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# PRODUCTIVITY OF SUMMER GROUNDNUT (*ARACHIS HYPOGAEA* L.) AND SOIL PROPERTIES AS INFLUENCED BY DIFFERENT NUTRIENT MANAGEMENT IN NEW ALLUVIAL ZONE OF WEST BENGAL

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**ABSTRACT**

The experiment was conducted at Regional Research Station, New Alluvial Zone, Gayeshpur, BCKV, Nadia, West Bengal during the period of March-July 2014 to study the productivity of summer groundnut (*Arachis hypogaea* L.) and soil properties as influenced by different nutrient management in New Alluvial Zone of West Bengal. The analyzed data revealed that application of 50% recommended dose of fertilizer (RDF) + 50% N as Farmyard manure (FYM) *i.e.* $T_1$ gave the highest yield of 2501.23 kgha$^{-1}$ and was statistically at par with the treatment $T_6$ receiving 1/3$^{rd}$ of recommended N each from FYM, vermicompost (VC) and neemcake (NC) + Rock phosphate, *Rhizobium* and Phosphate solubilizing bacteria (PSB) with a yield of 2426.67 kgha$^{-1}$. Regarding soil chemical properties, $T_6$ gave the highest organic carbon (0.93%), total nitrogen (0.078 %), available phosphorus (21.32 kgha$^{-1}$) and potassium (176.27 kgha$^{-1}$), respectively. Similarly, lowest bulk density (1.38 Mgm$^{-3}$), increase in water holding capacity (61.02 %) and higher percentage of soil aggregates (> 0.25 mm) with a value of 49.14 % (0-15 cm) and 41.98 % (15-30 cm) was observed in $T_6$. Thus, application of organic manures including biofertilizers either alone or with inorganic fertilizer can be recommended for sustained productivity of groundnut and soil .

## INTRODUCTION

The groundnut (*Arachis hypogaea* L.), an important oilseed and food legume crop of tropical and subtropical areas, is being cultivated in about 25 million hectare of land in about 90 countries under different agro-climatic regions. About 94 % of the global groundnut (peanut) production comes from the developing countries however, their productivity remains low. The main limiting factors responsible for low yield and productivity in groundnut are inadequate and imbalance use of nutrients as well as their deficiencies. However, indiscriminate use of fertilizers and pesticides has its adverse effect on soil like decline in soil fertility, deterioration of soil physical properties, depletion of organic matter in soil, low availability of water, contamination of food and water due to agrochemicals and also adverse affect on biodiversity. With the increasing degradation of soil through chemical fertilizer, the need to replace them with organic sources has become vital (Kamdi *et al.,* 2014).

The organic manure such as FYM is a very important input for groundnut production and accounted for 40.92 % of total variation in pod yield. Moreover, organic manures provide a good substrate for the growth of micro-organisms and maintain a favourable nutrient supply environment and improve soil physical properties (Amruta *et al.,* 2015). The use of either FYM, vermicompost alone and along with other organic amendments like neem seed cake, biofertilizers and biopesticides etc. has become imperative for sustainable crop production with better quality. Use of organic manures show promising in arresting the decline in productivity through correction of deficiencies of secondary and micro nutrients and supports the soil micro, meso and macro fauna and makes the soil a living body (Ramakrishnan *et al.,* 2005). Integration of inorganic fertilizers and biofertilizers resulted in better growth yield and nutrient uptakes in black gram (Kumpawat, 2010), green gram (Mandal and Pramanick, 2014), sesame (Nayek *et al.*, 2014) and rice (Kumar *et al.*, 2014) as compared to sole application of inorganic fertilizers. Sustained growth in agricultural productivity without environmental exploitation and degradation cannot be achieved unless efforts to enhance farmers' fertilizer use and organic fertilization are taken seriously. In view of the above facts and growing concern for sustained crop productivity and growing environmental pollution, the investigation was carried out with an aim to find out the best nutrient management package for groundnut and for improving soil physical and chemical properties.

