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Effect of Phosphorus Management on Quality of Maize (*Zea mays* L.) and Green Gram (*Vigna radiata* L.) under South Gujarat Condition

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Authors' contributions

This work was carried out in collaboration between all authors. Author AD designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors ST and LJD managed the analyses of the study and manuscript writing. Authors HD, KS and AY managed the literature references. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted at the College Farm, Navsari Agricultural University, Navsari to study the "Effect of phosphorus management on quality of *rabi* maize (*Zea mays L.)* and summer Green gram (*Vigna radiata L.*) under south Gujarat condition with an objective to assess the residual effect of rock phosphate (RP) and single super phosphate (SSP) along with *Vascular Arbuscular Mycorrhiza* (VAM) applied to *rabi* maize crops with four teen different phosphorus management treatment rock phosphate (RP), single super phosphate and *Vascular Arbuscular Mycorrhiza* (VAM) two levels I,e. 100% RDF (recommended dose of fertilize) and 75% RDF in summer green gram. Application of 75 percent phosphorus as enriched rock phosphate along with

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VAM gave significantly higher grain yield, straw yield protein content and protein yield over rest of the treatments under study during the individual years as well as in the pool. The same trend was observed in Green gram seed and stover, from the results, it can be concluded that the application 75 percent rock phosphate along with VAM to *rabi* maize and improvements in quality of both crops of sequence.

Keywords: Grain and straw yield of maize; seed and stover yield of green gram and protein content and yield of maize and green gram.

1. INTRODUCTION

Maize has high production potential crop when compared to any other cereal crop. The productivity of maize is mainly dependent on its nutrient management. It is well known that maize is a heavy feeder of nutrients and because of its C_4 nature; it is very efficient in converting solar energy into production of dry matter. The crop has high genetic yield potential. Hence, it is called Miracle crop and "Queen of Cereals" [1].

Pulses are an integral part of Indian dietary system because of its richness in proteins and other essential nutrients such as Ca, Fe, and vitamins viz., carotene, thiamine, riboflavin and niacine. Indian population is predominantly vegetarian and protein requirement for the growth and development of the human being is mostly met with pulses. Pulses are said to be poor man's meat and rich man's vegetables. As per recommendation of world health organization (WHO), the minimum requirement of pulses is 80 g/ capita/ day. Apart from the human diet, pulses form an essential fraction of cattle feed and fodder as hay, green fodder and concentrate. Due to their short duration, they can be grown as main, intercrop, catch and green manure crop [2].

Phosphorus (P), a significant macronutrient, can limit normal plant growth if not applied at the proper time and right amount. It must be used as either organic or inorganic forms for optimal crop production in deficit soils low in available P [3]. In India, most of the soils are either deficient or marginal in P status. Adequate P fertilisation is thus essential for economic and sustained crop production. Phosphorus deficient soils require a heavy dose of phosphatic fertilizers which are imported and expensive. Also, immediate conversion of water-soluble P due to P fixation results in low fertilizer use efficiency. Among the different inorganic P sources, single super phosphate (SSP) is the most widely used phosphatic fertilizers which supply P in a water-soluble form in the immediate vicinity of roots. Its importance as the most efficient P fertilizer source is well established, but it is very expensive and needs to be imported. It also suffers from the problem of fixation in the long run. However, India has vast resources of indigenous rock phosphate (RP). Unfortunately, most of the RPs of Indian origin have the limitation of low P_20_5 content and low reactivity and perform poorly when applied directly to the neutral soil and are not suitable for the manufacture of phosphatic fertilizer. With the discovery of several deposits of RP in the country, interest in the use of this original material as alternative phosphatic fertilizers has significantly increased. Although RP can effectively replace water-soluble phosphates in acid soils, but its efficiency in neutral, alkaline and calcareous soils is extremely low. To make it effective in such soils it is being converted into a water-soluble form by Appling like vesicular-arbuscular mycorrhiza (VAM), and the role of VAM in the acquisition of immobile nutrients like P from the soil has been long recognised and well documented. The arbuscular mycorrhizal fungi are known to work more efficiently at low soil solution P levels [4]. Compared to water-soluble P fertilizers, the application of PR is less likely to increase soil solution P concentration to the levels that are detrimental to arbuscular mycorrhiza colonisation and effectiveness [5]. Enhanced uptake of other essential elements in soils colonised by arbuscular mycorrhiza has also been reported [6].

