The Pharma Innovation Journal 2023; 12(10): 725-732

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(10): 725-732
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www.thepharmajournal.com
Received: 20-08-2023
Accepted: 29-09-2023

Phosphorus dynamics and post-harvest soil nutrient status in *Alfisols* as influenced by compost coated and blended phosphatic fertilizers

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Abstract

An experiment was conducted to study the effect of compost coated and blended phosphatic fertilizers on phosphorus dynamics and post-harvest nutrient status in *Alfisols*. The experiment was laid out in Randomized Complete Block Design and treatments that include 100, 75 and 50 percent of compost coated DAP (T_3, T_4 and T_5, respectively) and compost blended rock phosphate (T_6, T_7 and T_8, respectively) along with recommended dose of N and K, keeping 100% RDF (using uncoated DAP) as check which were replicated thrice. Results indicated that application of 75 percent RDP through compost coated DAP with recommended dose of N and K (T_4) recorded higher Saloid-P, Occluded-P, organic-P, WS-P and available P at harvest, whereas, higher Al-P, Fe-P, reductant soluble-P, Ca-P, Available N and K_2O content was recorded in T_2. Available Ca and Mg content was recorded higher in T_6 whereas, higher available S content was recorded in T_8.

Keywords: Phosphorus, coated, blended, dynamics, nutrient status

1. Introduction

Phosphorus (P), a fascinating essential plant nutrient element is known to be involved in a plethora of functions in plant growth, development and metabolism. Chemical fertilizers have played a significant role in the green revolution, but their unbalanced use has led to reduction in soil fertility and environmental degradation. However, a large portion of soluble inorganic phosphate applied to soil as chemical fertilizer is immobilized rapidly and becomes unavailable to plants, which is not an environment friendly approach. Globally, P stocks may be limited to last another 40 years or so only, requiring a more efficient use of P. Furthermore, the use of phosphate fertilizer has become a costly affair and there is urgent need for alternative sources. The fixation of P as iron (Fe) and aluminium (Al) phosphates in acid soils and calcium (Ca) phosphates in alkaline soils and neutral soils (*Alfisols*) is defined as a historical problem of soil science (Sanders *et al.*, 2012) [11].

This historical problem corresponds to very low P use efficiency (PUE) of applied P-fertilizer in the soil system even after employing the best management practices for crop production resulting in poor growth and yield of the crop. Complex nature arises because of its low total soil phosphorus content, highly insoluble nature, unavailability of the native phosphorus compounds for plant uptake and transformation of readily available phosphorus present in manures and fertilizers into unavailable forms when they are added to soil. Henceforth, phosphorus is regarded as the most studied, but least understood element because of its unique character.

The depletion of global rock phosphate (RP) reserves is emerging as one of the major challenges to regulate P fertilizer supply for global food security in the 21st century. Globally, around 90 percent of the P is mined from non-renewable RP and approximately 60 percent of it is used in cropping as fertilizer. Thus, care should be given to the development of eco-friendly strategy to improve the P availability and P use efficiency in farming systems. Coated phosphatic fertilizers is an innovative option to improve phosphorus use efficiency and sustained release of P in the soil.

The coated phosphatic fertilizers is one such new generation fertilizer that are coated with natural or semi-natural, environmentally friendly macromolecule material which is designed to release plant nutrients in a steady manner so as to synchronize the release with crop demand.

This technology not only helps in improving the nutrient use efficiency but also suggests a suitable mechanism to reduce environmental hazards posed by indiscriminate and excessive use of fertilizers (Shaviv, 1999) [14]. In general, coated phosphatic fertilizers or control release fertilizers exhibit numerous preferences over the traditional water-soluble fertilizers, for example, savings in huge quantities of fertilizers, reducing the rate of release of fertilizer nutrients and thus supplying nutrients to crops for better P transformation and use efficiency of the fertilizer.

Maize (*Zea mays* L.) is one of the most versatile emerging crop having greater adaptability under varied agro-climatic conditions. Globally, it is cultivated over an area of 197 m ha with production of 1,147.6 m t and a productivity of 5.8 t ha^{-1} (Anon., 2019a) [1]. Besides, it is a staple food for poor people in most of the developing countries and in the world, it provides about 30 percent of the food calories for more than 4.5 billion people. In India, it is grown under diverse agro climatic situations covering an area of 9.56 m ha with 28.56 m t production and 3.07 t ha^{-1} productivity (Anon., 2020) [3]. While, in Karnataka maize is cultivated in an area of 1.29 m ha with a production of 3.73 m t with productivity of 2.89 t ha^{-1} (Anon., 2019b) [2]. In Mandya district of Karnataka, maize is grown in an area of 3,903 ha with a production of 15,978 t and productivity of 4.308 kg ha^{-1} (Anon., 2020) [3]. Hence considering the above facts, an attempt has been made to evaluate the efficiency of usage of coated and blended phosphatic fertilizers in agriculture by using maize as a test crop in *Alfisols*.