## MATERIALS AND METHODS

The field experiment was conducted during the pre kharif period of March to July 2014 at Regional Research Station, New Alluvial Zone, Gayeshpur, BCKV, Nadia, West Bengal situated at 23°5′ N latitude and 89°E longitude with an altitude of 9.75m above the mean sea level. The soil of the experimental area was sandy clay loam in texture with good drainage facilities and having medium soil fertility with 0.68% organic carbon, 0.061% total N, 16.51 kgha$^{-1}$ available P and 165.30 kgha$^{-1}$available K respectively with pH 7.34, bulk density 1.50 Mg m$^{-3}$ and water holding capacity 51.87 %. The experiment was carried out in randomized block design with 8 treatments *i.e.*,$T_1$: 50% RDF + 50% N as FYM;$T_2$: 1/3$^{rd}$ recommended N each from FYM, Vermicompost (VC), Neemcake (NC);$T_3$: $T_2$ + intercropping (Groundnut + okra – 3:2); $T_4$: $T_2$ + straw mulch for weed management;$T_5$: 50% N as FYM + Rock phosphate + PSB + *Rhizobium*;$T_6$: $T_2$ + Rock phosphate + PSB + *Rhizobium*;$T_7$: 100% RDF; $T_8$: Control (without manures and fertilizers) and each treatment replicated thrice. The test variety grown was JL-24 (Phule Pragati).The recommended dose of fertilizer of groundnut was 20-60-40 kg N, $P_2O_5$ and $K_2O$ ha$^{-1}$, respectively and the sources used were Urea for Nitrogen, SSP for Phosphorus and MOP for Potassium. The full dose of N, $P_2O_5$ and $K_2O$ was applied before sowing of the crop. Organic manure was applied at the final land preparation as per treatments. Seed inoculation with *Rhizobium* strains was done before sowing. Rock Phosphate was mixed thoroughly with Phosphate Solubilizing Bacteria (PSB) before their application. Freshly shelled kernels were sown in rows of 30 cm apart by tynes and 10 cm within rows @120 kgha$^{-1}$. 2-3 irrigations were given to the crop and weeding was done manually as when required. Pod and haulm yield were recorded at harvest. Soil was analyzed at initial stage and after completion of the experiment to monitor the changes in nutrient status *viz.* organic carbon (%), total nitrogen (%), available phosphorus (kg ha$^{-1}$) and potassium (kg ha$^{-1}$) as per the standard methods (Jackson, 1973, Muhr e*t al.,* 1965). The bulk density was determined by the formula-

$$\text{Bulk density(BD)} = \frac{\text{Oven dry weight of the soil core}}{\text{Volume of the soil core}}$$

It was expressed as Mgm$^{-3}$

The water holding capacity of the soil was measured with the help of Kins Box as described by Piper (1966) and expressed as percentage. Water stable aggregate and their distribution in soil layers were determined by wet sieving method as described by Yoder (1936) and expressed in percentage. Data of different parameters were analyzed as per standard procedure with 5% probability level (Gomez and Gomez, 1984).

## RESULTS AND DISCUSSION

### Yield

Highest pod yield of 2501.23 kgha$^{-1}$was obtained with the treatment receiving 50% RDF + 50% N as FYM ($T_1$) i.e. integrated nutrient management which was found to be statistically at par with the treatment receiving 1/3$^{rd}$ of recommended N each from FYM, VC and NC along with *Rhizobium,* Rock phosphate and PSB *i.e.* organic based nutrient management ($T_6$) with a yield of 2426.67 kgha$^{-1}$ (Table 1). But considering the groundnut equivalent yield of intercrop okra, organic nutrient management under intercropping with

