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# Effect of different organic sources on protein content, nutrient uptake of summer groundnut [*Arachis hypogaea* L.] and soil nutrient status under organic farming

**JP Bhutadiya, MG Chaudhary, RP Damor, JC Patel and H Chaudhary**

**Abstract**
An experiment was conducted during summer-2017 at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar to study the effect of different organic sources on protein content, nutrient uptake of summer groundnut [*Arachis hypogaea* L.] and soil nutrient status under organic farming." The soil of experimental field was loamy sand in texture, low in organic carbon (0.30 %) and available nitrogen (142.5 kg/ha), medium in available phosphorus (43.41 kg/ha) and available potash (253.02 kg/ha) with soil pH of 7.7. Different twelve treatments comprising of application of nutrients through different organic sources *viz*., FYM, castor cake, NPK consortium, Rhizobium + PSB. The experiment was laid out in randomized block design and replicated three times. Groundnut variety TG 37 was used as test crop. An application of 1.0 t/hacastor cake + *Rhizobium* + PSB ($T_{12}$) gave significant impact on increment of protein content in kernel (22.81 %) and remained at par with treatments 1.0 t/ha castor cake, 1.0 t/ha castor cake + NPK consortium, 2.5 t/ha FYM + *Rhizobium* + PSB, 5.0 t/haFYM + *Rhizobium* + PSB and 0.5 t/ha castor cake + *Rhizobium* + PSB. In case of nitrogen and phosphorus content and uptake, application of 1.0 t/hacastor cake + *Rhizobium* + PSB surpassed rest of the treatments bearing maximum values of content and uptake of N and P. Significant improvement in available N (166.93 kg/ha) and $P_2O_5$ (53.97 kg/ha) status in the soil after harvest of the crop were observed with the application of 1.0 t/ha castor cake + *Rhizobium* + PSB over rest of the treatments.

**Keywords:** Groundnut, castor cake, FYM, rhizobium, PSB and NPK consortium

## Introduction
Groundnut (*Arachis hypogaea* L.) is one of the most important edible oil seed crop in the world. It belongs to the Leguminosae family. Groundnut is also known as "peanut," "monkeynut," "manilanut," "pinda" and "gobbernut." The groundnut originated in South America from where it spread to Asia, Africa, Sudan, Nigeria, U.S.A. and other parts of the worlds. In India, groundnut is known as poor man's almond. Groundnut has a useful role in offsetting deficiencies as a rich source of edible oil and protein which play important position in Indian diet. Groundnut is an important food, fodder and cash crop for the farmers of India.

In India, groundnut is grown on 4.56 million hectare and production of 6.77 million tonnes with an average productivity of 1486 kg/ha (DAC and FW, 2016) [6]. In India, 80.00 per cent of the groundnut area and 84.00 per cent of the production is confined to the states of Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka and Maharashtra. Among these, Gujarat rank first both in area and production. In Gujarat, the area under kharif and summer groundnut was 1.599 million ha. and 0.063 million ha. With the production of 3.77 and 0.13 M.T., respectively, during the year 2017-18. The average productivity of groundnut was 2360 kg/ha in kharif and 2140 kg/ha in summer of groundnut (DOA, 2018). In Gujarat, largely cultivated districts are Junagadh, Jamnagar, Rajkot, Amreli, Bhavnagar, Sabarkantha and Banaskantha. The hand-picked selected (HPS) groundnut is mainly exported from Saurashtra region of Gujarat state, looking to the demand of the edible oil seed, groundnut cultivation has extended to *rabi* and summer season depending upon the exiting temperature regimes.

The yield potentially of summer groundnut as observed under North Gujarat Agro-climatic Condition is more than 2 t/ha (Dodia, 1998). The productivity of summer groundnut is considerably higher than the kharif groundnut due to favorable condition such as high

temperature, more sunshine hours, assured irrigation under control condition and comparatively low incidence of disease and pests (Sabale and Khuspe, 1986) [14].