Studies were initiated to evaluate the performance of above said phosphorus fertilizer SSP, RP alone or along with VAM to *rabi* maize (*Zea mays L.)* and two level F_1 (75% RDF) and F_2 (100% RDF) recommended dose of fertilizer to summer green gram (*Vigna radiata* L.) on yield and quality parameters of *rabi* maize and green gram.

2. MATERIALS AND METHODS

The field experiment was conducted at the College Farm, Navsari Agricultural University, Navsari. To study the "Effect of phosphorus management on quality maize (*Zea mays* L.) and green gram (*Vigna radiata* L.) under south Gujarat condition" during 2015-16 and 2016-17. The treatments consisted for the study *viz* T_1: *Rabi* Fallow T_2: Absolute control (No fertilizer and AM in *rabi* maize), T_3: 50% P(phosphorus) as RP(phosphorus as rock phosphate), T_4: 50% P as RP +AM(Vascular Arbuscular Mycorrhiza),T_5: 50% P as SSP(Single super phosphate), T_6: 50% P as SSP+ AM, T_7: 75% P as RP, T_8: 75% P as RP +AM, T_9: 75% P as SSP, T_{10}: 75% P as SSP +AM , T_{11}: 100% P as RP, T_{12}: 100% P as RP+ AM, T_{13}: 100% P as SSP and T_{14}: 100% P as SSP+ AM in *rabi* maize as main plot size (4×4.8 m^2)and treatments which replicated for three times in randomized block design and summer green gram with split plot design having plot size of 4.8 m x 2m with two level of RDF F_1: 75% RDF (recommended dose of fertilizer) and F_2: 100% RDF thought urea 20 kg/ha and SSP 40 kg/ha, respectively. The plant geometry for *rabi* maize was 60×20 cm and for green gram it was 30x10 cm. Maximum temperature ranged between 23.7° to 36.7°C and 19.1° to 37.5°C, while minimum temperature ranged between 9.8° to 26.6°C and 10.4° to 26.8°C during the period of experimentation in 2015-16 and 2016-17, respectively. Gujarat Maize 6 and Meha varieties were selected for cultivation of Maize and Green gram respectively.

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), medium in available phosphorus (38.20 Kg/ha) and high in available potassium (323.18 kg/ha). Total available micronutrient content iron 4.18 mg/kg, lower of copper (Cu) 0.049 mg/kg, zinc (Zn), 0.264 mg/kg and 6.2 mg/kg of manganese (Mn). Properties of the bio-compost which applied (15 t/ha), bio-compost (pH 6.32), EC 0.14 (dS/m), 122.6, 38.2 and 274.8 mg/kg, Available (NPK) respectively. However the properties of rock phosphate enriched compost 2% of total P, 97 and 175 mg/kg of N and K respectively. The biometric observations were recorded on five randomly selected plants from net plot.

Plant samples (grain and straw) were dried at about 60°C and their dry weight was recorded. Grain and straw yield were also recorded. Total N from plant sample was analyzed by micro-kjeldhal assembly according to procedure outlined by [7]. The protein content of maize and green gram from grain was worked out by multiplying nitrogen content in grain with 6.25 [8]. The protein yield (q/ha) was calculated by multiplying the protein content with grain yield (q/ha). The data on various variables were analysed by using statistical procedures as described by [9]. The treatment effects on all the characters under study were compared by employing 'F' test. The data of the preceding *rabi* maize and succeeding summer green gram were analyzed with Randomized Block Design and Split Plot Design, respectively.

