92	101	622	625	623	179	186	182
T5	510	439	475	129	109	119	129	70	99	505	508	506	103	110	107
T6	685	465	575	144	95	119	149	95	122	607	609	608	251	259	255
T7	640	568	604	53	84	69	93	80	91	442	445	444	82	89	85
T8	682	667	674	125	125	125	105	96	106	570	573	571	319	327	323
T9	594	593	594	117	117	117	137	76	106	315	318	316	176	184	180
T10	388	364	376	107	108	107	131	105	118	756	759	757	223	230	227
T11	565	404	484	93	93	93	114	94	104	732	734	733	85	92	89
T12	635	487	561	120	93	106	119	91	105	400	402	401	240	247	244
T13	442	400	421	102	78	90	113	75	94	440	443	442	149	156	153
T14	484	405	444	87	87	87	135	92	113	456	459	458	130	138	134
S.Em.±	114	76	69	23	23	16	37	11	19	196	196	138	90	90	63
C.D. @5 %	NS	NS	197	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S.Em.±															
YXT S.Em.±	—	—	98	—	—	23.2	—	—	27	—	—	196	—	—	90
C.D. @5 %	—	—	NS	—	—	NS	—	—	NS	—	—	NS	—	—	NS
CV. %	12.7	18.4	13.2	11.4	11.9	9.0	11.3	11.9	14.6	8.5	12.2	9.3	9.3	12.2	14.2

Mn (mg kg^{-1}) Content in Maize Straw, cob, Silk and Grain

The manganese (Mn) content in maize straw revealed that not to be reached at the level of significant during the both years of the study 2015-16, 2016-17 and pooled analysis. Application of 100 % P as RP+ AM (T_{12}) resulted in not significantly maximum manganese (Mn) content in straw which was numerically higher than other phosphorus fertilizer treatments during the both years and pooled analysis that is due to the application of bio-compost and RP enriched compost which have initially of the micronutrient contents. It is evident from the data in respect of Manganese (Mn) content in maize cover (Table 4) revealed that, influence of different treatments during both the years of investigation was found non-significant. While the average of the pooled analysis manganese (Mn) in maize cover was observed in 75% P as RP+AM (T_8) treated plot and lower was in control (T_2) which was significant during the pooled analysis. The value of manganese (Mn) in maize cover in pooled analysis was significant. Manganese (Mn) ranged 23.6 mg kg-1 in control (T_2) to 56.2 mg kg^{-1} with the application of 75% P as RP+AM (T_8) treated plot during the pooled analysis which was significantly higher as compared to control (T_2) and all other phosphorus fertilizer treatments, however it was at par for 50% P as RP (T_3), 50% P as RP +AM (T_4) and 75% P as SSP +AM (T_{10}) treatments.

Manganese (Mn) content in maize cob was not reach the level of significance due to different treatments in the both years of the experiments and average of the pooled analysis. Numerically, the 50 % P as SSP+ AM (T_6) and 75% P as SSP (T_9) in increasing the Manganese (Mn) content in maize cob value over control (T_2) and other phosphorous fertilizer treated plots in (Table 4). In generally Manganese (Mn) content was higher in maize cob in the year of 2016 than to 2015. It is evident from the data in respect of Manganese (Mn) content in maize silk (Table 4) and results revealed that, influence of different treatments during both the years of investigation was found non-significant.

The numerically high value of the manganese (Mn) in maize silk was observed in 75% P as RP+AM (T_8) treated plot and lower was in control (T_2) which was non-significant during the both years of the experiment while the value of manganese (Mn) in maize silk in pooled analysis was significant. Manganese (Mn) ranged 27.0 mg kg-1 in control (T_2) to 78.9 mg kg-1 with the application of 75% P as RP+AM (T_8) treated plot during the pooled analysis which was significantly higher as compared to control (T_2) and 100% P as SSP+AM treatment.