2. Materials and Methods

The experiment was conducted at College of Agriculture, Vishweshwaraiah Canal Farm, Mandya, which comes under the Region III and Agro Climatic Zone VI (Southern Dry Zone) of Karnataka, which has 12° 34' North latitude and 76° 49' East longitude with an altitude of 705 meters above mean sea level during *Kharif* 2020. The Soil of the experimental site was red loamy sand with neutral soil pH (7.15), electrical conductivity (0.12 dSm^{-1}) and organic carbon content (4.64 g kg^{-1}) was found to be low. The available nitrogen (310.23 kg ha^{-1}), phosphorus (28.63 kg P_2O_5 ha^{-1}) and potassium (276.72 kg K_2O ha^{-1}) was medium. The investigation was carried out in Randomized Complete Block Design with eight treatments and replicated thrice. The treatments comprised of application of three levels of compost coated DAP *viz*., 100, 75 and 50% RDP (T_3, T_4 and T_5, respectively) and three levels of compost blended RP *viz*., 100, 75 and 50% RDP (T_6, T_7 and T_8, respectively), 100% RDF through conventional fertilizers with FYM (T_2) and absolute control (T_1). In the present experiment, maize (*Zea mays* L.) variety MAH-14-05 was grown as the test crop. The land was prepared by ploughing with tractor drawn disc plough followed by disc harrowing and passing cultivator twice to bring the soil to fine tilth.

Layout was prepared with gross plot and net plot size of 5.4 m × 3.6 m and 4.2 m × 2.4 m. A distance of 0.5 m between two plots and 0.6 m was set to differentiate the replications. The bund height of 30 cm was raised in the space available between replications and plots. The recommended FYM (10 t ha^{-1}) was applied uniformly to all the treatments two week before sowing except for control plot. After layout of experiment, recommended quantity of zinc sulphate (10 kg ha^{-1}) were applied. Furrows at an interval of 60 cm were opened using furrow openers attached to bullock pair. Basal dose of RDF [1/2rd N (50%) and 50, 75, 100 percent of compost coated P and 100 percent K] was applied to each treatment and mixed with soil. Urea, di-ammonium phosphate (DAP), Rock phosphate and muriate of potash (MOP) were used as sources of N, P and K, respectively. Seeds were dibbled at 30 cm spacing (2 seeds per hill). The remaining 1/2rd dose of nitrogen was top dressed in two equal splits, one at 30 DAS and another at 45 DAS in the form of urea. First irrigation was given on the day of sowing and subsequent irrigations were given as and when required by the crop using ridges and furrow method. Inter-cultivation practice was done at 35 and 60 DAS with the help of bullock drawn harrow. Hand weeding was done at 30 and 60 DAS to keep the plots devoid of weeds.

Surface soil was collected from each plot at 30, 60, 90 DAS and at harvest and processed. The 2 mm soil was used to determine different phosphorus fractions like water soluble, Available P, Saloid bound P, Al bound P, Fe bound P, Reductant bound P, Occluded P, Ca bound P, Total P, Organic P by following standard protocol (Table 1). The available macronutrient (N, P, K, Ca, mg and S) and micronutrient (Fe, Mn, Cu and Zn) in soil at harvest of the crop were analysed by following the standard protocol. The data was statistically analysed by following the method of Gomez and Gomez, 1984 [5].

Table 1: Methods followed for the analysis of phosphorus fractions

Phosphorus Fraction	Extractant (1 gm soil + 50 ml extractant)	Method	Estimation Technique
Saloid bound P	1 M NH_4Cl (shaken for 30 min)	Peterson and Corey (1966) [10]	Chloromolybdic-boric acid blue colour method + $SnCl_2$ reductant (at 660 nm)
Al bound P	0.5 M NH_4F (shaken for 1 hr) {Residue is taken}	Peterson and Corey (1966) [10]	Chloromolybdic-boric acid blue colour method + $SnCl_2$ reductant (at 660 nm)
Iron bound P	0.1 M NaOH (shaken for 17 hrs) {Residue is taken}	Peterson and Corey (1966) [10]	Chloromolybdic-boric acid blue colour method + $SnCl_2$ reductant (at 660 nm)
Reductant bound P	0.3 M $Na_3C_6H_5O_7$ (40 ml) + 5 mL of 1 M $NaHCO_3$ (heat) + 1.0 g $Na_2S_2O_4$ for 15 min in water bath at 85 °C). {Residue is taken}	Peterson and Corey (1966) [10]	Chloromolybdic-boric acid blue colour method + $Sncl_2$ reductant (at 660 nm)
Occluded P	0.1 N NaOH (shaken for 1hr) {Residue is taken}	Peterson and Corey (1966) [10]	Chloromolybdic-boric acid blue colour method + $SnCl_2$ reductant (at 660 nm)
Calcium bound P	0.25 M H_2SO_4 (shaken for 1 hr) {Residue is taken}	Peterson and Corey (1966) [10]	Chloromolybdic-boric acid blue colour method + $SnCl_2$ reductant (660 nm)
Total P	Perchloric acid digetion	Olsen and Sommers (1982) [9]	Vanadomolybdophosphoric acid method (420 nm)
Organic P	Total P – Inorganic fractions = Organic P		
Water soluble P	2 g soil +20 ml water Deionized (shaken for 1 hr) Acidify to pH 2.0 using conc. HCl	Luscombe *et al.* (1979) [8]	Deionized water extract
Available P	5 g soil +50 ml Olsen's extractant (shaen for 30 min)	(Jackson, 1973) [6]	Olsen extract

