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Residual Effect of Integrated Nutrient Management to Preceding Maize on Yield of Succeeding Groundnut under Maize-groundnut Cropping Sequence

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted at Krishi Vigyan Kendra, Anand Agricultural University, Dahod during the years 2020-21 and 2021-22 to study the effect of integrated nutrient management in maize-groundnut cropping sequence. The residual effect of INM treatment applied to preceding *rabi* maize crop was beneficial for increasing growth and yield attributing characters of succeeding summer groundnut crop *viz*., plant height and number of branches per plant, number of pods per plant, pod yield and haulm yield per hectare as influenced by different treatments. The residual effect of combination of organic and inorganic to preceding *rabi* maize crop, application of 75% RDN through inorganic fertilizer + 25% RDN through vermicompost + Bio NPK consortium (M_5) produced significantly higher pod and haulm yields which was at par with 75% RDN through inorganic fertilizer + 25% RDN through FYM + Bio NPK consortium in two years of pooled data. Among the levels of RDF, directly applied to summer

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groundnut, significantly higher yield attribute, pod and haulm yield was recorded with the application of 100% RDF (G_1) which was at par with 75% RDF + Bio NP consortium (G_2) in two years of pooled experiment data.

Keywords: Groundnut; bio NP; cropping sequence; pod yield; residual.

1. INTRODUCTION

"Groundnut, also known as peanut or *Arachis hypogaea*, the premier oilseed crop of India, occupying an area of about 6.7 million ha, contributing around 7.3 million tonnes towards the oilseed production. India stands first in area, second in production and fifth in productivity (1000 kg/ha) after USA, China, Indonesia and Nigeria. The productivity of groundnut is low in India when compared with other countries mainly due to rain dependency (85%), monoculture (60%) and cultivation on marginal soils of low fertility. Groundnut is an energy rich crop, needs sufficient amount of nutrients and moisture to meet the requirement for their growth and development and high yields. Sustainable groundnut production can be achieved by diversifying the groundnut cropping system and nutrient management practices" [1].

"As the oilseed crops are backbone of Indian economy from time immemorial, the oilseed is more hungry than thirsty and there is a wide gap in fertilizer demand and applications which results in huge mining of soil fertility leading to complex nutrient imbalances and deficiencies, that is difficult to manage. The grim situation of oilseed nutrient in the country indicates that only about 1/3 of fertilizer needs are actually applied. Thus, there is urgent need for steeping the use of major, secondary and micro nutrients" (Hedge and Sudhakara, 2009). "We can solve this problem by adopting the usage of inorganic fertilizers according to soil testing report and its recommended dose of fertilizers. Along with inorganic fertilizers use of organic fertilizers like bio-fertilizers will also help is improving fertility level of the soil. The indiscriminate use of chemical fertilizers harm the fertility and productivity of soil, which can be overcome by the use bio-fertilizers in the same". (Hedge and Sudhakara, 2009) Considering these facts and view, the present experiment was planned to study "Effect of Integrated Nutrient Management in Maize-Groundnut Cropping Sequence"

2. MATERIALS AND METHODS

The field experiment was conducted at Krishi Vigyan Kendra, Anand Agricultural University, Muvaliya Farm, Dahod in block - C, Plot No. - 21 during *rabi* seasons of 2020-21 and 2021-22. The soil of experimental plot was clayey in texture, low in available nitrogen (271 kg/ha), medium in organic carbon (0.51%) and available phosphorus (39.25 kg/ha) where's higher in available potash (341.21 kg/ha). The treatment consisted of integrated nutrient management *viz*., M_1 : 100% RDN through inorganic fertilizer (150:40:00 N:P_2O_5:K_2O kg/ha), M_2 : 75% RDN through inorganic fertilizer + 25% RDN through FYM, M_3 : 75% RDN through inorganic fertilizer + 25% RDN through vermicompost, M_4 : 75% RDN through inorganic fertilizer + 25% RDN through FYM + Bio NPK consortium and M_5 : 75% RDN through inorganic fertilizer + 25% RDN through vermicompost + Bio NPK consortium 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 three sub plot treatments with three levels of recommended dose of fertilizers *viz*., G_1 : 100% RDF, G_2 : 75% RDF + Bio NP consortium and G_3 : 50% RDF + Bio NP consortium to groundnut resulting in fifteen treatment combinations replicated four times in split plot design. The experiment was conducted on same site without changing randomization of treatments for successive year. The test variety of groundnut cultivar GG 34 with spacing of 45 x 10 cm was adopted. The groundnut crop was fertilized as per treatments. The nitrogen was applied through urea (46% N) whereas phosphorus was applied through single superphosphate (16% P_2O_5).

