EFFECT OF INM ON NUTRIENT CONCENTRATION AND THEIR UPTAKE UNDER MAIZE-BLACKGRAM-GROUNDNUT CROPPING SEQUENCE IN ALFISOLS

Abstract : A field experiment was carried out at S.V. Agricultural College Farm, Tirupati during rabi (maize) summer (blackgram) and kharif (groundnut) seasons of 2019-20 with a view to study the direct and residual effects of integrated use of inorganic and organic sources of N and P on performance of maize - blackgram- groundnut cropping sequence in terms of yield. Ten treatments viz. control, fertilizers applied at 50, 75 and 100% of the recommended dose (N240P80K80), N240 only, P80 only, FYM (@ 5 t ha^{-1}) applied alone, and in combination with100%,75% and 50% recommended NPK were applied to maize. These treatments were compared with no-fertilizer and manure control. Blackgram was grown following maize without any fertilizer or manure application. It was allowed to grow till maturity, and after two pickings, the stover was incorporated into the soil. During succeeding rabi season on the same field black gram was grown for which each main plot treatment of RBD was split into three sub plot treatments with three levels of recommended dose of fertilizers viz., S1 (control), S2 (75% RDF) and S3 (50% RDF) resulting in ninety treatment combinations replicated three times in split plot design. The results revealed that the total N and P uptake in maize varies from 56 - 142 kg/ha and 8.28 - 22.12 kg/ha, in blackgram it varies from 86 – 173 kg/ha and 11.1 – 22.7 kg/ha and in groundnut 75.8 – 126.9 and 9.5 -20.0 kg/ha respectively. The maximum nutrient concentration and uptakes in case of all treatments was found in INM treatments and lowest in T_1 (Control)

Keywords: INM, maize, blackgram, groundnut sequence, N and P uptake

Introduction

The excess use of high analysis fertilizers in an unbalanced manner has affected the soil health viz., acidity, alkalinity, the emergence of secondary and micro nutrient deficiencies and deterioration in soil physical environment (SubbaRao and Sammi Reddy, 2005). This was more seen in recent years due to the advent of high yielding varieties (HYVs) which were responsive to chemical fertilizers and increased area under assured irrigation led to a major shift from organic based nutrient application to chemical fertilizers. The rapid spurt in the use of inorganic fertilizers is because of the quick yield responses of crops to their application.In this context, INM holds great promise not only for achieving optimum yields in a cropping system but also protecting soil health against degradation. Therefore, inorganic and organic sources of the nutrient were combined to study the possibility of substitution of N requirement of crops through organic sources and most effective combination of these materials the create impact on soil and plant systems.

Material and Methods

Site Description : Field experiments were carried out during rabi, summer and kharif seasons of 2019-20 at S.V. Agricultural Farm, Tirupati, geographically situated at 13.5o N latitude and 79.5o E longitude at an altitude of 182.9 meters above mean sea level, categorised as the Southern Agroclimatic 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 (21 kg ha^{-1}) and medium in potassium (162 kg ha-1).

Experimental design and treatments : The treatments consisted of integrated nutrient management viz., T1- control, T2- FYM @ 5 t ha-1 , T3- 100 RDF, T4- 75% RDF, T5- 50% RDF, T6 – 100% RDN, T7 – 100% RDP, T8 – 100% RDF+ FYM @ 5 t ha-1 , T9- 75% RDF + FYM @ 5 t ha1 , T10 – 50% 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. FYM was incorporated before sowing of maize. The data recorded were statistically analyzed using OPSTAT Software. The purpose of analysis of variance was to determine the significant effect of treatments on maize- blackgramgroundnut cropping sequence.

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 :

Maize

Data related to N, P and K concentration in given in table 2. showed that integration of FYM results higher N,P and K concentrations over remaining treatments. N concentration varied from 0.98% (control) to 1.63% in T9 (100% RDF + FYM@ 5 t ha^{-1}). It was also observed that integration of FYM showed higher increase in N, P and K concentration over rest of the treatments.