3. RESULTS AND DISCUSSION

3.1 Maize

3.1.1 Grain yield (kg/ha)

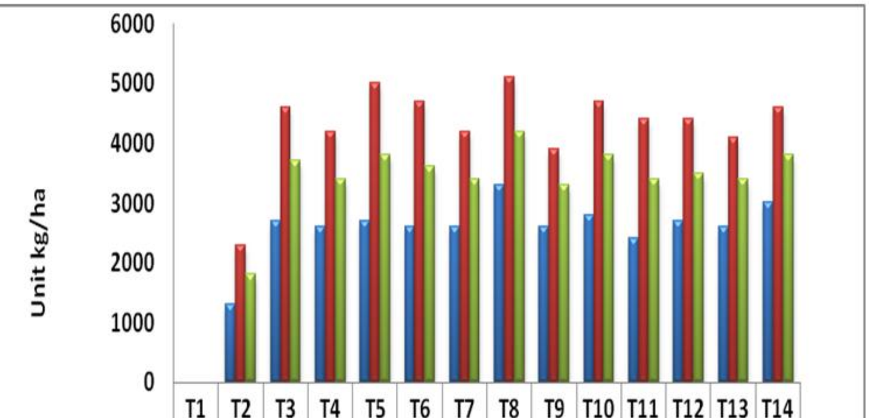
The result depicted in Fig. 1, regarding the test weight, grain yield and straw yield revealed that the grain yield of maize was significantly influenced by different treatments during both the years of investigation and in pooled analysis, while interaction between treatment was non significant. Significantly higher grain yield was recorded with the application of 75% P as RP +AM (T_8, 3300 kg/ha), which was at par with 100% P as SSP+AM ($T_{14,}$ 3000 kg/ha). However the application of phosphorus fertilizers SSP, RP and SSP, RP along with AM treatments significantly increased maize grain yield as compared to control (T_2). The significantly lowest grain yield was recorded under T_2. In second year of experiments 2016-17, significantly higher value of the maize grain yield was obtained with in 75% P as RP+AM ($T_{8,}$ 5100 kg/ha), which was statistically at par with all other phosphorus fertilizer treatment except control (T_2) and 75% P as SSP (T_9) treated plots. While significantly lowest grain yield was obtained in control ($T_{2,}$ 2300 kg/ha) plots. Similarly the grain yield in pooled analysis was significantly higher in 75% P as RP+AM ($T_{8,}$ 4200.6 kg/ha), but it was statistically at par with 50% P as SSP ($T_{5,}$ 3800 kg/ha), 75% P as SSP +AM ($T_{10,}$ 3800 kg/ha) and 100% P as SSP+ AM ($T_{14,}$ 3800 kg/ha). The data on grain yield of maize expressed that the application of phosphorus fertilizer ether SSP, RP alone or along with AM increased significantly grain yield over control (T_2) during the both years of the study and with respect pooled analysis. Similarly result was found by [10], from study the effect of composted rock phosphate with organic materials on yield and phosphorus uptake of berseem and maize.

3.1.2 Straw yield (kg/ha)

Data presented in the Fig. 2, showed that significantly higher straw yieldof both the years of experiment and also in pooled (4100, 5500 and 4700 kg/ha, respectively) was recorded with the application 75% P as RP+AM (T_8) and significantly lowest was recorded under control ($T_{2,}$ 1900, 3100 and 2500 kg/ha, respectively). During 2015-16, the application of 75%P as RP+AM (T_8) was at par with, treatment 50% P as RP($T_{3,}$ 3900 kg/ha), 50% P as RP+AM ($T_{4,}$ 3700 kg/ha), 50% P as SSP (T_5 3800 kg/ha), 75% P as RP ($T_{7,}$ 3600 kg/ha) 100% P as RP+AM ($T_{12,}$3700 kg/ha) 100% P as SSP ($T_{13,}$ 3700 kg/ha) and 100% P as SSP+AM ($T_{14,}$3600 kg/ha). The data registered significantly higher straw yield under the application of different phosphorus fertilizer over control plots. In the second year 2016-17, significantly higher value of the straw yield was found 5500 kg/ha with application 75% P as RP+AM (T_8) and significantly lowest with control ($T_{2,}$ 2500 kg/ha). Among different treatments tried in experimental plot application of 75% P as RP+AM (T_8), it was at par with 50% P as RP ($T_{3,}$ 4700 kg/ha), 50% as SSP ($T_{5,}$ 4800 kg/ha), 75% as RP ($T_{7,}$4800 kg/ha), 75% P as SSP ($T_{9,}$ 4800 kg/ha), 75% P as SSP+AM ($T_{10,}$ 5300 kg/ha), 100% P as RP+AM ($T_{12,}$ 5000 kg/ha) and 100% P as SSP+AM ($T_{14,}$ 4700 kg/ha) treatments. Pooled analysis, result showed that the significantly higher straw yield was recorded in 75% P as RP+AM ($T_{8,}$ 4700 kg/ha), while significantly lowest straw yield was recorded in the control ($T_{2,}$ 2500.5 kg/ha) plot. Straw yield under 75% P as RP+AM (T_8) was at par with 50% P as RP ($T_{3,}$ 4300 kg/ha), 50% P as SSP ($T_{5,}$ 4300 kg/ha) and 100% P as RP+AM $T_{12,}$ (4300 kg/ha). Similarly results were found by [11], that the use of ogun rock phosphate with 3 t/ha cow dung manure produced the highest yield of maize, okra and cowpea.