3. RESULTS AND DISCUSSION

3.1 Growth Attributes

The residual effect of INM treatment applied to preceding *rabi* maize crop was beneficial for increasing the growth attributing characters of succeeding summer groundnut crop *viz*., plant height and number of branches per plant. At 60 DAS, 90 DAS and at harvest, treatment receiving application of 75% RDN through inorganic fertilizer + 25% RDN through vermicompost + Bio NPK consortium (M_5) produced significantly taller plants which was statistically at par with 75%

RDN through inorganic fertilizer + 25% RDN through FYM + Bio NPK consortium (M_4) in pooled analysis basis. Significantly lower plant height was found in 100% RDN through inorganic fertilizer treatment in pooled analysis at all growth stages of groundnut. "Significant increase in plant height with RDN along with FYM and vermicompost was probably due to cell and inter nodal elongation, plant metabolism, there by promoting vegetative growth which is positively correlated to the productive potentiality of plant" Bharath et al. [1], Srinivasa Rao et al. [2] in groundnut.

Significantly taller plants were recorded with an application of 100% RDF (G_1) at all the stages of crop growth in two years of average data, which was at par with treatment 75% RDF + Bio NP consortium (G_2). Significantly the lower plant height was found in treatment 50% RDF + Bio NP consortium (G_3) in pooled study in all growth stages of groundnut. "The increase in plant height with higher level of fertilizer application was result of enhanced activities of meristematic tissues of the plant, increase in number and size of cell & efficient utilization of nutrients uptake". Bhosale and Pisal [3], Vala et al. [4], Sathiya et al. [5] in summer groundnut.

3.2 Yield Attributes and Yield

Yield contributing characters of groundnut viz., number of pods per plant, pod yield and haulm yield per hectare as influenced by different treatments is show in Table 2. The residual effect of combination of organic and inorganic to preceding *rabi* maize crop, application of 75% RDN through inorganic fertilizer + 25% RDN through vermicompost + Bio NPK consortium (M_5) produced significantly higher pod and haulm yields being at par with 75% RDN through inorganic fertilizer + 25% RDN through FYM + Bio NPK consortium (M_4) in pooled data. It might be due to increased growth and yield attributes *i.e*. plant height and number of branches per plant resulting in favorable environment for vegetative as well as reproductive crop growth, from initial growth stage to harvest, thus enabling the crop for maximum utilization of nutrients, moisture, light and space which consequently caused significant increase in photosynthesis, which resulted in higher yield of groundnut. These findings are also in accordance with those of Chavan et al. [6], Dhadge and Satpute [7], Reddy et al. [8], Bharath et al. [1], Srinivasa Rao et al. [2], Srinivasulu et al. [9] and Ushasri et al. [10] also reported similar results for summer groundnut on residual basis.

Yield attributes namely number of pods per plant were significantly higher with an application of 100 % RDF which was at par with 75% RDF + Bio NP consortium (G_2) in pooled results. Application of 100% RDF (G_1) produced significantly higher pod and haulm yield which was at par with 75% RDF + Bio NP consortium (G_2) in pooled analysis. This large attributes was due to better growth of plant in terms of plant height and number of branches which resulted in adequate supply of photosynthates for development of sink. Thus, the overall better growth performance and higher values of yield attributes reflected into higher yield under this treatment. Similar findings were reported by Chavan et al. [6], Bhosale and Pisal [3], Waghmode et al. [11], Aruna and Karuna Sagar (2018), Chaudhary et al. [12], Reddy et al. (2019), Sathiya et al. [5] as well as Satpute et al. [13] in groundnut crop.