Table 2: Effect of compost coated and blended phosphatic fertilizers on saloid and occluded phosphorus content in soil at different growth stages of maize

Treatment	**Saloid bound P (mg kg^{-1})**				**Occluded P (mg kg^{-1})**			
	30 DAS	**60 DAS**	**90 DAS**	**At Harvest**	**30 DAS**	**60 DAS**	**90 DAS**	**At Harvest**
T_1	10.14	10.15	10.31	10.51	9.92	9.89	9.78	9.69
T_2	14.38	13.65	12.73	12.24	12.62	12.51	12.47	12.32
T_3	17.76	18.12	18.66	18.95	15.98	16.17	16.58	16.96
T_4	18.73	19.05	19.58	19.98	16.86	17.05	17.44	17.83
T_5	14.68	14.98	15.39	15.72	13.21	13.41	13.83	14.27
T_6	16.89	17.20	17.63	18.04	15.63	15.85	16.16	16.57
T_7	17.95	18.15	18.59	19.02	16.61	16.82	17.23	17.62
T_8	13.90	14.31	14.74	15.05	12.94	13.16	13.58	13.95
S. Em±	0.64	0.65	0.66	0.67	0.59	0.60	0.61	0.62
CD @ 5%	1.95	1.96	1.99	2.02	1.80	1.81	1.84	1.87

Treatment details

T_1: Absolute control
T_2: RDF (150:75:40 NPK kg ha^{-1})
T_3: 100% RDP through compost coated DAP
T_4: 75% RDP through compost coated DAP
T_5 50% RDP through compost coated DAP
T_6: 100% RDP through compost blended RP
T_7: 75% RDP through compost blended RP
T_8: 50% RDP through compost blended RP
Note: RDF: Recommended dose of fertilizers
RD N and K: Recommended dose of nitrogen and potassium
RDP: Recommended dose of phosphorus, RP: Rock phosphate

Table 3: Effect of compost coated and blended phosphatic fertilizers on organic and available phosphorus content in soil at different growth stages of maize

Treatment	**Organic bound P (mg kg^{-1})**				**Available P (kg ha^{-1})**			
	30 DAS	**60 DAS**	**90 DAS**	**At Harvest**	**30 DAS**	**60 DAS**	**90 DAS**	**At Harvest**
T_1	18.40	26.40	34.40	42.40	28.38	25.41	21.71	19.77
T_2	31.64	39.64	48.32	54.07	40.47	37.36	32.12	29.20
T_3	48.76	53.78	64.74	75.72	51.14	53.97	56.73	59.68
T_4	50.98	55.99	72.40	84.12	54.31	57.35	60.26	63.28
T_5	33.39	40.41	52.25	54.78	45.66	48.71	51.74	53.77
T_6	47.65	52.67	65.63	69.65	50.82	53.60	56.11	59.47
T_7	49.83	54.85	69.83	79.85	53.82	56.93	59.95	62.92
T_8	32.91	40.27	46.23	52.27	44.55	47.58	50.55	53.57
S. Em±	1.62	1.88	2.34	2.66	1.08	1.14	1.33	1.27
CD @ 5%	4.92	5.71	7.09	8.07	3.26	3.44	4.03	3.84

Treatment details

T_1: Absolute control
T_2: RDF (150:75:40 NPK kg ha^{-1})
T_3: 100% RDP through compost coated DAP
T_4: 75% RDP through compost coated DAP
T_5: 50% RDP through compost coated DAP
T_6 : 100% RDP through compost blended RP
T_7: 75% RDP through compost blended RP
T_8: 50% RDP through compost blended RP
Note: RDF: Recommended dose of fertilizers
RD N and K: Recommended dose of nitrogen and potassium
RDP: Recommended dose of phosphorus, RP: Rock phosphate