However it was at par for all other phosphorus fertilizer treatments. Numerically increased Manganese (Mn) content in maize grain was recorded with the application 100% P as RP+AM (T_{12}) treatment and lower were recorded in control (T_2) treatment which was statistically not significant during the both years 2015-16 and pooled analysis in (Table 4). Similarly Jakobsen (1983) [8] reported increased dry matter production, P, Zn, Cu uptake by barley inoculated with Glomus caledonium. Raju *et al.* (1990) [14] showed that sorghum plant inoculated with VAM recorded higher amount of P, K, Mg, Mn, S, Ca, Fe, Cu and Zn than non-mycorrhizal plants.

Table 4: Effect of different treatments on Mn (mg kg^{-1}) in the different part of maize crop (Pooled data of 2015-16 and 2016-17)

Treatment	Straw Mn		Pooled	Cover Mn		Pooled	Cob Mn		Pooled	Silk Mn		Pooled	Grain Mn		Pooled
	2015	2016		2015	2016		2015	2016		2015	2016		2015	2016	
T1	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0
T2	128.5	116.4	122.5	16.1	31.1	23.6	11.2	38.4	24.8	25.3	28.8	27	9.5	9.1	9.3
T3	190.4	118.3	154.3	40.5	40.1	40.3	15.2	66.3	40.8	67.6	69.5	68.6	12.2	11.8	12
T4	150.1	126.2	138.1	42.8	42.3	42.5	11.8	44.0	27.9	51.2	50.8	51.0	9.4	9.0	9.2
T5	127.6	118.1	122.8	27.4	32.4	29.9	8.4	70.3	39.4	53.4	53	53.2	10.0	9.5	9.7
T6	155.4	274.9	215.1	37.3	36.8	37.0	10.8	78	44.4	73.4	73	73.2	11.3	10.8	11.0
T7	183.2	159.6	171.4	27.5	27.1	27.3	6.1	68.3	37.8	43.2	42.8	43	11.0	10.5	10.7
T8	134.0	163.3	148.6	56.4	56.0	56.2	10.3	62.0	36.8	79.1	78.7	78.9	11.9	11.5	11.7
T9	134.8	120.0	127.4	33.3	39.6	36.4	12.3	73.3	42.8	46.3	45.9	46.1	10.8	10.3	10.6
T10	136.8	113.5	125.1	55.6	29.7	42.7	9.0	74.0	41.5	64.9	64.5	64.7	10.4	10	10.2
T11	164.5	171.0	167.8	32.9	32.5	32.7	8.4	52.0	30.2	59.8	59.4	59.6	11.4	10.9	11.2
T12	161.2	287.6	224.4	39.0	38.5	38.7	8.6	62.3	35.4	53.3	52.8	53.0	15.7	15.2	15.4
T13	108.4	107.9	108.1	25.6	30.6	28.1	8.2	54.1	31.2	53.6	65	59.3	9.5	9.1	9.3
T14	119.2	138.2	128.7	31.9	31.4	31.6	14.6	75.3	45	32.7	32.3	32.5	11.9	11.5	11.7
S.Em.±	26	78.3	35.4	9.9	5.8	5.7	2.1	17.9	9.1	12.2	12.2	8.6	2.1	2.1	1.5
C.D. @5 %	NS	NS	NS	NS	NS	16.3	NS	NS	NS	NS	NS	24.5	NS	NS	NS
S.Em.±															
YXT	—	—	50.1	—	—	8.1	—	—	12.8	—	—	12.2	—	—	2.1
C.D. @5 %	—	—	NS	—	—	NS	—	—	NS	—	—	NS	—	—	NS
C.V. %	13.9	11.6	17.7	17.8	8	9.1	14.8	9.3	10.4	9.1	12.2	11.7	11.2	13.6	11.9

Zn (mg kg-1) Content in Maize Straw, cob, Silk and Grain

The Zn content in maize straw influence of different treatments during both the years of investigation 2015-16, 2016-17 and pooled analysis was found non-significant. While the zinc (Zn) content the maize cover during the pooled analysis was significant. Numerically maximum zinc (Zn) content in maize cover was recorded with the application 75% P as RP+AM (T_8) treatment and lower were recorded in control (T_2) treatment which was statistically not significant during the both years 2015-16, 2016-17 but the pooled analysis was significant. It is evident from the data (Table 5) in respect zinc (Zn) content in maize cover increased significantly 43.8 mg kg-1 in 75% P as RP+AM (T_8) treated plots over control (T_2) and different phosphorus fertilizer treatments during the pooled analysis. An examination of data (Table 5) indicated that the different treatments tried in the experiment did not exert their significant effect on the plant cob Zinc (Zn) count during both the years of experimentation and in pooled analysis.

