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Research Article

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Effect of Potash Fertilizer on Vegetative Growth and Pod Yield of Groundnut (*Arachis hypogaea* l.) in Semiarid Region

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Abstract

Groundnut (or peanut, earthnut, monkey nut) is taxonomically classified as *Arachis hypogaea* and it belongs to family Fabaceae (Leguminosae). In Pakistan, the groundnut is mainly cultivated in rain fed areas, mostly in Punjab, also in some areas of Sindh and North-West Frontier Province. A field experiment was carried out at the Horticultural Research area, Sindh Agriculture University, Tandojam during the year 2021. Two ground nut cultivarrs ("Golden" and "Bari-2011") were used and sulphate of potash (SOP) was used @ 60, 80, 100 kg ha^{-1}as treatments. Different growth and yield related parameters were studied in this experiment, such as days to flowering, plant height (cm), canopy width (cm), pods plant^{-1}, kernels plant^{-1}, 100 kernels weight, pod yield ha^{-1}, edible portion (%) and non-edible portion (%). Randomized Complete Block Design (RCBD) was used with three replications. Results revealed that the potassium applied @ 80 kg ha^{-1} significantly affected for canopy width (1213.5 cm), pods plant^{-1} (52.27), kernels plant^{-1} (100.99), weight of 100 kernels (58.07 g)**,** pod yield (1590.4 kg ha^{-1}) and edible portion (63.50 %). To compare cultivars, Bari-2011 had superior results for early flowering (28.37 days), plant height (18.68 cm), canopy width (1102.9 cm), pods plant^{-1} (48.00), kernels plant^{-1} (94.43), weight of 100 kernels (55.26 g), yield (1543.6 kg ha^{-1}) and edible portion (65.31%) as compared to Golden. The results revealed that potassium application at 80 kg ha^{-1} produced better results for growth and pod yield related attributes of the groundnut. Whereas, "Bari-2011" responded significantly better for growth and yield related parameters as compared to "Golden"

Key words: *Kernel production, fertilization, edible part*

Introduction

Groundnut (or peanut, earthnut, monkey nut) is taxonomically classified as *Arachis hypogaea* and it belongs to family Fabaceae (Leguminosae). It is believed that ground nut was originated in South America in the area of Bolivia and Argentina (Bertioli *et al*., 2011). Groundnut is adorned as the one of the important sources of vegetable oil, protein, vitamins and several minerals, which can mitigate the nutritional; gap worldwide (Mondal *et al*., 2020). It is world's fourth most important source of edible oil (44–56%), third-most important source of high-quality vegetable protein (22–30%), carbohydrates (20%), essential fatty acids, vitamins and minerals for human nutrition (Ojiewo *et al*., 2020). Groundnut is an annual legume crop grown mainly for its edible seeds in the tropics and subtropics of agro-climatic areas of Asia, Africa, and the Americas (FAO, 2010). Now a day, groundnut is mainly cultivated in more than 40 countries including United States of America, China, Mayanmar, Argentina, India, Brazil, Pakistan, Sudan, Nigeria, Indonesia and Senegal being the top producers in the world (Ahmad *et al*., 2019). At present, China, India, USA, and Argentina are the most notable groundnut exporters (Akram *et al*., 2018). In Pakistan, the groundnut is mainly cultivated in rain fed areas, mostly in Punjab, also in some areas of Sindh and North-West Frontier Province (Mubeen *et al*., 2019). According to Agricultural Statistics of Pakistan, (2021-2022), groundnut was cultivated in an area of 97,000 hectares in Punjab, 5,000 hectares in Sindh, and 46000 hectares in KPK with a total of 148,000 hectares in Pakistan. Although, in 2021-2022, groundnut was produced 137760 tons in Punjab,1230 tons in Sindh and 5990 tons in KPK with a total production of 144980 tons in Pakistan. It also occupies the second largest area among the oilseed crops after mustard and rapeseed in Pakistan (Aslam *et al*., 2017). Groundnut has a special place among domesticated plant species as it produces seeds below the soil and produces flowers above the ground. Two fatty acids—namely oleic acid and linoleic acid accounts for up to 80% of the groundnut oil. (Bertioli *et al.,* 2019). Market-oriented and/or export-led commercial production is a necessity for sustainable legume value chain (Rubyogo *et al.,* 2019). The plant grows up to 30-50 cm in height having yellow flowers with reddish veining. The ovary is pushed underground where the mature fruit develops into a pod. The pods mature underground are 3-7 cm long containing 1-4 seeds (Nahreen, 2018). While groundnut cultivars vary in plant habit, shape and color of pods and seeds (Kishlyan *et al*., 2020). Groundnuts prefer to grow in light, sandy loam soil with a pH of 5.9-7. Adequate levels of phosphorous, potassium, sulphur, calcium, magnesium and micronutrients are needed for good yield. However, due to its ability to fix nitrogen, they do not require nitrogen containing fertilizers (Nahreen, 2018). The optimal soil temperature for good germination and vegetative growth is 27°C–30°C and 24°C–27°C for reproductive growth. Low temperature at the time of sowing delays germination and increases the likelihood of seed and seedling diseases and of infestation by sucking pests (Ojiewo *et al*., 2019). Potassium has an important role in alleviation of biotic and abiotic stresses in crop (Read *et al*., 2006) and it also enter in many processes in plant such as transport, assimilation, storage in tissue (Cakmak, 2005). protein synthesis, photosynthesis, activation of enzymes (Hawkesford *et al*., 2012) and nitrogen fixation which effect on plant growth and yield components. Though potassium application is not regularly practiced, it plays equally important role as nitrogen and phosphorus in plants for their growth and development (Lu *et al*., 2019). A good crop production would depend upon the time and appropriate amount of fertilization (Orji *et al*., 2022). One of the important factors influencing the production of crops in the tropics is soil fertility such that soil productivity is hampered by the deficiencies of nutrients such as nitrogen, phosphorus, and potassium One of the important nutrients in groundnut production is potassium because of its large effects on seed oil content, and as such, potassium in excess or deficiency may reduce oil percentage (Lien *et al*., 2019). In light soils to minimize the loss of potassium due to leaching under heavy rainfall conditions, it is recommended to apply potassium in two splits. In such cases the top dressing is to be carried out after 30 to 40 days of sowing (Jamal *et al*., 2010). Potash increases the pod yield, kernel yield, individual grain weight and oil content (Ramdevputra *et al*., 2010). It has substantial effect on grain yield, total biological yield, sulphur concentration in grain, total sulphur uptake, grain protein content, oil content and oil yield (Chattopaddhyay & Ghosh, 2012). Sulphate of potash (SOP) is a combined fertilizer that contains both i.e sulphur 18% and potash 50%. The Present study is therefore planned to examine the effect of different levels of sulphate of potash on the growth, and pod yield related characteristics of two groundnut varieties.

