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Research Article

NUTRIENT CONTENT AS WELL AS UPTAKE OF MAIZE AND GREEN GRAM AS AFFECTED BY INTEGRATED NUTRIENT MANAGEMENT IN MAIZE- GREEN GRAM CROPPING SEQUENCE UNDER SOUTH GUJARAT CONDITION

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Abstract- The investigation entitled, "Nutrient content as well as nutrient uptake of maize and green gram as affected by integrated nutrient management in maize-green gram cropping sequence under south Gujarat condition" was conducted during *rabi* and summer seasons of 2014-15 and 2015-16 at College Farm, Navsari Agricultural University, Navsari to study the production potential of maize- green gram cropping sequence under integrated nutrient management system. The treatment consisted of integrated nutrient management *viz*., T_1-General RDF (RDF + FYM @ 10 t/ha), T_2 - 75% RDN through chemical fertilizer + 25% RDN through biocompost, T_3 -75% RDN through chemical fertilizer + 25% RDN through vermicompost, T_4 -75% RDN through chemical fertilizer + 25% RDN through FYM and T_5 -control to maize in *rabi* season as main plot treatments replicated four times in randomized block design. During summer season each main plot treatment was split into four sub plot treatments with four levels of recommended dose of fertilizers *viz*., S_1 -control, S_2 -50% RDF, S_2 -75% RDF and S_4 -100% RDF to green gram resulting in twenty treatment combinations replicated four times in split plot design. Grain and straw yields as well as nutrient content (N, P and K) and their uptake by *rabi*maize (grain and straw) were maximum under application of maize grain recorded significantly higher nitrogen content with the application of general RDF (RDF + FYM @ 10 t/ha) (T_1) being remained at par with T_3 (75% RDN through chemical fertilizer + 25% RDN through vermicompost), T_2 (application of 75% RDN through chemical fertilizer + 25% RDN through bio-compost) and T_4 (75% RDN through chemical fertilizer + 25% RDN through FYM).Significantly higher grain yield (56.00 q/ha) and straw yield (64.50 q/ha) was observed under application of general RDF (RDF + FYM @ 10 t/ha) (T_1) which was at par with 75% RDN through chemical fertilizer + 25% RDN through vermicompost (T_3) and 75% RDN through chemical fertilizer + 25% RDN through biocompost (T_2).Similarly, during summer season the residual effect of general RDF (RDF + FYM @ 10 t/ha) applied to *rabi* maize showed higher seed and stover yields, nutrient content (N, P and K) and their uptake by green gram (seed and straw) after harvest of green gram, followed by 75% RDN through chemical fertilizer + 25% RDN through vermicompost. Among the levels of RDF directly applied to green gram in summer season, significantly higher values of seed and stover yields, nutrient content (NPK) and their uptake by green gram.

Keywords- Green gram, Nutrient content and uptake, Maize, Yields

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Introduction

In India, the concept of cropping systems is as old as agriculture. Cropping systems has to be evolved based on climate, soil and water availability for efficient use of available natural resources This cropping system should provide enough food for the family, fodder for cattle and generate sufficient cash income for domestic and cultivation expenses. Application of imbalanced and/or excessive nutrients led to declining nutrient-use efficiency making fertilizer consumption uneconomical and producing adverse effects on atmosphere and groundwater quality causing health hazards and climate change. Therefore, to overcome these problem there is need to develop integrated nutrient management which conserve land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable. Maize- pulses is one of the important cropping system practiced in India. The productivity of the system mainly depends on proper nutrient management practices. Low organic matter content in soil coupled with low and imbalanced application of macro nutrients to the crop limits the full potential of yield (Tandon [17]). Integrating chemical fertilizers with organic manures was quite promising, in maintaining higher productivity. In the maize-green gram cropping system, application of vermi compost, bio compost and FYM increased growth attributes, yield parameters and yield of individual crops. Green gram is an important pulse crop of India as it is grown an area of 2.98 million hectares with total production of 1.61 million tonnes and productivity of 407 kg/ha. (Singh *et al*. 2015) India, major green gram producing states are Odisha, Madhya Pradesh, Rajasthan, Maharashtra, Gujarat and Bihar. In Gujarat, it is cultivated in about 2.3 lakh hectares with an annual production of 1.21 lakh tonnes and average productivity of 526 kg /ha (Anonymous, 2014 [1]).

