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Influence of residual effect of integrated nitrogen management on rice fallow *rabi* maize

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Abstract
Crop demand for nutrients is met by a combination of inherent soil fertility and externally applied nutrients. For high yielding crops with high rates of dry matter accumulation and matching high rates of nutrient uptake such as rice and maize, soil must allow unrestricted root growth be able to absorb nutrients at the rate for maximum growth. In this context, adoption of integrated nitrogen management involving organic and inorganic sources is the best nutrient technology available. A field experiment was conducted for two consecutive years (2015-16 & 2016-17) on clayloam soils of Agricultural College Farm, Bapatla. The experiment was laid out in a two sample t-test for rice in *kharif* season with 2 treatments and replicated thrice. The treatments consists of M_1 100% RDF, M_2 (50% RDN + 25% N through FYM + 25% N through neem cake + Azospirillum + PSB @ 2.5 kg ha^{-1} (INM). During the immediate *kharif*, the experiment was laid out in a split plot design without disturbing the soil for succeeding *rabi maize* crop with the two treatments given to *kharif* rice as main plot treatments and popular cultivars of rice (BPT 5204), Maize (Sandhya), were used for this study. In *rabi* the recommended dose of fertilizers applied for maize crop and the residual effect of integrated nitrogen management on rice fallow *rabi* maize was studied by taking drymatter production, kernel yield and nutrient contents of maize crop. INM application to preceding rice not only improved the fertility status of the soil and also improved the supply of nutrients to succeeding *rabi* crop of maize. Application of INM to preceding rice crop, increased the maize crop yield by 25-30% when compared to M_1. The residual effect of Integrated nitrogen management treatment was played an important role in enhancing the nitrogen, phosphorus and potassium contents and uptakes by maize crop.

Keywords: Integrated nitrogen management, rice fallow *rabi* maize, yield, nutrient content, uptake

Introduction
Rice-maize cropping system form an integral part of agriculture in Coastal Andhra Pradesh. For high yielding crops with high rates of dry matter accumulation and matching high rates of nutrient uptake such as rice and maize, soil must allow unrestricted root growth be able to absorb nutrients at the rate for maximum growth. While intensive agriculture, involving exhaustive high yielding varieties of rice and maize has led to heavy withdrawal of nutrients from the soil, imbalanced and indiscriminate use of chemical fertilizers has resulted in deterioration of soil health. In this context, adoption of integrated nitrogen management involving organic and inorganic sources is the best nutrient technology available. Therefore, there is a need to develop a suitable integrated nitrogen management treatment which may be a viable option to improve the soil health.

Material and Methods
A field experiment was conducted for two consecutive years (2015-16 & 2016-17) on clayloam soils of Agricultural College Farm, Bapatla. The experiment was laid out in a two sample t-test for rice in *kharif* season with 2 treatments and replicated thrice. The treatments consists of M_1 100% RDF, M_2 (50% RDN + 25% N through FYM + 25% N through neem cake + Azospirillum + PSB @ 2.5 kg ha^{-1}(INM). During the immediate *kharif*, the experiment was laid out in a split plot design without disturbing the soil for succeeding *rabi maize* crop with the two treatments given to *kharif* rice as main plot treatments and popular cultivars of rice (BPT 5204), maize (Sandhya), were used for this study. Experimental soil is clayloam in texture, slightly alkaline in reaction, medium in organic carbon, low in available nitrogen, high in available phosphorus and potassium. The secondary nutrients (Calcium, Magnesium and Sulphur) were also in normal range.

All the micronutrients (Iron, Manganese, Zinc and Copper) were sufficient in the soil with the values above their critical limits.

Results and Discussion

Plant Height

Residual effect of M_2 (INM) to preceding rice crop resulted significant increase in plant height of succeeding maize in *rabi* than the treatment that had not received organics (M_1-100% RDN) during *kharif* at all growth stages of growth. It might be due to positive residual effect of organics applied to preceding rice on succeeding maize crop as mentioned earlier by Rajput (1995) [16]. FYM and neem cake applied during *kharif*, released sufficient nutrients to produce taller plants (Bhat *et al*., 2013) [4]. FYM worked as soil conditioner in addition to supplying plant nutrients and resulted in improvement in plant height at different stages of plant growth (Prasad, 1993) [15]. Plant height was increased with advancement of age of crop. The highest plant height was observed at harvesting stage. Similar type of results were quoted by Rajput, (1995) [16].

