

Effect of POLY4 Application on the Growth and Yield of Groundnut (*Arachis hypogaea* L.)

ABSTRACT

Aim: To evaluate the effect of POLY4 Application on the Growth and Yield of Groundnut

Study design: Randomized Block Design

Place and Duration of Study: Gungal Research Farm, ICAR-Central Research Institute for Dry land Agriculture, Hyderabad, India between June 2022 and October 2022.

Methodology: A field experiment was conducted at Gungal Research Farm, ICAR-Central Research Institute for Dry land Agriculture, Hyderabad, and Telangana during the *Kharif* season of 2022 to evaluate the Impact of POLY4 Application on the Growth and Yield of Groundnut. The experiment was assigned in ten treatments, laid out in Randomized Block design with three replications. The treatments were T₁-Recommended NPK (20:40:50 kg ha⁻¹) + gypsum @ 500 kg ha⁻¹, T₂-Recommended NP only, T₃-Recommended NPK, T₄-Recommended NP + 50% K through MOP, T₅-Recommended NP + 100% of rec. K through Poly4, T₆-Recommended NP + 100% of rec. K through Poly4 + gypsum @ 310 kg ha⁻¹, T₇-Recommended NP + 50% of rec. K through Poly4, T₈-Recommended NP + 50% of rec. K through Poly4 + gypsum @ 310 kg ha⁻¹, T₉-Recommended NP + gypsum @ 500 kg ha⁻¹ and T₁₀-Control.

Results: The application of Recommended NP(20:40 kg ha⁻¹) + 100% of rec. K(50 kg ha⁻¹) through POLY4 (T₅) treatment resulted in a significant increase in both plant height and leaf area at vegetative (18.1 cm and 320.4 cm² plant⁻¹), at flowering (31.9 cm and 554.7 cm² plant⁻¹), at pegging (39.5 cm and 785.3 cm² plant⁻¹), at pod formation (48.5 cm and 1088.5 cm² plant⁻¹), and at the harvest (54.4 cm and 359.5 cm² plant⁻¹) respectively compared to the control. Significantly higher pod yield (1556 kg ha⁻¹) was recorded under Recommended NP (20:40 kg ha⁻¹) + 100% K (50 kg ha⁻¹) through POLY4 (T₅). The lower yield (844 kg ha⁻¹) was recorded in control (T₁₀).

Conclusion: Polyhalite, also known as POLY4, is a highly effective fertilizer that provides potassium (K), sulfur (S), magnesium (Mg), and calcium (Ca) in a more efficient manner compared to equivalent soluble salts. Based on the findings of the current study, it can be concluded that application of 100% K through polyhalite (POLY4) along with recommended doses of nitrogen and phosphorus (20:40 kg ha⁻¹) in sandy loam soil was the best performing treatment

Keywords: POLY4, DAS, growth, yield attributes, groundnut

1. INTRODUCTION

Groundnut is the fourth most important source of edible oil and a third most important source of vegetable protein in the world. In terms of acreage, groundnut occupies first position in India with an area of 6.09 million hectares and 101 lakh tonnes of production with productivity of 1863 kg ha⁻¹ (agricoop.nic.in, 2021-22). Although India ranks first in area and production of groundnut, its productivity (1893 kg ha⁻¹) is much less than U.S.A., China and few other countries. The crop is cultivated in *kharif* in about 0.15 lakh acres across Telangana region. It is widely grown in Mahbubnagar, Warangal, Nalgonda and Karimnagar Districts (pjtsau.edu.in.agrimkt 2022). The main reasons for low yield are that this energy

