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Effect of application of manures and bio-fertilizers on yield, soil fertility and economics of Groundnut (*Arachis hypogaea* L.) under middle Gujarat conditions

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Abstract
A field experiment was conducted at the Agronomy Farm. B. A. College of Agriculture, Anand Agricultural University, Anand to study the "Effect of application of manures and bio-fertilizers on yield, soil fertility and economics of Groundnut (*Arachis hypogaea* L.) under middle Gujarat conditions." during *kharif* season of 2008. The soil of experimental plot was loamy sand in texture. It was low in organic carbon and available nitrogen, while high in available phosphorus and potash with pH 7.8 and EC value 0.14 dSm^{-1}. The experiment comprising twelve-treatment combinations was laid out in factorial randomized block design with four replications. The treatment consisted of combinations of three type of manures *viz.*, recommended dose of 12.5 kg N/ha + 25 kg P_2O_5/ha (M_1), vermicompost @1000 kg/ha (M_2) and poultry manure @ 500 kg/ha (M_3) and four type of bio-fertilizers (seed inoculation) viz., no bio-fertilizers (B_1), *Rhizobium* (B_2), VAM (B_3) and PSB (B_4). The results of experiment revealed that the groundnut crop fertilized with manures showed marked increase in pod yield (2.6 t/ha) and haulm yield (4.7 t/ha) were obtained under application of RDF (12.5 kg N/ha + 25 kg P_2O_5/ha) and was significantly superior over poultry manure @ 500 kg/ha and vermicompost @1000 kg/ha. This type of manures has also recorded the maximum net realization of Rs 54542/ha with 4.16 benefit cost ratio emerged as optimum and the most economical for groundnut. The results indicated that the groundnut crop fertilized with bio-fertilizers significantly higher pod yield (2.7 t/ha) and haulm yield (5.0 t/ha) was registered under seed inoculation with *Rhizobium* which was statistically at par with PSB (Seed inoculation) B_4. The seed inoculation with *Rhizobium* has also recorded the maximum net returns of Rs 56576/ha with 4.17 BCR.

Keywords: Groundnut, FYM, vermicompost, poultry manure, O.C., available NPK, soil fertility status, yield & economics

Introduction
Groundnut is one of the most important oilseed crops of India. Gujarat being the leading state in groundnut production contributes about 27 percent of national production. Over the time it has been observed that the groundnut production is not stable and national average yield of 1400 kg/ha Agricultural Statistics at a Glance; (2015-16) is far below than potential as well as global average. There are several factors responsible for low and unstable yield of groundnut *viz.* lack of improved varieties, poor fertility status of soils besides biotic and abiotic stresses. Moreover, most of the soils of Gujarat, where groundnut is being cultivated are low in organic carbon and available nitrogen. One of the most important aspects in this regard is proper nutrient management. So far most of the farmers are relying on application of chemical fertilizers that too with low doses. The other source *viz.* organic manures and biofertilizers though proven under controlled condition are yet to show presence in farmer's field. With the introduction of intensive cropping, independent use of neither the chemical fertilizer nor the organic sources can sustain the fertility of the soil and productivity of crops. Therefore considering the importance of organic and biological sources of nutrient for increasing the productivity a field study was undertaken to study the effect of chemical fertilizer, organic manures and biofertilizers on growth and productivity of groundnut with an aim to identify most remunerative combination.

Material and Methods
An experiment was conducted during *kharif* 2008 at Agronomy Farm, B.A. College of Agriculture, Anand Agricultural University, Anand situated between 220-35' North latitude

and 720-55' East longitude with an altitude of 45.1 m above mean sea level. Climate of the location is semi-arid to subtropical. The soil popularly known as '*Goradu*' is alluvial in origin, loamy sand in texture. The soil had 7.8 pH, 0.21 % organic carbon, 190 kg $KMnO_4$ oxidizable N/ha, 30.3 kg 0.5N $NaHCO_3$ extractable P/ha and 355.6 kg 1N ammonium acetate exchangeable K/ha. The experiment was laid out in Factorial Randomized Block Design with four replications. The treatment consisted of recommended dose of fertilizers *i.e.*, 12.5 kg N + 25 kg P_2O_5 /ha (RDF), vermicompost @ 10 q/ha (VC) and poultry manure @ 5 q/ha (PM) in combination with biofertilizers (seed inoculation) *viz.*, control, *Rhizobium*, VAM and PSB. The vermicompost and poultry manure were applied prior to sowing and seed of groundnut was inoculated with *Rhizobium*, PSB and VAM as per treatments. Gujarat groundnut-20 (GG-20), a semi spreading variety was sown on 9th June, 2008 with seed rate of 100 kg/ha at 45 cm row spacing. Other management practices were adopted as per recommendations for the crop.

