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Effect of Different Levels of FYM and Recommended Dose of Fertilizer and their Methods of Application on Groundnut in Western Uttar Pradesh

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ABSTRACT

A two-year field experiment was conducted at the Research farm of Kisan Post Graduate College (Chaudhary Charan Singh University, Meerut), Simbhaoli, Hapur, Uttar Pradesh, from July-October of 2016 and 2017, respectively, to investigate the response of organic manures (farmyard manure) and chemical fertilizers and their method of application (broadcasting and root zone application) on Groundnut crop under assured irrigation. The soil of the field experiment was clay loam with chemical reaction 7.80, electrical conductivity (0.31 mm uS cm^{-1}), low in organic carbon content (0.37%), low in available nitrogen and medium in phosphorus, and high in potassium. Results of the field experiment revealed that pod yield of groundnut improved by root zone placement of farmyard manure (FYM) and inorganic fertilizers mainly through a significant improvement in weight of 100 kernels. FYM and different NPK levels of fertilizers were applied as broadcasting and root zone placement in different treatments. Application of 14.0 tonnes of FYM ha^{-1} recorded significantly higher pod yield over the control plot. Root zone application of 75% of the recommended dose of 20 kg N, 80 kg P_2O_5, and 20 kg K_2O ha^{-1} resulted in higher dry matter accumulation which leads to higher pod yield. Amid the interaction effect, a combination of 14.0 tonnes of FYM ha^{-1}+75% RDF, 14.0 tonnes of FYM ha^{-1}+root zone application and 100% RDF of NPK+root zone application obtained the highest pods yield as compared to other treatment combinations.

KEYWORDS: Groundnut, FYM, RDF, methods of application, yield

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1. INTRODUCTION

Sustainable agricultural practices are essential to meet global food demand with minimal adverse effects on soil health and the environment. Nitrogenous and phosphatic fertilizers are being used in many folds in excess due to their low use efficiency (Kumar et al., 2022). Intensive crop rotation and imbalance use of chemical fertilizers have resulted from multi-essential plant nutrient deficiencies and their long-term application may lead to soil degradation and a decrease in crop yield (Vishwakarma et al., 2012; Khem et al., 2018). The average use efficiency of nitrogen and phosphorus in agriculture is 30–40% and 15–20%, respectively. To improve nutrient use efficiency, alternative sources of nutrients are required (Ghaffari et al., 2011). Groundnut is one of the major sources of vegetable oils and India is the largest consumer of edible oils in the world. Increases in oilseed crop production especially of groundnut are needed for edible oil security in India (Rajagopal et al., 2000; Partha et al., 2011; Mehrotra, 2011; Singh et al., 2014). India is the fourth largest oilseeds producer 10.0% of the world with 20.80% acreage. Seven oilseed crops namely groundnut, soybean, sunflower, mustard, niger, sesamum, and safflower are under cultivation in our country (Yadav et al., 2015). Oilseed crops are considered crops of rainfed areas and about 72.0% of the total area under oilseed cultivation is rainfed which leads to lower yield potential. An average productivity of oilseed crops is 1254.0 kg ha^{-1} in Indiawhich is lower than the global average. An average productivity of oilseed crops is higher for *rabi* season crops at 1526.0 kg ha^{-1} in comparison to the *kharif* season at 1151.0 kg ha^{-1} (Anonymous, 2021). The leading states in groundnut productivity are Tamilnadu (2310.0 kg ha^{-1}) followed by Gujarat (1909.0 kg ha^{-1}) whereas it is (1209 kg ha^{-1}) in Uttar Pradesh (Anonymous, 2021). There are many reports that the yield of not only food-grain crops but also oilseed crops has either stagnated or declined in recent years due to the continuous application of mineral fertilizers (Lal, 2004; Manna et al., 2005). The major reason behind this is a decline in soil organic carbon content due to the rapid rate of oxidation in the Indo-Gangetic Plains of India which is considered the most important factor for sustained soil fertility and profitable crop production (Su et al., 2006). Soil organic matter is an important source of nitrogen and soils of Indo-Gangetic Plains are incapable of maintaining adequate nitrogen supply during the active growth period of the crop plants. The need for integrated nutrient management was felt, as a result of the concern over the indiscriminate and excessive use of chemical fertilizers causing serious environmental hazards including soil degradation. There it is necessary to maintain the soil fertility for sustainable production through the judicious use of organic manures and chemical fertilizers, (Ramachandran and Biswas, 2015). Being a leguminous crop, groundnut can help to increase soil available nitrogen through the biological nitrogen fixation in root nodules and it leaves a lot of residual fertility which in turn helps succeeding crops. Improving and maintaining soil fertility and productivity is of great importance to meet the demand for edible oil with an ever-increasing human and animal population in India. According to the 20th animal census of India, there are 536.76 million of the total livestock population. Judicious use of both organic and inorganic sources of nutrients with emphasis on their use efficiency results in higher production and monetary relief. Although nutrients are applied through different sources the information on their interaction effects and also the impact of different methods of application is not available. This experiment was therefore carried out to study the effect of the integration of organic and inorganic sources of nutrients and their method of application. The sustainability of higher crop production could be achieved through the integrated nutrient management system.