MaterialsandMethods

The investigation entitled, "Nutrient content as well as nutrient uptake of maize and green gram as affected by integrated nutrient management in maize- green gram cropping sequence under south Gujarat condition" was conducted during *rabi* and summer seasons of 2014-15 and 2015-16 at College Farm, Navsari Agricultural University, Navsari. The soil of the experimental field was clayey in texture and slightly alkaline in reaction (pH 7.8), 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). The treatment consisted of

integrated nutrient management *viz*., T_1-General RDF (RDF + FYM @ 10 t/ha), T_2 - 75% RDN through chemical fertilizer + 25% RDN through biocompost, T_3 -75% RDN through chemical fertilizer + 25% RDN through vermicompost, T_4 -75% RDN through chemical fertilizer + 25% RDN through FYM and T_5 -control to maize in *rabi* season as main plot treatments replicated four times in randomized block design. During summer season each main plot treatment was split into four sub-plot treatments with four levels of recommended dose of fertilizer *viz*., S_1 -control, S_2 -50% RDF (10-15-00 kg N-P-K/ha), S_2 -75% RDF(15-30-00 kg N-P-K/ha) and S_4 -100% RDF(20-40-00 kg N-P-K/ha) to green gram resulting in twenty treatment combinations replicated four times in split plot design.

Plant samples of grain/seed and straw/stover of maize and green gram collected at harvest were ground in willey mill to pass through 40 mesh sieve. The ground material was collected in butter paper bags and later used for chemical analysis. Nitrogen, phosphorus and potassium content from grain/seed and straw/stover were estimated using standard procedures given by Jackson [5]. The nutrient (NPK) uptake was worked out by using of nutrient content and biomass production data. The data on various variables were analysed by using statistical procedures as described by Panse and Sukhatme [10].

Results and Discussion

The integrated nutrient management showed great impact on grain and straw yields of maize. Maize crop produced significantly highest grain and straw yields [Table-1] supplied through application general RDF (RDF + FYM @ 10 t/ha) (T_1) in pooled. This might be due the fact that increased absorption of nutrients and their assimilation. Supply of N in balanced quantity enabled the maize plants to assimilate sufficient photosynthetic products and thus increased the dry matter accumulation. The increased grain and straw yields can also be ascribed to the effect of adequate availability of NPK in soil solution, may cause increase in root growth, thereby increasing uptake of nutrients. These findings are in close agreement with the results obtained by Tetarwal [16] and Joshi [6] in *kharif* maize. Similar results were also reported by Shinde [13], as well as Maske [8] in *rabi* maize. The data presented in [Table–1] revealed that N content in grain and straw were found significant, but in case of P and K content in grain and straw at harvest by maize were not affected significantly. However, N, P and K uptake by grain and straw were significantly influenced due to different treatments.[Table–2&3] Application of 100% RDF + FYM @ 10 t/ha (T_1) recorded significantly higher nitrogen content in grain and straw which was at par with remaining treatments except control. The higher concentration of nitrogen in maize grain and straw might be due to addition of nitrogen in soil through application of organic and inorganic sources of nutrients, which in turn increased efficiency of applied nitrogen by forming clay humus complex. The findings are in accordance with those reported by Tetarwal [16]. Probable reason for initially higher availability of nutrients enhance root and early vegetative growth which increased photosynthetic activity in plant as evident from increased plant height recorded higher availability of metabolites from root to shoot and especially in the reproductive organ *i.e.* maize. This might have promoted growth of root as well as their functional activity resulting in higher extraction of nutrients from soil environment to aerial parts.

Table-2 *NPK uptake (kg/ha) by maize grain at harvest as influenced by different treatments (Pooled data of 2 years)*

Treatment	Nitrogenuptake (kg/ha)	Phosphorus uptake (kg/ha)	Potassium uptake (kg/ha)
T_1: General RDF (RDF + FYM @ 10 tonnes/ ha)	89.48	12.83	28.35
T_2: 75% RDN through chemical fertilizer + 25% RDN through biocompost	81.21	9.92	25.47
T_3:75% RDN through chemical fertilizer + 25% RDN through vermicompost	83.25	11.57	26.38
T_4: 75% RDN through chemical fertilizer + 25% RDN through FYM	73.06	9.07	23.01
T_5: Control	36.44	7.00	12.30
SEm±	4.51	0.54	1.40
CD (P=0.05)	13.27	1.58	4.12
CV (%)	17.55	15.08	17.13
General mean	72.69	10.08	23.10