2.1 Preparation of compost coated and blended phosphatic fertilizers

The two different sources of phosphorus like DAP and Rock phosphate were selected for coating and blending with compost, respectively. Compost coated DAP and blended rock phosphate were prepared by coating and blending fertilizer with compost in different ratios *i.e.,* 5:1, 10:1 and 10:1.5 proportions. Slightly wet DAP granules were taken in a circular plastic basin and coating material was sprinkled and mixed with compost. The fertilizer granules were subjected to swirling movement by rotating basin circularly. The process was repeated twice or thrice until the satisfactory visual coating was obtained. For blending rock phosphate with compost, rock phosphate powder was mixed thoroughly with the coating material. Compost coating or blending with either DAP or Rock phosphate in 5:1 ratio is used for the experiment. The coated DAP granules or blended rock phosphate were air dried in shade and were used in the treatment implication (Figure 1).

3. Results and Discussion

3.1 Forms of phosphorus present in soil

3.1.1 Saloid, Occluded, Organic and available-P

At 30, 60, 90 DAS and at harvest, significantly higher saloid-P (18.73, 19.05, 19.58 and 19.98 mg kg^{-1}, respectively), occluded-P (16.86, 17.05, 17.44 and 17.83 mg kg^{-1}, respectively), organic-P (50.98, 55.99, 72.40 and 84.12 mg kg^{-1}, respectively) and available P (54.3, 57.35, 60.26 and 63.28 kg ha^{-1}, respectively) content was recorded in T_4 which were on par with T_7, T_3 and T_6 and are significant with rest of the treatments. Lower saloid-P, occluded-P, organic-P and available P content was observed in absolute control at various stages of crop growth, respectively (Table 2, 3).

The increase in the above P fractions over days might be due to addition of coated phosphatic fertilizers which increase the solubilization and mineralization of phosphorus further resulting in increase of P concentration (Singh, 2003) [16]. Moreover, products of organic decay, such as organic acids and humus are thought to be effective in forming complexes with Fe and Al compounds. This might have increased the above P fraction content in soil with compost coated and blended P fertilizers treated plots.

3.1.2 Al-bound P and Reductant Soluble-P

Higher Al-bound P (16.83, 17.03, 17.49 and 17.85 mg kg^{-1}, respectively), reductant soluble-P (60.82, 59.64, 56.29 and 55.46 mg kg^{-1}, respectively) content was recorded with T_2 at 30, 60, 90 DAS and at harvest of the crop which was observed to be significantly higher with all the treatments. Lower Al-bound P and reductant soluble-P status was recorded in T_1 treatment (Table 4).

There was a decrease in Al-bound P over days and also due to compost coated and blended treatments. It may be due to the addition of humic compounds through compost coating and FYM application resulted in decrease of exchangeable Al concentration. Similar observations were reported by Winarso *et al.* (2011) [17].

Table 4: Effect of compost coated and blended phosphatic fertilizers on aluminium bound phosphorus and reductant soluble P content in soil at different growth stages of maize

Treatment	Al bound P (mg kg^{-1})				Reductant soluble P (mg kg^{-1})			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At Harvest
T_1	11.02	11.09	11.15	11.17	38.45	37.37	36.29	35.04
T_2	16.83	17.03	17.49	17.85	60.82	59.64	56.29	55.46
T_3	13.54	13.32	12.97	12.54	46.45	45.28	43.85	42.43
T_4	12.67	12.43	12.06	11.61	44.36	43.13	41.72	40.36
T_5	14.32	14.10	13.72	13.35	48.74	47.57	46.19	44.76
T_6	13.89	13.64	13.27	12.82	46.78	45.59	44.17	42.78
T_7	13.23	13.05	12.63	12.20	44.68	43.45	42.06	40.63
T_8	14.88	14.63	14.27	13.63	49.32	48.10	46.67	45.25
S. Em±	0.59	0.59	0.59	0.58	2.05	2.00	1.93	1.87
CD @ 5%	1.80	1.79	1.78	1.76	6.23	6.07	5.85	5.69

Treatment details

T_1: Absolute control
T_2: RDF (150:75:40 NPK kg ha^{-1})
T_3: 100% RDP through compost coated DAP
T_4: 75% RDP through compost coated DAP
T_5: 50% RDP through compost coated DAP
T_6 : 100% RDP through compost blended RP
T_7: 75% RDP through compost blended RP
T_8: 50% RDP through compost blended RP

Note: RDF: Recommended dose of fertilizers
RD N and K: Recommended dose of nitrogen and potassium
RDP: Recommended dose of phosphorus, RP: Rock phosphate

3.1.3 Iron bound P

Significantly highest Fe-P content (T_2 -20.87, 20.98, 21.37 and 21.43 mg kg^{-1}, respectively) was recorded with T_2 at 30, 60, 90 DAS and at harvest which was on par with T_8 (18.90, 18.69, 17.91 and 17.55 mg kg^{-1}) and T_5 (18.76, 18.52, 17.76 and 17.32 mg kg^{-1}, respectively) and was significantly highest than rest of the treatments.