2. MATERIALS AND METHODS

A two-year field experiment was carried out at the Research Farm of Kisan Post-Graduate College, SimbhaoliHapur, Uttar Pradesh during the *kharif* seasons of 2016 and 2017. The experimental farm is located on the mean sea level of 226.90 meters and the latitude and longitude of the farm's location are 28 46 North and 77 59 East, respectively. The experimental field was well-leveled and had an irrigation facility by tube well. The average annual rainfall of the area is about 800-1000 mm, most of which is usually received between July and September months. Summers are hot and dry while winters are cold. The Soil was clay loan in texture and chemical test values of the soil was 7.80 pH, 0.31 mm uS cm^{-1} electrical conductivity, 0.37% organic carbon content and available nitrogen, phosphorus and potassium 178.0, 12.0 and 200.5 kg ha^{-1}, respectively. The experiment consisted of two treatments on- two levels of farm yard manure (0 and 14.0 t ha^{-1} and four levels (25%, 50%, 75% and 100%) of the recommended dose of fertilizers (20 kg nitrogen, 80 P_2O_5 and 20 kg K_2O ha^{-1}) and second-two methods of application (broadcasting and root zone application). An experiment was carried out in a split-plot design with three replications. Treatment methods of application of farmyard manure (FYM) were allocated to the main plot and two levels of FYM and four levels of recommended dose of fertilizers to the sub plots. Chemical fertilizers such as Urea, single super phosphate and muriate of potash were the source of nitrogen, phosphorus and potassium. The well-decomposed FYM was evenly distributed on the soil surface and incorporated into the soil during last ploughing. Fertilizers were mixed together and applied in two methods viz. broadcasting

and root zone placement method as per the treatment just before sowing. In the broadcasting method of application fertilizers, shallow furrows were opened in the plots keeping a spacing of 40 cm between rows. In the broadcasted plots, sources of nutrients were mixed in the soil by raking. In the root zone application, chemical fertilizers were placed at a depth of 6–8 cm deep in the soil in rows spaced 40 cm apart. Chemical fertilizers were covered with a thin layer of the soil. Chitra is a semi-spreading variety of groundnut was tested and seeds were sown with a spacing of 40 cm from row to row and 15 cm from plant to plant with a seed rate of 80.0 kg seeds ha^{-1}. The facility of assured irrigation was available and all other recommended agronomic packages and practices were adopted during the active growing period of the crop. Irrigation was given as and when there was no rainfall. Growth parameters like number of branches $plant^{-1}$ at 30 days after sowing (DAS), number of nodules $plant^{-1}$ at 60 DAS, number of pegs $plant^{-1}$, and plant biomass at 90 DAS. Ten plants were tagged with plastic pegs in each plot having treatment and were used for counting the number of branches per plant at 30 DAS. Five plants were dug-out at optimum soil moisture with the help of khurpi without damaging root nodules at 60 DAS. Plants were washed in fresh running water and after that number of nodules $plant^{-1}$ was counted manually and taken as an average of the five plants. The crop was harvested manually when its foliage colour was changed from dark green to light green and pods were matured. Ten pre-tagged plants were dug-out with the help of khurpi at 90 DAS. Pods were counted per plant and their average was taken. After that, the plant was oven-dried to get constant moisture content. For recording shelling percentage and pod yields, the crop was harvested from an area of 9 square meters as per the treatments and sun-dried. Seeds were removed from two-kilogram sun-dried pods and the weight of both seeds and pods-shell were recorded with the help of digital electronic balance. The weight of 100 seeds per treatment was recorded with a physical balance to get the seed index value. Pods yield was converted from kg 9 m^{-2} to kg ha^{-1}. Data regarding the yield attributes such as pods per plant, shelling percentage and seed index of 100 seeds and pods yield kilogram per hectare were recorded.