Table-3 *NPK uptake (kg/ha) by maize straw at harvest as influenced by different treatments (Pooled data of 2 years)*

Treatment	Nitrogenuptake(kg/ha)	Phosphorus uptake (kg/ha)	Potassium uptake (kg/ha)
T_1: General RDF (RDF + FYM @ 10 tonnes/ ha)	37.91	12.16	60.63
T_2: 75% RDN through chemical fertilizer + 25% RDN through biocompost	32.28	10.19	52.72
T_3:75% RDN through chemical fertilizer + 25% RDN through vermicompost	35.54	11.09	56.05
T_4: 75% RDN through chemical fertilizer + 25% RDN through FYM	30.66	9.70	50.32
T_5: Control	13.4	5.41	28.79
SEm±	1.77	0.70	3.20
CD (P=0.05)	5.21	2.05	9.42
CV (%)	16.72	20.32	18.22
General mean	29.97	9.71	49.70

The phosphorus and potassium content in maize (grain and straw) did not attain the level of significance during both the years and pooled [Table–1]. This might be due to fact that organic manure maintained higher phosphorus and potassium availability to maize may be ascribed to the solubilising effects of carbonic acids formed during decomposition of organic manures, which promotes the release of organic phosphorus and potassium ultimately, the P and K uptake by the maize crop under all integrated nutrient management treatments may be more or less same. The above results confirming the findings of Gaud [2].

It is evident from the [Table–2&3] that uptake of N by maize (grain and straw) crop increased significantly with integration of inorganic fertilizer and organic manures over control, however significantly higher N uptake was observed with the general RDF (RDF + FYM @ 10 t/ha) (T_1) which was at par with the all treatments except control during individual years, while in pooled result, it was at par with T_3 and T_2. Same trend was observed in potassium uptake. In case of phosphorus uptake, treatments T_3, T_2 and T_4 were at par with T_1, during first year of study, while during second year of study T_3 and T_2 were at par with T_1 and only T_3 was at par with T_1 in pooled analysis.

The nutrient uptake is a function of yield and nutrient concentration in plant. Thus, this might be due to in general, the trend of nutrient uptake was very well resembled with dry matter accumulation and per hectare yield data of various treatments. The enhanced uptake of these nutrients in the corresponding treatments could be due to the increased and sustained availability of nutrients through organic and inorganic fertilizers. The increased uptake by maize might be due to improvement in soil physical, chemical and biological health through application of organic and inorganic fertilizers under integrated nutrient management. The results of present investigation are in close agreements with

the findings of Kumar [7], Tetarwal [16] and Singh [15] in *kharif* maize.

The seed and stover yield was varied materially due to conjunctive use of inorganic and organics in both the years and pooled. The significant increase in stover yield was under the application of general RDF (RDF + FYM @ 10 t/ha) which was at par with application of 75% RDN through chemical fertilizer + 25% RDN through vermi compost (T_3) and treatment receiving 75% RDN through chemical fertilizer + 25% RDN through bio compost (T_2). Significantly, higher stover yield under above treatments might be due to increase in vegetative growth through in terms of plant height, number of branches and dry matter accumulation. The results corroborate the findings of Singh [14] in rice-lentil, Gawai and Pawar [3] in sorghum-chickpea, Gudadhe [4] in cotton-chickpea, Nawle [9] in sorghum-chickpea, Shanwad [12] in maize-bengal gram and Saha [11] in maize- mustard cropping sequence.

The present study revealed that nitrogen content in seed [Table-4] and nitrogen, phosphorus and potassium uptake [Table-4 and 5] by seed were influenced significantly but nitrogen content in stover [Table-4], phosphorus and potassium content in seed and stover [Table-4] did not differ significantly due to residual effect of INM applied to preceding *rabi* maize crop. In case of nitrogen, phosphorus and potassium uptake by stover [Table-6] did not differ significantly due to residual effect of INM applied to preceding *rabi* maize crop except second year of nitrogen uptake by stover.

