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### RESEARCH ARTICLE

## GROUNDNUT GROWTH AND YIELD RESPONSES TO CALCIUM AND PHOSPHOROUS FERTILIZATION

Razan Malla<sup>1</sup>, Saraswoti Kandel<sup>1</sup>, Bisheswar Prasad Yadav<sup>2</sup>, Santosh Rasaily<sup>2</sup> and Pramod Wagle<sup>2</sup>

1. National Soil Science Research Center, Khumaltar Lalitpur, Nepal.
2. Oilseed Research Program, Nawalpur Sarlahi, Nepal.

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### Abstract

An experiment was conducted in factorial design with three replications in Nawalpur, Sarlahi, Nepal in 2018 and 2019 to investigate the impact of calcium and phosphorous application on yield and yield components of groundnut (*Arachis hypogaea* L.). Baidehi variety of groundnut was used. Calcium concentrations in three levels (0, 110, and 165 kg ha<sup>-1</sup> from Gypsum) and phosphorous rates in three levels (0, 25, and 50 kg ha<sup>-1</sup> from SSP) were used in this study. The application of calcium had a major impact on pod production, quantity of filled pods, and hundred seed weight, with 165 kg ha<sup>-1</sup> calcium from gypsum performing significantly better than the others. The highest pod yield (2006 and 2477 kg ha<sup>-1</sup>) was obtained from calcium 165 kg ha<sup>-1</sup> in 2018 and 2019 respectively. Calcium application (165 kg ha<sup>-1</sup>) increased the mean pod yield by 24% compared to the control. Control plots resulted in more than 13% empty pods (pops) compared to when applied with 165 kg Ca ha<sup>-1</sup>. Phosphorus was rich in the inherent soil leading to no significant effect on the yield components. According to the findings of this research, efficient fertilizer application, especially calcium and phosphorus, is critical for groundnut nutrition and pod filling.

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### Introduction: -

Groundnut (*Arachis hypogaea* L.) is one of the world's most important economic crops. In Nepal, groundnut is the 3<sup>rd</sup> important oil seed crop on the basis of annual production, and stand 4<sup>th</sup> on the basis of acreage among the major oil crops. Around two-thirds of the world's groundnut seed production is used to make oil. It is high in dietary fibers, minerals, and vitamins, and contains 48-50 percent oil and 26-28 percent protein. Groundnut is a key food and oil crop in Nepal during the rainy season. Groundnut cultivation in Nepal was limited to kitchen gardens in the 1970s, but by the early 1980s, this crop had become commercially viable. (Chaudhary, 2006). Systematic research and development activities in groundnut were initiated after the signing of memorandum of understanding between NARC and ICRISAT in 1987 and conducting various activities under AGLOR (Asian grain legumes on-farm research) project. After launching of IFAD-532-ICRISAT project and IFAD-954-ICRISAT Project area of groundnut have increased. Based on the reports of land resource mapping project over 572000 ha of land is potential

for groundnut cultivation in Nepal. There are 16 vegetable ghee/oil industries are operating in Nepal and they are running at 40% of their capacity (Chaudhary, 2006). Nepal is importing over \$25 million of vegetable oils annually to meet the demand. There is strong domestic demand of oils in the country. To meet the challenge of food security and nutritional security for feeding the ever-increasing population of Nepal, low and stagnant yield of crop is threat to the country. The burning global issue is to meet food and nutritional requirement through proper management of agriculture production productivity. During 2018/2019, area under groundnut was 3342 ha with production of 4999 mt and productivity 1.49 mt ha<sup>-1</sup>. The low rate of increase in area is mainly due to high cost of cultivation, higher labor requirement and inadequate availability of groundnut seeds.

Groundnut is a heavy feeder of nutrients. The optimization of mineral nutrients is a key to its production besides the organic supplements. One of the main causes of low groundnut yield is severe mineral nutrient deficiencies caused by insufficient and unbalanced nutrient use. Groundnut production is determined by variety selection, fertilizer control, and other management activities (Lourduraj, 1999). Nitrogen, phosphorus, calcium, and boron fertilizer doses have a major impact on groundnut yield. (Subrahmaniyan et. al, 2000). As a result, the most important consideration for optimal groundnut yield is the best fertilizer combination. Despite the fact that groundnut is grown in many parts of the country, very little research has been done on the best fertilizer management for groundnut production. With this context in mind, the aim of this research is to see how P and Ca affect groundnut growth and yield.