rich crop is grown under energy starved conditions, mainly under rainfed (85%), and in less fertile light-textured soils. Further, groundnut being drought tolerant in nature, suffers from the nutrient deficiencies resulting in low yield. On an average, the groundnut crop requires 160-180 kg N, 20-25 kg P, 80-100 kg K, 60-80 kg Ca, 15-20 kg S, 30-45 kg Mg, 3-4 kg Fe, 300-400 g Mn, 150-200 g Zn, 140-180 g B, 30-40 g Cu and 8-10 g Mo, to produce 2.0 to 2.5 t ha⁻¹ of economic yield (Kulkarni *et al.*, 2021). In addition to this, there are widespread deficiencies of macro, micro, and secondary nutrients under rainfed conditions, it is estimated as 89% for N (63% low and 26% medium); 80% for P (42% low and 38% medium); 50% for K (13% low and 37% medium), 41% for S; 48% for Zn; 33% for B; 12% for Fe; 13% for Mo; 5% for Mn; and 3% for Cu (Rao *et al.*, 2015). Large-scale deficiencies of Mg and Ca have been reported recently in red and lateritic sandy soils. Several crops including groundnut is affected by deficiency of Ca and Mg. So, among macronutrients the K, Ca, Mg and S are to be managed properly because these elements play a key role in the kernel filling and oil synthesis of groundnut. In Southern Telangana, the major soil constraints in the descending order are dry soil moisture, gravelliness, low K reserve, low organic carbon content, and low cation exchange capacity (Chandrakala *et al.*, 2021). Further, semiarid regions of Telangana are deficient in micronutrients in an order of Mn > B > Zn > Fe > Cu in groundnut growing soils (Gangothri and Dadhich, 2020). Polyhalite is a natural combination of four (K, S, Mg and Ca) of the total six essential macronutrients required for growth and development of plants. POLY4 contains 14% K₂O, 17% CaO, 6% MgO and 19% S. It is obtained from polyhalite (K₂SO₄.MgSO₄.2CaSO₄.2H₂O), a potassium-bearing mineral in UK (Kemp *et al.*, 2016). However, meager information is available on the effect of POLY4 on the performance of groundnut in India. The present study is therefore proposed to study the effect of POLY4 on groundnut growth, yield and yield attributes under rainfed conditions.

2. MATERIAL AND METHODS

A field experiment was conducted during the *Kharif* season of 2022 at Gungal Research Farm, ICAR-Central Research Institute for **Dry land** Agriculture, Hyderabad, and Telangana. The experimental site is situated at 17°40' 40.4" N latitude and 78°39', 55.7" E longitude. The study was conducted in a randomized block design with three replications, and ten treatments. The treatments were T₁-Recommended NPK (20:40:50 kg ha⁻¹) + gypsum @ 500 kg ha⁻¹, T₂-Recommended NP only, T₃-Recommended NPK, T₄-Recommended NP + 50% K through MOP, T₅-Recommended NP + 100% of rec. K through Poly4, T₆-Recommended NP + 100% of rec. K through Poly4 + gypsum @ 310 kg ha⁻¹, T₇-Recommended NP + 50% of rec. K through Poly4, T₈-Recommended NP + 50% of rec. K through Poly4 + gypsum @ 310 kg ha⁻¹, T₉-Recommended NP + gypsum @ 500 kg ha⁻¹ and T₁₀-Control. A healthy and mature seed of the groundnut variety Kadiri-9 was selected for sowing. The seeds were sown with a plant spacing of 30 cm x 10 cm on flat beds. Nitrogen, phosphorous, and potassium fertilizers were applied at the rates of 20:40:50 kg N, P₂O₅, and K₂O per ha, respectively using urea, DAP, MOP, POLY4, and gypsum at 310 kg ha⁻¹, as per the treatments. All fertilizers, except gypsum, were applied as a basal dose, while gypsum was applied at the flowering stage of the crop. The crop was grown by following standard agricultural practices and was manually harvested in the second week of October. Throughout the experiment, growth parameters such as plant height (cm) and leaf area (cm² plant⁻¹) were recorded during the vegetative stage, flowering stage, peg formation stage, pod formation stage, and harvest stage of the groundnut. Yield parameters, including the number of pods plant⁻¹, pod yield (kg ha⁻¹), haulm yield (kg ha⁻¹), and test weight (g), were also measured. Observations were collected at regular intervals from five randomly selected plants within each plot and replication. All the replicated data obtained from the experiment were statistically analyzed using the F test as per the procedure given by Gomez and Gomez (1984).