Table 1: Residual effect of INM on plant height (cm) of maize

Treatment	2015-16			2016-17		
	Knee high	Tasseling	Maturity	Knee high	Tasseling	Maturity
M_1 : 100% RDN	30.8	57.2	198.3	36.8	56.5	181.2
M_2 : 50% RDN + 25% N - FYM + 25% N - neem cake + bacterial consortium	36.5	58.6	202.5	39.2	60.5	195.5
t-value	3.11	2.85	3.25	2.50	2.77	4.06

Table 2: Residual effect of INM on dry matter production (kg ha^{-1}) of maize

Treatment	2015-16			2016-17		
	Knee high	Tasseling	Maturity	Knee high	Tasseling	Maturity
M_1 : 100% RDN	402	2575	6250	415	3023	6733
M_2 : 50% RDN + 25% N - FYM + 25% N - neem cake + bacterial consortium	611	3728	7135	628	3919	7328
t-value	3.15	2.09	3.88	2.50	2.68	4.15

Dry matter production

Data pertaining to dry matter production are presented in table 2 and figure 1. Dry matter production was increased from 402 to 6250 kg ha^{-1} and 415 to 6733 kg ha^{-1} in M_1 and from 611 to 7135 and 628 to 7328 kg ha^{-1} in M_2 (INM) during first and second years, respectively with advancement of growth. Dry matter production increased steadily with advancing growth stages and reached the maximum at harvest and lowest at vegetative stage (initial stages). This was in accordance with earlier findings of Ramamurthy and Shivashankar, (1996) [17].

INM followed to preceding rice crop resulted in significantly higher dry matter accumulation by succeeding maize in *rabi* over M_1 (inorganics alone) at all the growth stages. These results could be attributed to that organics supplied the nutrients in a balanced proportion and improved soil physical conditions which might have affected the crop synergistically (Bhat *et al*., 2013) [4]. It also might be due to residual effect of organic manures applied to preceding rice crop as it provided major as well as micronutrients for longer period (Gudadhe *et al*., 2011) [7]. Significant increase of dry matter/plant was due to the fact that nitrogen helped in maintaining higher auxin level which might have resulted in better plant height, leaf area and more chlorophyll leading to high dry matter production. He also justified that combined inoculation of seed with *Rhizobium* and *PSB* improved the nitrogen and phosphorus status of soil, which enhanced dry matter production ultimately absolute growth rate might have increased. Bijarnia *et al*. (2017) [5] also observed that dry matter accumulation was significantly influenced due to integrated nitrogen management treatments. Maximum number of branches and dry matter was recorded under FYM + 100% RDF at different stages.

Kernel yield

Kernel yield was also influenced by the residual effect of INM and presented in table 3. In fact the applied FYM to the preceding crop released the nutrients. The applied FYM released the nutrients in adequate amount in the following season also (Bhat *et al*., 2013) [4]. These results were in close conformity with the findings of Bashir *et al*. (2010) [3].

Residual effect of INM to rice increased the kernel yield of maize by 866 and 1582 kg compared with 100% RDN (M_1) in first and second years, respectively. The kernel yield was obtained 7192 kg ha^{-1} during 2015-16 and 7682 kg ha^{-1} in M_2 during 2016-17 year. These results were in line with the findings of Singh *et al*. (2000) [23]. Experiments performed by Negassa *et al*. (2001) [12] exhibited that there was significant residual effects of FYM which influenced maize grain yields. The manure was believed to increase yields of maize as a result of improved water holding capacity, soil aeration, soil structure, nutrient retention and microbial activities, all of which were known to play a significant role in enhancing crop performance (Lekasi *et al*., 2000) [10]. The residual effect of organic fertilizers on yield has been found to be positive in corn (Ramamurthy and Shivashankar, 1996) [17].

Farm yard manure application to rice showed significant residual effects in the following maize through better supply of nutrients, improved physical condition resulting in higher maize kernel yields. Ahmed *et al*., (2006) [1]; Parmer and Sharma (2002) [13] also claimed increased yield of rice as well as wheat with the use of organic materials in combination with mineral fertilizer to preceding rice crop (Islam and Munda, 2012) [8]. This had clearly brought that application of organic manures along with optimal levels of recommended dose of inorganics to preceding crop had an added advantage to enhance the yield of maize. Similar results were reported by Dixit and Gupta, 2000 [6]. The residual effect of M_2 increased the kernel yield of maize by 13.6 and 25.9% during first and second year, respectively over RDF alone (M_1).