Table 2. Effect of fertilizer and manurial treatments on N, P and K content (%) and uptake (kg ha^{-1}) by maize at silking stage

Treatments	N		P		K	
	N content	N uptake	P content	P uptake	K content	K uptake
T_1	0.98^{f}	54.0^{d}	0.10^{b}	5.64^{c}	3.03^{a}	168^{d}
T_2	1.14^{ef}	68.6^{d}	0.10^{b}	6.01^{c}	3.01^{b}	180^{d}
T_3	1.58^{ab}	164.4^{a}	0.14^{ab}	14.01^{a}	3.17^{a}	328^{a}
T_4	1.50^{abc}	119.8^{b}	0.11^{b}	8.54^{c}	3.16^{a}	252^{b}
T_5	1.36^{cd}	102.3^{bc}	0.10^{b}	7.47^{c}	3.06^{a}	229^{c}
T_6	1.36^{cd}	110.4^{bc}	0.12^{b}	9.34^{bc}	3.17^{a}	258^{b}
T_7	1.20^{de}	91.2^{cb}	0.11^{b}	8.60^{c}	3.13^{a}	237^{b}
T_8	1.60^{ab}	170.7^{a}	0.16^{a}	16.93^{a}	3.17^{a}	337^{a}
T_9	1.63^{a}	185.1^{a}	0.15^{a}	17.02^{a}	3.16^{a}	359^{a}
T_{10}	1.44^{bc}	107.8^{bc}	0.13^{ab}	9.73^{b}	3.16^{a}	237^{b}
Mean	1.38	117.49	0.12	10.33	3.12	259
SEm ±	0.06	7.89	0.01	1.29	0.05	12.08
CD (P=0.05)	0.18	23.65	0.04	3.85	0.16	36.21

Table 3. Effect of fertilizer and manurial treatments on N and P content (%) and uptake (kg ha^{-1}) by maize at harvest

Treatments	Grain		Stover			Grain		Stover		
	N content	N uptake	N content	N uptake	Total N Uptake	P content	P uptake	P content	P uptake	Total P Uptake
T_1 : Control	1.56^{c}	32^{a}	0.37^{e}	24^{f}	56^{e}	0.34^{cde}	7.0de	0.02^{b}	1.36^{c}	8.33^{d}
T_2 : FYM @5 t ha^{-1}	1.55^{c}	33^{a}	0.36^{e}	32^{de}	65^{e}	0.32^{ef}	6.8^{e}	0.02^{b}	1.46^{c}	8.28^{d}
T_3 : 100% RDF	1.75^{a}	81^{a}	0.53^{b}	58^{ab}	139^{b}	0.38^{a}	17.1^{a}	0.04^{b}	3.85^{b}	20.99^{a}
T_4 : 75% RDF	1.68^{ab}	74^{ab}	0.50^{bc}	54^{b}	128^{b}	0.36^{abc}	9.0^{c}	0.03^{b}	2.16^{c}	11.18^{c}
T_5 : 50% RDF	1.60^{bc}	61^{c}	0.40^{de}	38^{d}	99^{d}	0.35^{bcd}	8.1^{cd}	0.03^{b}	2.06^{c}	10.14^{c}
T_6 : 100% RDN	1.70^{ab}	73^{ab}	0.45^{cd}	38^{d}	111^{c}	0.31^{f}	7.3^{de}	0.03^{b}	2.48^{c}	$9.79a^{cd}$
T_7 : 100 % RDP	1.66^{abc}	64^{c}	0.40^{e}	30^{ef}	94^{d}	0.33^{def}	7.9^{cde}	0.03^{b}	2.40^{c}	10.27^{c}
T_8 : 100 % RDF + FYM @5 t ha^{-1}	1.73^{a}	79^{a}	0.52^{b}	60^{ab}	139^{b}	0.37^{ab}	16.7^{a}	0.05^{a}	5.44^{a}	22.12^{a}
T_9 : 75% RDF + FYM @5 t ha^{-1}	1.75^{a}	78^{a}	0.54^{a}	63^{a}	142^{a}	0.36^{abc}	16.9^{a}	0.04^{b}	4.77^{ab}	21.70^{a}
T_{10} : 50% RDF + FYM @5 t ha^{-1}	1.69^{ab}	69^{bc}	0.48^{bc}	46^{c}	115^{c}	0.34^{cde}	11.7^{b}	0.03^{b}	2.21^{c}	13.93^{b}
Mean	1.67	64	0.46	44	109	0.35	10.9	0.03	2.82	13.67
SEm$\pm$	0.04	2.76	0.02	2.11	3.79	0.01	0.37	0.01	0.45	0.52
CD (P=0.05)	0.12	8.26	0.06	6.31	11.36	0.03	1.11	0.03	1.36	1.57