Results and Discussion

Soil fertility parameters like available potassium did not influenced due to application of fertilizers and manure and found non significant (Table 1), while available phosphorus (37.06 kg/ha) under RDF was observed significantly higher than VC and PM. Application of PM significantly improved soil fertility status *viz.* organic carbon and available nitrogen over VC and RDF.

Yield parameters like pod yield (2.6 t/ha) was obtained with application of RDF being significantly at par with the application of Poultry manure @5 q ha^{-1} (2.4 t/ha) and found superior over Vermicompost @10 q ha^{-1} (2.29 t/ha), while haulm yield was found at par under RDF and PM treatment. Higher pod yield may be attribute to easy availability of nutrients from inorganic sources as compared to organic sources might have triggered created favorable condition uptake by plants. Initial boost of nitrogen might have helped in higher chlorophyll formation and ultimately higher photosynthesis. Poultry manure might be attributed to higher vegetative activity for longer time because of nitrogen availability for longer period. Poultry manure is relatively rich in nitrogen content but the slow release of N might have led to higher nitrogen availability during late stage of crops. Higher photosynthates generated during late stage of crop could not be translocated to reproductive organ/sink (pods/kernels) and ultimately resulted in higher haulm yields.

Inoculation of groundnut with bio-fertilizers significantly soil fertility parameters (organic carbon and available N) and crop yield. The highest pod and haulm yield was recorded in *Rhizobium* which was 35.5 and 26.1 percent higher over no inoculation. Pad yield was recorded significantly higher with the application of *Rhizobium* (2.7 t/ha) which remained at par with the application of PSB (2.6 t/ha). Seed inoculation with symbiotic nitrogen fixers (*Rhizobium*) and Phosphorus solubilising bacteria (PSB) might have increased the number of efficient and healthy nodules in *rhizosphere*, which in turn resulted in greater fixation of atmospheric nitrogen and availability of available phosphorus in soil for use by the plants and consequently resulting in to higher growth. Yadav and Malik (2005) [4] also reported similar results in groundnut.

The highest net returns (Rs. 54542) and B: C ratio (4.16) was obtained under RDF. Amongst the biofertilizers maximum net returns (Rs. 56576) and B: C ratio (4.17) was found in *Rhizobium*. The maximum net returns could be ascribed to highest pod yield obtained owing to application of RDF and *Rhizobium* inoculums. While higher B: C ratio was mainly due to lower cost of inorganic fertilizers as compared to vermicompost. The findings are in conformity with those reported by Halepyati (2001) [2] and Reddy *et al.* (2005) [3]

Summary and Conclusion

The performance of RDF + *Rhizobium* to increase yield parameters like pod yield (2.61 t/ha) was obtained with application of RDF being significantly superior over application of PM (2.38 t/ha) and VC (2.29 t/ha), while haulm yield was found at par under RDF and PM treatment. The highest net returns (Rs. 54542) and B: C ratio (4.16) was obtained under RDF. Amongst the bio-fertilizers maximum net returns (Rs. 56576) and B: C ratio (4.17) was found in *Rhizobium*.

From the above study it is concluded that application of RDF with seed inoculation with symbiotic nitrogen fixers (*Rhizobium*) might have increased the number of efficient and healthy nodules in *rhizosphere*, which in turn resulted in greater fixation of atmospheric nitrogen in soil for use by the plants and consequently resulting in to higher soil fertility status.

Table 1: Effects of various sources of nutrients on yield, soil fertility status and economics of groundnut

Treatment	Organic carbon (%)	available N	available P_2O_5	available K_2O	Pod yield (t ha^{-1})	Haulm Yield (t ha^{-1})	Net returns (Rs/ha)	B:C ratio
Fertilizers and manures								
*RDF	0.27	208.55	37.06	365.21	2.6	4.77	54542	4.2
Vermicompost @10 q ha^{-1}	0.28	216.70	32.61	368.72	2.3	4.18	43897	2.8
Poultry manure@5 q ha^{-1}	0.31	236.48	29.36	381.46	2.4	4.53	49138	3.9
S. Em±	0.01	7.81	1.29	6.29	0.1	0.15		
C.D.at 5 %	0.03	22.47	3.72	NS	0.2	0.44		
Bio-fertilizers								
Control	0.24	204.29	30.67	366.28	2.0	3.98	38443	2.8
Rhizobium	0.34	241.43	32.12	378.79	2.7	5.02	56576	4.2
VAM	0.33	220.87	32.36	368.65	2.4	4.42	49523	3.7
PSB	0.24	215.71	36.89	373.46	2.6	4.56	52228	3.8
S. Em±	0.01	9.01	1.49	7.26	0.1	0.18		
C.D.at 5 %	0.03	25.95	4.30	NS	0.2	0.51		

*RDF: Recommended dose of fertilizers (12.5 kg N + 25 kg P_2O_5)

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