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# Effect of Integrated Nutrient Management on Growth, Yield Attributes, Yield and Quality Parameters of Groundnut (*Arachis hypogaea*) in an Acidic Upland of Odisha

**P. Mohanty, B.K. Pany, G. Sahu, S. Mohapatra and B.K. Nayak***

*Department of Soil Science and Agricultural Chemistry, Siksha 'O' Anusandhan Deemed to be University*
*Bhubaneswar-751 030, India*
**E-mail: bkpany2@gmail.com*

***Abstract*:** Field experiment was conducted during *Rabi* 2019-2020 at Agricultural Research Station, IAS, Siksha 'O' Anusandhan, Bhubaneswar, Odisha, India in a sandy loam soil. There were seven treatments of different levels of nutrient managements. The experimental results revealed that significantly higher values of growth parameters, yield attributes, pod yield and quality factors under the application of 125% RDF (STBR) [N, $P_2O_5$, $K_2O$ (25:50:50 kg $ha^{-1}$) + Combo i.e., [FYM 5t $ha^{-1}$ + Gypsum @250 k g $ha^{1}$ + *Rhizobium* seed inoculation + PSB soil application @ 2Kg $ha^{-1}$] followed by application of 100% RDF + Combo , 75% RDF + Combo over application of inorganic fertilizer levels (125%, 100 and 75 % RDF) only.

***Keywords:*** Groundnut, INM, *Arachis hypogaea,* Acidic soil

Groundnut (*Arachis hypogaea* L.), one of the principal economic crops, ranked as the second most important cultivated grain legume and the fourth largest edible oilseed crop in the world is grown in more than 100 countries. India is the second largest producer of groundnut in the world (Tiwari et al 2018, Hauser 2018). In India, though the area and production of groundnut are high, but great variation in productivity is observed. The productivity of groundnut in India is much less as compared to other leading countries due to soil heterogeneity, imbalanced fertilization, uncertainty of monsoons, poor cultural practices adopted by farmers, growing the energy crop groundnut under energy starved conditions like marginal and sub-marginal lands (mainly under rainfed condition), shortage of calcium, low soil pH, biological limitations, biotic and abiotic stress and many socio- economic factors. (Kamara et al 2011, Kumar, 2012, Gashti et al 2012). Improving the soil fertility by providing adequate nutrients to the crop could be a viable option to raise the productivity of groundnut. Various researchers working in this area opined that none of the inorganic and organic sources of nutrients alone can meet the total plant nutrient needs of the crop adequately. Hence, an integrated use of nutrients from chemical, organic manures, biofertilizers is the most efficient way to supply plant nutrients for sustained crop productivity and improved soil fertility (Dhadge and Satpute 2014, Vala et al 2018). Integrated nutrient management (INM) ensures the plant nutrient supply through optimization of benefits from all possible sources of plant nutrients in an integrated manner to achieve as well as sustain the desired crop productivity while maintaining soil fertility and can be considered as an important tool for sustainable agriculture to achieve the sustainable development goals (SDG) to ensure sustainable consumption and production patterns. This experiment was planned to study the effect of different nutrient management practices on growth attribute, yield, yield attributes and quality of groundnut.

## MATERIAL AND METHODS

The field experiment was conducted with groundnut variety Smruti at Institute of Agricultural Sciences, Siksha 'O' Anusandhan, Bhubaneswar, Odisha during Rabi (2019-2020) which was laid out at 85.7920°E longitude and 20.2588°N latitude with an elevation of 50.6 meter above mean sea level. The site comes under East and South Eastern Coastal Plain Agro-climatic zone of the state of Odisha, India. The climate is hot and humid with mean annual rainfall of 1467 mm. About 70% of total rainfall is received from July to September. The mean maximum and minimum temperatures were 33.2$^0$C and 21.4$^0$C, respectively. The experiment was laid out in randomized block design (RBD) with three replications and seven treatments. The treatments were viz.; $T_1$ [Control], $T_2$ =75% RDF [N, $P_2O_5$, $K_2O$ (15:30:30 kg $ha^{-1}$)], $T_3$ =100% RDF [N, $P_2O_5$, $K_2O$ (20:40:40 kg $ha^{-1}$)], $T_4$ = Soil Test Based Recommendation (STBR i.e.125% RDF) equal to N, $P_2O_5$, $K_2O$ (25:50:50 kg $ha^{-1}$)], $T_5$ =75% RDF[N,