Nitrogen: The treatments T_9 (1.75%), T_3 (1.75%), T_8 (1.73%), T_6 (1.70%), T_{10} (1.69%), T_4 (1.68%) and T_7 (1.66%) were found to be at par in terms of high nitrogen (N) content of maize grain. The lowest value was recorded under the treatment T_2 (1.63%), which was statistically similar to T_1 (1.56%) and T_5 (1.60%).The nitrogen content of maize stover lower than that in grain, indicating thereby translocation of nitrogen from the vegetative to the reproductive parts.

Treatment T_3 recorded the highest N uptake (81 kg ha^{-1}), followed by T_8 (79 kg ha^{-1}), T_9 (78 kg ha^{-1}) and T_4 (74 kg ha^{-1}), all of which were at par. The treatments T_5 (61 kg ha^{-1}) T_7 (64 kg ha^{-1}) and T_{10} (69 kg ha^{-1}) were superior to the treatments T_2(33 kg ha^{-1}) and T_1 (32 kg ha^{-1}). Application of nitrogen at lower level or through only FYM could not match with the other treatments in terms of N uptake by grain as these were unable to supply sufficient nitrogen to the crop in a soil which was low in available N status.

Higher uptake of N by maize stover obtained under the treatments T_9 (63 kg ha^{-1}), T_8 (60 kg ha^{-1}) and T_3 (58 kg ha^{-1}) which were not significantly different among themselves. Lowest value of 24 kg ha^{-1} recorded under control (T_1).

The results suggest that the treatment T_9, which involved applying 75% of the recommended dose of fertilizer (RDF) along with farmyard manure (FYM), resulted in the highest total nitrogen uptake by the maize crops (142 kg ha^{-1}). The second-highest nitrogen uptake was observed in treatment T_3 (139 kg ha^{-1}).The nitrogen uptake values were lower under treatments T_2 (65 kg ha^{-1}) and T_1 (56 kg ha^{-1}), and these values were statistically similar. The study indicates that applying nitrogen at the recommended rate led to higher nitrogen content and uptake by the maize crops. This outcome can be attributed to the ability of these treatments to provide a substantial amount of readily available nitrogen to fulfill the crop's demand for this essential nutrient. Additionally, the application of phosphorus alongside nitrogen appeared to enhance nitrogen uptake by the maize crops through a synergistic effect. This suggests that the combination of phosphorus and nitrogen contributed to better nutrient uptake by the plants. Interestingly, substituting 25% of the inorganic nitrogen with farmyard manure seemed to be as effective as using 100% NPK (nitrogen, phosphorus, and potassium) fertilizer. This could be attributed to the rapid mineralization of farmyard manure in an environment rich in readily available nutrients. The study suggests that the organic matter in the farmyard manure contributed to a continuous release of nutrients, supporting the growth and nutrient uptake of the maize crops (Rahale *et al*., 2018)

Phosphorus: The treatments T_3 (0.38%), T_8 (0.37%), $T_4 = T_9$ (0.36%), were found to be at par in terms of high nitrogen (P) content of maize grain. The lowest value was recorded under the treatment T_6 (0.31%), which was statistically similar to T_7 (0.33%) and T_2 (0.32%).