Shelling (%)=(Weight of seeds (kg)/Weight of pods (kg)) ×100

Statistical analysis of the growth, yield attributes and yield data of the groundnut crop was subjected to split plot design. The data related to various observations were collected, tabulated and analyzed statistically as per the analysis of variance technique (ANOVA) and critical difference (CD) at 0.05 probabilities as per the procedure mentioned by Gomez and Gomez (2010).

3. RESULTS AND DISCUSSION

3.1. Growth parameters

The dry weight of plants, number of branches per plant and number of pegs per plant were significantly influenced by the method of application of chemical fertilizers. The roots zone application recorded significantly higher values in all these as compared to the broadcasting method. Meanwhile, the number of nodules $plant^{-1}$ was statistically at par in both methods of application. Application of farmyard manure @ 14.0 t ha^{-1} recorded higher values of these growth attributes as compared to 0 t ha^{-1}. Moreover, the application of 75% RDF recorded a significant increase in all the growth attributes as compared to 25% and 50% RDF and was at par with 100% RDF, except for the number of nodules $plant^{-1}$ where all treatments were observed to be statistically at par with each other. Besides, farmyard manure 14.0 t ha^{-1} supplying necessary nutrients might have helped plants to achieve higher growth as compared to control. Easy availability of nutrients in the vicinity when applied to the root zone as compared to broadcasting might be the reason for better performance in growth attributes in that treatment. The 25% and 50% of RDF (Table 1) being inadequate to meet the early nutrient demand, especially nitrogen of the crop thus failed to record higher value of growth parameters. Application of 75% of the recommended dose of fertilizers resulted in higher values of growth parameters and the crop performed better with 100% RDF. It may be due to increased availability of N, P and K and meeting the initial nutrient demand successfully before the biological nitrogen fixation (BNF) started by the crop plants. There was no significant difference in levels of application of RDF and their method of application. Availability and or application of nitrogen in the soil have direct relationships with the number of nodule-forming bacteria. Almost similar findings were reported by Kumaret al., 2021.

3.2. Yield attributes and yield

The 100 seed weight and number of nuts per plant were significantly influenced by the treatment. The root Zone application was significantly superior as compared to broadcasting. Similarly, the application of FYM @ 14.0 t $ha^{-1}$was significantly superior to control in all these yield attributes. The application of 75% was significantly superior as compared to 25% and 50% RDF and was at par with 100% RDF. This may be due to better vegetative growth culminating in higher yield attributes. The pod's yield of groundnut was significantly higher when nutrients were applied in the root zone. When nutrients are easily available in the rhizosphere, the energy spent in proliferating roots in search of nutrients is diverted to yield attributes and ultimately pod yield. Moreover, the application of FYM

Table 1: Effect of levels of FYM and RDF (%) and their method of application on the growth and yield attributes of groundnut

Treatment	Harvesting (plant^{-1}) at 30 DAS	No. of nodules (plant^{-1}) at 60 DAS	Dry wt. (g plant^{-1}) at 90 DAS	Pegs (plant^{-1}) at 90 DAS	Seed per pods plant^{-1}	Seed index (g)	Kernel yield (kg ha^{-1})	Shelling (%)
Method of application								
Broadcasting	5.88	127.09	102.08	32.10	70.0	55.0	2345	67.0
Root zone	6.94	119.34	114.81	34.90	87.1	55.9	2565	68.0
CD (p=0.05)	0.64	NS	8.71	4.10	16.5	0.91	198	NS
Levels of FYM								
0 t ha^{-1}	5.94	115.1	98.10	28.20	69.0	55.0	2140	65.0
14 t ha^{-1}	6.88	129.8	118.81	40.20	87.5	56.1	2770	66.8
CD (p=0.05)	0.70	10.5	14.50	13.50	14.5	0.46	431	1.05
Levels of RDF(20 kg N, 80 kg P_2O_5 and 20 kg K_2O ha^{-1})								
25%	6.01	116.58	97.10	27.91	70.98	52.8	2220	66.0
50%	6.93	120.92	105.94	29.01	76.48	54.9	2510	67.1
75%	7.12	123.01	115.04	36.59	81.67	55.4	2690	68.0
100%	7.26	131.11	116.13	37.90	82.04	54.6	2710	69.0
CD (p=0.05)	0.38	NS	6.45	5.85	2.62	0.37	283	1.31