Materials and Methods

The experiment was conducted during the year 2021 in Horticultural Research area, Sindh Agriculture University Tandojam in order to determine the effect of sulphate of potash (SOP) on growth and yield related parameters of ground nut. Two cultivars of the ground nut viz. “Golden” and “Bari-2011” were cultivated by using different levels of SOP fertilizer. The experiment was laid out factorial in Randomized Complete Block Design with three replications. The SOP was applied at the rate of 60, 80, and 100 kg ha^{-1} along with control. At the time of soil preparation, one basal dose of 30 kg nitrogen and 60 kg phosphorus was applied. Whereas, entire dose of potassium was applied after 15 days of plantation. The pre-sowing soil analysis is shown in the Table 1

Table 1. Pre-Sowing soil analysis

Characteristics	Units	Value
pH	---	8.2
EC	dS/m	2.1
Soil Organic Matter	%	0.65
Extractable K	mg/Kg	82
Available P	mg/Kg	7.3
Texture	Sandy Loam	
Saturation	%	29

All the appropriate cultural practices and timely plant protection measures were adopted uniformly for all the treatments. The observations were recorded for vegetative and pod related attributes of the groundnut.

This includes seed germination (%), days to flowering, plant height, canopy width (cm), pods plant^{-1}, kernels plant^{-1}, 100 kernels weight, pod yield ha^{-1}, edible portion (%) and non-edible portion (%). At physiological maturity, five plants were randomly selected from each net plot for recording observations regarding: plant height, days to flowering, canopy width**,** number of pods plant^{-1}, number of kernels plant^{-1} and 100 kernels weight. However, seed germination was regularly checked up to the one week of the plantation and counted. The seed germination (%) was calculated by using following formula (Larsen & Andreasen, 2004).

$$Seed\ germination\ (\%) = \frac{\sum n}{N}\ x100$$

Where n is number of germinated seeds at each counting and N is total seeds in each treatment. In pod yield (kg ha^{-1}) Pods were harvested from the plants of two central rows of each plot followed by sun drying and weighing in grams. The pod weight was multiplied with total number of rows in a plot to calculate pod weight plot^{-1}. The data were then converted into pod yield (kg ha^{-1}) by using following formula (Varshney *et al*., 2019).

$$Yield\ (kg\ ha^{-1}) = \frac{(Pod\ weight(kg\ plot-1)/(plot\ size\ (m2)\ x\ area\ of\ hectare\ (10{,}000\ m^2)}{Plot\ size\ (9\ m^2)\ x\ grams\ in\ kg\ (1000)}$$