The P uptake by grain was highest under T_3 followed by T_9 and T_8 , all of which were at par.These were followed by statistically similar treatments T_4 , T_5 and T_7. The lowest value of 6.8 kg ha^{-1} was recorded under T_2 followed by statistically similar treatments,T_1, T_6 and T_7 .

Among all, significantly higher total P uptake by maize recorded by 100% RDF+FYM @ 5 t ha^{-1} (22.12 kg ha^{-1}) which was closely followed with 75% RDF+ FYM @ 5 t ha^{-1} (21.7 kg ha^{-1}) 100% RDF (20.99 kg ha^{-1}) and was found to be superior to T_7 (10.27 kg ha^{-1}). The lowest P uptake was recorded under T_2 (8.28 kg ha^{-1}). Compared to inorganic treatments, INM treatments recorded high total P uptake may be due to solubilization of fixed phosphorus by P-solubilizer due to secretion of organic acids. Similar findings corroborate with the studies of Venkata Lakshmi *et al*. (2020).

Blackgram

The content and uptake of N and P by blackgram grain were not found to be significantly affected by any of the treatments applied to maize. Compared to the plots T_1 and where only phosphorus was applied to maize T_7 and all the other treatments were found to yield statistically similar and superior N uptake by blackgram. The higher N,P,K uptake of blackgram at flowering stage was registered by T_9 (212 ,71.3 and 214 kg ha^{-1}) respectively. However the highest P uptake was registered under T_3. The treatments combining FYM with fertilizer, *viz.*, T_8 and T_9 compared favourably with T_4 with respect to P uptake by blackgram haulms. The lower values of P uptake was observed under the treatments where no P was applied to maize, *viz.*, T_1, T_6 and FYM treatment T_2. The rest of the treatments, *viz.*, T_5 and

T_{10}, were statistically at par and significantly superior to T_7. The total P uptake by blackgram almost followed a similar trend as that by haulms. As in the case of yield, high uptake of N and P in case of blackgram was resulted where INM treatment and 100% RDF applied to maize.

Statistically similar treatments, namely T_2 (10.0 kg ha^{-1}) and T_1 (10.3 kg ha^{-1}), were found to be inferior to the rest of the treatments, all of which were found to be at par when the K uptake by blackgram grain was compared. The K content, uptake by blackgram haulms and total K uptake were found low under control (T_1).

The integrated application seems to result in higher nutrient uptake by plants due to the balanced and combined use of various nutrient sources. This leads to improved absorption, translocation, and assimilation of nutrients, ultimately resulting in increased dry matter accumulation and nutrient content in plants, particularly nitrogen (N), phosphorus (P), and potassium (K) nutrients.

Tyagi *et al.* (2014) and Kalaiyarasi *et al.* (2019) likely support the idea that combining different nutrient sources leads to enhanced plant growth and nutrient uptake. This concept aligns with the principles of nutrient management and sustainable agriculture, where optimizing nutrient availability for plants is essential for higher yields and efficient resource utilization.

Higher N content was noticed under T_8 (3.14 %), followed by T_9 (3.13 %), T_{10} (3.11 %),T_4 (3.01 %),T_6 (2.95 %) and T_3 (2.92 %) lowest was under T_7 (2.40 %) which received only 100% P. T_9 (212 kg ha^{-1}) recorded higher N content and low N uptake by T_1 (60 kg ha^{-1}).

Both P content (1.05 %) and uptake (71.3 kg ha^{-1}) was higher under T_9, while T_1 recorded lower P content (0.85%) and uptake (19.8 kg ha^{-1}). Almost similar trend by K content and uptake, high values were observed by T_9 (3.17 %) and (214 kg ha^{-1}).

In later stages i.e., at harvest stage, content and uptakes gradually decrease, which might be due to translocation of nutrients from vegetative part of crop plant to grain at the time of maturity. INM treatments showed more content and uptakes of N, P and K when compared to sole application of inorganics, due to favourable effect of incorporation of organic sources together with inorganic nutrients.