**Table1: Effect of different nutrient management on pod and haulm yield of summer groundnut**

| Treatment | Pod yield (kg ha$^{-1}$) | Haulm yield (kg ha$^{-1}$) |
|---|---|---|
| $T_1$: 50% RDF + 50% N as FYM | 2501.23 | 6207.07 |
| $T_2$: 1/3$^{rd}$ recommended N each from FYM, VC, NC | 1913.57 | 6045.47 |
| $T_3$: $T_2$ + intercropping (Groundnut + okra – 3:2) | 3043.51(1465.13+1578.37)* | 5190.77 |
| $T_4$: $T_2$ + straw mulch for weed management | 1830.5 | 5593.73 |
| $T_5$ : 50% N as FYM + Rock phosphate + PSB + *Rhizobium* | 1756.83 | 5477.47 |
| $T_6$: $T_2$ + Rock phosphate + PSB + *Rhizobium* | 2426.67 | 6286.97 |
| $T_7$: 100% RDF | 2107.47 | 6076.91 |
| $T_8$: Control (without manures and fertilizers) | 1355.27 | 4599.5 |
| S.Em ± | 81.59 | 82.11 |
| CD (at 5 %) | 247.47 | 249.04 |

**figure in parenthesis depicts groundnut pod equivalent yield of intercrop okra along with pod yield.*;RDF: Recommended dose of fertilizer, FYM: Farmyard manure, VC: Vermicompost, NC: Neem cake, PSB: Phosphate solubilizing bacteria

**Table 2:Effect of different nutrient management on soil organic carbon (%), total N (%), available P (kg ha$^{-1}$) and available K (kg ha$^{-1}$) after harvest of groundnut**

| Treatments | Organic carbon (%) | Total N (%) | Available $P_2O_5$(kgha$^{-1}$) | Available $K_2O$ (kgha$^{-1}$) |
|---|---|---|---|---|
| $T_1$: 50% RDF + 50% N as FYM | 0.73 | 0.069 | 18.44 | 167.94 |
| $T_2$: 1/3$^{rd}$ recommended N each from FYM, VC,NC | 0.87 | 0.077 | 20.19 | 169.22 |
| $T_3$: $T_2$ + intercropping (Groundnut + okra – 3:2) | 0.81 | 0.069 | 17.21 | 160.47 |
| $T_4$: $T_2$ + straw mulch for weed management | 0.89 | 0.074 | 20.45 | 171.44 |
| $T_5$ : 50% N as FYM + Rock phosphate + PSB + *Rhizobium* | 0.91 | 0.073 | 19.93 | 168.90 |
| $T_6$: $T_2$ + Rock phosphate + PSB + *Rhizobium* | 0.93 | 0.078 | 21.32 | 176.27 |
| $T_7$: 100% RDF | 0.66 | 0.067 | 17.75 | 174.07 |
| $T_8$: Control (without manures and fertilizers) | 0.63 | 0.054 | 12.43 | 140.11 |
| Initial | 0.68 | 0.061 | 16.51 | 165.30 |
| S.Em ± | 0.017 | 0.001 | 0.617 | 1.016 |
| CD (at 5 %) | 0.051 | 0.004 | 1.872 | 3.083 |

RDF: Recommended dose of fertilizer, FYM: Farmyard manure, VC: Vermicompost, NC: Neem cake, PSB: Phosphate solubilizing bacteria

**Table 3: Effect of different nutrient management on soil physical properties *i.e.* bulk density (Mg/m³), water holding capacity (%) and percentage soil aggregates (> 0.25 mm) after harvest of groundnut**