14.0 t ha^{-1} recorded a significantly higher yield (2770.0 kg ha^{-1}) as compared to the control (t ha^{-1}). As groundnut is a leguminous crop, the application of FYM tends to enhance biological nitrogen fixation (BNF) along with the facilitation of proper proliferation of roots and pegging. This might have resulted in a higher pod yield (2770 kg ha^{-1}). The levels of RDF also increased the nut yield of groundnut linearly up to 75% RDF. The 75% RDF was significantly at par with 100% RDF. The easy availability of nutrients, enhanced growth, and yield attributes might be the reason for the higher yield at 75% RDF recording a yield comparable to 100% RDF. Such effects of FYM and the inorganic nutrients on the yield attributes of groundnuts have been also reported by Mathivanand et al. 2012; Choudhary et al., 2011; Abdelkader, 2019. The interaction effects of different treatments were also observed to be statistically significant (Table 2). Application of nutrients in the root zone at 75% RDF was significantly superior to all the other combinations of treatments except 100% RDF and root zone application. This may be attributed to again easy availability of nutrients to the rhizosphere and increased nutrient use efficiency. Moreover, the contribution of FYM @ 14.0 ha^{-1}+75% RDF recorded significantly higher nut yield of groundnut as compared to all other treatment combinations except 100% RDF+FYM @ 14.0 ha^{-1}. It clearly showed a complementary effect between organic and inorganic sources of nutrients and improved crop productivity. Almost similar findings were reported by Kondappa et al., 2009.

Table 2: Interaction effect of levels of RDF (%) and method of application of organic onpod yield of groundnut

Treatment	Method of application		Mean
	Broadcasting	Root-zone	
RDF (%)×method of application			
25%	22.1	25.8	24.1
50%	23.1	26.3	25.2
75%	24.7	27.7	25.7
100%	25.6	29.1	26.8
Mean	22.88	27.18	
CD (p=0.05)	1.15		
Levels of FYM (t ha^{-1})×RDF (%)			
	25%	50%	75%
0t ha^{-1}	23.4	24.3	26.1
13.0 t ha^{-1}	25.0	25.8	28.9
Mean	24.2	25.05	27.5
CD (p=0.05)	2.10		

Organic manures alone may meet the lower nutrient demand under low to medium-intensive cropping, but a combination of organic manures and chemical fertilizers has become imperative to sustain a high nutrient supply for higher productivity. In a sustainable nutrient management system, the method of application of manures and fertilizers is very important. Judicious integration of these sources of plant nutrients together with bio-fertilizers would form a

basic integrated nutrient system (INS), technically efficient, economically viable, environmentally sound and socially acceptable. In view of the findings of the experiment, it may be concluded that application of FYM 14.0 t ha^{-1} along with 75% RDF in the root zone as compared to the other levels of RDF and FYM and application through broadcasting was found to result in higher growth and pods yield of groundnut crop under irrigated conditions of North-Western Plains of India.

4. CONCLUSION

Groundnut showed greater response to the various levels of organic manure (farmyard manure) and recommended dose of fertilizers (15.0 t FYM ha^{-1}+75% RDF) over the other treatment combinations and ideal growth and higher productivity of groundnut, nutrients should be supplied with farmyard manure @ 14.0 t ha^{-1}+75% recommended dose of fertilizers (RDF). This combination of both FYM and chemical fertilizers helped to meet its nutritional requirement at early growth stages as well as at the pod formation stage and resulted in economically profitable groundnut production.

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