3.1.3 Protein content (%)

Data on protein content (%) as influenced by different treatments are presented in Fig. 3. The findings showed that the different treatments were found significant in respect of protein content (%). Significantly maximum protein content was recorded of 6.46, 6.91 and 6.68 (%) respectively, with the application of 75% P as RP+AM (T_8) which was at par with all other phosphorus fertilizes SSP, RP and SSP, RP with AM treatments except for control T_2 (4.17 , 3.90 and 4.03%) respectively, during the both years of the study and pooled analysis. The pooled data resulted protein content in T_8 (6.68%) was higher and it was at par with T_3 (5.91%), T_4 (6.09%), T_5 (6.28%), T_{11} (6.56%), T_{12} (6.31%), T_{13} (6.04%) and T_{14} (6.34%) treatments and significantly higher than T_2 (4.03%), T_6 (5.82%), T_7 (5.48%), T_9 (5.75%) and T_{10} (5.55%)



	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14
Grain yield (Kg/ha) 2015-16	0	1300	2700	2600	2700	2600	2600	3300	2600	2800	2400	2700	2600	3000
Grain yield (Kg/ha) 2016-17	0	2300	4600	4200	5000	4700	4200	5100	3900	4700	4400	4400	4100	4600
Pooled	0	1800	3700	3400	3800	3600	3400	4200	3300	3800	3400	3500	3400	3800

Fig. 1. Effect of phosphorus management of maize grain yield (kg/ha)

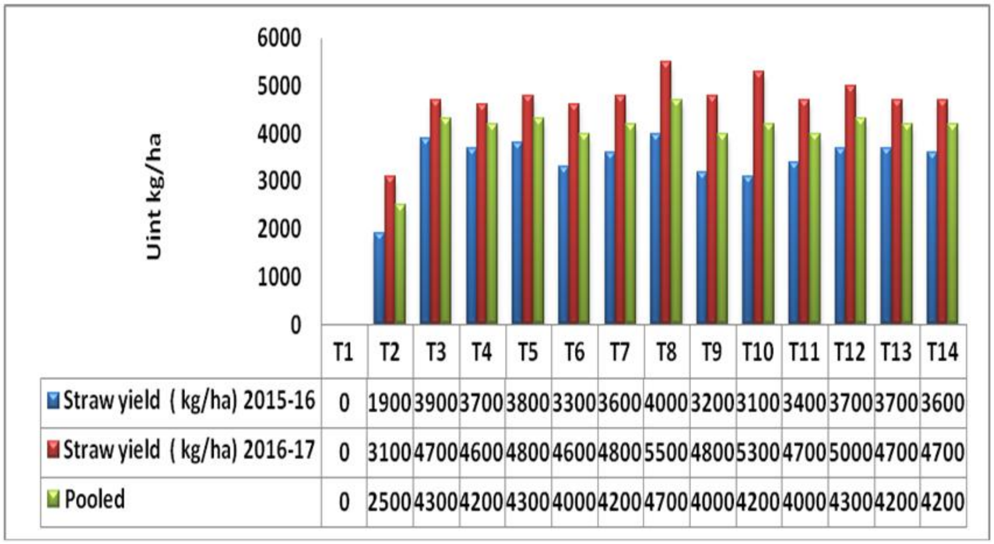


Fig. 2. Effect of phosphorus management of maize straw yield (kg/ha)