Stover yield

Stover yields of maize during both the years of the study are

presented in the table 3. The highest stover yield was recorded in residual effect of M_2 treatment with 8147 kg ha^{-1} followed by M_1 treatment of
7411 kg ha^{-1} during 2015-16 year and 7326 kg ha^{-1} in M_1 followed by 8222 in M_2 during 2016-17 year. The treatment M_2 increased the stover yield of maize by 9.93 and 12.23%, respectively over RDF alone (M_1) which might be due to carry over effect of organic and inorganic fertilizers applied to rice which in turn increased the availability of nutrients to plants resulting in higher uptake and productivity. The residual effect of organic and inorganic treatment combinations significantly enhanced the stover yield of maize. These results were in line with the findings of Mehra and Singh (2007) [11] and Reddy and Reddy, (2005) [19].

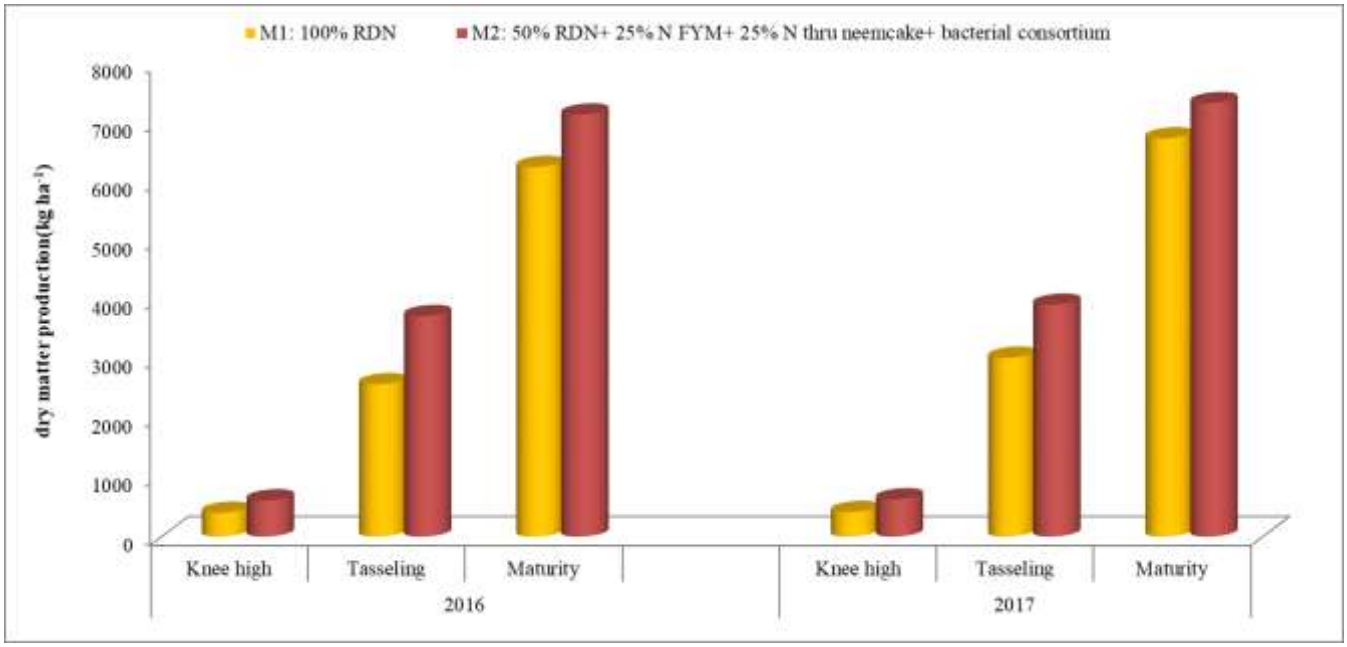

Fig 1: Residual effect of INM on dry matter production of maize

Table 3: Residual effect of INM on yield of maize

Treatment	2015-16				2016-17			
	100 kernel weight (g)	Kernel yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index (%)	100 kernel weight (g)	Kernel yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index (%)
M_1 : 100% RDN	26.29	6326	7411	46.00	27.96	6100	7326	45.43
M_2 : 50% RDN + 25% N - FYM + 25% N - neem cake + bacterial consortium	32.30	7192	8147	46.88	31.81	7682	8222	48.30
t-value	6.72	5.25	7.11	2.15	2.25	16.70	13.41	3.11