| Treatments | Bulk density (Mg/m³) (0-15 cm) | Water holding capacity (%) (0-15 cm) | Percentage of soil aggregates > 0.25 mm 0-15 cm soil depth | 15-30 cm soil depth |
|---|---|---|---|---|
| $T_1$: 50% RDF + 50% N as FYM | 1.49 | 51.38 | 46.50 | 36.37 |
| $T_2$: 1/3rd recommended N each from FYM, VC,NC | 1.42 | 53.66 | 47.20 | 38.77 |
| $T_3$: $T_2$ + intercropping (Groundnut + okra – 3:2) | 1.45 | 52.57 | 46.81 | 36.69 |
| $T_4$: $T_2$ + straw mulch for weed management | 1.39 | 55.18 | 46.85 | 36.95 |
| $T_5$: 50% N as FYM + Rock phosphate + PSB + *Rhizobium* | 1.47 | 57.73 | 48.89 | 41.34 |
| $T_6$: $T_2$ + Rock phosphate + PSB + *Rhizobium* | 1.38 | 61.02 | 49.14 | 41.98 |
| $T_7$: 100% RDF | 1.53 | 50.60 | 45.07 | 35.40 |
| $T_8$: Control (without manures and fertilizers) | 1.56 | 47.98 | 43.83 | 33.70 |
| Initial | 1.50 | 51.87 | 45.12 | 34.32 |
| S.Em ± | 0.017 | 0.811 | 0.40 | 0.58 |
| CD (at 5 %) | 0.052 | 2.461 | 1.21 | 1.76 |

RDF: Recommended dose of fertilizer, FYM: Farmyard manure, VC: Vermicompost, NC: Neem cake, PSB: Phosphate solubilizing bacteria

okra ($T_3$) recorded highest yield, followed by integrated nutrient management ($T_1$). Organic nutrient management ($T_6$) gave the highest haulm yield of 6286.97 kgha$^{-1}$, followed by integrated nutrient management, $T_1$ (6207.07 kgha$^{-1}$) and chemical fertilizer based nutrient management, $T_7$ (6076.91 kgha$^{-1}$) but with no significant difference between them. Manisha *et al.* (2007) also revealed that the integrated application of FYM or water hyacinth compost in combination with chemical fertilizer significantly improved the yield and quantity of peanuts kernel over that of the chemical fertilizer alone. Malligawad (2010) also found that application of organics like FYM, vermicompost with PSB, *Rhizobium* and *Trichoderma* increases shelling percent in groundnut.

The result is also in conformity with the results obtained by Kumar *et al.* (2012).

**Soil chemical properties**

All the organic and integrated based treatments showed an increase in organic carbon content over the initial value of 0.68 % (Table 2). Maximum organic carbon content was found under $T_6$ i.e. 1/3rd of recommended N each from FYM, VC and NC along with *Rhizobium,* Rock phosphate and PSB with 0.93 % organic carbon which was statistically at par with $T_5$ (0.91 %) and $T_4$ (0.89 %), followed by $T_2$ (0.87 %) and $T_3$ (0.81 %). Increased content of organic carbon in soil under organic nutrient treatments might be attributed to the application of organic matter from outside into the soil. Similar results were also observed by Vidyavathi *et al.* (2011). Like organic carbon, treatments receiving organic nutrient management showed higher total nitrogen content in soil in comparison with treatment receiving 100% RDF *i.e.* $T_7$ and integrated nutrient management $T_1$. Maximum increase in total nitrogen content in soil over the initial (0.061 %) was found under $T_6$ (0.078 %) which was statistically at par with $T_2$ (0.077 %), $T_4$ (0.074%) and $T_5$ (0.073 %) and their percentages increase was 27.87, 26.22, 21.31 and 19.67 % respectively. Chemical fertilizer treatment ($T_7$) recorded lower N content (0.067 %), followed by control (0.054 %). Singh *et al.* (2008) also confirmed the role of organic manures in releasing N and improving N availability in soil. Available phosphorus content in soil was found to be higher under all the organic based nutrient management treatments except $T_3$, followed by integrated nutrient management ($T_1$) and treatment with 100 % RDF ($T_7$). Maximum value of available phosphorus was obtained in $T_6$ (21.32 kgha$^{-1}$) followed by $T_4$, $T_2$ and $T_5$ (20.45, 20.19 and 19.93 kgha$^{-1}$) respectively with no significant differences among them and their percentages of increase over the initial value (16.51 kgha$^{-1}$) were 29.13, 23.86, 22.28 and 20.71, respectively. The improvement in the soil available P with FYM addition could be attributed to many factors, such as the addition of P through FYM, and retardation of soil P fixation by organic anions formed during FYM decomposition (Ali *et al.,* 2009). Similarly, maximum available K in soil was recorded under organic based nutrient management $T_6$ (176.27 kgha$^{-1}$) which was statistically at par with treatment receiving 100% RDF *i.e.* $T_7$ (174.07 kgha$^{-1}$). Available K in soil increased with the application of organic manures which is due to solubilizing action of organic acids produced during FYM decomposition and its higher capacity to hold K in available form (Vidyavathi *et al.*, 2011). Lowest available K in soil was observed in $T_3$ (160.47 kgha$^{-1}$) followed by untreated control $T_8$ (140.11 kgha$^{-1}$). Higher N, P, K under organic treatments may be due to continuous application of FYM and organic sources. These sources may enhance organic matter status in soil, which further improves soil physical as well as microbiological activities and increases the availability of plant nutrients (Kumar and Dhar, 2010 and Meena *et al.*, 2014). According to Vanilarasu and Balakrishnamurthy (2014), application of organics showed higher available P and K rather than direct addition through inorganic sources. The organic materials form a cover on sesquioxides, thus reducing the phosphate fixing capacity of the soil and solubilisation of insoluble P fractions resulting into release of available P. Ipsita Das and Singh (2014) also observed that combined application of farm compost, FYM with *Rhizobium* + PSB + Trichoderma increases nutrient content in soil and nutrient uptake by plant.