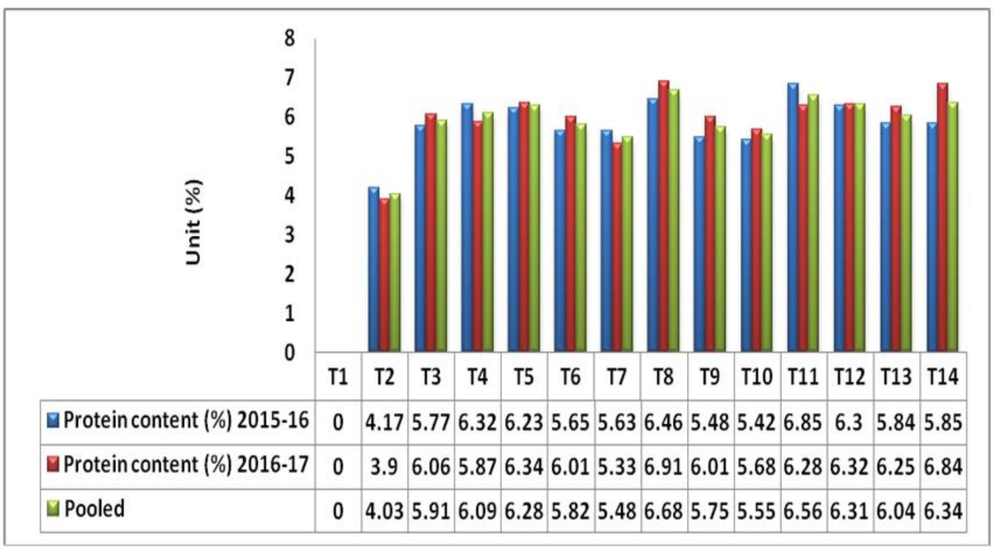


Fig. 3. Effect of phosphorus management of maize protein content (%)

treatments. The increased in protein content under 75% P as RP+AM (T_8) treatment might be due to the beneficial effect of RP along with AM fungi which contributed the higher yield attributes. From other side the increased in protein content in maize grain also due to higher content of the nitrogen in grain which resulted into improvement in metabolic activities of plant. The results were conformity also with findings of [12,13].

<u>**3.1.4 Protein yield (kg/ha)**</u>

Data regarding the protein yield as affected by various treatments are tabulated in Fig. 4, during individual years and pooled. The results were showed Table, that the different treatments were found significant in respect of protein yield. Significantly maximum protein yield (218, 357, 287 kg/ha) was recorded respectively, with in application of 75% P as RP+AM (T_8) treated plots which was significantly higher than other phosphorus fertilizers treatments during year 2015-16, 2016-17 and pooled analysis. Protein yield was significantly higher in T_8 (218 kg/ha) which was at par with T_3 (282 kg/ha), T_5 (318 kg/ha), T_6 (283 kg/ha) and T_{12} (283 kg/ha) treatments during yeas 2016-17. However, the protein yield during pooled analysis in T_8 (287 kg/ha) was at par with T_5 (245 kg/ha) and T_{14}

(249 kg/ha) and significantly higher than other phosphorus fertilizer and unfertilized treatments. The data also resulted that the application of phosphorus fertilizer alone or combined with AM significantly increasing the protein yield over unfertilized plots during the both years of the study and pooled analysis and these were at par with each others. The increased protein content and protein yield in 75% P as RP+AM (T_8) treatment might be due to the beneficial effect of RP along with AM fungi which contributed the higher yield attributes under this treatment. The variation in protein yield was observed because uptake of nutrients associated with its levels of supply as well as plant potential to absorb and utilize for growth as well as accumulation of protein in grain under adequate nutrient supply might be accounted to continuous availability of nutrient for protein synthesis. On the other hand it has increased in protein content in maize grain also due to more quantity of the nitrogen content in grain under this nominated treatment which resulted into improvement in metabolic activities in the plant. The results were conformity also with findings of [14,15,13].

3.2 Green Gram

Significantly higher seed yield was recorded during 2015-16 by application of 75% P as RP+AM ($T_{8,}$ 1058.6 kg/ha) and it was found at par with T_1(723.7 kg/ha), T_4(914.9 kg/ha), T_5(844.7 kg/ha), T_6(978.9 kg/ha), T_7(960.7kg kg/ha), T_9 (927.4 kg/ha), T_{10} (977.4 kg/ha), T_{11} (768.2 kg/ha), T_{12} (988.4 kg/ha), T_{13}(802.7 kg/ha) and T_{14}(1032.7 kg/ha) treatments except T_2(329.4 kg/ha) and T_3(701.8 kg/ha) treated plots the results was also showed that the application phosphorus fertilizer treatments increased significantly seed yield over unfertilized plots (T_2). Similarly in 2016-17 and pooled results showed the higher green gram seed yield was recorded in 75%P as RP+AM (T_8) and lower was observed in control plots (Table 1). Application of adequate rate of P fertilizer is usually associated with higher residual phosphorus in soil. [12], observed that rate of phosphatic fertilizers had more pronounced residual effects and increased level of application lead to a greater increase in a available P status of soil which was further affected growth attributed and finally higher seed and stover yield.