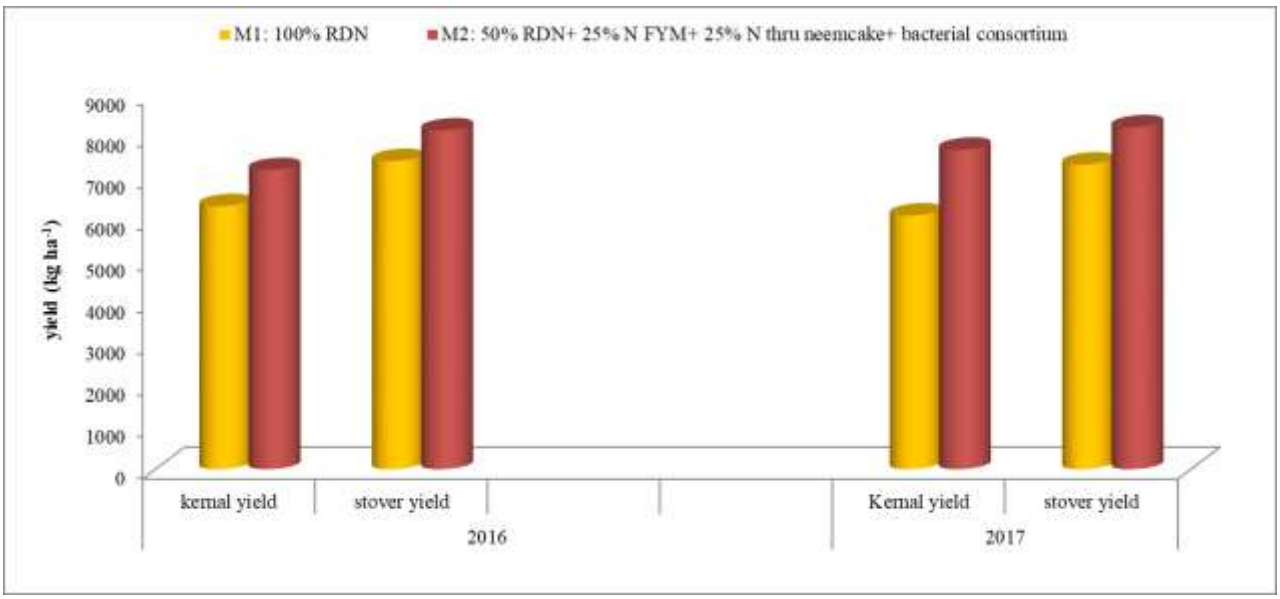

Fig 2: Residual effect of INM on yield of maize

The FYM application to rice showed significant residual effects in the following maize through better supply of nutrients, improved physical condition resulting in higher maize stover yields (Singh *et al*., 2004) [20]. These results were in agreement with the findings of Bhat *et al*. (2013) [4]. The beneficial effect of FYM could be attributed to the fact that FYM supplied higher amount of both macro and micronutrients particularly nitrogen and phosphorus that helped in rapid cell division and cell elongation. Jayaprakash *et al*. (2003) [9] and Sujatha *et al*. (2008) [21] also reported similar findings.

Harvest index

Significantly higher harvest index was obtained with residual effect of INM treatment compared to M_1 in both the years. The conversion of biomass into reproductive organs of highest yield attributing character was revealed in INM treatment. The harvest index value was recorded in M_1 (46%, 45.43%) was significantly inferior to that of M_2 (46.88%, 48.30%) during 2015-16 and 2016-17, respectively (Sujatha *et al*. 2008) [21].