The application of organic manure *viz*., FYM and castor cake may serve the source of macro and micro nutrient and complexing agent. Organic manure addition in the soil is not only acts as a source of nutrient, but also influences their availability. Inoculation of seed with Rhizobium recorded higher protein content and increase yield due to more nitrogen fixation and better utilization by plants. The PSB like Pseudomonas and Bacillus also enhances the availability of phosphorus to the plant by converting inherent insoluble phosphorus into soluble form. Keeping this in view, a field experiment was conducted to study the Response of summer groundnut (*Arachis hypogaea* L.) to different organic sources under organic farming.

## Materials and Methods

A field experiment was conducted during summer season of 2017 in loamy sand soil of Agronomical Farm, C.P.C.A., S.D.A.U., Sardarkrushinagar. Twelve treatments comprising of application of nutrients through different sources *viz*., $T_1$: 2.5 t/ha FYM, $T_2$: 5.0 t/ha FYM, $T_3$: 0.5 t/ha castor cake, $T_4$: 1.0 t/ha castor cake, $T_5$: 2.5 t/ha FYM + NPK consortium, $T_6$: 5.0 t/ha FYM + NPK consortium, $T_7$:0.5 t/ha castor cake + NPK consortium, $T_8$: 1.0 t/ha castor cake + NPK consortium, $T_9$: 2.5 t/ha FYM + *Rhizobium* + PSB, $T_{10}$: 5.0 t/ha FYM + *Rhizobium* + PSB, $T_{11}$: 0.5 t/ha castor cake + *Rhizobium* + PSB, $T_{12}$: 1.0 t/ha castor cake + *Rhizobium* + PSB. The experiment was laid out in randomized block design and replicated three times. Groundnut variety TG 37 was used as test crop. The soil of experimental field was loamy sand in texture, low in organic carbon (0.30 %) and available nitrogen (142.5 kg/ha), medium in available phosphorus (43.41 kg/ha) and available potash (253.02 kg/ha) with soil pH of 7.7. Groundnut seeds (120 kg $ha^{-1}$) were sown at a row distance of 30 cm and 10 cm plant to plant distance. Various growth and yield attributing characters of the crop were measured and studied during the course of investigations. Other management practices were followed as recommended.

## Results and Discussion

### Protein content in kernel (%)

The results indicated that an application of 1.0 t/ha castor cake + *Rhizobium* + PSB ($T_{12}$) registered significantly higher protein content in kernel (22.81%) over all other treatments and it was at par with $T_4$ (20.89%), $T_8$ (21.52%), $T_9$ (21.56%), $T_{10}$ (22.50%) and $T_{11}$ (21.81%). However, significantly minimum protein content in kernel (18.06 %) was noted by 2.5 t/ha FYM ($T_1$) compared to other treatments.

The quality parameters such as protein content in kernel was increased might be due to application ofcastor cake along with PSB and *Rhizobium* increased availability of nutrients timely which accelerated crop growth there by enhanced yield and quality parameters of groundnut. *Rhizobium* fix the atmospheric nitrogen which in turn to better absorption and utilization of all plant nutrient thus resulting increase the concentration of nitrogen in plant. PSB solubilise in soluble phosphorus to soluble phosphorus, so plant easily uptake of the phosphorus and increase the concentration of phosphorus in plant. Nitrogen is the integral part of protein synthesis and phosphorus is an integral part of certain co-enzyme involved in a protein synthesis. So increase the concentration of nitrogen and phosphorus in plant to increase the protein content in kernel. These results are in close vicinity with the findings of Guar and Neelkantan (1984) [9], Arvadia (1997) [2], Ramesh and Sable (2001) [13], Chaudhary (2008) [3], Pramanik and Bera (2012) [12], Chaudhary (2014) [4] and Kamdi *et al.* (2014) [10] in groundnut.