However, the maximum values maize cob zinc (Zn) was observed under 100% P as SSP+ AM (T_{14}) treatments in the both years of the study 2015-16 and pooled as compared to the other various phosphorus fertilizer treatments but did not achieve the level of significance. In general application of SSP and RP along with AM showed higher value of the zinc (Zn) content in maize cob as compared to SSP and RP without of AM treated plots. Numerically maximum zinc (Zn) content in maize silk was recorded with the application 75% P as RP+AM (T_8) treatment and lower were recorded in control (T_2) treatment which was statistically not significant during the both years 2015-16 and pooled analysis. A glimpse of (Table 5.) revealed that, the zinc (Zn) content in maize silk increased non-significantly over control due to different phosphorus fertilizer treatments during both the years of investigation and pooled analysis. It is evident from the data in respect of Zinc (Zn) content in maize grain (Table 5) revealed that, influence of different treatments during both the years of investigation was found be significant during the first year 2015 and pooled analysis. The high value of the Zinc (Zn) 45.7 and 45.5 mg kg-1 during 2015 and pooled in maize grain was observed in 100% P as RP+AM (T_{12}) treated plots and lower was in control (T_2) 28.4 and 31.9 mg kg^{-1}. Zinc (Zn) content in maize grain during 2015 and pooled analysis was significantly higher as compared to control (T_2), 50% P as RP+AM (T_4) 50 % P as SSP (T_5), 50% P as SSP+AM (T_6) and 75% P as SSP+AM (T10) treatments and it was at par for 50% Pas RP (T_3), 75% P as RP (T_7), 75% P as RP+AM (T_8), 75% P as SSP (T_9), 100% P as RP (T_{11}), 100% P as SSP (T_{13}) and 100% P as SSP+AM (T_{14}) treatments. (Tisdale *et al.*, 1993) [20] and Tarafdar and Marschner (l994) [19] demonstrated the production of phosphatase by VAM fungi and their efficiency in utilization of organic P. They also reported that shoot dry weight increased along with increase in shoot concentrations of P, Cu, Zn while that of Mn and Fe decreased slightly and K concentration increased significantly only in the presence of organic P. Similarly result were obtained by Bashir *et al.*, (2012) [6] study the effect of rock phosphate and micronutrient content in maize and Sharif *et al.*, (2013) [16] study the effect of rock phosphate composted with organic matter on yield and phosphorous uptake of wheat and mungbean crop.

Table 5: Effect of different treatments on Zn (mg kg^{-1}) in the different part of maize crop (pooled data of 2015-16 and 2016-17)