Groundnut, a leguminosae crop, can fix up to 40-80 kg of nitrogen per hectare (Islam and Noor, 1992). Biological Nitrogen Fixation (BNF) accounts for 86-92 percent of the nitrogen taken up by the groundnut, or 125-178 kg N ha<sup>-1</sup> (Dart, Mc Donald and Gibbons, 1983). Even though legumes can fix nitrogen on their own, they often require phosphorus, calcium, and other nutrients for proper seed formation (Asiedu et. al., 2000). The most apparent influence of P is on the root system of plants. P is needed in higher amounts in nodulating legumes than in non-nodulating crops because it is essential for nodule formation and nitrogen fixation (Brady and Well, 2002). Since P plays such an important role in plant physiological processes, adding it to nutrient-deficient soil boosts groundnut yields.

Calcium is the most important nutrient for groundnut seed growth and development, and it is the primary constraint to groundnut production in many parts of the world. Increased yield, oil content, and protein content of the kernel are all benefits of having enough calcium in the soil around the groundnut pods. Calcium boosts the symbiotic bacteria's growth and survival in groundnuts, particularly in acidic soil, thus having positive effect on nitrogen fixation. Groundnut plants require calcium (Ca) from the time pegs appear, through fruit formation, and until the pods are mature (Walker, 1975). Ca deficiency results in a high percentage of aborted seeds (empty pods), poorly filled pods (Ntare et al., 2008), and other causes of aborted or shriveled berries, such as darkened plumules and pods without seed (Ntare et al., 2008). (Singh and Oswalt, 1995). Gypsum can also boost seed-oil content in certain low-calcium soils (Walker and Keisling, 1978). On the other hand, there is evidence that a high degree of soil Ca is linked to a lower occurrence of various pod and root rots. Only fruit yield and quality seemed to be affected by calcium deficiency. The yield was generally lower and the seed quality was weaker when calcium was not present. (Harris & Brolmann, 1966).

### **Methodology: -**

The experiment was conducted at Oilseed Research Program (ORP), Nawalpur Sarlahi for two growing seasons, 2018 and 2019. ORP lies at 27° 03' 86" north latitude and 85° 35' 52" east longitude and at an elevation of 144 meter above mean sea level. The experiment was conducted in factorial design with 3 replications. Baidehi variety of groundnut was used. There were 9 treatments with a plot size of 2.5m \* 2m and 30 cm \* 15 cm spacing. The fertilizers were used as 20:00:20; N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O kg ha<sup>-1</sup>. In this experiment 3 levels of phosphorus (0kg ha<sup>-1</sup>, 25 kg ha<sup>-1</sup>, 50 kg ha<sup>-1</sup>) and 3 levels of calcium (0, 110, 165 kg ha<sup>-1</sup> as Gypsum) was used to find out the optimum dose of these fertilizers for better growth and yield of groundnut variety.

The data was compiled and subjected to an analysis of variance (ANOVA), with significant means segregated using the Least Significant Difference (LSD) test at 1% and 5% level of significance as described by Gomez and Gomez (1984). R studio package was used for data analysis. Rating of soil parameters were based on rating chart of Soil Science Division (2019).

**Table 1:** - Initial physical and chemical properties of the top soil at experiment site.

Soil character	Unit	Mean	Rating*
pH	-	5.03	Moderately Acidic
Organic Matter	%	2.02	Medium
Total Nitrogen	%	0.10	Medium
Available Phosphorous	ppm	51.83	Very High
Extractable Potassium	ppm	128.97	High
Extractable Calcium	ppm	697.89	Low
Available Sulphur	ppm	2.15	Very Low
Soil texture	-	Loam	-

\* Soil Science Division, 2019

**Results: -**

The means of plant height, branches per plant, shelling percentage and hundred seed weight for year 2018 and 2019 is given in Table 2. There was no significant effect of Calcium and Phosphorous on the plant height of groundnut. The results similar plant height in all three calcium levels and all three phosphorous levels. There was no interaction effect of Ca\*P on the plant height. The branches per plant parameter was also unaffected by the difference in calcium levels. All the phosphorus levels resulted similar effect to branches number. There was no interaction effect of Ca\*P on branches per plant. Also, the Shelling parentage revealed no significant effect of the levels of Calcium and Phosphorous. The same was true for interaction of Ca\*P in case of shelling percentage. The hundred seed weight of the treatments revealed no significant effect to the seed weight irrespective of the increasing doses of Calcium and Phosphorous application. There was no interaction of Ca\*P for hundred seed weight.