Table 4: Residual effect of INM on N, P and K contents in maize

Treatment	2015-16				2016-17			
	Knee high	Tasseling	Stover	Kernel	Knee high	Tasseling	Stover	Kernel
Nitrogen (%)								
M_1 : 100% RDN	2.60	2.02	0.94	1.55	2.33	1.82	0.76	1.27
M_2 : 50% RDN + 25% N - FYM + 25% N - neem cake + bacterial consortium	2.73	2.33	0.96	1.71	2.62	2.04	0.85	1.35
t – value	5.28	10.52	2.80	17.36	6.66	3.25	4.81	5.41
Phosphorus (%)								
M_1 : 100% RDN	0.25	0.16	0.07	0.26	0.33	0.19	0.09	0.24
M_2 : 50% RDN + 25% N - FYM + 25% N - neem cake + bacterial consortium	0.34	0.24	0.13	0.34	0.38	0.23	0.10	0.31
t – value	8.94	9.86	9.94	9.87	2.17	8.05	14.21	11.53
Potassium (%)								
M_1 : 100% RDN	2.71	2.31	2.15	0.33	2.85	2.31	2.52	0.31
M_2 : 50% RDN + 25% N - FYM + 25% N - neem cake + bacterial consortium	2.88	2.55	2.43	0.36	3.19	2.56	2.72	0.39
t - value	5.40	15.13	7.48	4.45	6.69	4.78	9.64	6.12

Nutrient content and uptake

Nitrogen

The data pertaining to N content are given in the table 4. The highest mean N content in maize at knee high stage was recorded due to residual effect of M_2 with 2.73% and 2.62% during first and second year of the study, respectively. These results were in accordance with the findings of Zbiec *et al*. 1999 [22]. This was in line with the findings of Alexandrova and Donov (2003) [2] who reported the N content at 37 DAS ranging 2.2 to 2.9% with different cultivars.

The lowest nitrogen content (0.94%) was noticed in residual effect of M_1 treatment which had received only inorganics i.e 100% RDN only preceding rice crop during 2015-16 and 0.76% during 2016-17. Application of organics in combination with inorganic fertilizers to preceding rice crop, resulted in significant increase in N content of succeeding maize in *rabi* than the treatment that had not received organics during both the years of study. Similar results were reported by Patidar and Mali (2001) [14], Rao and Shakawat (2002) [18].

N content in maize at tasseling stage was less when compared to knee high stage and followed similar trend of N content with treatments at knee high stage during both the years of study.

The data regarding N uptake at different growth stages during both the years of the study are given in the table 5. With the age of crop, the N uptake was gradually increased from knee high to harvest stage. At harvest the stover and kernel uptake were determined during both the years of study. The N uptake was increased drastically from knee high (10.45 kg ha^{-1}) to tasseling (52.01 kg ha^{-1}) and knee high (9.66 kg ha^{-1}) to tasseling (55.01 kg ha^{-1}) during first and second years, respectively in M_1 treatment. The N uptake was increased from knee high (16.68) to tasseling (86.86) and knee high (16.45) to tasseling (79.94) during 2015-16 and 2016-17, respectively in M_2 treatment. At maturity, the highest N uptake was found in residual effect of M_2 treatment in kernal i.e 122.00 and 98.92 kg ha^{-1} during first and second years, respectively in M_2 treatment.

Irrespective of stage of crop and year of the study, the residual effect of INM treatment was played an important role in enhancing the N uptake by maize crop. These results were in accordance with the findings of Thind *et al*. (2002) [26] who reported that the residual effect of organic manures on uptake of N by succeeding wheat in FYM applied plots followed by dhaincha, moong, guar and cow pea added plots in maize-wheat cropping system. This effect might be due to the application of slow nutrient releasing organic manures in mineralization process, restricting the losses of nutrients either through leaching or volatilization resulted in higher nutrient uptake. The N uptake due to only inorganic fertilizers i.e 100% RDN (M_1) recorded lower values of nutrient uptake in maize. It was proved the residual effect and superiority of combined application of inorganic fertilizers in conjunction with organic manures.

Phosphorus

P content in maize at various growth stages was significantly influenced by INM imposed in preceding rice over 100% RDN during both the years of the study (Table 4.0).

Application of organics viz. FYM and neem cake in combination with inorganic fertilizers to preceding rice crop, resulted in significant increase in P content of succeeding maize at knee high stage in *rabi.* The mean highest P content in maize at knee high stage was recorded in the treatment M_2 with 0.34 and 0.38% during 2015-16 and 2016-17 years, respectively. Similar trend was followed in tasseling stage also.