To calculate edible portion (%), the weight of the harvested groundnuts was measured. After that, shells of the groundnuts were removed and edible kernels were separated and weighed. The percentage of the edible portion of the groundnut was calculated by using following formula (Varshney *et al*., 2019).

$$Edible\ portion(\%) = \frac{kernel\ weight\ (gms)}{groundnut\ weight\ (gms)}\ x100$$

To calculate the non-edible portion (%). The separated shells of the groundnut were weighed along with total weight of the groundnut. The percentage of the non-edible portion was calculated by using following formula (Varshney *et al*., 2019).

$$Nonedible\ portion\ (\%) = \frac{shells\ weight\ (gms)}{groundnut\ weight\ (gms)}\ x100$$

The data were statistically analyzed using Statistix-8.1 computer software (Statistix, 2006). The LSD test was applied to compare treatments superiority in case results are significant at P≤ 0.05 probability level

Results and Discussion

Effect of different levels of potassium on vegetative growth and pod yield of groundnut: The results related to different level of potassium on groundnut crop are given in table 2 and table 3. It is evident from the data that there was significant effect of different level of potassium on almost all the recorded parameters except seed germination and days to flowering. Generally, increasing potassium levels from 0 to 100 kg ha^{-1} showed increase in plant height (cm), canopy width (cm), pods plant^{-1}, kernels plant^{-1}, weight of 100 kernels (gm), pod yield (kg ha^{-1}), edible portion (%) and reduction in non-edible portion (%). The result of plant height shows minimum plant height (16.87cm) was observed in controlled treatment while the maximum plant height (19.50 cm) was observed at potassium level 100 kg ha^{-1}. The results revealed that there was significant effect of potassium levels on plant height. The results regarding seed germination are also illustrated in the same table which indicate that minimum seed germination was in T_0 and maximum was observed in T_3 (82.62%) but difference among treatments is non-significant. The application of potassium did not respond positively on flowering of groundnut, the flowering started at the same time in all the treatments. The canopy width also responded significantly, and maximum was observed in T_2 while the minimum was observed in controlled. These results are in the same line with the findings of Lobo *et al.* (2012), who reported that application of potassium has positive effect on plant height and germination and canopy with of peanuts. The results of present study are also in confirmation with the findings of Almeida *et al.* (2015). Pods plant^{-1} (52.2) , kernels plant^{-1} (100.99) were observed higher where SOP was applied at the rate of 80 kg ha^{-1} and minimum was observed in controlled . T_2 also significantly reflect the effect of potassium application on weight of 100 kernels, (58.07 g), pod yield (1590.4 kg ha^{-1}) and edible portion (63.50 %) while the minimum were observed on controlled treatment. With the increase in potassium level from 0 to 100 kg ha^{-1}, non-edible portion decreases. The maximum result of non-edible portion (41.50 %) was found at control (0 kg ha^{-1}). Liu *et al.* (2023) reported that Potassium is one of the most important elements for crop growth and development. However, potassium deficiencies are common in the cultivated land of oil crops in the world, which limits the increase in their yields. The photosynthesis, fluorescence, and physiological indexes of peanut plants were affected by low K to varying degrees, and finally the yield decreased. However, the effect of low K on the photosynthetic physiological mechanism of peanut plants remains unclear. A similar study by Dudhade *et al*. (2021) showed that the pod and haulm yield were significantly increased under groundnut crop grown to potash level 30 kg K_2O ha^{-1} as compared to other potash levels. The dry pod yield (kg ha^{-1}), kernel yield (kg ha^{-1}) and dry haulm yield (kg ha^{-1}) were significantly increased in potash significantly increased gross and net monetary returns as compared to other potash levels. Sousa *et al*. (2013) applied different doses of potassium to the groundnut crop in two application methods. They recorded maximum yield (1531 kg ha^{-1}) by applying fertigation method with a dose of 69 kg potassium ha^{-1}, while for the conventional method with a dose of 66 kg potassium ha^{-1} resulted (1092 kg ha^{-1}) yield.