Table 4. Effect of fertilizer and manurial treatments on N,P and K content (%) and uptake (kg ha^{-1}) by blackgram at flowering stage

Treatments	N		P		K	
	N content	N uptake	P content	P uptake	K content	K uptake
T_1	2.60^{bc}	60^{f}	0.85^{e}	19.8^{e}	2.71^{e}	62^{e}
T_2	2.56^{c}	108^{e}	0.85^{e}	35.7^{d}	2.97^{b}	125^{d}
T_3	2.92^{a}	149^{cd}	1.04^{ab}	52.7^{c}	3.17^{a}	161^{c}
T_4	3.01^{a}	190^{ab}	0.97^{abc}	60.9^{bc}	3.01^{b}	190^{ab}
T_5	2.87^{ab}	206^{a}	0.89^{cde}	63.5^{ab}	2.95^{bc}	211^{a}
T_6	2.95^{a}	122^{de}	0.70^{f}	29.2^{d}	2.80^{de}	116^{d}
T_7	2.40^{c}	174^{bc}	0.87^{de}	62.9^{ab}	2.82^{cde}	204^{a}
T_8	3.14^{a}	186^{ab}	1.00^{ab}	59.0^{bc}	2.96^{b}	175^{bc}
T_9	3.13^{a}	212^{a}	1.05^{a}	71.3^{a}	3.17^{a}	214^{a}
T_{10}	3.11^{a}	199^{ab}	0.94^{bcd}	59.8^{bc}	2.92^{bcd}	187^{abc}
Mean	2.87	160	0.91	51.5	2.95	165
SEm ±	0.10	10.03	0.03	3.12	0.04	9.12
CD (P=0.05)	0.29	30.06	0.08	9.35	0.13	27.36

Table 5. Effect of fertilizer and manurial treatments on N and P uptake (kg ha^{-1}) by blackgram at harvest

Treatments	Grain		Haulm		Root		Total N uptake	Grain		Haulm		Root		Total P uptake
	N content	N uptake	N content	N uptake	N content	N uptake		P content	P uptake	P content	P uptake	P content	P uptake	
T_1	3.62	27.0	1.7^{c}	56^{d}	0.77^{c}	3.74	86^{c}	0.45	3.32	0.22^{a}	7.14^{f}	0.15	0.731	11.1^{f}
T_2	3.66	27.4	1.7^{c}	84^{c}	0.82^{bc}	5.51	117^{b}	0.45	3.40	0.23^{c}	11.24^{e}	0.12	0.828	15.4^{e}
T_3	3.56	30.8	2.0^{ab}	126^{ab}	1.07^{a}	6.56	164^{a}	0.45	3.93	0.28^{a}	17.90^{a}	0.15	0.902	22.7^{a}
T_4	3.66	31.4	2.0^{ab}	127^{ab}	0.88^{abc}	5.41	164^{a}	0.46	3.97	0.26^{ab}	16.23^{b}	0.13	0.817	21.0^{b}
T_5	3.59	30.8	1.9^{b}	119^{b}	0.79^{c}	4.90	155^{a}	0.44	3.81	0.24^{bc}	14.74^{bc}	0.12	0.752	19.3^{c}
T_6	3.69	30.6	2.0^{ab}	123^{ab}	0.84^{bc}	5.23	159^{a}	0.44	3.69	0.19^{d}	11.77^{de}	0.13	0.791	16.2^{de}
T_7	3.59	29.0	1.5^{d}	82^{c}	0.89^{abc}	5.72	116^{b}	0.45	3.66	0.23^{c}	12.65^{d}	0.12	0.786	17.0^{d}
T_8	3.70	32.3	2.1^{a}	132^{ab}	1.03^{ab}	6.61	171^{a}	0.47	4.13	0.26^{ab}	16.6^{ab}	0.15	0.926	21.6^{ab}
T_9	3.63	31.4	2.0^{ab}	126^{ab}	0.89^{abc}	5.82	163^{a}	0.48	4.14	0.27^{a}	16.55^{ab}	0.14	0.895	21.5^{ab}
T_{10}	3.67	31.3	2.1^{a}	136^{a}	0.87^{abc}	5.94	173^{a}	0.46	3.92	0.24^{bc}	15.63^{bc}	0.13	0.933	20.4^{bc}
Mean	3.64	30.2	1.90	111	0.83	5.54	147	0.46	3.80	0.24	14.04	0.13	0.836	18.674
SEm ±	0.05	1.93	0.06	5.63	0.07	1.04	6.44	0.01	0.21	0.01	0.46	0.01	0.09	0.52
CD (P=0.05)	NS	NS	0.19	16.88	0.21	NS	19.31	NS	NS	0.02	1.39	NS	NS	1.55