**Table 2:** - Effect of Calcium and phosphorous on growth parameters of groundnut, Nawalpur Sarlahi.

Treatment	Plant Height, cm	Branches per plant	Shelling Percentage, %	Hundred Seed Weight, gm
Calcium, kg ha <sup>-1</sup>				
0	67	7	74	38.62 b
110	66	7	74	39.08 b
165	66	8	73	42.54 a
ANOVA	NS	NS	NS	*
Phosphorous, kg ha <sup>-1</sup>				
0	68	8	74	39.41
25	66	7	73	38.08
50	64	7	73	39.75
ANOVA	NS	NS	NS	NS

In a column, figures with same letter or without letter do not differ significantly, whereas figures with dissimilar letter differ significantly. \*Significant at 5% level of significance, \*\*Significant at 1% level of significance, NS= Not significant

**Table 3:** - Effect of calcium and phosphorous on pod number, Nawalpur Sarlahi.

Treatment	Pods per plant			% of empty pods per plant
	Filled Pods	Empty pods	Total Pods	
Calcium, kg ha <sup>-1</sup>				
0	20 b	13 a	33 b	39.39
110	22 b	11 ab	33 b	33.33
165	28 a	10 b	38 a	26.31
ANOVA	**	**	**	
Phosphorous, kg ha <sup>-1</sup>				
0	21	11	32	34.37
25	23	11	34	32.35
50	25	11	36	30.55
ANOVA	NS	NS	NS	

In a column, figures with same letter or without letter do not differ significantly, whereas figures with dissimilar letter differ significantly. \*Significant at 5% level of significance, \*\*Significant at 1% level of significance, NS= Not significant

The number of filled pods per plant and empty pods per plant along with the percentage of empty pods per plant as per treatment from the two-year experiment is given in Table 3. Application of Calcium @ 165 kg ha<sup>-1</sup> significantly increased the number of filled pods per plant whereas application of Calcium @ 110 kg ha<sup>-1</sup> and no application revealed statistically similar results for filled pods per plant. There was no significant interaction observed.

**Table 4:** - Effect of calcium and phosphorous on yield of groundnut, Nawalpur Sarlahi.

Treatment	Pod Yield		
	2018	2019	Mean
Calcium, kg ha <sup>-1</sup>			
0	1706 b	1920 b	1813
110	1938 a	2219 ab	2078
165	2006 a	2477 a	2241
ANOVA	*	*	*
Phosphorous, kg ha <sup>-1</sup>			
0	1764	2285	2024
25	2022	1953	1988
50	1864	2377	2120
ANOVA	NS	NS	NS

In a column, figures with same letter or without letter do not differ significantly, whereas figures with dissimilar letter differ significantly. \*Significant at 5% level of significance, \*\*Significant at 1% level of significance, NS= Not significant

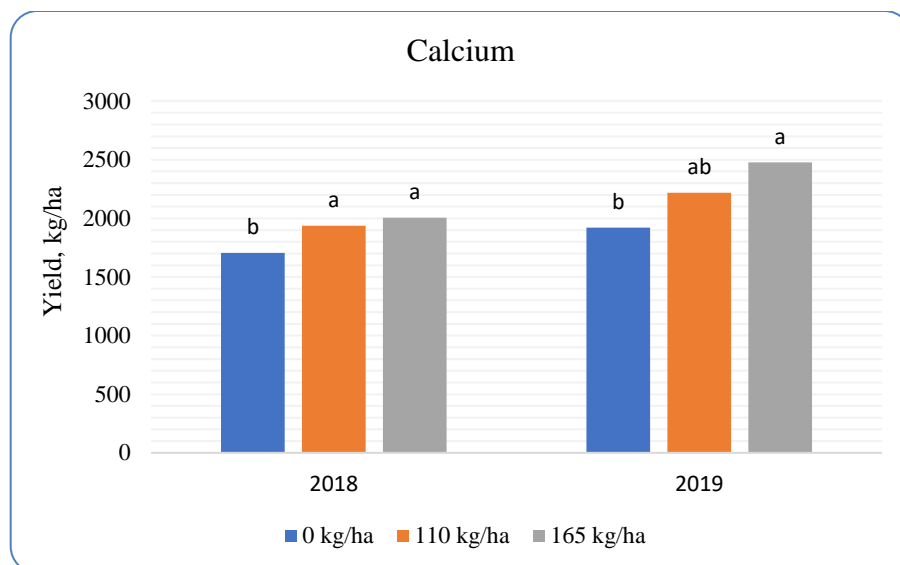
The effect of Calcium and Phosphorous on the pod yield is given in Table 4 and Figure 1. Calcium application showed significant effect on the pod yield in both the years. The treatment with 165 kg Ca ha<sup>-1</sup> gave the highest pod yield (2006 and 2477 kg ha<sup>-1</sup>) in 2018 and 2019 respectively and were significantly higher from the control treatment. Calcium application increased the mean pod yield (2018 and 2019) by 24% compared to the control. Phosphorous application had no significant effect on the pod yield in either of the years.