Table-5 *NPK uptake (kg/ha) by green gram seed at harvest as influenced by different treatment (Pooled data of 2 years)*

Treatment	Nitrogen uptake (kg/ha)	Phosphorus uptake (kg/ha)	Potassium uptake (kg/ha)
I). Main plot treatment(*Rabi* maize)			
T_1: General RDF (RDF + FYM @ 10 tonnes/ ha)	28.55	1.13	10.26
T_2: 75% RDN through chemical fertilizer + 25% RDN through biocompost	26.45	1.05	9.50
T_3:75% RDN through chemical fertilizer + 25% RDN through vermicompost	27.51	1.09	9.88
T_4: 75% RDN through chemical fertilizer + 25% RDN through FYM	25.45	1.01	9.14
T_5: Control	22.81	0.90	8.19
SE m±	0.89	0.04	0.34
C.D. at 5 %	2.73	0.13	1.04
C.V. %	13.54	16.23	14.31
II). Sub plot treatment (Summer green gram)			
S_1 : Control	21.31	0.86	7.81
S_2 : 50 % RDF	25.48	1.01	9.18
S_3 : 75 % RDF	28.57	1.13	10.18
S_4 : 100 % RDF	29.26	1.15	10.39
SE m±	0.69	0.03	0.27
C.D. at 5 %	1.97	0.09	0.77
C.V. %	11.81	13.95	12.83
Interaction (M x S)			
SE m±	1.54	0.07	0.60
C.D. at 5 %	NS	NS	NS
C.V. %	11.81	13.95	12.83
General mean	24.39	0.97	9.39

Table-6 *NPK uptake (kg/ha) by green gram stover at harvest as influenced by different treatment (Pooled data of 2 years)*

Treatment	Nitrogen uptake (kg/ha)	Phosphorus uptake (kg/ha)	Potassium uptake (kg/ha)
I). Main plot treatment(*Rabi* maize)			
T_1: General RDF (RDF + FYM @ 10 tonnes/ ha)	19.11	1.95	38.55
T_2: 75% RDN through chemical fertilizer + 25% RDN through biocompost	17.91	1.82	36.06
T_3:75% RDN through chemical fertilizer + 25% RDN through vermicompost	18.51	1.89	37.33
T_4: 75% RDN through chemical fertilizer + 25% RDN through FYM	17.32	1.76	34.78
T_5: Control	15.77	1.59	31.48
SE m±	0.72	0.08	1.47
C.D. at 5 %	NS	NS	4.53
C.V. %	16.18	17.76	16.49
II). Sub plot treatment (Summer green gram)			
S_1 : Control	14.82	1.49	29.74
S_2 : 50 % RDF	17.34	1.76	34.87
S_3 : 75 % RDF	19.17	1.96	38.57
S_4 : 100 % RDF	19.57	2.00	39.38
SE m±	0.55	0.06	1.10
C.D. at 5 %	1.56	0.18	3.13
C.V. %	13.76	15.28	13.80
Interaction (M x S)			
SE m±	1.22	0.14	2.46
C.D. at 5 %	NS	NS	NS
C.V. %	13.76	15.28	13.80
General mean	16.87	1.72	33.94

Table-1 *Mean grain and straw yield of maize (q/ha) and nutrient (NPK) content (%) of maize grain and straw at harvest as influenced by different treatment (Pooled data of 2 years)*

Treatment	Grain yield (q/ha)	Straw yield (q/ha)	NPK content in maize grain			NPK content in maize straw		
			N content (%)	P content (%)	K content (%)	N content (%)	P content (%)	K content (%)
T_1: General RDF (RDF + FYM @ 10 tonnes/ ha)	56.0	64.5	1.591	0.302	0.504	0.586	0.188	0.936
T_2: 75% RDN through chemical fertilizer + 25% RDN through biocompost	52.1	57.5	1.554	0.292	0.486	0.560	0.176	0.913
T_3:75% RDN through chemical fertilizer + 25% RDN through vermicompost	52.6	60.9	1.577	0.299	0.499	0.581	0.181	0.916
T_4: 75% RDN through chemical fertilizer + 25% RDN through FYM	47.6	55.5	1.529	0.286	0.481	0.551	0.174	0.903
T_5: Control	26.6	32.0	1.359	0.267	0.459	0.418	0.168	0.894
SEm±	0.17	0.20	0.038	0.006	0.011	0.013	0.006	0.025
CD (P=0.05)	0.51	0.58	0.112	NS	NS	0.037	NS	NS
CV (%)	10.38	10.33	7.090	5.760	6.580	6.550	10.160	7.860
General mean	4.70	5.41	1.522	0.289	0.486	0.539	0.177	0.912

Table-4 *Mean seed and stover yields (q/ha) as well as nutrient content in seed and stover of green gram as influenced by different treatment (Pooled data of 2 years)*