Groundnut :

Higher N uptake (Table 6) was noticed under T_8 (52.77 %), followed by T_3 (52.09 %) and T_9 (51.11 %), lowest was under T_2 (42.28 %).

Both P content (0.38 %) and uptake (8.26 kg ha^{-1}) was higher under T_7, while T_1 recorded lower P content and uptake.

Data on potassium uptake also manifested the similar trend as was noticed with N and P uptake. Among the doses of phosphorus to *kharif* groundnut, 100 % RDF + FYM recorded significantly higher potassium uptake (43.21 kg ha^{-1}) in haulm which was closely followed with 75 % RDF + FYM (41.80 kg ha^{-1}), and lowest was under control (32.75 kg ha^{-1}).

Nitrogen:

Consequent to the high yield, the nitrogen uptake by both pod and haulm was highest under the treatment T_8, the values were 83.8 and 43.1 kg ha^{-1} for pod and haulm, respectively (Table 7). In case of pod, T_8 was followed by T_3 (81.8 kg ha^{-1}) T_9, T_4,T_6,T_5,T_7 and T_{10} were at par except T_1 (54.4 kg ha^{-1}) and T_2 (kg ha^{-1}). It was noticeable that none of the treatments applied to maize had any significant effect on N content of haulm. This indicates that there was a residual effect of FYM in terms of N release to groundnut. Incorporation of blackgram before sowing of groundnut could enhance the N recovery from FYM applied to maize due to increase in microbial population. The order followed by the treatments applied to maize in terms of total N uptake was: T_8 (127 kg ha^{-1}) > T_3 (124 kg ha^{-1}) > T_9 (122 kg ha^{-1}) > T_4 (120 kg ha^{-1}) > T_6 (120 kg ha^{-1}) > T_5,T_7, T_{10} (117 kg ha^{-1}) > T_2 (90 kg ha^{-1}) > T_1 (75 kg ha^{-1}).

Significantly higher N uptake of pod (79.66 kg ha^{-1}) and haulm (45.7 kg ha^{-1}) was observed under S_2 compared to the S_3 and S_1. The nutrient availability, slow nutrient release and reduction of nutrient fixation in soil enhances the nutrient uptake by groundnut. The total N uptake followed the order : S_2 (125.3 kg ha^{-1}) > S_3 (116.0 kg ha^{-1}) > S_1 (97.5 kg ha^{-1}).

Table 6. Effect of fertilizer and manurial treatments on N,P and K content(%) and uptake (kg ha^{-1}) by groundnut at flowering stage

Treatments	N		P		K	
	content	uptake	content	uptake	content	uptake
Main plots						
T_1 : Control	2.19	42.28^{c}	0.27^{c}	5.32^{b}	1.64^{b}	32.75^{j}
T_2 : FYM @5 t ha^{-1}	2.21	43.62^{bc}	0.29^{bc}	5.59^{b}	1.77^{ab}	33.89^{i}
T_3 : 100% RDF	2.36	52.09^{a}	0.33^{abc}	7.41^{a}	1.80^{ab}	39.87^{e}
T_4 : 75% RDF	2.31	49.51^{ab}	0.34^{ab}	7.41^{a}	1.79^{ab}	38.60^{f}
T_5 : 50% RDF	2.25	47.79^{abc}	0.33^{abc}	7.10^{a}	1.79^{ab}	38.25^{h}
T_6 : 100% RDN	2.34	49.98^{ab}	0.33^{abc}	7.08^{a}	1.80^{ab}	38.52^{g}
T_7 : 100 % RDP	2.30	48.95^{abc}	0.38^{a}	8.26^{a}	1.91^{a}	41.09^{c}

