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Influence of Integrated Nutrient Management on Nitrogen and Phosphorus in Soil under Maize-Blackgram-Groundnut Cropping System

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ABSTRACT

In order to investigate the immediate effects of integrated use of inorganic and organic sources of N and P on the performance of the maize-blackgram-groundnut cropping sequence in terms of yield, a field experiment was conducted at S.V. Agricultural College Farm, Tirupati during the *rabi* (maize), *summer* (blackgram), and *kharif* (groundnut) seasons of 2019-20. Ten treatments were applied to maize, including the control, fertilizers administered at 50%, 75%, and 100% of the recommended dose (NPK), N_{240} only, P_{80} only, FYM (@ 5 t ha^{-1}) applied alone, and in combination with 100%, 75%, and 50% of the recommended NPK. These interventions were contrasted with the manure and no-fertilizer control. Blackgram was produced after maize without the use of fertilizer or manure. It was allowed to mature and expand for two pickings, the stover was incorporated into the soil. In the following rabi season, black gram was grown on the same field, and each main plot treatment of RBD was divided into three sub plot treatments with S_1 (control), S_2 (75% RDF), and S_3 (50% RDF), yielding ninety treatment combinations replicated three times in split plot design .–increased fertilizer-N addition rates resulted in increased soil concentrations of ammonia, nitrate, and alkaline $KMnO_4$ oxidisable (available) N. Similar to this, greater Olsen-P and total inorganic P values led to higher fertilizer-P dosages. It was discovered that applying FYM @ 5 t ha^{-1} and inorganic N together helped to keep the levels of all these types of soil N stable until groundnut harvest. Organic P revealed an inverse relationship with the Inorganic P content at all the growth stages of the three crops under study.

***Key words**: Summer legume, Ammoniacal-N, nitrate-N, Blackgram, Organic P, Inorganic P,Olsen-P, Farmyard manure*

Introduction

The effective combination of renewable organic/ biological plant nutrient sources with mineral fertilizers, aiming to maintain or enhance soil quality and optimize crop performance. An integral aspect of this approach involves introducing short-duration legumes like greengram and blackgram during the fallow period after rabi crop harvest, contributing to integrated nutrient management (INM). These legumes are valuable for their nitrogen-fixing capability, benefiting subsequent non-legume crops. However, challenges such as low legume yield under limited fertilizer application and water scarcity in summer prompt the exploration of residual fertilizer effects from prior crops. If these residual effects can elevate the productivity of summer legumes when rotated with exhaustive non-legume crops, the entire system's value would be significantly amplified

The interactions between nitrogen (N) and phosphorus (P) dynamics within the soil are heavily influenced by shifts in the organic matter content of the soil, which is, in turn, impacted by integrated nutrient management (INM) practices. While extensive research has been dedicated to nitrogen in the past, its behavior in the soil remains puzzling in various aspects. The study of phosphorus chemistry in the soil is equally captivating due to the paradox that, although it tends to remain relatively stable in the soil, its accessibility to plants is not guaranteed.

In contrast to nitrogen, only a small proportion of phosphorus is contributed by organic sources. Nonetheless, the synergistic application of organic manures in combination with phosphatic fertilizers has not only enhanced the efficacy of the latter (Vats *et al*., 2001) but has also significantly augmented phosphorus availability (Mahajan *et al*., 1997). The breakdown of organic matter gives rise to organic acids, which either replace phosphorus that is adsorbed onto metal hydroxides or facilitate the release of phosphorus immobilized in metal oxides by forming intricate complexes with iron and aluminum. There is a dearth of comprehensive information concerning the alterations in distinct soil nitrogen and phosphorus pools at various stages of sequentially grown crops. The current investigation represents an effort to evaluate the impact of integrated nutrient management on diverse soil nitrogen and phosphorus reservoirs during distinct physiological phases of maize-blackgram-groundnut cultivation within an annual cycle.