### Effect on Content and Uptake of Nutrients

### Nutrients content

### Nitrogen content in kernel and haulm (%)

The data showed that treatment $T_{12}$ (1.0 t/hacastor cake + *Rhizobium* + PSB) estimated significantly higher nitrogen content (3.65%) in kernel found better over all other treatments and it was at par with $T_4$ (3.34%), $T_8$ (3.44%), $T_9$ (3.45%), $T_{10}$ (3.60%) and$T_{11}$ (3.49). Treatment $T_1$ (2.5 t/ha FYM) registered significantly the lowest nitrogen content (2.89 %).

The data inferred that treatment $T_{12}$ (1.0 t/hacastor cake + *Rhizobium* + PSB) analyzed significantly higher nitrogen content (1.53%) in haulm, but it was found statistically at par with $T_4$ (1.38%), $T_8$ (1.41%), $T_9$ (1.45%), $T_{10}$ (1.49%) and $T_{11}$ (1.47%). Treatment $T_1$ (2.5 t/ha FYM) beard significantly the lowest nitrogen content (1.22%) compared to rest of treatments.

This might be due to castor cake and application of PSB and *Rhizobium* promoted higher nitrogen fixation might have helped in increase of uptake of nutrients due to release of nutrients at its optimum amount for a longer period. These results are in close proximity with the findings Pramanik and Bera (2012) [12], Chaudhary (2014) [4] and Ola *et al*. (2014) [11] in groundnut.

### Phosphorus content in kernel and haulm (%)

Appraisal data showed that significantly higher P content (0.81%) in pod was found with treatment $T_{12}$ (1.0 t/hacastor cake + *Rhizobium*+ PSB) which being at par with treatment $T_4$ (0.74%), $T_8$ (0.75%), $T_9$ (0.76%), $T_{10}$ (0.79%) and $T_{11}$ (0.77%). Treatment $T_1$ (2.5 t/ha FYM) recorded significantly the minimum P content (0.65 %).

The data showed that treatment $T_{12}$ (1.0 t/hacastor cake + *Rhizobium* + PSB) registered significantly higher phosphorus content (0.36%) in haulm, but it was found statistically at par with $T_4$ (0.32%), $T_8$ (0.32%), $T_9$ (0.33%), $T_{10}$ (0.35%) and $T_{11}$ (0.33%) treatment. Treatment $T_1$ (2.5 t/ha FYM) recorded the minimum P content (0.25%).

This might be due to higher availability of available phosphorus to the crop by application of castor cake and PSB are improves the absorption of nutrients by plant roots and their transportation towards foliage and later on translocation in the kernel by various metabolic activities. This resulted in higher phosphorus content in kernel and haulm. These results corroborate with those reported by Pramanik and Bera (2012) [12], Chaudhary (2014) [4] and Ola *et al*. (2014) [11] in groundnut.

### Nutrients uptake (kg/ha)

### Nitrogen uptake (kg/ha)

The data indicated that significantly the maximum nitrogen uptake by kernel (104.53 kg/ha), haulm (74.87kg/ha) and total (179.41 kg/ha) by groundnut crop was observed with treatment $T_{12}$ (1.0 t/ha castor cake + *Rhizobium* + PSB) and at par with treatments $T_4$, $T_6$, $T_8$, $T_9$, $T_{10}$ and $T_{11}$ in case of pod, in case of haulm uptake treatments $T_8$, $T_9$, $T_{10}$ and $T_{11}$ were at par with treatment $T_{12}$. In case of total uptake treatments $T_4$, $T_8$, $T_9$, $T_{10}$ and $T_{11}$ were at par with treatment $T_{12}$. Significantly the lower total nitrogen uptake by groundnut crop of kernel

(58.38 kg/ha), haulm (36.68 kg/ha) and total uptake (95.06 kg/ha) were noted with treatment $T_1$ (2.5 t/ha FYM).