T_8 : 100 % RDF + FYM @5 t ha^{-1}	2.36	52.77^{a}	0.36^{a}	8.04^{a}	1.93^{a}	43.21^{a}
T_9 : 75% RDF + FYM @5 t ha^{-1}	2.36	51.11^{a}	0.36^{a}	7.81^{a}	1.93^{a}	41.80^{b}
T_{10} : 50% RDF + FYM @5 t ha^{-1}	2.34	49.47^{ab}	0.34^{ab}	7.24	1.88^{ab}	40.00^{d}
SEm±	0.066	2.301	0.020	0.481	0.082	0.023
CD (P=0.05)	NS	6.84	0.06	1.43	0.24	0.07
Sub plots						
S_1 : Control	2.16^{c}	39.55^{c}	0.30^{c}	5.41^{c}	1.62	29.72^{c}
S_2 : 75% RDF	2.44^{a}	56.34^{a}	0.37^{a}	8.49^{a}	1.97	45.59^{a}
S_3 : 50% RDF	2.31^{b}	50.37^{b}	0.34^{b}	7.46^{b}	1.88	41.08^{b}
SEm±	0.014	0.693	0.004	0.130	2.408	0.725
CD (P=0.05)	0.04	1.98	0.01	0.37	NS	2.07
Interaction						
S at T						
SEm±	0.004	2.192	0.014	0.412	0.074	2.292
CD (P=0.05)	NS	NS	NS	NS	NS	NS
T at S						
SEm±	0.097	3.491	0.030	0.720	0.123	3.732
CD (P=0.05)	NS	NS	NS	NS	NS	NS

Table 7. Effect of fertilizer and manurial treatments on N and P content (%) and uptake (kg P ha^{-1}) by groundnut at harvest

Treatments	N				Total N uptake	P				Total P uptake
	Pod		Haulm			Pod		Haulm		
	content	uptake	content	uptake		content	uptake	content	uptake	
Main plots										
T_1	3.29^{b}	40.6^{c}	1.68	35.2^{b}	75.8^{c}	0.51^{d}	6.2^{b}	0.16^{c}	3.31^{c}	9.5^{b}
T_2	3.37^{ab}	55.5^{b}	1.69	34.8^{b}	90.3^{d}	0.52^{cd}	8.6^{b}	0.17^{c}	3.54^{bc}	12.1^{b}
T_3	3.40^{a}	81.8^{a}	1.79	42.0^{a}	123.9^{ab}	0.56^{bcd}	13.6^{a}	0.20^{b}	4.62^{a}	18.2^{a}
T_4	3.42^{a}	80.0^{a}	1.77	40.2^{ab}	120.2^{ab}	0.57^{bcd}	13.5^{a}	0.20^{b}	4.64^{a}	18.1^{a}
T_5	3.41^{a}	78.8^{a}	1.71	38.4^{ab}	117.2^{b}	0.56^{bcd}	13.0^{a}	0.20^{b}	4.52^{a}	17.5^{a}
T_6	3.42^{a}	79.4^{a}	1.79	40.4^{ab}	119.8^{ab}	0.56^{bcd}	13.1^{a}	0.20^{b}	4.46^{ab}	17.5^{a}
T_7	3.41^{a}	77.1^{a}	1.77	39.6^{ab}	116.8^{b}	0.65^{a}	14.8^{a}	0.23^{a}	5.18^{a}	20.0^{a}
T_8	3.45^{a}	83.8^{a}	1.81	43.1^{a}	126.9^{a}	0.61^{ab}	14.7^{a}	0.21^{ab}	5.06^{a}	19.8^{a}
T_9	3.44^{a}	80.0^{a}	1.82	41.6^{a}	121.6^{ab}	0.60^{ab}	14.0^{a}	0.21^{ab}	4.88^{a}	18.9^{a}
T_{10}	3.39^{a}	76.8^{a}	1.79	39.9^{ab}	116.7^{b}	0.58^{bc}	13.2^{a}	0.20^{b}	4.56^{a}	17.8^{a}
SEm±	0.034	2.638	0.052	1.939	2.847	0.025	0.780	0.012	0.320	0.922
CD (P=0.05)	0.10	7.84	NS	5.76	8.46	0.07	2.32	0.03	0.95	2.74
Sub plots										
S_1 : Control	3.29^{c}	65.44^{c}	1.65^{c}	32.08^{c}	97.52^{c}	0.52^{c}	10.40^{c}	0.17^{c}	3.41^{c}	13.81^{c}
S_2 : 75% RDF	3.52^{a}	79.66^{a}	1.87^{a}	45.70^{a}	125.36^{a}	0.62^{a}	14.06^{a}	0.22^{a}	5.36^{a}	19.42^{a}
S_3 : 50% RDF	3.39^{b}	75.21^{b}	1.77^{b}	40.85^{b}	116.06^{b}	0.58^{b}	12.97^{b}	0.20^{b}	4.66^{b}	17.63^{b}
SEm±	0.011	0.747	0.011	0.580	1.076	0.006	0.201	0.003	0.089	0.248
CD (P=0.05)	0.03	2.14	0.03	1.66	3.08	0.02	0.58	0.01	0.25	0.71
Interaction										
S at T										
SEm±	0.034	2.364	0.034	1.833	3.403	0.020	0.637	0.009	0.281	0.785
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
T at S										
SEm±	0.052	3.972	0.076	2.939	4.481	0.037	1.163	0.017	0.481	1.380
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Phosphorus: It was evident from the (Table *7*), the phosphorus content and uptake of pod, haulm and total P uptake was maximal under treatment (T_7) supplied only with 100% P, followed by (T_8) in all cases. Total P uptake was found low under T_1 (9.5 kg ha^{-1}) which was found to be at par with T_2 (12.1 kg ha^{-1}).