Fe-P content in soil at 90 DAS and at harvest indicate that, application of recommended dose of fertilizers (T_2) was observed to be significantly higher (21.37 and 21.43 mg kg^{-1}, respectively) when compared to rest of the treatments. The lowest Fe-P was registered with control (T_1 -14.48 and 14.49 mg kg^{-1}, respectively).

There was a decrease in Fe-bound P over different intervals and also treatments with coated DAP and blended RP (Table 5). It may be due to iron held by humic acid released from organic manures (compost and FYM) which contains non-carboxylic hydroxyl groups, that helps in providing bonding sites for Fe, thus acting as chelating agent.

3.1.4 Calcium bound phosphorus

At 30, 60 and 90 DAS and at harvest, higher Ca bound P of 42.85, 39.20, 36.28 and 33.87 mg kg^{-1}, respectively was recorded in T_2 treatment which was on par with T_8 and T_5 and significant with rest of the treatments. Lower Ca bound P was recorded in control (Table 5).

Lower Ca bound P content in coated DAP and blended RP treated plots was observed compared to RDF without coating and absolute control treatment which might be due to more retardation of formation of Ca bound P by humic acid and also due to higher uptake by the crop in coated and blended P fertilizers treated plots.

3.1.5. Total Phosphorus

Data indicated that at 30 and 60, 90 DAS and at harvest, significantly higher total phosphorus of 200.01 and 202.65, 204.95 and 207.24 mg kg^{-1}, respectively was recorded in T_2 compared with control (125.18 and 132.12,138.98 and145.79 mg kg^{-1}, respectively) and it was on par with rest of the treatments.

Application of 75 percent RDP through compost coated DAP along with recommended dose of N and K (206.26 and 214.39 mg kg^{-1}, respectively) resulted in an on-par results with rest of the treatments except control (138.98 and 145.79 mg kg^{-1}, respectively) during 90 DAS and at harvest of the crop (Table 6).

The total P content in soil increased with crop growth period in all the treatments except in absolute control treatment. This may be due to increase in the content of saloid bound P, occluded P, as well as organic bound P with time.

3.1.6. Water soluble phosphorus

The supply of 75 percent RDP through compost coated DAP with recommended dose of N and K recorded significantly higher water soluble phosphorus (27.15 kg ha^{-1}) and was on par with T_7, T_3 and T_6, respectively. At 60 DAS, application of 75 percent RDP through compost coated DAP with recommended dose of N and K recorded significantly higher plant height (T_4 - 25.67 kg ha^{-1}) and was on par with T_7 (24.65 kg ha^{-1}) and T_3 (23.98 kg ha^{-1}). Higher water soluble P of 22.13 kg ha^{-1} was recorded in T_4 which was on par with, T_7, T_3 and T_6 but it was significant with rest of the treatments during 90 DAS of crop growth. Control registered lower water soluble phosphorus of 9.88 kg ha^{-1} which increased significantly to 19.64 kg ha^{-1} in treatment T_4 which was on par T_3 (17.84 kg ha^{-1}) and significant with rest of the treatments during harvest of the crop (Table 6).

The moisture absorption and DAP fertilizer dissolution rates decreased by coating in comparison to uncoated, increased with time which in turn influenced availability of phosphorus. Similar results were also reported by Singh, 2003 [16].

Table 5: Effect of compost coated and blended phosphatic fertilizers on Fe-bound and calcium bound phosphorus content in soil at different growth stages of maize

Treatment	Fe bound P (mg kg^{-1})				Ca bound P (mg kg^{-1})			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At Harvest
T_1	14.43	14.46	14.48	14.49	22.82	22.76	22.57	22.49
T_2	20.87	20.98	21.37	21.43	42.85	39.20	36.28	33.87
T_3	17.76	17.54	16.73	16.69	35.58	34.19	31.73	28.58
T_4	16.98	16.77	15.98	15.53	33.89	31.46	27.08	24.96
T_5	18.76	18.52	17.76	17.32	40.32	37.95	34.57	31.32
T_6	18.21	18.01	17.25	16.81	37.83	34.41	30.06	27.79
T_7	17.43	17.24	16.67	16.26	34.68	31.45	28.05	25.73
T_8	18.90	18.69	17.91	17.55	40.74	37.38	34.92	31.69
S. Em±	0.77	0.76	0.75	0.74	1.51	1.41	1.30	1.21
CD @ 5%	2.33	2.32	2.27	2.25	4.58	4.27	3.95	3.68