Materials and Methods

Field experiments were carried out during *rabi, summer* and *kharif* seasons of 2019-20 at S.V. Agricultural Farm, Tirupati, geographically situated at 13.5^o N latitude and 79.5^o E longitude at an altitude of 182.9 meters above mean sea level, categorised as the Southern Agro-climatic Zone of Andhra Pradesh. The soil of experimental site was sandy loam in texture with bulk density of 1.49 Mg m^{-3}, neutral in reaction (pH 6.8), electrical conductivity 0.35 dSm^{-1}, low in organic carbon (0.30 per cent) and low in available nitrogen (95 kg ha^{-1}), medium in available phosphorus (21kg ha^{-1}) and medium in potassium (162kg ha^{-1}). The treatments consisted of integrated nutrient management *viz*., T_1- control, T_2- FYM @ 5 t ha^{-1}, T_3- 100 RDF, T_4- 75% RDF, T_5- 50% RDF, T_6 - 100% RDN, T_7-100% RDP, T_8-100% RDF+ FYM @ 5 t ha^{-1}, T_9 - 75% RDF + FYM @ 5 t ha^{-1}, T_{10} - 5 0% RDF+ FYM @ 5 t ha^{-1} to maize in *rabi* season as main plot treatments replicated three times in randomized block design. Maize hybrid 'Pioneer 3396' was sown on 25th November, 2019 and harvested on march,12 2020. Blackgram variety 'TBG-104' was grown as residual crop sown after harvest of maize on March 29,2020 and was allowed to grow till maturity. After two pickings, the stover was incorporated into the soil on June 11, 2020. Groundnut variety 'Dharani' was sown on July 1, 2020 and harvested on October 23, 2020. Standard package of practices were followed for all the three crops. Phosphorus and potassium were applied as basal whereas nitrogen was applied in three splits, *viz*., before sowing, at knee high stage and before silking satges. FYM was incorporated before sowing of maize.

Table 1. Initial properties of the experimental soil

Particulars	Field Number 50 B
Particle size distribution	
Sand (%)	82.24
Silt (%)	14.16
Clay (%)	3.60
Texture	Sandy loam
pH (1:2.5)	6.70
EC (dSm^{-1})	0.26
Organic C (%)	0.35
CEC [cmol (p+) kg^{-1} soil]	15
Available N (kg ha^{-1} soil)	98
Available P (kg ha^{-1} soil)	25
Available K (kg ha^{-1} soil)	166
Available Fe (ppm)	2.51
Available Mn (ppm)	3.35
Available Cu (ppm)	0.95
Available Zn (ppm)	0.72

Results and Discussion

$KMnO_4$-oxidisable (available) N

Before seeding maize, the soil's $KMnO_4$-oxidisable N concentration (an indicator of accessible N pool) was fairly consistent, with no significant differences across plots assigned to different treatments (Table 2). At the silking stage of maize, control (T_1) had the lowest accessible N content of 104 mg kg-1 soil, whereas T_3 had the highest available N content, with an extra 27 mg kg^{-1} soil over control. The priming effect of P on N mineralization could explain the increase in available N even in plots receiving only phosphatic fertilizer (T_7) compared to controls

(Singh *et al.*, 1980). This was further increased by the addition of more nitrogen fertilizer.The increase in soil accessible N caused by nitrogenous fertilizer application is a well-documented phenomena (Glendining and Powlson, 1995). The plots that had previously received 100% NPK (T_3) were found to have the maximum accessible N content till the blossoming stage of blackgram (Table 2). T_3 had an accessible N concentration of 108 mg kg^{-1} soil prior to blackgram incorporation, which was comparable to T_{10}. As a result, by this point, the treatment T_{10}, which got FYM together with inorganics during maize, had improved in terms of available N content due to delayed but consistent N release. It was also discovered that after the introduction of blackgram residues, the soil's accessible N content increased. During all stages of groundnut, available N was observed to increase with increased levels of fertilizer addition, *i.e.*, when one advances from S_1 (no fertilizer control) to S_2 (75% of the RDF) (Table 2). T_3 and T_9 were on par with one other and superior to the other main plot treatments up until groundnut harvest. The available N content of the soil increased from seeding to flowering stage of groundnut.