**Phosphorus uptake (kg/ha)**

The data indicated that significantly the maximum phosphorus uptake by kernel (23.29 kg/ha), haulm (17.58 kg/ha) and total (40.87 kg/ha) by groundnut crop was observed with treatment $T_{12}$ (1.0 t/ha castor cake + *Rhizobium* + PSB) and at par with treatments $T_4$, $T_6$, $T_8$, $T_9$, $T_{10}$ and $T_{11}$ in case of kernel, in case of haulm uptake treatments $T_8$, $T_9$, $T_{10}$ and $T_{11}$ were at par with treatment $T_{12}$. In case of total uptake treatments $T_4$, $T_8$, $T_9$, $T_{10}$ and $T_{11}$ were at par with treatment $T_{12}$. Significantly the lower total nitrogen uptake by groundnut crop of kernel (13.13 kg/ha), haulm (7.45 kg/ha) and total uptake (20.58 kg/ha) were noted with treatment $T_1$ (2.5 t/ha FYM).

Increase in N and P uptake by groundnut crop under 1.0 t/ha castor cake +*Rhizobium* + PSB due to higher nutrient content and yield of kernel and haulm in the same treatment resulting in higher N and P removal by plants. *Rhizobium* fix the atmospheric nitrogen in root nodules helped in better absorption of nitrogen thus resulting in increase in uptake of nitrogen. PSB solubilize insoluble to soluble phosphorus thus increase the availability of phosphorus cause greater root extension and help to greater uptake of nutrients. The results are in conformity with those reported by these results are in close proximity with the findings of Choudhary *et al.* (2011) [5], Pramanik and Bera (2012) [12], Walpola and Yoon (2013) [15], Chaudhary (2014) [4] and Ola *et al*. (2014) [11] in groundnut.

**Table 1:** Protein content in kernel and available nutrients in soil after harvest of crop (kg/ha) of groundnut as influenced by different organic sources

| Treatments | | Protein Content in kernel (%) | Available nutrients in soil after harvest of crop (kg/ha) | |
|---|---|---|---|---|
| | | | N | $P_2O_5$ |
| $T_1$ | 2.5 t/ha FYM | 18.06 | 143.05 | 43.05 |
| $T_2$ | 5.0 t/ha FYM | 19.02 | 146.33 | 45.62 |
| $T_3$ | 0.5 t/ha castor cake | 18.68 | 145.35 | 44.29 |
| $T_4$ | 1.0 t/ha castor cake | 20.89 | 155.94 | 48.91 |
| $T_5$ | 2.5 t/ha FYM + NPK consortium | 19.37 | 148.66 | 46.18 |
| $T_6$ | 5.0 t/ha FYM + NPK consortium | 20.50 | 150.30 | 47.20 |
| $T_7$ | 0.5 t/ha castor cake + NPK consortium | 19.87 | 150.77 | 47.03 |
| $T_8$ | 1.0 t/ha castor cake + NPK consortium | 21.52 | 158.19 | 50.83 |
| $T_9$ | 2.5 t/ha FYM + *Rhizobium* + PSB | 21.56 | 161.88 | 51.65 |
| $T_{10}$ | 5.0 t/ha FYM + *Rhizobium* + PSB | 22.50 | 164.93 | 53.12 |
| $T_{11}$ | 0.5 t/ha castor cake + *Rhizobium* + PSB | 21.81 | 163.05 | 52.32 |
| $T_{12}$ | 1.0 t/ha castor cake + *Rhizobium* + PSB | 22.81 | 166.93 | 53.97 |
| S.Em.± | | 0.73 | 4.46 | 1.22 |
| C.D. at 5 % | | 2.15 | 13.09 | 3.59 |
| C.V. % | | 6.15 | 5.00 | 4.32 |