Treatment details

T_1: Absolute control	T_5: 50% RDP through compost coated DAP
T_2: RDF (150:75:40 NPK kg ha^{-1})	T_6 : 100% RDP through compost blended RP
T_3: 100% RDP through compost coated DAP	T_7: 75% RDP through compost blended RP
T_4: 75% RDP through compost coated DAP	T_8: 50% RDP through compost blended RP

Note: RDF: Recommended dose of fertilizers
RD N and K: Recommended dose of nitrogen and potassium
RDP: Recommended dose of phosphorus, RP: Rock phosphate

Table 6: Effect of compost coated and blended phosphatic fertilizers on total P and water-soluble phosphorus content in soil at different growth stages of maize

Treatment	Total P (mg kg^{-1})				Water soluble P (kg ha^{-1})			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At Harvest
T_1	125.18	132.12	138.98	145.79	14.18	12.71	10.85	9.88
T_2	200.01	202.65	204.95	207.24	20.25	18.68	15.06	12.60
T_3	195.83	198.40	205.26	211.87	25.59	23.98	20.36	17.84
T_4	194.47	195.88	206.26	214.39	27.15	25.67	22.13	19.64
T_5	183.42	186.94	189.71	191.52	22.83	19.35	16.87	13.88
T_6	196.88	197.37	201.17	204.46	25.41	22.80	19.05	16.74
T_7	194.41	195.01	205.06	211.31	26.91	24.65	21.97	18.46
T_8	183.59	186.54	188.32	189.39	22.27	18.79	15.27	12.78
S. Em±	7.70	7.83	8.07	8.26	0.95	0.86	0.73	0.63
CD @ 5%	23.35	23.75	24.47	25.07	2.88	2.60	2.21	1.90

Treatment details

T_1: Absolute control	T_5: 50% RDP through compost coated DAP
T_2: RDF (150:75:40 NPK kg ha^{-1})	T_6 : 100% RDP through compost blended RP
T_3: 100% RDP through compost coated DAP	T_7: 75% RDP through compost blended RP
T_4: 75% RDP through compost coated DAP	T_8: 50% RDP through compost blended RP

Note: RDF: Recommended dose of fertilizers
RD N and K: Recommended dose of nitrogen and potassium
RDP: Recommended dose of phosphorus, RP: Rock phosphate

3.2 Soil available nutrient status

3.2.1 Available nitrogen

Results on available N content of soil after harvest of maize crop revealed that significantly higher content of soil N was recorded in treatment RDF (T_2- 293.84 kg ha^{-1}) compared with control (T_1- 237.00 kg ha^{-1}) and was on par with rest of the treatments (Figure 2).

3.2.1 Available phosphorus

Application of compost coated and blended phosphatic fertilizers indicate that, lower soil available P status was recorded in control (28.38, 25.41, 21.71 and 19.77 kg ha^{-1}, respectively) at 30, 60, 90 DAS and at harvest which significantly incre54.31, 57.35, 60.26 and 63.28 kg ha^{-1}, respectively in the T_4 and was on par with T_7 , T_3 and T_6 (Figure 2).

3.2.3 Available potassium

Significantly higher potassium content of soil was recorded in T_2 treatment (244.30 kg ha^{-1}) which was significantly highest compared to T_1 (175.56 kg ha^{-1}) and T_4 (217.33 kg ha^{-1}) and was observed to be on par with rest of the treatments (Figure 2).

The decrease in available nitrogen and available potassium content with the application of coated and blended phosphatic fertilizers might be due to higher uptake of N and K by the crop, because coated DAP and blended RP has no effect on the potassium availability, whereas the nitrogen in coated DAP released in delayed manner which was synchronized with the needs of plant. The superiority of coated and blended phosphatic fertilizers over the commercial P fertilizer in recording highest available P status compared to N and K in post-harvest soil might be due to slow release of nutrient element and coincide of nutrient release with crop demand. Similar results are observed with Sarkar *et al.* (2018) and Assimi *et al.* (2020) [4].

3.2.4 Available calcium and magnesium

Significantly higher calcium content was recorded in treatment receiving 100% RDP through compost blended RP (T_6- 5.50 cmol (p^+) kg^{-1}) which was found to be on par with T_7 (5.23 cmol (p^+) kg^{-1}) and T_8 (5.07 cmol (p^+) kg^{-1}). Lower calcium content of 2.67 cmol (p^+) kg^{-1} was recorded in T_1 treatment. Magnesium status in soil varied significantly due to treatments. Significantly higher value of 2.44 cmol (p^+) kg^{-1} was recorded in T_6 compared to control (1.49 cmol (p^+) kg^{-1}) and on par with rest of the treatments (Figure 3).