With increase in the age of the crop the P content was decreased from knee high stage (0.34 and 0.24%) to tasseling stage (0.38 and 0.23%) during both the years of study it might be due to dilution effect of nutrients.

Application of INM to preceding rice crop, influenced significant increase in P content in succeeding maize in *rabi* than the treatment that had not received organics during both the years of study. The P content in maize stover (0.13 and 0.10%) was very less when compared with that of maize kernel (0.34 and 0.31%) during both the years of study. This could be attributed to the translocation of large proportions of phosphorus from other parts of the plant to the kernel (Hussaini *et al*., 2008). A certain degree of synergy between nitrogen and phosphorus had been reported for some field crops. The addition of nitrogen influenced the uptake by the plant of soil and fertilizer phosphorus sources. This phenomenon could be explained by the fact that the supply of nitrogen enhanced the production of small roots and root hairs, which in turn facilitated the high absorbing and adsorbing capacity per unit of dry weight.

The data regarding P uptake at different growth stages during both the years of the study are given in the table 5. Application of organics in combination with inorganic fertilizers to preceding rice crop, resulted in significant increase in P uptake by succeeding maize in *rabi* than the treatment that had not received organics during both the years of study.

With the age of crop, the P uptake was gradually increased from knee high to harvest stage. At harvest, the stover and kernel uptake were determined during both the years of study. The P uptake was increased from knee high (2.07) to tasseling(8.94) during first and knee high (2.38) to tasseling (9.01) during second year. The significant highest P uptake was found in M_2 treatment at kernel i.e 24.25 and 22.71kg ha^{-1} during 2015-16 and 2016-17 years, respectively.

Organics application in combination with inorganic fertilizers to preceding rice crop resulted in significant increase in P uptake by succeeding maize in *rabi* than the treatment that had not received organics during both the years of study. This might be due to continuous supply of P throughout the crop growth period as the nutrient from inorganic sources was available in addition from organic sources to the crop. The low and continuous release of P from the organic sources made available leading to higher uptake of P (Vidyavathi *et al*., 2011) [25].

These results were in accordance with the findings of Thind *et al.* (2002) [26] who reported the residual effect of organic manures on uptake of P by succeeding wheat in FYM treated plots followed by dhaincha, moong, guar and cowpea treated plots in maize-wheat cropping system. The greater P uptake was probably ascribed to mobilization of accessible soil P from deeper layers (Gangaiah *et al.*, 2012) [24].

Potassium

The highest mean K content was recorded in the residual effect of M_2 with 2.88 and 3.19% in 2015-16 and 2016-17, respectively at knee high stage (Table 4).

K content in maize at various growth stages was significantly influenced by nutrient management imposed in preceding rice followed by maize during both the years of the study. Application of organics viz. FYM, neem cake and bacterial inoculants in combination with inorganic fertilizers to preceding rice crop, resulted in significant increase in K content of succeeding maize in *rabi.*

Application of organics in combination with inorganic fertilizers to preceding rice crop, irrespective of NPK levels influenced in significant increase in K content of succeeding maize in *rabi* than the treatment that had not received organics during both the years of study. The highest mean K content in maize kernel was recorded in the treatment M_2 with 0.36 and 0.39% during first and second year of the study, respectively.

With increase in the age of the crop the K content was decreased from knee high stage (2.88 and 3.19%) to tasseling stage (2.55 and 2.56%) during both the years of study it might be due to dilution effect of nutrients. The K content in maize stover (2.23 and 2.22%) was high when compared with that of maize kernel (0.36 and 0.39%) during both the years of study.

The data regarding K uptake at different growth stages during both the years of the study are given in the table 5. Adoption of INM to preceding rice crop, resulted in significant increase in K uptake of succeeding maize in *rabi* than the treatment that had not received organics during both the years of study.

With the age of crop, the K uptake was gradually increased from knee high to tasseling stage. At harvest the stover and kernel uptake were determined during both the years of study. The potassium uptake was increased from knee high (17.59) to tasseling (95.06) and knee high (19.84) to tasseling (100.32) during 2015-16 and 2016-17 years, respectively. The significantly highest K uptake was found in M_2 treatment at stover (173.3 and 199.3 kg ha^{-1} during 2015-16 and 2016-17 years, respectively. The highest (173.3 kg ha^{-1}) K uptake during first year and (199.3 kg ha^{-1}) in second year by stover during 2016-17 year.