Treatment	Straw Zn		Pooled	Cover Zn		Pooled	Cob Zn		Pooled	Silk Zn		Pooled	Grain Zn		Pooled
	2015	2016		2015	2016		2015	2016		2015	2016		2015	2016	
T1	0	0		0	0	0.0	0	0	0	0	0	0	0	0	0
T2	27.6	41.2	34.4	17	21.9	19.5	29.6	37.4	33.5	64.8	58.3	61.5	28.4	37.4	32.9
T3	34.7	42.5	38.6	21.1	20.7	20.9	16.7	68.3	42.5	99.8	92.2	96	45.5	45	45.3
T4	23.9	49	36.5	37.8	27	32.4	59.9	44	51.9	77.8	77.3	77.6	31.9	34.3	33.1
T5	32.3	27.2	29.8	25.4	25	25.2	37.3	62.7	50	95.7	95.3	95.5	29.7	40.7	35.2
T6	22.5	33.7	28.1	38	27.4	32.7	56.4	62.7	59.5	97.4	96.9	97.1	35	34.5	34.8
T7	25.0	23.5	24.3	17.9	18.6	18.3	40	42.7	41.3	124.7	105.6	115.2	36.6	36.2	36.4
T8	34.1	38.7	36.4	41.4	46.2	43.8	46.5	59	52.7	76.6	76.1	76.4	37.5	37	37.2
T9	28.6	32.2	30.4	21.8	21.4	21.6	24.1	48.3	36.2	92.6	92.2	92.4	39.4	39	39.2
T10	21.5	43.3	32.4	17.7	20.2	19	57.9	53.1	55.5	109.3	81.4	95.4	32.1	37.1	34.6
T11	21.1	37.9	29.5	24.4	24	24.2	27.5	66.7	47.1	100.3	99.8	100	36	35.5	35.7
T12	32.9	43.1	38	32	31.5	31.8	45.2	62.3	53.8	83.2	82.8	83	45.7	45.3	45.5
T13	20.7	41.5	31.1	23.5	23	23.2	35.5	61.4	48.5	86.9	81.5	84.2	37	36.6	36.8
T14	30.2	42.9	36.5	22.3	27.6	25	55.2	65.8	60.5	65.7	65.2	65.5	41.1	40.7	40.9
S.Em.±	4.9	9.6	5.4	5.7	4.9	3.7	13.3	7.2	7.6	16.3	15.1	11.1	3.6	4.3	2.8
C.D. @5 %	NS	NS	NS	NS	NS	10.7	NS	NS	NS	NS	NS	NS	10.4	NS	8
S.Em.±															
YXT	—	—	7.6	—	—	5.3	—	—	10.7	—	—	15.7	—	—	4
C.D. @5 %	—	—	NS	—	—	NS	—	—	NS	—	—	NS	—	—	NS
C.V. %	10.8	13.5	10.2	15.6	10	8.4	11.5	12	8.1	10.2	10.8	11	12.9	9.6	8.4

Copper (Cu) Content in Maize straw, cob, Silk and Grain

The numerically high value of the copper (Cu) in maize straw was observed in 75% P as RP+AM (T_8) treated plot and lower was in control (T_2) which was non-significant during the both years of the experiment while the value of manganese (Mn) in maize silk in pooled analysis was significant. Copper (Cu) ranged 12.4, 23.7 and 18.2 mg kg^{-1} in control (T_2) to 29.4, 30.3 and 29.9 mg kg^{-1} with the application of 75% P as RP+AM (T_8) treated plot during the both years 2015-16, 2016-17 and pooled analysis which was statistically not significant. Data presented in (Table 6), regarding the copper (Cu) content in maize cover was statically not influenced by different phosphorus fertilizer treatments during both the years of investigation 2015-16, 2016-17 and in pooled analysis. It is evident from the data in respect of copper (Cu) content in maize cob in (Table 6) revealed that, influence of different treatments during both years 2015-16 of investigation and in pooled was found non-significant. However, that the application of different rate of phosphorus fertilizers along with the AM increased copper (Cu) content in maize cob which was not significant than the other phosphorus fertilizer treatments and control plots. That is du to the effect of bio-compost and (RP enriched compost) The result depicted also in (Table 6), regarding the copper (Cu) content in maize silk was statically not influenced by different treatments during both the years of investigation and in pooled analysis. Similarly an examination of data (Table 6) resulted that the different treatments tried in the experiment did not exert their non-significant effect on the maize grain Copper (Cu) count during both the years of experimentation and in pooled analysis. The non-significant increased nutrient content in maize due to different treatment might be addition of bio-compost which we are applied 15 t ha^{-1} to the soil that was further released micronutrient content in soil. Tiwari (2005) [21] studied the response of soybean to basal application of P_2O_5 and K_2O. They observed a significant increase in seed yield, straw yield and uptake of N, P, K and S nutrients due to application of P_2O_5. Phosphorus application, however, increased the concentration of Ca, Mg, Fe, Zn, Cu and Mn in the plants. Similarly result was found by Jones and Eck (1973) and Bashir *et al*., (2012) [6] study the effect of rock phosphate and micronutrient content in maize.