3.2.1 Stover yield (kg/ha)

Significantly maximum stover yield was noted under 75% P as RP+AM (T_8) and 100% P as RP+AM (T_{12}) (1587.3 and 1558.7 kg/ha, respectively) during 2015-16, which was found at par with T9 (1437.7 kg/ha), T_{10} (1442.8 kg/ha), T_{13} (1510.10 kg/ha) and T_{14} (1400.2 kg/ha) treatments. While in the year's 2016-17 it was at par with T_5 (1426.2 kg/ha), T_6 (1435.8 kg/ha), T_9 (1507.7 kg/ha), T_{10} (1462.8 kg/ha), T_{11} (1442.1 kg/ha), T_{13} (1540.6.3 kg/ha) and T_{14} (1450.6 kg/ha) treatments (Table.1). Similarly trends were observed in pooled data. This was largely attributes due to better growth of plant in terms of plant height, number of branches and dry matter accumulation per plant which resulted in adequate supply of photosynthates for development of sink. Thus, the overall better growth performance and higher values of the yield attributes reflected into higher seed and stover yields under this treatment. Residual effect of 75% P as RP+AM (T_8) treatment superior phosphorus management might have reflected in the better growth and yield parameters of green gram with 75% RDF (F_1) was the best recommended dose for summer green gram as comported to 100% RDF (F_2) since save 25% more fertilizer and protect environment. The results were in close conformity with those reported [16], in legume crops (green gram, black gram and cowpea) 50% RDF and 100% RDF for respective crops. The interaction between different phosphorus fertilizer to preceding *rabi* maize crop and fertilizer levels to green gram (summer) did not exert any significant effect on seed, stover yield and harvest index (%) during both the years and in pooled analysis. [17], from greengram (*Vigna radiata*) to rock phosphate enriched compost in Inceptisol. These findings corroborate the observations of [18].

3.2.2 Protein content (%)

The data on protein content (%) in green gram seeds as affected by different treatments are presented in (Table 2). While examining the data, it was found that significantly higher protein content was noted (13.4, 15.9 and 14.7%) respectively, under the treatment of 75% P as RP+AM (T_8) which was statistically at par with all the treatments except T_1 (9.4 %), T_2 (7.0 %), T_{13} (10.4%) and T_{14} (9.6%) treatments during first year and second year at par with all treatments without T_1 (9.0%) and T_2 (8.7%) treatment. However the result of pooled data showed protein content in the treatment T_8 (14.7%) was at par with T_4 (13.0%), T_5 (13.5 %), T_6 (14.1%), T_7 (13.5%), T_9 (13.5%), T_{11} (13.2%) and T_{12} (13.9%) treatments. Significantly lowest protein content was registered with control T_2 (7.0, 8.7

and 7.8%) during both the years of study and pooled analysis respectively. 75% P as RP+AM (T_8) with (75% RDF) F_1 produce significantly higher protein content and protein yield in seed of green gram during individual years of study and pooled analysis, due to more availability of nutrient especially phosphorus and other, nurtured from RP along with AM fungi to previous *rabi* maize treatments, higher protein yield was obviously due to more seed yield. There were