3.3 Quality Parameters

Oil contents were significantly influenced by residual effect of integrated nutrient management treatments applied to preceding *rabi* maize. The application of 75% RDN through inorganic fertilizer + 25% RDN through vermicompost + Bio NPK consortium observed numerically higher oil content of groundnut over 100% RDN through inorganic fertilizer in two years of pooled result. This might be due to increased nutrient especially N and P in above organic manures that increased fatty acid synthesis which in turn increased oil production in groundnut. This was supported by Patra et al. [14], Bharath et al. (2017) in groundnut.

Oil content in groundnut kernels was not influenced significantly due to different levels of inorganic fertilizer in pooled data basis. Significantly higher oil content was observed due to an application of 100% RDF (51.79%) in groundnut kernels in pooled analysis. These results are in line with finding of Vala et al. [4] and Chaudhary et al. [12].

Table 1. Periodical plant height and number of branch of summer groundnut after *rabi* maize as influenced by different treatments (two years pooled data)

Treatment Details	Plant Height at 30 DAS (cm)	Plant Height at 60 DAS (cm)	Plant Height at 90 DAS (cm)	Plant Height at Harvest (cm)	Number of Branches/Plant
I) Main plot (*Rabi* maize) : M					
M_1 : 100% RDN (150:40:00 kg N:P_2O_5:K_2O kg/ha)	11.21	26.71	37.80	49.65	5.26
M_2 : 75% RDN + 25% RDN through FYM	11.35	27.36	41.84	53.86	6.12
M_3 : 75% RDN + 25% RDN through vermicompost	11.62	27.55	43.23	54.55	6.25
M_4 : 75% RDN + 25% RDN through FYM + Bio NPK consortium	11.75	28.47	46.02	56.52	6.87
M_5 : 75% RDN + 25% RDN through vermicompost + Bio NPK consortium	12.16	29.27	47.36	59.06	7.25
S.Em.±	0.21	0.32	1.12	1.31	0.17
C.D. at 5 %	NS	0.94	3.28	3.83	0.50
C.V. %	8.97	5.64	12.74	11.75	13.31
II) Sub plot (Summer groundnut) : G					
G_1 : 100% RDF (25:50:00 kg N:P_2O_5:K_2O/ha)	11.91	28.88	45.59	57.00	6.82
G_2 : 75% RDF + Bio NP consortium	11.66	28.23	43.71	55.09	6.54
G_3 : 50% RDF + Bio NP consortium	11.29	26.52	40.45	52.10	5.68
S.Em.±	0.09	0.24	0.52	0.51	0.09
C.D. at 5 %	0.28	0.68	1.49	1.45	0.25
Interaction effect : M × G	NS	NS	NS	NS	NS
: Y × M	NS	NS	NS	NS	NS
: Y × G	NS	NS	NS	NS	NS
: Y × M × G	NS	NS	NS	NS	NS
C.V. %	5.39	5.46	7.74	5.95	9.12

Table 2. Yield attributes and yield of summer groundnut after *rabi* maize as influenced by different treatments (two years pooled data)

Treatment Details	Number of Pods/Plant	Pod Yield (kg/ha)	Haulm Yield (kg/ha)	Oil Content (%)	Protein Content (%)
I) Main plot (*Rabi* maize) : M					
M_1 : 100% RDN (150:40:00 kg N:P_2O_5:K_2O kg/ha)	31.37	2026	3091	51.38	23.91
M_2 : 75% RDN + 25% RDN through FYM	34.25	2615	3918	51.45	24.31
M_3 : 75% RDN + 25% RDN through vermicompost	35.59	2767	4039	51.52	24.62
M_4 : 75% RDN + 25% RDN through FYM + Bio NPK consortium	39.14	3040	4369	51.57	24.78
M_5 : 75% RDN + 25% RDN through vermicompost + Bio NPK consortium	41.18	3152	4582	51.71	25.06
S.Em.±	0.91	50.10	88	0.12	0.17
C.D. at 5 %	2.67	146	258	NS	0.50
C.V. %	12.36	11.65	11.99	1.19	3.44
II) Sub plot (Summer groundnut) : G					
G_1 : 100% RDF (25:50:00 kg N:P_2O_5:K_2O/ha)	39.12	2962	4348	51.79	25.27
G_2 : 75% RDF + Bio NP consortium	37.70	2810	4155	51.44	24.76
G_3 : 50% RDF + Bio NP consortium	32.11	2388	3496	51.35	23.59
S.Em.±	0.48	51	69	0.12	0.18
C.D. at 5 %	1.34	145	195	0.35	0.51
Interaction effect : M × G	NS	NS	NS	NS	NS
: Y × M	NS	NS	NS	NS	NS
: Y × G	NS	NS	NS	NS	NS
: Y × M × G	NS	NS	NS	NS	NS
C.V. %	8.27	9.22	9.85	1.53	4.65