**Table 2:** Nitrogen and Phosphorus content in kernel and haulm of groundnut as influenced by different organic sources

| Treatments | | Nitrogen content (%) | | Phosphorus content (%) | |
|---|---|---|---|---|---|
| | | Kernel | Kernel | Haulm | Kernel |
| $T_1$ | 2.5 t/ha FYM | 2.89 | 1.22 | 0.65 | 0.25 |
| $T_2$ | 5.0 t/ha FYM | 3.04 | 1.28 | 0.66 | 0.26 |
| $T_3$ | 0.5 t/ha castor cake | 2.99 | 1.26 | 0.66 | 0.25 |
| $T_4$ | 1.0 t/ha castor cake | 3.34 | 1.38 | 0.74 | 0.32 |
| $T_5$ | 2.5 t/ha FYM + NPK consortium | 3.10 | 1.31 | 0.69 | 0.28 |
| $T_6$ | 5.0 t/ha FYM + NPK consortium | 3.28 | 1.33 | 0.72 | 0.30 |
| $T_7$ | 0.5 t/ha castor cake + NPK consortium | 3.18 | 1.32 | 0.71 | 0.29 |
| $T_8$ | 1.0 t/ha castor cake + NPK consortium | 3.44 | 1.41 | 0.75 | 0.32 |
| $T_9$ | 2.5 t/ha FYM + *Rhizobium* + PSB | 3.45 | 1.45 | 0.76 | 0.33 |
| $T_{10}$ | 5.0 t/ha FYM + *Rhizobium* + PSB | 3.60 | 1.49 | 0.79 | 0.35 |
| $T_{11}$ | 0.5 t/ha castor cake + *Rhizobium* + PSB | 3.49 | 1.47 | 0.77 | 0.33 |
| $T_{12}$ | 1.0 t/ha castor cake + *Rhizobium* + PSB | 3.65 | 1.53 | 0.81 | 0.36 |
| S.Em.± | | 0.12 | 0.05 | 0.02 | 0.02 |
| C.D. at 5 % | | 0.34 | 0.15 | 0.07 | 0.04 |
| C.V. % | | 6.16 | 6.25 | 5.72 | 8.53 |

**Table 3:** Nitrogen uptake by kernel, haulm and total uptake of groundnut as influenced by different organic sources

| Treatments | | Nitrogen uptake (kg/ha) | | |
|---|---|---|---|---|
| | | Kernel | Haulm | Total |
| $T_1$ | 2.5 t/ha FYM | 58.38 | 36.68 | 95.06 |
| $T_2$ | 5.0 t/ha FYM | 68.28 | 42.81 | 111.09 |
| $T_3$ | 0.5 t/ha castor cake | 62.37 | 38.78 | 101.15 |
| $T_4$ | 1.0 t/ha castor cake | 84.54 | 56.03 | 140.57 |
| $T_5$ | 2.5 t/ha FYM + NPK consortium | 70.45 | 44.61 | 115.06 |
| $T_6$ | 5.0 t/ha FYM + NPK consortium | 81.42 | 52.23 | 133.65 |
| $T_7$ | 0.5 t/ha castor cake + NPK consortium | 73.61 | 46.70 | 120.31 |
| $T_8$ | 1.0 t/ha castor cake + NPK consortium | 90.31 | 60.70 | 151.01 |
| $T_9$ | 2.5 t/ha FYM + *Rhizobium* + PSB | 94.11 | 66.11 | 160.22 |

| | | | | |
|---|---|---|---|---|
| $T_{10}$ | 5.0 t/ha FYM + *Rhizobium* + PSB | 101.27 | 71.24 | 172.51 |
| $T_{11}$ | 0.5 t/ha castor cake + *Rhizobium* + PSB | 96.70 | 68.37 | 165.07 |
| $T_{12}$ | 1.0 t/ha castor cake + *Rhizobium* + PSB | 104.53 | 74.87 | 179.4 |
| S.Em.± | | 8.70 | 6.28 | 14.70 |
| C.D. at 5 % | | 25.68 | 18.54 | 43.4 |
| C.V. % | | 18.33 | 19.80 | 18.57 |