3.2.5 Available sulphur

Higher sulphur content of 11.88 mg kg^{-1} was recorded in T_8 treatment followed by T_5 (11.70 mg kg^{-1}) and T_6 (11.50 mg kg^{-1}) which was on par with all the treatments except T_2 which received recommended dose of fertilizer application (T_2- 10.20 mg kg^{-1}) (Figure 3).

Significant difference was observed in secondary nutrient status of soil with the application of coated and blended phosphatic fertilizers especially blended RP treated plots due to additional supply of these nutrients through rock phosphate, compost and Zinc sulphate. The rock phosphate used in the investigation had appreciable amont of these nutrients along with compost might have contributed these elements into the labile pool. Similar results were recorded by Shafar *et al.* (2017) [13].

3.2.6 Micronutrients

DTPA extractable iron, manganese, copper and zinc content of soil did not vary significantly due to application of compost coated and blended phosphatic fertilizer along with recommended quantities of N and K and the data is presented in Table 7.

Though there was no significant difference with respect to DTPA extractable micro nutrient status of soil. However, there was slight increase in Zn content of soil which might be due to supply of Zn from zinc sulphate and FYM. Humic acid ion released from compost or FYM form aqueous complexes with these micronutrients and binds to soil colloidal surfaces, it is not easily leached . Apart from this humic acid has high affinity for chelating the metals and protect them from adsorption on soil matrix (Jakhro *et al.*, 2015) [7].

a) b)

Fig 1: a) Compost coated DAP, b) Compost blended rock phosphate

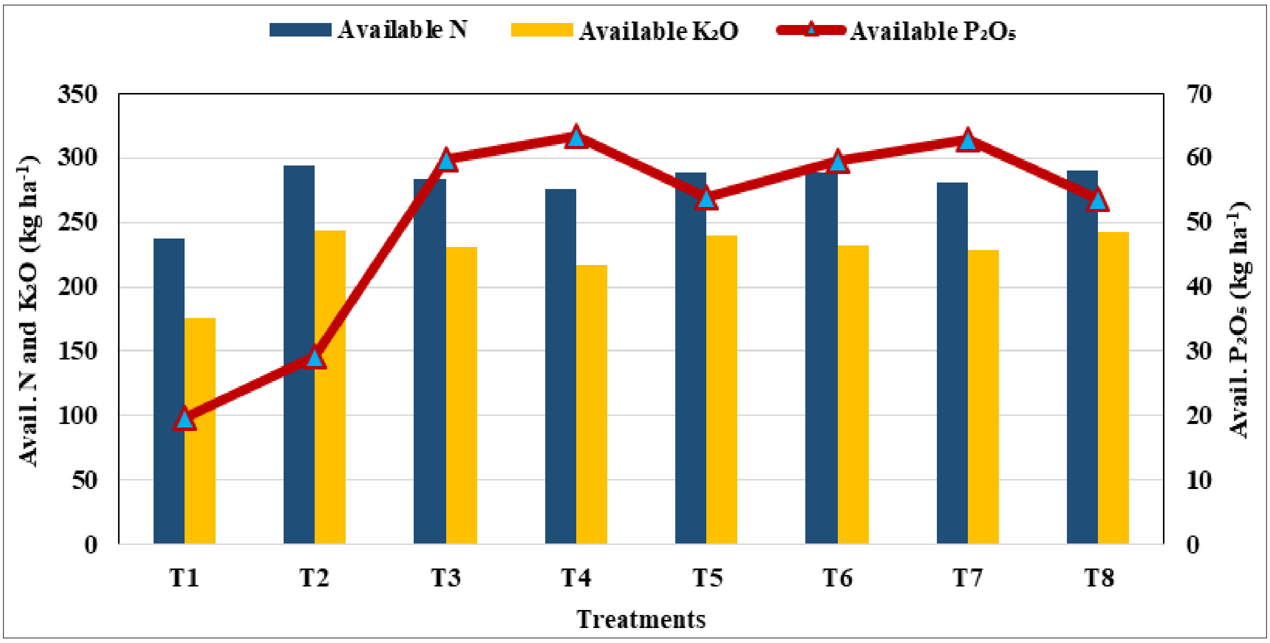

Fig 2: Effect of compost coated and blended phosphatic fertilizers on available N, P_2O_5 and K_2O status of soil after harvest of maize