Table 2. Effect of different levels of potassium on vegetative growth and pod yield of groundnut

SOP levels	**Seed germination**	**Days to flowering**	**Plant height (cm)**	**Canopy width (cm)**	**Pods plant^{-1}**	**Kernels Plant^{-1}**	**Weight of 100 kernels (gm)**	**Pod yield (kg ha^{-1})**	**Edible portion (%)**	**Non-edible portion (%)**
T_0 = Control	74.25±2.5	29.85±0.2	16.87±1.1 B	963.4±10.3 B	41.90±2.1 B	74.25±3.8 B	50.13±0.97 B	1157.8±2.3 C	58.50±1.1 B	41.50±1.3 A
T_1 = 60 kg (K) ha^{-1}	77.87±2.9	29.85±0.4	18.50±0.65 AB	986.0 ±23.5 B	44.55±1.2 B	82.93±4.7 B	51.42±1.25 B	1435.1±6.1 B	62.51±1.8 AB	37.48±1.7 AB
T_2 = 80 kg (K) ha^{-1}	80.50±2.3	29.62±0.9	18.00±0.82 AB	1213.5±41.25 A	52.27±0.98 A	100.99±3.1 A	58.07±2.4 A	1590.4±3.7 A	63.50±2.3A	36.50±2.2 AB
T_3 = 100 kg (K) ha^{-1}	82.62±3.2	29.62±0.3	19.50±0.51 A	1170.8±58.2 A	44.92±2.1 B	84.63±2.2 B	56.32±2.1 A	1469.8±2.4 AB	62.71±1.4 AB	37.28±1.4 B
SE±	3.3025	0.5483	0.7669	63.288	1.4169	4.2787	1.5228	3.3025	1.7437	1.7437
$LSD_{0.05\%}$	Ns	Ns	2.1380	176.44	3.9500	11.928	4.2452	9.2067	4.8610	4.8610

Comparison of groundnut varieties on vegetative growth and pod yield of groundnut: Two groundnut varieties ("Golden" and "Bari-2011") were selected for the comparison on vegetative growth and pod yield of groundnut in this study (Table 3). The comparison of groundnut varieties had also significant effect for parameters viz: days to flowering, plant height (cm), canopy width (cm), pods plant^{-1}, kernels plant^{-1}, weight of 100 kernels (g)**,** pod yield (kg ha^{-1}), edible portion (%) and non-edible portion (%). There was no significant difference among treatments regarding seed germination. "Golden" showed days to flowering late (31.12 days), which ultimately effects on non-edible portion (41.70 %) of groundnut. Bari-2011 found superior in all parameters except days to flowering and non-edible portion might be due to varietal and climatically admissible condition. The cultivar "Bari-2011" was found to take fewer days to flowering (28.37 days), higher in plant height (18.68 cm), canopy width (1102.9 cm) and gave more pod yield (1543.6 kg ha^{-1}) along with maximum edible portion (65.31 %). The pod plant^{-1} (48.00), kernels plant^{-1} (94.43) and weight of 100 kernels (55.26 g) revealed that "Bari-2011" performance is better than "Golden".

Leghari *et al*., (2017) conducted field experiment and concluded that 100 kernels weight and number of pods plant^{-1} were recorded at 60 kg/ha of sulphate of potassium and maximum yield (2122 kg ha^{-1}) was recorded @ 70 kg/ha of sulphate of potassium. Ijaz *et al*. (2021); Javed *et al*. (2020) and Sher *et al*. (2019) concluded that varietal performance variation may be due to genetic variation and different varieties perform differently in different ecological zone

Table 3. Comparison of groundnut varieties on vegetative growth and pod yield of groundnut

Varieties	Seed germination	Days to flowering	Plant height (cm)	Canopy width (cm)	Pods plant^{-1}	Kernels Plant^{-1}	Weight of 100 kernels (g)	Pod yield (kg ha^{-1})	Edible portion (%)	Non-edible portion (%)
Golden	79.43±3.1	31.12±0.5 A	17.75±0.48 A	1064.0±22.7 A	43.82 ±0.8 B	77.46±2.6 B	52.71±2.5 B	1283.0±3.1	58.29±2.1 B	41.70±1.7 A

								B		
Bari-2011	78.18±2.07	28.37±0.25 B	18.68±0.61 A	1102.9±51.3 A	48.0±2.2 A	94.43±4.1 A	55.26±1.1 A	1543.6±1.04 A	65.31±1.2 A	34.68±2.4 B
SE±	2.3352	0.3877	0.5423	44.751	1.0019	3.0255	1.0768	2.3352	1.2330	2.3352
$LSD_{0.05\%}$	Ns	0.8066	0.0985	93.114	2.0846	6.2952	2.2404	4.8588	2.5654	2.5654

Conclusion

It was concluded from this study that effect of potassium application remained non-significant in germination percentage and flowering, but all other growth and yield related parameters responded significantly to potassium application. Maximum plant height, 100 kernels weight and non-edible portion was recoded in T_3(100 kg ha^{-1}), while yield related parameters like canopy width, pods $plant^{-1}$, kernels $plant^{-1}$, yield ha^{-1}, edible portion were recorded maximum in T_2 (80 kg ha^{-1}). In case of groundnut cultivars comparison “Bari – 2011” performed significantly better as compared to “Golden”.

Conflict of Interest: Authors did not show any conflict of interest.

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