**Table 4:** Phosphorus uptake by kernel, haulm and total uptake of groundnut as influenced by different organic sources

| Treatments | Phosphorus uptake (kg/ha) | | |
|---|---|---|---|
| | Kernel | Haulm | Total |
| $T_1$ | 2.5 t/ha FYM | 13.13 | 7.45 | 20.58 |
| $T_2$ | 5.0 t/ha FYM | 15.01 | 8.94 | 23.95 |
| $T_3$ | 0.5 t/ha castor cake | 13.77 | 7.95 | 21.72 |
| $T_4$ | 1.0 t/ha castor cake | 18.83 | 12.85 | 31.68 |
| $T_5$ | 2.5 t/ha FYM + NPK consortium | 15.67 | 9.72 | 25.39 |
| $T_6$ | 5.0 t/ha FYM + NPK consortium | 17.95 | 11.82 | 29.77 |
| $T_7$ | 0.5 t/ha castor cake + NPK consortium | 16.43 | 10.34 | 26.77 |
| $T_8$ | 1.0 t/ha castor cake + NPK consortium | 19.86 | 13.96 | 33.82 |
| $T_9$ | 2.5 t/ha FYM + *Rhizobium* + PSB | 20.85 | 15.09 | 35.94 |
| $T_{10}$ | 5.0 t/ha FYM + *Rhizobium* + PSB | 22.31 | 16.84 | 39.15 |
| $T_{11}$ | 0.5 t/ha castor cake + *Rhizobium* + PSB | 21.46 | 15.82 | 37.28 |
| $T_{12}$ | 1.0 t/ha castor cake + *Rhizobium* + PSB | 23.29 | 17.58 | 40.87 |
| S.Em.± | 1.89 | 1.57 | | 3.40 |
| C.D. at 5 % | 5.58 | 4.65 | | 10.03 |
| C.V. % | 17.97 | 22.09 | | 19.25 |

**Effect on Available Nutrients Status in Soil**

**Available nitrogen in soil after crop harvest (kg/ha)**

It is clear from the data presented that available N in soil after harvest of crop was significantly influenced by different organic sources. The data showed that significantly the higher available N (166.93 kg/ha) status in soil after harvest of groundnut crop was estimated under the treatment receiving 1.0 t/ha castor cake + *Rhizobium* + PSB ($T_{12}$), but it was found at par with treatments $T_4$ (155.94 kg/ha), $T_8$ (158.19 kg/ha), $T_9$ (161.88 kg/ha), $T_{10}$ (164.93 kg/ha) and $T_{11}$ (163.05 kg/ha). Significantly the lower available nitrogen (143.05 kg/ha) in soil after harvest of crop was registered with treatment of 2.5 t/ha FYM ($T_1$), which was at par with $T_2$ (146.33 kg/ha) and $T_3$ (145.35 kg/ha).

**Available phosphorus in soil after crop harvest (kg/ha)**

The data showed that significantly higher available $P_2O_5$ (53.97 kg/ha) status in soil after harvest of crop was noticed with application of 1.0 t/hacastor cake + *Rhizobium* + PSB ($T_{12}$) and it was statistically at par with treatments $T_8$, $T_9$, $T_{10}$ and $T_{11}$. Significantly lower $P_2O_5$ content (43.05 kg/ha) in soil after harvest of crop was found with the treatment of 2.5 t/ha FYM ($T_1$).

This might be due to application of castor cake, *Rhizobium* and PSB in groundnut crop which may increases the available soil nitrogen and phosphorus by adding nitrogen through N fixation by symbiosis with *Rhizobium* and though castor cake. PSB also enhance the availability of phosphorus by make the insoluble phosphorus to soluble phosphorus. So, castor cake, *Rhizobium* and PSB results in higher post-harvest nitrogen and phosphorus status of soil. These findings corroborated with the reports of Akbari *et al*. (2011) [1], Choudhary *et al.* (2011) [5] and Chaudhary (2014) [4] in groundnut.