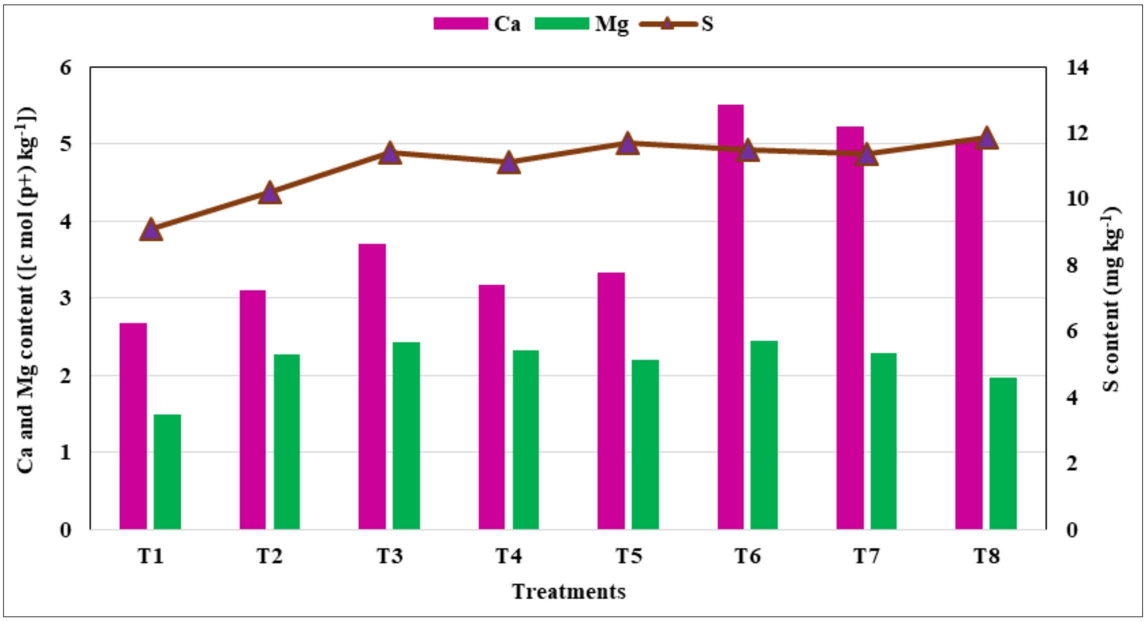

Fig 3: Effect of compost coated and blended phosphatic fertilizers on available Ca, Mg and S status of soil after harvest of maize

Table 7: Effect of compost coated and blended phosphatic fertilizers on DTPA extractable Fe, Mn, Cu and Zn status of soil after harvest of maize

Treatment	**Fe**	**Mn**	**Cu**	**Zn**
	(mg kg^{-1})			
T_1	9.83	7.27	0.51	0.48
T_2	10.60	7.45	0.51	0.51
T_3	10.43	7.60	0.53	0.58
T_4	10.39	7.72	0.55	0.56
T_5	10.55	7.41	0.54	0.53
T_6	10.48	7.78	0.52	0.57
T_7	10.42	7.33	0.56	0.55
T_8	10.59	7.48	0.53	0.52
S.Em±	0.45	0.33	0.02	0.02
CD @ 5%	NS	NS	NS	NS

Treatment details

T_1: Absolute control
T_2: RDF (150:75:40 NPK kg ha^{-1})
T_3: 100% RDP through compost coated DAP
T_4: 75% RDP through compost coated DAP
T_5 50% RDP through compost coated DAP
T_6: 100% RDP through compost blended RP
T_7: 75% RDP through compost blended RP
T_8: 50% RDP through compost blended RP
Note: RDF: Recommended dose of fertilizers
RD N and K: Recommended dose of nitrogen and potassium
RDP: Recommended dose of phosphorus, RP: Rock phosphate

4. Conclusion

The present study highlighted the preparation of compost coated DAP and compost blended rock phosphate fertilizers and their effect on on P dynamics and post-harvest nutrient status at different levels by using maize as a test crop. The content of Al-bound P, Fe-bound P, reductant soluble P and Ca bound P in soil decreased with crop growth period in the treatments with coated and blended phosphatic fertilizers. The saloid P, occluded P, organic bound P and total P content in soil increased with crop growth period in the treatments receiving coated DAP and blended RP. Irrespective of the source of coated and blended phosphatic fertilizers application, the content of saloid, occluded P and organic bound P were higher due to release of humic acid from compost compared to treatment without coating. The superiority of coated and blended phosphatic fertilizers over the commercial P fertilizer in recording highest available P status in comparison with available N and K in post-harvest soil might be due to slow release of nutrient element and coincide of nutrient release with crop demand. Significant difference was observed in secondary nutrient status of soil with the application of coated and blended phosphatic fertilizers especially blended RP treated plots due to additional supply of these nutrients through rock phosphate, compost and Zinc sulphate. Though there was no significant difference with respect to DTPA extractable micro nutrient status of soil. However, there was slight increase in Zn content of soil which might be due to supply of Zn from zinc sulphate and FYM.

5. Acknowledgement

Author 1 thanks all the teachers, seniors, friends and juniors who have supported her in completing her research work. And also thank College of Agriculture, VC Farm, Mandya for all the support and encouragement.

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