Irrespective of stage of crop and year of the study, the residual effect of M_1 and M_2 treatment had played an important role in enhancing the K uptake by maize crop. The significant lowest uptake was observed with M_1 treatment at knee high stage (10.89 kg ha^{-1}). M_2 had the highest uptake compared to M_1 treatment. This might be due to continuous supply of K throughout the crop growth period as the nutrient from inorganic sources was available in addition from organic sources due to the continuous release of K from the organic sources made available which led to higher uptake of K (Vidyavathi *et al*., 2011) [25].

Table 5: Residual effect of INM on N, P and K uptake by maize

Treatment	2015-16				2016-17			
	Knee high	Tasseling	Stover	Kernel	Knee high	Tasseling	Stover	Kernel
Nitrogen(kg ha^{-1})								
M_1 : 100% RDN	10.45	52.01	58.75	96.87	9.66	55.01	51.17	85.50
M_2 : 50% RDN + 25% N - FYM + 25% N - neem cake + bacterial consortium	16.68	86.86	68.49	122.00	16.45	79.94	62.25	98.92
t - value	3.11	9.38	7.67	10.21	13.02	8.43	8.57	15.78
Phosphorus(kg ha^{-1})								
M_1 : 100% RDN	1.00	4.12	4.37	16.25	1.36	5.74	6.05	16.15
M_2 : 50% RDN + 25% N - FYM + 25% N - neem cake + bacterial consortium	2.07	8.94	9.27	24.25	2.38	9.01	7.32	22.71
t – value	7.92	10.60	10.86	20.02	6.01	8.88	19.5	19.88
Potassium(kg ha^{-1})								
M_1 : 100% RDN	10.89	59.98	134.3	20.62	11.82	69.83	169.6	20.87
M_2 : 50% RDN + 25% N - FYM + 25% N - neem cake + bacterial consortium	17.59	95.06	173.3	25.68	19.84	100.32	199.3	28.57
t – value	3.51	5.07	9.00	7.82	11.22	7.86	15.08	11.83

Conclusion

Integrated nitrogen management followed to preceding rice crop resulted in significantly higher dry matter accumulation and higher kernel yield by succeeding maize in *rabi* over M_1 (inorganics alone). Addition of integrated nitrogen management enhances the Integrated nitrogen management application to preceding rice not only improved the fertility status of the soil and also improved the supply of nutrients to succeeding *rabi* crop of maize. Application of integrated nitrogen management to preceding rice crop, increased the maize crop yield by 25-30% when compared to 100% RDN. The residual effect of integrated nitrogen management treatment was played an important role in enhancing the nitrogen, phosphorus and potassium contents and uptakes by maize crop.