**Soil physical properties**

Physical parameter of soil like bulk density (BD), water holding capacity (WHC) and percentage of soil aggregates (>0.25 mm) were influenced significantly due to different nutrient management (Table 3). Improvement in soil condition as lowering of bulk density (BD) was observed in organic nutrient management with the lowest in $T_6$ *i.e.* 1/3rd of recommended N each from FYM, VC and NC along with *Rhizobium,* Rock phosphate and PSB (1.38Mg/m³), followed by $T_4$ *i.e.,*1/3rd recommended N each from FYM, VC, NC + straw mulch (1.39 Mg/m³) with no significant difference between them. The lowering of bulk density in organic treated plots and with integrated nutrient management may be due to higher organic carbon, more pore space and good soil aggregation (Singh *et al.,* 2014). Like bulk density, water holding capacity (WHC) was also found to be highest in organic based nutrient management treatments and among them $T_6$ showed highest water holding capacity (61.0 %), followed by $T_5$, $T_4$, $T_2$, and $T_3$(57.73%, 55.18%, 53.66%, 52.57%) respectively. The improvement in water holding capacity in response to the addition of organic matter is due to improved soil structure and water stable aggregates, as well as moisture retention capacity by increasing the total number of storage pores (Bhattacharyya *et al.,* 2008). However lower values of water holding capacity of 51.38% and 50.60% were recorded under integrated nutrient management $T_1$ and $T_7$ treatment with 100% RDF respectively. The favourable effect of FYM on soil water holding capacity and bulk density was also reported by Tadesse *et al.* (2013). Similar to WHC, soil aggregate value was also registered higher in treatments with organic nutrient management, followed by integrated nutrient management which showed improvement over the initial values. At the surface soil, maximum percentage of soil aggregate was obtained under $T_6$ (49.14 %) which was statistically at par with $T_5$ (48.89 %), $T_2$ (47.20%) while integrated nutrient management ($T_1$) and treatment with 100% RDF ($T_7$) showed lowest aggregate values of 46.50% and 45.07 % after untreated control $T_8$ (43.83 %). Similarly, percentage of soil aggregate at subsurface soil layer (15-30 cm) was found maximum under $T_6$ (41.98 %) and was statistically at par with $T_5$ (41.34 %). Integrated nutrient management ($T_1$) and treatment with 100% RDF ($T_7$) showed lower aggregate values of 36.37 % and 35.40 % after untreated control $T_8$ (33.70 %) which is similar with the trend observed in surface soil (0-15cm). This increase may be attributed to the increased microbial biomass and activity due to the addition of organic manures resulting in extra cellular polysaccharides which act as the good cementing agent of soil aggregates (Wang *et al.*,2013).

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