It was found that after one cycle of the cropping system, the available N content of the soil rose from its initial value under all treatments except control, which may be attributable to N being applied in a balanced and integrated manner. When organic matter (FYM) is combined with inorganic nitrogen, the soil's available nitrogen content is increased as a result of the soil's faster mineralization after inorganic nitrogen satisfied the microbes' need for N.

Ammoniacal N (NH_4-N)

Ammoniacal-N (NH_4-N) increased significantly throughout the silking stage of maize (65 DAS) in all treatments, while the rise was reduced in the control and plots with only P (Table 3). The rise could have been caused by the application of N via inorganics and/or organics. This backs with the prior findings of Duraisami *et al.* (2001). The application of total N via urea resulted in a rapid conversion to NH_4-N, which was further accelerated in the presence of an optimal amount of P and K. This explains the significant rise in NH_4-N content of soil under T_3 relative to the other treatments (Figure 1). As the amount of N given by fertilizers is reduced from its optimum dose, the formation of NH_4 - N in soil decreases (Duraisami *et al.*, 2001). A good effect of 25% N substitution by FYM was seen in terms of improved soil NH_4-N content. The application of FYM increases microbial activity and amplifies mineralization, resulting in the accumulation of NH_4-N in the soil. This is consistent with the findings of Radhakumari and Sreenivasulu *et al*. (2010). T_3 maintained the greatest NH_4-N level throughout the silking stage of maize to the flowering stage of blackgram. Following the introduction of blackgram residues, the NH_4-N level of the soil increased in all plots. The NH_4-N

Table 2. Effect of fertilizer and manurial treatments on the available N (mg kg^{-1}) content of the soil during various stages of crop growth

Treatments	BSM	SM	HM	BF	BIB	BGS	GF	GH
T_1 : Control	103	104^{f}	99.4^{e}	96^{e}	98^{f}	101^{f}	104^{e}	101^{d}
T_2 : FYM @5 t ha^{-1}	102	125^{bc}	104.7^{c}	102e	103^{cd}	108^{ed}	112^{cd}	106^{bc}
T_3 : 100% RDF	100	131^{a}	110.3^{a}	113a	108^{a}	117^{a}	119^{ab}	111a
T_4 : 75% RDF	103	128^{ab}	108.7^{ab}	110^{ab}	106^{ab}	112^{b}	115^{abc}	109^{ab}
T_5 : 50% RDF	103	118^{e}	100.3^{de}	103^{de}	100^{ef}	102^{ef}	104^{e}	100^{d}
T_6 : 100% RDN	102	130^{a}	106.3^{bc}	105^{cde}	106^{ab}	108^{cd}	116^{abc}	108^{abc}
T_7 : 100 % RDP	103	120^{de}	102.7^{cde}	106^{cd}	102^{de}	105^{de}	109^{de}	105^{c}
T_8 : 100 % RDF + FYM @5 t ha^{-1}	102	125^{bc}	104.3^{c}	107^{bc}	105^{bc}	113^{b}	118^{ab}	109^{ab}
T_9 : 75% RDF + FYM @5 t ha^{-1}	104	126^{b}	105.3^{bc}	107^{bc}	104b ^{cb}	114^{ab}	121^{a}	111^{a}
T_{10} : 50% RDF + FYM @5 t ha^{-1}	104	122^{ed}	103.3^{de}	106^{cd}	108^{a}	111^{bc}	118^{ab}	109^{ab}
Mean	103	123	104.5	106	104	109	114	107
CD (P=0.05)	NS	3.48	3.61	3.16	2.88	3.89	5.11	3.52
Sub plots								
S_1 : Control							110^{c}	102^{c}
S_2 : 75% RDF							117^{a}	112^{a}
S_3 : 50% RDF							114^{b}	107^{b}
Mean							113.6	107
CD (P=0.05)							0.93	1.06

content of the soil increased significantly during the flowering stage of groundnut (Table 3). This could be attributable to the administration of fertilizer-N just prior to seeding, as well as the mineralization of blackgram residues.