As regards, subplot treatment, S_2 (75% RDF) was superior to S_3 and S_1 in case of P content and uptake of pod, haulm and total P uptake. Total P uptake is in the order : S_2 (19.42 kg ha^{-1}) > S_3 (17.63 kg ha^{-1}) > S_1 (13.81 kg ha^{-1}). Phosphorus recovery and uptake has been observed to improve either by the application of P to maize crop (Sarkadi, 1995) or by application of FYM along with chemical fertilizers to the preceding wheat crop (Negi *et al.*, 1992).

Conclusion :

The application of integrated nutrient management (INM) substantially increased the content of nitrogen (N), phosphorus (P), and potassium (K) in both grain and stover compared to the control. This indicates that the utilization of INM practices positively influenced nutrient uptake by the crops. The incorporation of Farm Yard Manure (FYM) in combination with recommended fertilizer doses (100% RDF and 75% RDF) notably affected nutrient content in grain and stover. This underscores the contribution of organic matter (FYM) along with conventional fertilizers to elevated nutrient concentrations. Furthermore, integrating FYM led to a more pronounced increase in nutrient concentration, not only for nitrogen, phosphorus, and potassium, but also for other essential nutrients. This suggests that the integration of organic matter positively impacted overall nutrient availability and uptake. The observed heightened concentrations of N, P, and K were attributed to their synergistic effects during various crop growth stages. This highlights the interplay between these nutrients, enhancing their uptake and utilization by the plants. The discrepancy in potassium (K) concentration between grain and stover was attributed to nutrient translocation, with nitrogen and phosphorus moving from vegetative parts to grain during maturity. Conversely, the higher K concentration in stover was attributed to the response of fibrous cells, particularly sclerenchyma cells, to potassium supply, leading to increased turgidity, cellulose, and hemicellulose content. Similar results are also reported by other workers Karki *et al*. (2005), Shashidhar *et al*. (2009), Mann *et al*. (2006), Mahala *et al*. (2006) and Vikas *et al*. (2007).

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