References

1. Ahmed P, Medhi D, Singh AK. Effect of organic and inorganic sources of nitrogen on ammonia volatilization and yield of transplanted Rice. Journal of the Indian society of Soil Science. 2006;54(3):348-350
2. Alexandrova P, Donov D. Nitrogen content and its uptake by maize as influenced by some meteorological elements and fertilization. International Agrophysics. 2003;17:41-45.
3. Bashir AS, Rilwanu AY, Musam, Muhammad MJ, Hakeem AA, Amim IS, *et al*. Response of cowpea to residual effect of different application rates of sheep manure on chilli pepper. Journal of food, agriculture and Environment. 2010;8(2):339-343.
4. Bhat RA, Ahmad L, Wani GA. Growth, yield and economics of maize as affected by cropping sequences, rates and frequency of farm yard manure. African Journal of Agricultural Research. 2013;8(27):3632-3638.
5. Bijarnia AL, Yadav RS, Rathore PS, Singh SP, Saharan B, Choudhary R. Effect of integrated nutrient management and weed control measures on growth and yield attributes of mustard. Journal of Pharmacognosy and Phytochemistry. 2017;6(4):483-488.
6. Dixit KG, Gupta BBR. Effect of FYM, chemical and biofertilizesr on yield and quality of rice and soil properties. Journal of Indian Society of Soil Science, 2000;48(4):773-780.
7. Gudadhe NN, Khnag VT, Thete NM, Lambade BM, Jibhkate SB. Studies on organic and inorganic sources of nutrient application in cotton- chickpea cropping sequence, Omonrice. 2011;18:121-128.
8. Islam M, Munda GC. Effect of organic and inorganic fertilizer on growth, productivity, nutrient uptake and economics of maize and toria. Agricultural Science Research Journal. 2012;2(8):470-479.
9. Jayaprakash TC, Nagalikar VP, Pujari BT, Setty RA. Effect of organics and inorganics on yield attributes of maize under irrigation. Karnataka Journal of Agricultural Science. 2003;16(3):451-453.
10. Lekasi TK, Tanner JC, Kimani SK, Harris PJC. Manure management in the Kenya highlands: Practices and Potential. 2nd edition. High potential production system portfolio of the natural resources, knowledge strategy, Department for international Development; c2000. p. 41.
11. Mehra M, Singh S. Effect of INM on the growth, yield and nutrient uptake by wheat under brahmi-wheat cropping system. Pantanagar Journal of Research, 2007;5(2):105-107.
12. Negassa W, Negisho K, Friesen DK, Ransom J, Yadessa A. Determination of optimum farm yard manure and NP fertilizers for maize on farmers fields. Seventh Eastern and Southern Africa Regional Maize Conference; c2001. p. 387-393.
13. Parmer DK, Sharma V. Studies on long-term application of fertilizers and manures on yield of maize-wheat rotation and soil properties under rainfged conditions in western Himalayas. Journal of Indian Society of Soil Science, 2002;50(3):311-312.
14. Patidar M, Mali AL. Integrated nutrient management in sorghum and its residual effect on wheat. Indian Journal of Agricultural Sciences. 2001;71:587-590.
15. Prasad B. Effect of continuous application of potassium on crop yields and potassium availability under different cropping sequences in calcareous soil. Journal of Potassium Research. 1993;9:48-54.
16. Rajput AL. Integrated nutrient management in rice-wheat sequential cropping system. Indian Journal of Agronomy. 1995;40(4):292-293.
17. Ramamurthy V, Shivshankar K. Residual effect of organic matter and phosphorus on growth, yield and quality of maize. Indian Journal of Agronomy. 1996;41:247-251.
18. Rao SS, Shakawat MS. Residual effect of organic manure, P and gypsum application in preceding ground nut on soil fertility and productivity of Indian Mustard. Indian Journal of Agronomy. 2002;47:487-494.

19. Reddy KC, Reddy KM. Differential levels of vermicompost and N on growth and yield of onion-radish cropping system. Journal of Research ANGRAU. 2005;33(1):11-17.
20. Singh SK, Verma SC, Singh RP. Residual effect of organic and inorganic sources of nutrients in lowland rice on succeeding lentil. Indian Journal of Agricultural Research. 2004;38(2):121-125.
21. Sujatha MG, Lingaraju BS, Palled YB, Ashalatha KV. Importnace of INM practices in maize under rainfed conditions. Karnataka Journal of Agricultural Sciences, 2008;67(1):13-15.
22. Zbiec II, Marczyk K, Gurgul E, Tryakowska U, Kasznska E. Response of spring wheat cultivar to irrigation and mineral fertilization part III activity of some physiological processes, chemical composition & technological properties of grain. Folio Universities Agriculture, Stetinensis, Agricultura. 1999;73:105-112.
23. Singh AK, Amgain LP, Sharma SK. Root characteristics, soil physical properties and yielfd of rice as influenced by INM in rice-wheat system. Indian Journal of Agronomy. 2000;45(2):217-222.
24. Gangaiah B, Ahlawat IPS, Shivalkumar BG. Crop rotation and recycling effects of legumes on wheat as influenced by nitrogen fertilization. Agricultural Science Research Journal. 2012;2(4):167-176.
25. Vidyavathi GS, Dasog H, Babalad B, Hebsur NS, Gali SK, Patil SG, *et al*. Influence of nutrient management practices on crop response and economics in different cropping systems in a Vertisol. Karnataka Journal of Agricultural Science. 2011;24(4):455-460.
26. Thind SS, Singh M, Sidhu AS, Chhiba IM. Influence of continuous application of organic manures and nitrogen fertilizer on crop yields, N uptake and nutrient status under maize-wheat rotation. Journal of Research, Punjab Agricultural University. 2002;39(3):357-361.