Fig. 1. Effect of fertilizer and manurial treatments on the ammonical - N content of soil at different stages of crop growth ...?

The highest content of NH_4-N at flowering stage and at harvest of groundnut was maintained by the T_6 and T_9 and the lowest by T_1 and T_7. The treatments applied to groundnut followed the order: $S_2 > S_3 > S_1$ in respect of NH_4-N, which could be attributed to the decreasing order of fertilizer application.

The NH_4-N content of the soil decreased at harvest of groundnut, which could be explained by the crop uptake and losses through various means. The NH_4-N content of the soil was higher at groundnut harvest as compared to its initial value recorded before sowing of maize under the treatments T_3, T_8, T_9 and T_{10}. This indicates that balanced and application of N through conjunctive use of organics and inorganics helps in increased accumulation of NH_4-N in the soil, which could be attributed to the continuous decomposition of organics (FYM in this study).

Nitrate N (NO_3-N)

Because the soil is well-drained, the NO_3-N content frequently exceeded the NH_4-N value. It accounted for 60 to 70% of total mineral nitrogen. In terms of soil NO_3-N content during the silking stage of maize, treatments T_6, T_8, and T_9 were comparable to and superior to the others (Table 4). The addition of nitrogenous fertilizer, one-fourth of which was added at the silking stage, resulted in a significant increase in the soil's NO_3-N concentration (Figure 2). Brar and Brar (2002) also reported higher NO_3-N content in soil as a result of greater N addition. Addition of FYM along with inorganic fertilizer also had a favourable impact on NO_3-N, as observed under T_8 and T_9, and supports the earlier results obtained by various workers Khankane and Yadav (2000).

At the time of maize harvest (105 DAS), NO3-N readings often decreased. This might be a result of maize absorbing N and losing it in numerous ways. Prior to the addition of blackgram, the treatments could be split into two groups in terms of NO_3-N, with T_3, T_6, T_9, T_8, and T_2 making up the superior group. The remaining treatments made up the other group. T_7, which solely received phosphorous, received the lowest NO_3-N value. According to figure

Table 3. Effect of fertilizer and manurial treatments on the NH_4-N (mg kg^{-1}) content of the soil during various stages of crop growth

Treatments	BSM	SM	HM	BF	BIB	BGS	GF	GH
T_1 : Control	9.2	10.1^{e}	7.8^{d}	7.5^{e}	7.1^{d}	8.3^{d}	12.4^{d}	8.11^{b}
T_2 : FYM @5 t ha^{-1}	9.6	11.8^{cd}	8.2^{cd}	7.9^{e}	7.8^{cd}	10.0^{c}	14.7^{bc}	8.44^{b}
T_3 : 100% RDF	9.3	17.2^{a}	9.5^{a}	12.3^{a}	11.3^{a}	12.8^{ab}	15.7^{abc}	11.00^{a}
T_4 : 75% RDF	9	14.2^{b}	9.2^{ab}	10.3^{b}	9.5^{b}	11.7^{ab}	16.0^{ab}	9.11a ^{b}
T_5 : 50% RDF	9.2	11.7^{cd}	9.2^{ab}	9.8^{bc}	8.4^{bcb}	12.5^{ab}	16.6^{ab}	8.56^{b}
T_6 : 100% RDN	9.5	12.6^{c}	8.6^{ab}	8.9^{cd}	8.6^{bcb}	11.8^{ab}	17.8^{a}	9.00^{ab}
T_7 : 100 % RDP	9.5	10.7^{de}	8.0^{cd}	7.6e	7.6^{cd}	11.3^{bc}	13.7^{cd}	8.11^{b}
T_8 : 100 % RDF + FYM @5 t ha^{-1}	9.2	14.5^{b}	8.6^{bc}	9.6^{bc}	11.2^{a}	13.0^{a}	14.7^{bc}	11.00^{a}
T_9 : 75% RDF + FYM @5 t ha^{-1}	9.2	14.8^{b}	8.6^{bc}	9.7^{bc}	11.4^{a}	13.0^{a}	16.1^{ab}	11.33^{a}
T_{10} : 50% RDF + FYM @5 t ha^{-1}	9.3	12.6^{c}	8.5^{c}	8.9^{cd}	8.9b^{c}	12.9^{ab}	16.1^{ab}	10.00^{ab}
Mean	9.3	13	8.6	9.2	9.2	11.7	15.4	9.5
CD (P=0.05)	NS	1.24	0.67	1.15	1.58	1.69	2.1	2.34
Sub plots								
S_1 : Control							13.8^{c}	7.13^{c}
S_2 : 75% RDF							17.3^{a}	11.90^{a}
S_3 : 50% RDF							14.9^{b}	9.37^{b}
Mean							15.3	9.46
CD (P=0.05)							0.62	0.67