Treatment	Seed yield (q/ha)	Stover yield (q/ha)	NPK content in seed			NPK content in stover		
			N content (%)	P content (%)	K content (%)	N content (%)	P content (%)	K content (%)
I). Main plot treatment(*Rabi* maize)								
T_1: General RDF (RDF + FYM @ 10 tonnes/ ha)	8.75	21.96	3.24	0.129	1.166	0.865	0.088	1.744
T_2: 75% RDN through chemical fertilizer + 25% RDN through biocompost	8.28	20.79	3.18	0.126	1.142	0.857	0.087	1.724
T_3:75% RDN through chemical fertilizer + 25% RDN through vermicompost	8.52	21.37	3.21	0.127	1.154	0.861	0.088	1.736
T_4: 75% RDN through chemical fertilizer + 25% RDN through FYM	8.04	20.21	3.15	0.125	1.130	0.852	0.086	1.712
T_5: Control	7.42	18.65	3.06	0.121	1.099	0.841	0.085	1.679
SE m±	0.18	0.52	0.04	0.002	0.016	0.013	0.002	0.028
C.D. at 5 %	0.56	1.61	0.12	NS	NS	NS	NS	NS
C.V. %	8.90	10.16	4.75	7.480	5.510	6.170	7.770	6.460
II). Sub plot treatment (Summer green gram)								
S_1 : Control	7.02	17.68	3.02	0.121	1.107	0.834	0.084	1.674
S_2 : 50 % RDF	8.06	20.25	3.15	0.125	1.135	0.853	0.086	1.715
S_3 : 75 % RDF	8.78	22.03	3.24	0.128	1.153	0.866	0.088	1.741
S_4 : 100 % RDF	8.94	22.42	3.26	0.128	1.157	0.869	0.089	1.747
SE m±	0.14	0.40	0.03	0.002	0.014	0.010	0.001	0.020
C.D. at 5 %	0.39	1.13	0.09	NS	NS	NS	NS	NS
C.V. %	7.55	8.62	4.33	6.520	5.380	5.250	6.770	5.240
Interaction (M x S)								
SE m±	0.31	0.89	0.07	0.004	0.031	0.023	0.003	0.045
C.D. at 5 %	NS	NS	NS	NS	NS	NS	NS	NS
C.V. %	7.55	8.62	4.33	6.520	5.380	5.250	6.770	5.240
General mean	7.63	19.59	3.16	0.125	1.13	0.855	0.087	1.719

The nitrogen content in seed and nitrogen and potassium uptake by stover as well as phosphorus uptake by seed were significantly higher due to application of RDF + FYM @ 10 t/ha (T_1) which was at par with remaining treatments except control during both the years and in pooled analysis. While in case of nitrogen and potassium uptake by seed, significantly higher uptake of nitrogen and potassium by seed was observed in treatment T_1 (RDF + FYM @ 10 t/ha) which was remained at par with T_3 (75% RDN through chemical fertilizer + 25% RDN through vermi compost) and T_2 (75% RDN through chemical fertilizer + 25% RDN through bio compost). The increase in nutrient content and uptake in green gram might be due to the application of organic manures (FYM or bio compost or vermi compost) which firstly mineralized the nutrients and slowly releasing them up on the action of microorganisms with lapse of time. Secondly, because of mineralization process, the losses of nutrients either through leaching or volatilization might have been restricted. Also it might be due to improvement in soil physical, chemical and biological properties of soil through application of organic and inorganic fertilizers due to preceding crop *rabi* maize. These findings are in agreement with those of Saha [11] in maize- mustard cropping sequence.

From this research work, it can be concluded that for getting maximum green gram yield, *rabi* maize crop should be nourished with 120 kg nitrogen (75% RDN through chemical fertilizer + 25% RDN through bio compost) or 120 kg nitrogen (75% RDN through chemical fertilizer + 25% RDN through vermi compost) along with recommended dose of 60 kg P_2O_5 (Considering the phosphorus content in bio compost and vermi compost) and summer green gram crop should be fertilized with 75% RDF (15-30-00 kg N-P-K/ha) through inorganic fertilizer in maize- green gram sequence under south Gujarat condition. By considering residual fertility in maize -green gram sequence there was improvement in nutrient content as well as uptake due to combination of organic manures and inorganic fertilizer over control.

Conflict of Interest: None declared

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