$P_2O_5$, $K_2O$ (15:30:30 kg $ha^{-1}$)] + Combo- [FYM 5t $ha^{-1}$ + Gypsum @250 kg $ha^{1}$ + *Rhizobium* seed inoculation + PSB soil application @ 2Kg $ha^{-1}$], $T_6$ =100% RDF[N, $P_2O_5$, $K_2O$ (20:40:40 kg $ha^{-}$1 + Combo,$T_7$ =STBR [N, $P_2O_5$, $K_2O$ (25:50:50 kg $ha^{-1}$)]+ Combo. The soil of the experimental plot was sandy loam in texture, acidic (pH -4.21) in soil reaction, non-saline (electrical conductivity-0.56 $dSm^{-1}$), bulk density 1.55 g/cc, particle density 2.60 g/cc and porosity 39.92%, cation exchange capacity 4.8 mol (P+) $kg^{-1}$ of soil with 24% moisture content. The soil was also low in organic carbon (0.49%), available N (248 kg $ha^{-1}$) sulphur (13.62 kg $ha^{-1}$), medium in available phosphorus (11.6 kg $ha^{-1}$) and potassium (162 kg $ha^{-1}$). Lime was applied @1.2 t $ha^{-1}$ with soil before 25 days of sowing. Well decomposed farmyard manure applied @ 5 t $ha^{-1}$ to the soil which contains 0.5 % nitrogen, 0.2% P and 0.4% K as organic source. The recommended dose of fertilizers @ 20:40:40 kg NPK $ha^{-1}$ was considered as 100% RDF. Fertilizers were given in the form of urea, diammonium phosphate, and muriate of potash. Gypsum @ 250 kg $ha^{-1}$ was applied at peg initiation stage. Seeds were treated with *Rhizobium* culture @ 1.5 kg $ha^{-1}$ and PSB culture applied to soil @ 2Kg $ha^{-1}$ before sowing. The seed rate of groundnut was @125 kg $ha^{-1}$ sown in rows with 30 cm apart and 10 cm plant to plant spacing. Regularly biometric observations were recorded at specific time intervals by selecting randomly five plants in each treatment. The initial soil samples at 10-15 cm depth and organic manures were analysed for different parameters by following standard methods (Jackson 1968). Yield and yield attributing parameters were recorded during harvest. Yield components in groundnut that composed of pod and kernel yield per unit area was collected from data analysis after harvest of the crop. Pod index (g) [The weight of 100- pod samples, drawn randomly and index (g) 100-kernel samples, drawn randomly from shelling of the pod samples were calculated by standard procedure. Protein content in kernel (seed) of groundnut was calculated by multiplying percent kernel nitrogen with a factor of 6.25 and oil was extracted from kernel of groundnut of each plot with the help of Soxhlet's (Socs plus) apparatus or solvent extractor using n-hexane as solvent (AOAC 1960).

## RESULTS AND DISCUSSION

### Effect of Integrated Nutrient Management

**Growth attributes:** Application of soil test based recommendation of fertilizer (STBR) (N, $P_2O_5$, $K_2O$ @ 25 :50: 50 kg $ha^{-1}$ respectively i.e. 125% RDF) + Combo [FYM 5 t $ha^{-1}$ + Gypsum @ 250 kg $ha^{-1}$ + Rhizobium seed inoculation + PSB @ 2Kg $ha^{-1}$ as soil application], ($T_7$) significantly registered higher values of all the growth parameters, plant height, plant spread, number of branches at harvest, total number of root nodules per plant, number of effective nodules per plant, number of pods per plant, root length, root volume and pod weight per plant over all the treatments including control followed by $T_6$. $T_5$ was at par with $T_6$ in all growth attributes, except number of pods per plant, and root volume (ml). The plant spread, number of branches at harvest, number of pods per plant, root length and root volume increased significantly in $T_4$ (STBR) as compared to $T_3$ and $T_2$. The pod weight per plant in $T_7$ out yielded all the treatments, however, $T_4$ STBR and $T_5$, 75% RDF and combo remained at par with each other.The integrated application of STBR (N, $P_2O_5$, $K_2O$ @ 25 :50: 50 kg $ha^{-1}$ respectively) with Combo (FYM 5t $ha^{-1}$+ Gypsum @250 kg $ha^{-1}$+ Rhizobium seed inoculation + PSB @ 2Kg $ha^{-1}$ as soil application) showed advantageous effect on growth parameters which may be due to the flattering effect of FYM in improving physical, chemical and biological environment as well refining the activity of applied and native Rhizobium (nitrogen fixation) and phosphate solubilizing bacteria (phosphate solubilization) of soil, favourable for better plant growth. Beneficial microorganisms also involved in decomposition of cellulose, production of antibiotics, vitamins and hormones that also adds to the positive impact to produce larger cells with thinner cell wall and influence cell division and cell elongation which enhanced vegetative growth and eventually enlarged plant height, plant spread, number of branches per plant, root length and number, total and effective root nodules per plant. These findings agree with the results of earlier workers (Kamalakannan 2017, Kulkarni et al 2018, Umadevi et al 2018).