BSM –Before sowing of maize, SM- Silking of maize, HM- Maize harvest, BF – Blackgram flowering, BIB- Before Incorporation of Blackgram, BGS- Before Groundnut Sowing, GF- Groundnut flowering, GH- Groundnut harvest

2, the soil's NO_3-N level significantly increased throughout the groundnut plant's flowering stage and thereafter decreased. This may be attributable to crop absorption and fertilizer-N application prior to sowing and crop uptake and other losses beyond flowering. The treatments applied to groundnut followed the order: $S_2 > S_3 > S_1$ with respect to NO_3- N content of soil throughout groundnut growth, which could be attributed to the decreasing order of fertilizer doses.

Fig. 2. Effect of fertilizer and manurial treatments on the nitrate - N content of soil at different stages of crop growth

Organic P

Throughout the experimental period, the total P content of the soil remained more or less stable for all maize and groundnut treatments (data not shown). The application of fertilizer or manurial treatments had no effect on the organic P content of the soil between maize sowing and the stage at which blackgram stover was integrated, which was 200 days after maize sowing (DAS). However, all treatments demonstrated a tendency for organic P content to decline up to the harvest stage of maize, 105 DAS (Figure 3). Due to an increase in litter fall and the release of organic acids through root exudates, the P sorbed in sesquioxides and other exchange sites as well as other exchange sites would have been released into the environment as the crop progressed through this stage. The solution P may have become trapped in the organic pools as a result of the dynamic equilibrium between the multiple P pools. All of the plots' soil organic P contents were seen to rise until maize was harvested, at which point they all sharply rose. Up until the introduction of blackgram, this proportion remained largely steady. It steadily decreased due to further mineralization until groundnut was harvested, or 335 DAS of maize.

Fig.3. Effect of fertilizer and manorial treatments on the organic - P content of soil at different stages of crop growth

Inorganic P

The increase in the inorganic P (Figure 4) content of the soil from the sowing to silking stage of maize might be attributed to the decline in the organic P (Figure 4) content due to the mineralization process (Sekhon and Black 1969). The increase was more pronounced in individuals who received higher fertilizer dosages. P. Bhardwaj *et al*. (2000) noted similar findings. After the maize reached the silking stage, and up until the addition of blackgram, none of the treatments had any impact on the soil's inorganic P content. From maize sowing to silking, the soil's overall inorganic P level (Fig. 4) rose. This could be explained by mineralization, which results

Table 4. Effect of fertilizer and manurial treatments on the NO_3-N (mg kg^{-1}) content of the soil during various stages of crop growth