Table 6: Effect of different treatments on Cu (mg kg^{-1}) in the different part of maize crop (Pooled data of 2015-16 and 2016-17)

Treatment	Straw Cu		Pooled	Cover Cu		Pooled	Cob Cu		Pooled	Silk Cu		Pooled	Grain Cu		Pooled
	2015	2016		2015	2016		2015	2016		2015	2016		2015	2016	
T1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T2	12.7	23.7	18.2	6	5.1	5.6	3.2	3.5	3.30	7	10.6	8.8	2.9	1.4	2.1
T3	23.9	27.3	25.6	7.9	7.4	7.6	3.8	4.1	3.90	11.1	27.6	19.3	3.8	1.1	2.4
T4	21.3	28.1	24.7	10.3	7.5	8.9	4.5	4.8	4.60	10.9	11.2	11	2.5	1.3	1.9
T5	19.3	25.6	22.4	12.9	6.1	9.5	4.3	4.6	4.50	11.6	11.9	11.8	2.3	1.5	1.9
T6	19.7	32	25.8	9.6	6.8	8.2	5.2	5.50	5.40	12.4	12.7	12.5	3.6	1.3	2.4
T7	22.5	20.8	21.6	9.2	5.9	7.5	1.9	4.00	3.30	16.6	18.6	17.6	3.7	1.2	2.4
T8	29.4	30.3	29.9	16.6	7.9	12.2	5.4	5.70	5.50	10.9	11.2	11	4.1	1.5	2.8
T9	12.3	27.7	20	7.6	6.4	7	2.2	3.20	3.00	12.5	12.8	12.6	3.6	1.1	2.4
T10	13.2	35.3	24.2	11	8.2	9.6	3.9	4.20	4.10	17.2	12.5	14.8	3	1.2	2.1
T11	13.1	32.3	22.7	5.1	5.4	5.3	3.9	4.20	4.10	13.9	14.2	14	6	1.8	3.9
T12	20.3	30.7	25.5	14.5	9	11.7	5.1	5.40	5.20	10.4	10.7	10.6	4.9	1.2	3.1

T13	14.6	34	24.3	5.2	5.5	5.3	4.6	4.90	4.7	19.1	20	19.5	3	1.4	2.2
T14	26.5	26.4	26.4	13.9	6.8	10.4	5.1	5.40	5.20	10.8	11.1	10.9	2.9	1.2	2
S.Em.±	6.5	5.8	4.4	4.1	1.3	2.1	1	0.90	0.70	2.9	4.9	2.9	0.9	0.2	0.4
C.D. @5 %	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S.Em.±															
YXT	—	—	6.2	—	—	3	—	—	1	—	—	4.1	—	—	0.6
C.D. @5 %	—	—	NS	—	—	NS	—	—	NS	—	—	NS	—	—	NS
C.V. %	13.1	8.1	9.8	10.5	9.3	12.4	10.9	14.7	7.7	10.2	11.1	12.3	12	9.5	9.4

Conclusion

The present study provides have the evidence that addition of enriched rock phosphate (RP) along with the potential role of *mycorrhiza* in the acquisition of nutrient from soil. It was increased significantly the Iron (Fe) concentration in maize straw in pooled analysis. Manganese (Mn) and zinc (Zn) in maize cover, silk and Zinc content and maize cover and grain significantly.