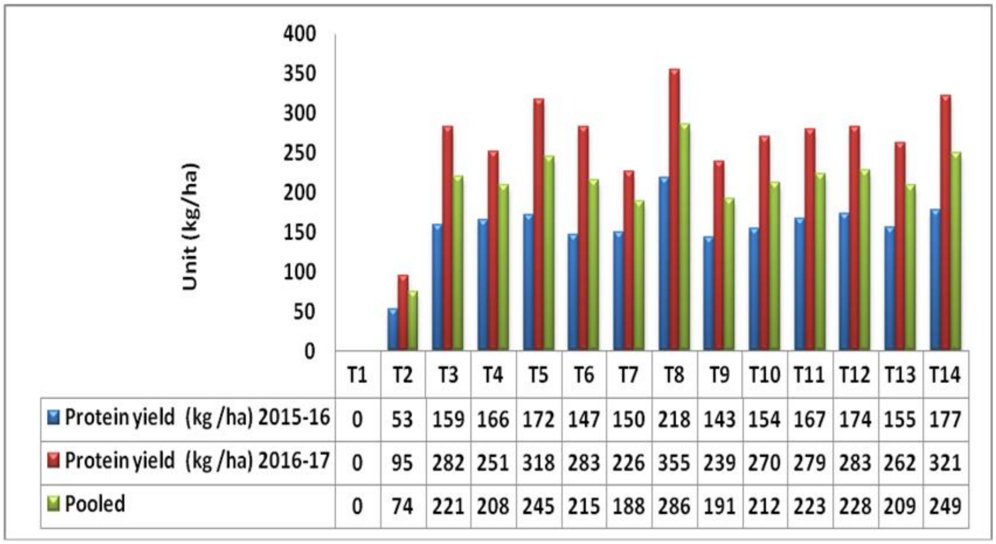


Fig. 4. Effect of phosphorus management of maize protein yield (kg/ha)

Table 1. Effect of phosphorus management of green gram grain and stover yield (kg/ha)

Treatments	Grain yield (kg/ha)		Pooled	Stover yield (kg/ha)		Pooled
	2015-16	2016-17		2015-16	2016-17	
T_1	723.7	737.5	730.6	836.6	1056.6	946.6
T_2	329.4	545.4	437.4	617.8	822.8	720.3
T_3	701.8	914.6	808.2	1033.8	1142.1	1088.0
T_4	914.9	909.5	912.2	1220.6	1270.6	1245.6
T_5	844.7	982.9	913.8	1376.2	1426.2	1401.2
T_6	978.9	904.3	941.6	1315.8	1435.8	1375.8
T_7	960.7	1061.6	1011.1	1282.9	1332.9	1307.9
T_8	1058.6	1310.1	1184.4	1558.7	1648.7	1603.7
T_9	927.4	925.9	926.7	1437.7	1507.7	1472.7
T_{10}	977.4	1157.7	1067.6	1442.8	1462.8	1452.8
T_{11}	768.2	1013.9	891.0	1322.1	1442.1	1382.1
T_{12}	988.4	946.9	967.7	1587.3	1617.3	1602.3
T_{13}	802.7	1219.0	1010.9	1510.6	1540.6	1525.6
T_{14}	1032.7	1048.2	1040.4	1420.6	1450.6	1435.6
S.Em.±	122.0	128.8	88.6	61.4	63.0	43.9
C.D. @5%	354.7	374.4	251.0	178.4	183.2	124.9
C.V. %	16.8	17.6	16.8	10.2	13.2	11.5
F_1	865.9	961.9	913.9	1293.2	1380.8	1337.0
F_2	849.7	992.0	920.9	1273.0	1355.9	1314.5
S.Em.±	21.7	38.5	31.3	17.1	17.5	62.2
C.D. @5%	Ns	NS	NS	NS	NS	NS
T×F S.Em.±	81.3	144.4	125.0	63.8	65.3	61.2
C.D. @5%	Ns	NS	NS	NS	NS	NS
C.V. %	10.9	12.4	11.9	8.3	11.3	9.6

Table 2. Green gram seed protein content (%) and Protein yield (kg/ha) as influenced by different treatments during 2015-16, 2016-17 and pooled

Treatment	Protein content (%)		Pooled	Protein yield (kg/ha)		Pooled
	2015-16	2016-17		2015-16	2016-17	
T_1	9.4	9.0	9.2	68.3	66.0	67.1
T_2	7.0	8.7	7.8	23.3	46.3	34.8
T_3	11.1	13.0	12.1	78.3	119.5	98.9
T_4	11.6	14.3	13.0	105.2	138.5	121.9
T_5	12.0	15.0	13.5	99.7	148.1	123.9
T_6	12.6	15.5	14.1	118.5	137.5	128.0
T_7	12.0	15.1	13.5	114.3	156.0	135.2
T_8	13.4	15.9	14.7	141.3	209.2	175.3
T_9	12.8	14.3	13.5	122.2	129.7	125.9
T_{10}	12.2	11.8	12.0	118.7	134.5	126.6
T_{11}	11.4	14.9	13.2	86.5	154.2	120.3
T_{12}	12.3	15.5	13.9	121.9	147.2	134.5
T_{13}	10.4	14.4	12.4	82.9	173.9	128.4
T_{14}	9.6	15.0	12.3	99.1	158.1	128.6
S.Em.±	1.0	1.3	0.8	16.6	24.6	14.8
C.D. @5%	2.8	3.6	2.3	48.2	71.4	42.1
C.V. %	9.9	10.9	10.9	16.0	16.5	13.7
F_1	11.3	13.9	12.6	99.3	137.8	118.5
F_2	11.3	13.6	12.5	97.9	136.3	117.1
S.Em.±	0.3	0.2	1.1	3.3	5.4	4.5
C.D. @5%	NS	NS	NS	NS	NS	NS
T×F S.Em.±	1.2	0.7	1.0	12.2	20.2	16.7
C.D. @5%	NS	N S	NS	NS	NS	NS
C.V. %	8.3	5.5	9.0	11.1	12.2	11.9