**Conclusion**

Based on the experimental results it can be concluded that summer groundnut yield, quality and nutrient uptake can be increased by applying one t/ha castor cake along or along with NPK consortium or *Rhizobium* + PSB and 2.5 t/ha FYM or 0.5 t/ha castor cake along with *Rhizobium* + PSB under loamy sand soil of North Gujarat.

**Reference**


1. Akabari KN, Ramdevputra MV, Sutaria GS, Vora VD, Padmani DR. Effect of organics, bio and inorganic fertilizer on groundnut yield and its residue effect on succeeding wheat crop. Legume Research. 2011; 34(1):45-47.
2. Arvadia MK. Effect of moisture stress and soil amendment on growth, yield and quality of summer groundnut on vertisol of South Gujarat. Ph.D. Thesis (Unpublished), Submitted to Gujarat Agricultural University, Sardarkrushinagar, 1997.
3. Chaudhary DC. Integrated nutrient management summer groundnut (*Arachis hypogaea* L.) under North Gujarat Agroclimatic condition. M.Sc. (Agri.) Thesis (Unpublished), Submitted to Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat, 2008.
4. Chaudhary VJ. Response of summer groundnut (*Arachi shypogaea*) to irrigation scheduling and sources of nitrogen under North Gujarat condition. M.Sc. (Agri.) Thesis (Unpublished), Submitted to Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat, 2014.
5. Choudhary SK, Jat MK, Sharma SR, Singh P. Effect of INM on soil nutrient and yield in groundnut field of semi arid area of Rajasthan. Legume Research. 2011; 34(4):283-287.
6. DAC and FW All India Area, Production and Yield in groundnut. Directorate of Economics and Statistics, Agricultural Statistics at a Glance, 2016.
7. DOA. District-wise area, production and yield per hectare of important food and non-food crops in Gujarat state. Directorate of Agriculture, Gujarat state, Ahmedabad, 2017-18.
8. Dodia IN. Response of *kharif* groundnut (*Arachis hypogaea* L.) to various *Rhizobium* strains with different levels of sulphur and phosphorus. Ph.D., Thesis (Unpublished), submitted to Gujarat Agricultural University, Sardarkrushinagar, 1998.
9. Guar, Neelkantan. Effect of non-edible oils and cakes on the rhizosphere microflora of groundnut. Environment and Ecology. 1984; 17(2):411-414.
10. Kamdi TS, Joshi Sapna, Sonkamble Priti. Effect of organic manure and biofertilizers on seed quality of groundnut. *The Bioscan.* 2014; 9(3):1011-1013.
11. Ola BL, Pareek BL, Kumawat A, Tiwari DK, Jeetarwal RL, Dhayal ML. Productivity, profitability and quality of groundnut (*Arachishypogaea*) as affected by integrated nutrient management. Annals of Agri-Bio-research. 2014; 19(4):692-696.
12. Pramanik K, Bera AK. Influence of biofertilizers and Homobrassinolides on nodulation, yield and quality of groundnut (*Arachishypogaea*). International Journal of

Bio-resource and Stress Management. 2012; 3(1):056-058.
13. Ramesh N, Sable NR. Effect of phosphate fertilization and PSM on yield and quality of summer groundnut. Indian Journal of Agronomy. 2001; 46(1):156-161.
14. Sabale RN, Khuspe VS. Effect of moisture, phosphate and anti-transparent on growth, dry matter and yield of summer groundnut. Journal of Maharashtra Agricultural University. 1986; 11(1):13-16.
15. Walpoda BC, Yoon MN. Phosphate solubilizing bacteria: Assessment of their effect on growth promotion and phosphorus uptake of mungbean (*Vigna radiata*). Chilean Journal of Agricultural Research. 2013; 73(3):275-281