References

1. Akanda MO, Adediran JA, Oluwatoyinbo F. Effects of rock phosphate amended with poultry manure on soil available phosphorus and yield of maize and cowpea. African Journal of Biotechnology. 2005; 4(5):444-448.
2. Akande MO, Adediran JA, Oluwatoyinbo FI. Effects of rock phosphate amended with poultry manure on soil available P and yield of maize and cowpea. African Journal of Biotech. 2005; 4(5):444-448.
3. Akande MO, Aduayi EA, Olayinka A. Sobulo RA. Efficiency of Sokoto Rock Phosphate as a fertilizer source for maize production in southwestern Nigeria. Journal of Plant Nutrition. 1998; 21(7):1339-1353.
4. Akande MO, Makinde EA, Oluwatoyinbo FI, Adetunji MT. Effects of phosphate rock application on dry matter yield and phosphorus recovery of maize and cowpea grown in sequence, African Journal of Environmental Science and Technology. 2010; 4(5):293-303.
5. Basakar K, Deg G. Release of phosphorus from partially acidulated rock phosphate in a Typical Ustifluvent**.** Journal of the Indian Society of Soil Science. 1997; 4(45):759-762.
6. Bashirullah, Arif Ullah, Sher Ali Khan, Anis ur Rehaman, Mohammad Javed Khan, Sheraz Ahmad Khan, *et al*. Effect of acidulated rick phosphate on micronutrients uptake by maize. Arpan Journal of Agricultural and Biological Science. 2012; 7(8):638-644.
7. Harry W, Menzies NW, Hunter MN. Zeolite/rock phosphate: a novel slow release phosphorus fertilizer for potted plant production. Journal of Horticultural Sciences. 2002; 94(1):333-343.
8. Jakobsen I. VAM in field grown crops. II. Effect of inoculation on growth and nutrient uptake in barley at two phosphorus levels in fumigated soils. New Phytologist. 1983; 94:595-604.
9. Khalil S, Zia MS, Mahmood IA. Biophos Influence on P Availability from Rock phosphate Appliedto Rice (*Oryza sativa L.)* With Various Amendments. International Journal of Agriculture and Biology. 2002; 4(2):272-274.
10. Li XL, Marschner H, George E. Acquisition of phosphorus and copper by VAMZ mycorrhizal hyphae and root to shoot transport in white sourghum, Plant- Soil. 1991; 136:49-57.
11. Lindsay WL, Norvell WA. Development of a DTPA soil test for zinc, iron, manganese, and copper. Soil Science Society of America Journal. 1978; 42:421-428.
12. Menkeni PNS, Semoka JMR, and Buganga JBBS. Sokoine University of agricultural, Morogoro (Tanzania). Dept of soil science). Zimbabwe Journal of Agricultural Research. 1991; 29(1):27-37.
13. Panse VG, Sukhatme PV, Statistical methods for Agricultural Workers. ICAR, New Delhi. 1967, 199-200.
14. Raju PS, Clark RB, Ellis JR, Maranville JW. Effects of species of VAM fungi on growth and mineral uptake of sorghum at different temperature, Plant Soil. 1990; 121:165-170.
15. Raju PS, Clark RB, Ellis JR, Maranville JW. Effects of species of VAM fungi on growth and mineral uptake of sorghum at different temperature, Plant- Soil. 1990; 121:165-170.
16. Sharif M, Burani T, Khan FW. Effect of rock phosphate composted with organic matter on yield and phosphorous uptake of wheat and mungbean crop. Pakistan Journal of Botany. 2013; 45(4):1349-1356.
17. Singh R, Gupta R, Saxena RK. Rock phosphate solubilization under alkaline conditions by Aspergillus's japonicas and A. foresides. Folia Micro biological. 1993, 39.
18. Srividya B, Prasad PVN, Srinivasa V, Veeraraghavaiah R. Influence of alternate source of P toconventional sources on the yield attributes and yieldof chickpea. Legume Research. 2009; 32(3):218-219.
19. Tarafdar JC, Marschner H. Efficiency of VAM hyphae in utilization of organic phosphorus by wheat plaflts. Soil Science and Plant Nutrition. 1994; 40:593-600.
20. Tisdale SL, Nealson WL, Beaton JD, Soil fertility and fertilizer. Macmillan Pub. Co., New York, 1985.
21. Tiwari RK. Long-term use of inorganic fertilizers and response of soybean to basal application of phosphorus. Journal of the Indian Society of Soil Science. 2005; 65:83-97.
22. White PF, Nesbitt HJ, Ros C, Seng V, Lor B. Local rock phosphate deposits are a good source of phosphorus fertilizer for rice production in Combodia. Soil Science and Plant Nutrition. 1999; 45:51-63.