Treatments	BSM	SM	HM	BF	BIB	BGS	GF	GH
T_1 : Control	19.2	16.8^c	15.3^f	13.1^e	13.0 ^{c}	15.2^f	18.7 ^{e}	13.0 ^{e}
T_2 : FYM @5 t ha^{-1}	20.2	24.5^{cd}	19.7^{de}	16.8^{cd}	17.0 ^{b}	20.0 ^{bc}	21.9 ^{d}	16.3^{cd}
T_3 : 100% RDF	19	38.5^a	27.3^a	24.9^a	23.0 ^{a}	22.2 ^{a}	27.2 ^{a}	20.7^a
T_4 : 75% RDF	19.7	32.0 ^{b}	25.3^{ab}	19.5^{bc}	17.5 ^{b}	18.5 ^{cde}	22.2 ^{d}	18.7^{abc}
T_5 : 50% RDF	19.7	31.1^{bc}	23.4^{bc}	16.9^{cd}	13.8 ^{c}	21.3 ^{ab}	24.1 ^{b}	18.4^{abc}
T_6 : 100% RDN	19.4	37.6^a	22.2^{cd}	20.8 ^{b}	18.8 ^{b}	18.6 ^{ed}	23.7 ^{bc}	17.3 ^{bc}
T_7 : 100 % RDP	19.1	23.3^d	18.2^{ef}	16.5 ^{d}	12.8 ^{c}	17.0^{de}	20.9^d	14.0 ^{de}
T_8 : 100 % RDF + FYM @5 t ha^{-1}	20	37.6^a	22.0^{cd}	21.0 ^{b}	17.2 ^{b}	20.0 ^{bc}	23.9 ^{b}	19.4 ^{ab}
T_9 : 75% RDF + FYM @5 t ha^{-1}	19.6	37.9^a	23.1^{bc}	21.6 ^{b}	17.5 ^{b}	20.7 ^{ab}	23.8 ^{bc}	19.1^{abc}
T_{10} : 50% RDF + FYM @5 t ha^{-1}	19.6	30.0^{bc}	21.0^{cde}	17.2 ^{cd}	13.2 ^{c}	18.4^{de}	22.0 ^{d}	18.3 ^{bca}
Mean	19.5	30.9	21.8	18.8	16.4	19.2	22.84	17.52
CD (P=0.05)	NS	2.39	3.07	2.7	2.84	1.59	1.62	2.85
Sub plots								
S_1 : Control							20.8^c	14.2^c
S_2 : 75% RDF							25.1^a	21.2^a
S_3: 50% RDF							22.6^b	17.2^b
Mean							23	17.5
CD (P=0.05)							0.53	0.82

in the release of P into the solution and an increase in inorganic P, which causes a decrease in organic P that is extractable (Fig. 4). The rise was bigger for the treatments receiving higher P doses. Similar observations were found by Sunitha *et al*. (2016) and Kumar *et al*. (2000).

Fig. 4. Effect of fertilizer and manorial treatments on the inorganic – P content of soil at different stages of crop growth

0.5 M $NaHCO_3$-extractable P (Olsen-P)

The Olsen-P content of the soil prior to maize seeding did not significantly differ between plots, indicating that the extractable P status of the plots was uniform (Table 5). All treatments, including the control, saw an increase from its baseline value at the silking stage of maize (Figure 5), which may have been caused by increased soil P dissolution through acidic root exudates. Olsen-P was most abundant in the treatment T_9 (Table 5). Similar treatments included T_3, T_8, T_5, T_7, T_4 and T_{10}. The soil's available P status could not be maintained at higher levels despite the administration of no or little P fertilizer. After the harvest of the maize, the soil's lowest Olsen P level was found under T_2. It was comparable to T_1. The available P status decreased from the baseline value in the treatments T_1 and T_2, where no inorganic N or P was administered externally (Fig. 5). Olsen P content indications of the T_6 treatment, which used solely N, were also present. This highlights the necessity of applying P to the soil coupled with N, which was previously mentioned by Begum *et al*. (2007) and Shiny (2021).