non-significant effect between 75% RDF (F_1) and 100% RDF (F_2). [19,20], reported that growth, yield parameters and protein yield of green gram with the application 75% RDF and 100% RDF was at par to each other. Similar findings were reported by [21,22] in cowpea, [18], in green gram.

3.2.3 Protein yield (kg/ha)

The data on protein yield of green gram seeds as influenced by different treatments are presented in (Table 2). The data furnished in Table 2, revealed that higher protein yield significantly affected by different phosphorus fertilizer SSP, RP alone and SSP, RP along with AM to preceding *rabi* maize crop to green gram during individual years of study and pooled analysis. Application of 75% P as RP+AM (T_8) treatment resulted significantly higher protein yield 141, 209 and 175 kg/ha respectively, in which was statistically at par with T_4,(105 kg/ka) T_5 (99 kg/ha), T_6 (118.5 kg/ha), T_7 (114.3 kg/ha), T_9 (122.2 kg/ha), T_{10} (118.7 kg/ha), T_{12} (121.9 kg/ha) and T_{14} (99.1 kg/ha) treatments during the first year of the study and significantly higher than T_1 (68.3 kg/ha), T_2 (23.3 kg/ha), T_3 (78.3 kg/ha), T_{11} (86.5 kg/ha) and T_{13} (82.9 kg/ha) treatments. During the first year 2015-16 protein yield was significantly higher with application of T_3, (78.3 kg/ha), T_{11} (86.5 kg/ha) and T_{13} (82.9 kg/ha) treatments as compared to control T_2 (23.3 kg/ha) plots. Similarly protein yield was higher during 2016-17 in the treatment T_8 (209.2 kg/ha) which was at par with T_4 (138.5 kg/ha), T_5 (148.1 kg/ha), T_6 (137.5 kg/ha), T_7(156.0 kg/ha), T_{11} (154.2 kg/ha), T_{12} (147.2 kg/ha), T_{13} (173.9 kg/ha) and T_{14} (158.1 kg/ha) treatments, and it was significantly higher than T_1 (66.0 kg/ha), T_2 (46.3 kg/ha), T_3 (119.5 kg/ha), T_9 (129.7 kg/ha) and T_{10} (134.5 kg/ha) treatments. However, in pooled analysis maximum value protein yield was recorded in the treatment T_8 (175.3 kg/ha) which was significantly higher than all other phosphorus fertilizers SSP, RP and SSP, RP along with AM treatments. An appraisal of data in Table 2, also indicated that the different phosphorus fertilizer increased significantly protein yield over *rabi* fallow T_1 (67.1 kg/ha) and control T_2 (34.8 kg/ha) plots during pooled analysis it means significantly lower value of the protein yield was obtained in T_2 (23.3, 46.3 and 34.8 kg/ha) plots during the both years of the study and pooled data respectively.

75% P as RP+AM (T_8) with (75% RDF) F_1 produce significantly higher protein content and protein yield in seed of green gram during individual years of study and pooled analysis, due to more availability of nutrient especially phosphorus and other, nurtured from RP along with AM fungi to previous *rabi* maize treatments, higher protein yield was obviously due to more seed yield. There were non-significant effect between 75% RDF (F_1) and 100% RDF (F_2). [19, 20], reported that growth, yield parameters and protein yield of green gram with the application 75% RDF and 100% RDF was at par to each other. Similar findings were reported by [18,22] green gram, [21] in cowpea.

4. CONCLUSION

From the discussion, it can be concluded that for getting higher yield and increasing the protein content of the crops, it is advisable to apply 75% phosphorus as enriched rock phosphate with AM at the time of *rabi* maize sowing among all treatments under study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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