**Yield attributes:** Increase in RDF fertilizers from 75% to STBR (125% RDF) alone and integrated with combo pack produced significantly higher pod number and pod weight of groundnut in comparison to lower levels. Significant higher pod number and pod weight were recorded with $T_7$ trailed by $T_6$. Higher test kernel weight (g) and shelling (%) were recorded in the same treatment ($T_7$). Significant increases were among 75, 100, 125% respectively as well as their combination with combo. The effects of treatments on pod index and seed index appeared to be less evident through significant differences were observed between very low and very high doses of fertilizers together with combination of combo. Highest pod index (75.28 g) and seed index (52.16 g) were also recorded with ($T_7$) followed by $T_6$ with pod index (g) and seed index (g). In case of pod index $T_4$ and $T_5$ were at par. Improved values of various yield attributes such as pod number, pod weight per plant, test weight and shelling percentage, pod index and seed indexes might have been due to development of vegetative growth and nodulation, which constructively prejudiced the flowering and fruiting and

eventually caused into augmented number of pods and pod weight per plant. These findings are in agreement with Patil et al (2018) and Vala et al (2017).

**Yield:** There was improvement with respect to biological; pod, kernel and haulm yield as well as harvest index of groundnut among various integrated nutrient packages (Table 3). Maximum biological yield (68.63 kg $ha^{-1}$), pod yield (3195 kg $ha^{-1}$), kernel (2398.10 kg $ha^{-1}$) and haulm yield (3668 kg $ha^{-1}$) were in $T_7$ which received STBR (125% RDF) and combo [FYM 5t $ha^{-1}$+ Gypsum @250 kg $ha^{1}$ + Rhizobium seed inoculation + PSB soil application @ 2Kg $ha^{-1}$] followed by $T_6$ [00% RDF + combo] with 6372 kg $ha^{-1}$ biological yield, 2896 kg $ha^{-1}$ pod yield, 2128.28 kg $ha^{-1}$ kernel yield and 3476 kg $ha^{-1}$ haulm yield. With respect to biological yield treatment $T_7$ and $T_6$ significantly out yielded other treatment and $T_7$ was significant over $T_6$. Pod, kernel and haulm yields increased with different RDF levels alone and combination of RDF levels with combo also, showing thereby a significant effect of RDF and its combination with combo on groundnut. Use of different levels of RDF was also found inferior to combined application of RDF levels and combo. No significant relationship existed among $T_3$ and $T_4$ with respect to pod and kernel yield whereas significant relationship expressed among $T_7$ and $T_6$, $T_6$ and $T_5$. The harvest index of groundnut in various treatments varied due to application of different levels of fertilizers and their combination with combo. The maximum harvest index (48.23%) was recorded under 75% + combo ($T_5$) followed by 125% (STBR) + combo ($T_7$) (46.55%), 100% RDF + combo ($T_6$) 45.44 %), 100% RDF ($T_3$) (47.31%), 75% RDF (47.12%) ($T_2$), 125% RDF (STBR) (47.11%) and the minimum harvest index (40.97%) was recorded in control but all treatments significantly superior over control and they remain at par with each other. Earlier reports of several workers indicated that combination of inorganic fertilizers and organic fertilizers together with biofertilizers enhanced the pod, kernel and haulm yield of groundnut. Biological yield, pod yield, kernel yield and haulm yield were expanded, due to the combined nutrient use of organic (FYM), inorganic fertilizers, gypsum and bio-fertilizers by providing cooperative effect and in turn upgraded the soil condition, stimulate root system with healthier absorption of nutrients, water from lower layers and expressed superior progress of plant growth resulting in higher photosynthetic activity and translocation of