Fig. 5. Effect of fertilizer and manorial treatments on the Olsen - P content of soil at different stages of crop growth

Leguminous plants like blackgram release particular organic acids into the soil through their roots. These acids aid in the better breakdown of phosphates found in nature. This mechanism may explain why Olsen-P levels in the soil remain largely stable as blackgram develops, even in the absence of external phosphorus delivery (shown in Figure 5). Throughout the development of the blackgram, Treatment T consistently had the greatest Olsen-P content. This shows that in circumstances where prior treatments had received larger doses (about 75%) of advised fertilizer phosphorus, the addition of blackgram to the system may have helped prevent the drop of Olsen-P levels. Olsen-P levels dropped throughout all treatments until groundnut harvest (Figure 5). However, increasing the fertilizer dosage for groundnut resulted in higher Olsen-P concentration for all maize treatments. This pattern (Olsen-P decline sequence: $S_2 > S_3 > S_1$) continued until groundnut harvest, emphasizing the importance of continual phosphorus fertilizer application for all crops in a cropping series.

Table 5. Effect of fertilizer and manurial treatments on the Olsen-P content (mg kg^{-1}) of the soil during various stages of crop growth

Treatments	BSM	SM	HM	BF	BIB	BGS	GF	GH
T_1 : Control	28	30.2^{e}	24.3^{de}	23.6^{d}	21.3^{e}	22.8^{d}	18.0^{c}	20.0^{d}
T_2 : FYM @5 t ha^{-1}	27	31.0^{e}	23.2^{e}	27.0^{c}	24.0^{d}	24.8^{cd}	20.1^{bc}	22.5^{c}
T_3 : 100% RDF	28	38.4^{ab}	35.1^{a}	37.6^{a}	35.1^{a}	28.5^{ab}	23.1^{a}	27.0^{ab}
T_4 : 75% RDF	27	36.0^{bcd}	32.5^{ab}	34.1^{b}	31.9^{b}	27.3^{abc}	23.4a	25.8^{ab}
T_5 : 50% RDF	29	33.5^{cde}	29.6^{bc}	33.5^{b}	29.0^{c}	26.4^{abc}	22.3^{ab}	25.1^{b}
T_6 : 100% RDN	27	32.0^{de}	27.7^{cd}	24.5^{d}	22.5^{de}	25.1^{bcd}	20.0^{bc}	22.0^{cd}
T_7 : 100 % RDP	26	37.0^{dbc}	33.0^{ab}	35.2^{b}	30.3^{bc}	27.3^{abc}	22.4^{ab}	24.8^{b}
T_8 : 100 % RDF + FYM @5 t ha^{-1}	26	37.3^{abc}	34.2^{a}	33.5^{b}	30.8^{bc}	28.2^{abc}	23.0^{a}	27.0^{ab}
T_9 : 75% RDF + FYM @5 t ha^{-1}	27	40.5^{a}	35.1^{a}	34.1^{b}	31.2^{b}	29.4^{a}	23.5^{a}	27.4^{a}
T_{10} : 50% RDF + FYM @5 t ha^{-1}	26	37.3^{abc}	32.8^{ab}	33.5^{b}	30.4^{bc}	27.2^{abc}	22.6^{ab}	25.3^{ab}
Mean	27	35.3	30.7	31.6	28.7	26.7	22	24.6
CD (P=0.05)	NS	4.28	3.94	2	1.85	3.42	2.82	2.28
Sub plots								
S_1 : Control							19.7^{c}	21.9^{c}
S_2 : 75% RDF							24.0^{a}	27.5^{a}
S_3 : 50% RDF							21.8^{b}	24.7^{b}
Mean							22	25
CD (P=0.05)							0.64	0.79

Conclusion

According to the study's findings, in order to keep the soil's N status stable and guarantee a steady supply of N to the crop, we could swap out up to 25% of the inorganic sources of nitrogen for FYM. The lingering effects of INM could therefore sustain a crop of blackgram. Maintaining plant accessible (Olsen) and other pools of phosphorus in the soil also requires applying crops at least 75% of the recommended P dose. Utilizing FYM with inorganic P (T_7, T_8 and T_9) buffered the Olsen-P content of the soil (*via* mineralization) in addition to its indirect benefit to total and organic P, which may be helpful in the long run.

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