Table 3. Economics of summer groundnut after *rabi* maize as influenced by different treatment (average 2020-21 and 2021-22 years)

Treatment Details	Yield (kg/ha)		Gross Returns (₹/ha)	Cost of Cultivation (₹/ha)	Net Returns (₹/ha)	BCR
	Pod	Haulm				
I) Main plot (*Rabi* maize) : M						
M_1 : 100% RDN (150:40:00 kg N:P_2O_5:K_2O kg/ha)	2026	3091	124171	58388	65783	2.13
M_2 : 75% RDN + 25% RDN through FYM	2615	3918	160162	58388	101774	2.74
M_3 : 75% RDN + 25% RDN through vermicompost	2767	4039	169312	58388	110924	2.90
M_4 : 75% RDN + 25% RDN through FYM + Bio NPK consortium	3040	4369	182874	58388	124486	3.13
M_5 : 75% RDN + 25% RDN through vermicompost + Bio NPK consortium	3152	4582	189689	58388	131301	3.25
II) Sub plot (Summer groundnut) : G						
G_1 : 100% RDF (25:50:00 kg N:P_2O_5:K_2O/ha)	2945	4348	178318	58755	119563	3.03
G_2 : 75% RDF + Bio NP consortium	2827	4155	169213	58587	110625	2.89
G_3 : 50% RDF + Bio NP consortium	2388	3496	143748	57820	85929	2.49

3.3 Economics

The data presented in Table 3 revealed that the highest net returns and BCR were observed with application of 75% RDN through inorganic fertilizer + 25% RDN through vermicompost + Bio NPK consortium (M_5), followed by 75% RDN through inorganic fertilizer + 25% RDN through FYM + Bio NPK consortium (M_4), 75% RDN through inorganic fertilizer + 25% RDN through vermicompost (M_3), 75% RDN through inorganic fertilizer + 25% RDN through FYM (M_2). The lowest net returns and BCR were observed under 100% RDN through inorganic fertilizer (M_1). Higher level of biomass accrual and efficient translocation to reproductive parts, was due to supply of adequate nutrients through integrated nutrient management for different maize might be responsible for the production of elevated yield attributes, yield which resulted in higher net returns and BCR. Similar results were also reported by Reddy et al. [8], Bharath et al. [1] and Srinivasulu et al. [9] in maize-groundnut cropping system. Also close agreement with findings of Dhadge and Satpute [7], Patra et al. [14] and Srinivasa Rao et al. [2] in groundnut - maize cropping system.

The data in Table 3 (sub plot) indicated that the highest net returns and BCR were observed under the treatment 100% RDF (G_1), followed by treatment 75% RDF+ Bio NP consortium (G_2) with net returns and BCR. The lowest net realization and BCR were noted under 50% RDF + Bio NP consortium treatment (G_3). Similar results reported by Chavan et al. [6], Waghmode et al. [11], Chaudhary et al. [12], Sathiya et al. [5] and Satpute et al. [13].

4. CONCLUSION

On the basis of two year experiment on maize-groundnut cropping system, it can be concluded that for getting higher yield and net returns, *rabi* maize should be fertilized with 150 kg nitrogen (75% RDN through inorganic fertilizer + 25% RDN either through vermi compost or FYM + Bio NPK consortium) along with recommended dose of 40 kg P_2O_5 (considering the phosphorus content in FYM and vermi compost) and succeeding summer groundnut should be fertilized with 75% RDF through inorganic fertilizer + Bio NP consortium.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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