**Table 1.** Effect of integrated nutrient management on growth attributes

| Treatment | Plant height (cm) | Plant spread (cm) | Number of branches on harvest | Total number of root nodules per plant | Number of effective nodules per plant | Root length (cm) | Root volume (ml) |
|---|---|---|---|---|---|---|---|
| $T_1$. Control | 9.8 | 15.48 | 4.88 | 65.95 | 16.85 | 9.86 | 13.26 |
| $T_2$. 75% RDF | 10.7 | 17.53 | 6.22 | 71.67 | 19.47 | 10.92 | 16.86 |
| $T_3$. 100%RDF | 11.0 | 19.87 | 6.96 | 74.16 | 20.25 | 12.97 | 19.60 |
| $T_4$. STBR | 11.7 | 21.56 | 7.86 | 76.88 | 20.96 | 13.45 | 23.36 |
| $T_5$. $T_2$ + Combo | 12.1 | 23.89 | 8.11 | 80.27 | 22.66 | 13.98 | 25.66 |
| $T_6$. $T_3$ + Combo | 12.7 | 24.66 | 8.65 | 82.75 | 23.92 | 14.32 | 29.43 |
| $T_7$. $T_4$ + Combo | 13.5 | 26.45 | 9.38 | 84.42 | 25.72 | 15.92 | 31.53 |
| CD (p=0.05) | 0.64 | 1.04 | 0.60 | 3.13 | 1.44 | 0.42 | 1.48 |

100% RDF = Recommended dose of fertilizer = [N, $P_2O_5$, $K_2O$ (20 :40:40 kg $ha^{-1}$)], STBR = Soil Test Based Recommendation =[N, $P_2O_5$, $K_2O$ (25 :50: 50 kg $ha^{-1}$)], Combo = (FYM 5t $ha^{-1}$+ Gypsum @250 kg $ha^{1}$ + Rhizobium seed inoculation + PSB soil application @ 2Kg $ha^{-1}$)

**Table 2.** Effect of INM on yield attributes of groundnut

| Treatment | Number of pods per plant | Pod weight per plant (g) | 100 Kernel weight (g) | Shelling (%) | Pod index (g) | Seed index (g) |
|---|---|---|---|---|---|---|
| $T_1$. Control | 7.66 | 6.8 | 36.56 | 62.18 | 66.52 | 42.66 |
| $T_2$. 75% RDF | 9.11 | 8.35 | 41.76 | 65.72 | 68.45 | 44.42 |
| $T_3$. 100% RDF | 11.55 | 9.77 | 43.78 | 68.62 | 70.72 | 46.58 |
| $T_4$. STBR | 12.88 | 10.85 | 44.16 | 70.65 | 71.94 | 47.56 |
| $T_5$. $T_2$ + Combo | 13.92 | 11.36 | 44.92 | 72.28 | 72.15 | 48.92 |
| $T_6$. $T_3$ + Combo | 15.21 | 12.06 | 45.53 | 73.48 | 73.76 | 50.07 |
| $T_7$. $T_4$ + Combo | 17.28 | 12.92 | 46.65 | 75.06 | 75.28 | 52.16 |
| CD (p=0.05) | 1.16 | 0.55 | 0.93 | 1.44 | 1.44 | 1.03 |

See Table 1

**Table 3.** Effect of integrated nutrient management on yield of groundnut

| Treatment | Biological yield kg ha$^{-1}$ | Pod yield kg ha$^{-1}$ | Kernel yield kg ha$^{-1}$ | Haulm yield kg ha$^{-1}$ | Harvest index (%) |
|---|---|---|---|---|---|
| $T_1$. Control | 3320 | 1360 | 845.68 | 1960 | 40.97 |
| $T_2$. 75% RDF | 5105 | 2406 | 1581.35 | 2699 | 47.12 |
| $T_3$. 100%RDF | 5326 | 2520 | 1728.88 | 2806 | 47.31 |
| $T_4$. STBR | 5454 | 2570 | 1816.04 | 2884 | 47.11 |
| $T_5$. $T_2$ + Combo | 5727 | 2762 | 1996.53 | 2965 | 48.23 |
| $T_6$. $T_3$ + Combo | 6372 | 2896 | 2128.28 | 3476 | 45.44 |
| $T_7$. $T_4$ + Combo | 6863 | 3195 | 2398.10 | 3668 | 46.55 |
| CD (p=0.05) | 270.53 | 98.93 | 97.04 | 75.32 | 3.55 |