### Discussion: -

Nutrient requirement of groundnuts plays a vital role in obtaining high quality yields. Calcium along with phosphorous are critical to proper growth and development of groundnuts. Calcium for its role in pod and seed development and phosphorous for role in root development and nodulation. In this trial, good vegetative growth was obtained in all the treatment combinations. Both calcium and phosphorous could not induce significant effect on plant height, branches per plant and shelling percentage.

The hundred seed weight showed significant response to increasing calcium application but phosphorous failed to do so. The control plots of phosphorous revealed similar results to that of fertilized plots. Kalita et al. (2015) reported similar results with increased pod yields but no significant response from the 100 seed weight. This may be due to very high status of available phosphorous at the experimental site. The highest 100 seed weight was obtained when applying 165 kg Ca ha<sup>-1</sup>. Hundred seed weight gives faint idea as to the filling of pods. This is due to the increased growth rate and more production, transportation of photosynthetic materials towards pods as reported by Gashti et al. (2012) who observed higher 100 seed weight with increasing calcium levels in their study in Iran. Moreover, application of gypsum aids absorption in groundnuts causing to increased seed weight as reported by Smart (1994). Calcium had a significant effect on filled pods, empty pods and total number of pods per plant (Table 3). Ca is needed primarily for the growth of pods and seeds, not for the having a healthy plant. Control plots resulted in more than 13 % empty pods (pops) compared to when applied with 165 kg Ca ha<sup>-1</sup>. This result was consistent with the results obtained by Hall (1975). The application of calcium fertilizer had a positive impact on the amount of filled pods, according to Kamara et al. (2011). Using calcium and phosphorus fertilizers increased the amount of nutrients available to the crop during the growing season. It resulted in a higher use of assimilates in the pods, resulting in a higher number of filled pods.

Phosphorous failed to show any significant effect on the pod yield as well, probably due to very high phosphorous levels observed at the experimental site. Whereas calcium revealed significant increase in the pod yield in both the years. In agreement with response showed to calcium on 100 seed weight and total pods per plant, pod yield too increased with increasing calcium levels. Similar results were reported when supplying calcium with combination of



**Figure 1:** - Pod yield of groundnut as effected by calcium in 2018 and 2019, Nawalpur Sarlahi.

Calcium and phosphorous (gypsum, SSP, ammonium sulphate) by Murata (2003) and Sumner (1995). Also, Wiatrak et al. (2006) in their study of groundnut with strip-till and gypsum reported that groundnut yields were higher with gypsum application in contrast to treatment without gypsum application. Gashti et al. (2012) reported that calcium from gypsum could increase the pod yield of groundnut. He observed significant effect on pod yield when applying 90 kg ca ha<sup>-1</sup>. This may be attributed to gypsum's beneficial effect on soil chemical properties, which helped in nutrient absorption and increased pod yield. Gypsum is effective in increasing Ca in the subsoil, alleviating Al toxicity, and, finally, in pod growth and yield (Ritchey and Snuffer, 2002, Sumner, 1994) The fruit, unlike other crops, grows from nutrients obtained directly from the soil rather than nutrients transferred from roots to shoots and then back to the fruit.

### Conclusion: -

The results of the experiment reinforce the importance of calcium in fruiting of groundnut. It reveals that Phosphorous level, in this case is on a satisfactory level and is not a limiting nutrient. The findings have brought expectation for further research in higher calcium levels in combination with varying cultivars and growing seasons and region for wider understanding.

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