See Table 1

**Table 4.** Effect of integrated nutrient management on quality parameters of groundnut

| Treatment | Protein content (%) | Protein yield kg ha$^{-1}$ | Oil content (%) | Oil yield kg ha$^{-1}$ | Saponi-fication value | Acid value | Iodine number |
|---|---|---|---|---|---|---|---|
| $T_1$. Control | 20.93 | 177.09 | 42.65 | 360.61 | 88.4 | 1.87 | 0.27 |
| $T_2$. 75% RDF | 21.99 | 348.03 | 44.92 | 710.06 | 90.2 | 1.82 | 0.29 |
| $T_3$. 100% RDF | 23.56 | 407.38 | 46.47 | 803.21 | 92.8 | 1.67 | 0.31 |
| $T_4$. STBR | 24.87 | 451.74 | 47.88 | 869.44 | 93.6 | 1.70 | 0.32 |
| $T_5$. $T_2$ + Combo | 26.68 | 532.70 | 49.42 | 986.83 | 94.3 | 1.75 | 0.34 |
| $T_6$. $T_3$ + Combo | 29.12 | 619.62 | 51.62 | 1099.02 | 95.5 | 1.69 | 0.36 |
| $T_7$. $T_4$ + Combo | 31.12 | 746.21 | 53.76 | 1289.26 | 96.8 | 1.64 | 0.41 |
| CD (p=0.05) | 0.98 | 31.1 | 1.92 | 63.49 | 1.89 | 0.12 | 0.03 |

See Table 1

photosynthates to the sink which resulted in higher pod and haulm yields. The present findings are in close agreement with the results obtained of earlier (Joshi et al 2018, Purbajanti et al 2019, Kamalakann and Elayaraja 2020)

**Quality parameters:** The maximum crude protein content (32.12%), protein yield (746.21 kg ha$^{-1}$), oil content of kernels (53.76 %), oil yield (1289.26 kg ha$^{-1}$), saponification value (96.8) and iodine number (0.41) were with application of 125% RDF (STBR) + Combo ($T_7$) and were significant better on all treatments followed by $T_6$. The improved values of quality parameters of groundnut in $T_7$ and $T_6$ may be due to favourable effect of FYM, *Rhizobium*, phosphate solubilizing bacteria (PSB) and gypsum that enhanced higher photosynthetic rate, uptake of nutrients, particularly nitrogen, nitrogen fixation and better translocation of assimilates, the accessibility of calcium, sulphur and phosphorus to plants, which might have used by the crop in improving root expansion and nodulation that in turn ensued in higher uptake of N, P, K, S and other nutrients. These findings are in agreement with finds of earlier workers (Chaudhari et al 2015, Swamy et al 2019).

## CONCLUSION

Application of fertilizers as per soil test in this case 125% of RDF [N, $P_2O_5$, $K_2O$ (25:50:50 kg ha$^{-1}$)] together with other combinations of organic and inorganic nutrients such as FYM 5t ha$^{-1}$, Gypsum @250 kg ha$^{1}$ , *Rhizobium* seed inoculation and PSB soil application @ 2Kg ha$^{-1}$ could provide significantly higher values of all the growth and yield attributes as well as biological, pod and haulm yields of Rabi groundnut with higher shelling percentage, protein and oil yields as compared to other nutrient packages followed with incorporation of 100% RDF [N, $P_2O_5$, $K_2O$ (20:40:40 kg ha$^{-1}$)] with FYM 5t ha$^{-1}$+ Gypsum @250 kg ha$^{1}$ + *Rhizobium* seed inoculation + PSB soil application@ 2Kg ha$^{-1}$ which farmers can use without much reduction in yield. However, these results are only indicative and require further investigation to arrive at more consistent and final conclusion.

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