3. RESULTS AND DISCUSSIONS

3.1 Growth parameters

The effect of Poly4 application on plant height and leaf area was found significant at vegetative, flowering, pegging, pod formation and harvest stages. Application of Recommended NP (20:40 kg ha⁻¹) + 100% K (50 kg ha⁻¹) through POLY4 (T₅) resulted in significantly higher plant height at vegetative (18.1cm), flowering (31.9 cm), pegging (39.5 cm), pod formation (48.5 cm) and harvest stages (54.4 cm) compared to control (Table 1). However, these measurements were comparable to Recommended NPK (20:40:50 kg ha⁻¹) + gypsum @ 500 kg ha⁻¹ (T₁), Recommended NP + 100% of rec. K through POLY4 + gypsum @ 310 kg ha⁻¹ (T₆), Recommended NPK (T₃) and Recommended NP + 50% of rec. K through POLY4 (T₇). The use of Poly4 can promote vegetative growth and increase the plant height in groundnut Karthikeyan *et al.*, (2022), Beer *et al.*, (2020) and Hemeid *et al.*, (2015). The increased plant height may be attributed to the balanced supply of potassium, calcium, magnesium, and sulfur through the use of POLY4. These associated nutrients likely contributed to rapid cell division and elongation, thereby enhancing photosynthesis rate and activity. Leaf area was also significantly higher in Recommended NP (20:40 kg ha⁻¹) + 100% K (50 kg ha⁻¹) through POLY4 (T₅) treatment at vegetative, flowering, pegging, pod formation and harvest stages (320.4, 554.7, 785.3, 1088.5, and 359.5 cm² plant⁻¹ respectively) compared to control (Table 2); however the treatments Recommended NPK (20:40:50 kg ha⁻¹) + gypsum @ 500 kg ha⁻¹ (T₁), Recommended NP + 100% of rec. K through POLY4 + gypsum @ 310 kg ha⁻¹ (T₆), Recommended NPK (T₃) and Recommended NP + 50% of rec. K through POLY4 (T₇) were statistically on par with each other. The results are similar with the findings of Truong *et al.*, (2017) and Baraker *et al.*, (2017).

3.2 Yield

The Table 3 shows the effect of Poly4 application on yield. The effect of application of Poly4 in conjunction with recommended NP (T₅) on yield was found significant and resulted in higher pod yield of 1556 kg ha⁻¹ compared to control. This yield was comparable to the yields obtained from treatments Recommended NPK (20:40:50 kg ha⁻¹) + gypsum @ 500 kg ha⁻¹ (T₁), Recommended NP + 100% of rec. K through POLY4 + gypsum @ 310 kg ha⁻¹ (T₆), Recommended NPK (T₃) and Recommended NP + 50% of rec. K through POLY4 (T₇) and Recommended NP + 50% of rec. K through Poly4 + gypsum @ 310 kg ha⁻¹ (T₈), which yielded 1549, 1544, 14790, 1461, and 1456 kg ha⁻¹, respectively. The plots treated with recommended NP + 100% K through Poly4 recorded 45.8% increase in yield compared to the control, while the recommended NPK treatment showed a 42.1% increase over control. Hoang *et al.*, (2016), Kumar *et al.*, (2023), Xue *et al.*, (2021) and Pramanick *et al.*, (2023) also reported similar results observed with application of different doses of Poly4 improved the yield due to availability of all essential nutrients. However, application of POLY4 in groundnut did not result in any significant difference in haulm yield.

3.3 Yield attributes

The plots applied with recommended NP + 100% of recommended K through Poly4 recorded significantly higher number of pods per plant (36.7) compared to control (27.3), although this count was comparable to treatments Recommended NPK (20:40:50 kg ha⁻¹) + gypsum @ 500 kg ha⁻¹ (T₁), Recommended NP + 100% of rec. K through POLY4 + gypsum @ 310 kg ha⁻¹ (T₆), Recommended NPK (T₃) and Recommended NP + 50% of rec. K through POLY4 (T₇) (Table 3). The increase in the number of pods per plant can be attributed to the improved availability of essential nutrients provided by Poly4. Higher number of pods per plant was also recorded due to application of Poly4 was reported by Gashti *et al.*, (2012), Melgar *et al.*, (2018) and Sireesha *et al.*, (2022). Test weight being a genetical character, it was not significantly influenced by the application of Poly4. Test weight was 30.7 and 33.7 g, respectively for control and Recommended NP + 100% of rec. K through Poly4 + gypsum @ 310 kg ha⁻¹ applied plots.

Table 1: Effect of POLY4 fertilization on plant height (cm) of groundnut

Treatment	Crop stage				
	VS	FS	PS	PFS	HS
T ₁ -Recommended NPK (20:40:50 kg ha ⁻¹) + gypsum @ 500 kg ha ⁻¹	17.2	29.8	38.3	47.2	53.7
T ₂ -Recommended NP only	13.3	20.2	27.3	36.5	39.8
T ₃ -Recommended NPK	16.0	27.9	35.3	43.4	51.6
T ₄ -Recommended NP + 50% K through MOP	14.6	22.7	29.8	38.2	44.7
T ₅ -Recommended NP + 100% of rec. K through Poly4	18.1	31.9	39.5	48.5	54.4
T ₆ -Recommended NP + 100% of rec. K through Poly4 + gypsum @ 310 kg ha ⁻¹	16.3	28.5	37.7	45.8	52.9
T ₇ -Recommended NP + 50% of rec. K through Poly4	15.2	26.2	33.5	41.5	48.5
T ₈ -Recommended NP + 50% of rec. K through Poly4 + gypsum @ 310 kg ha ⁻¹	15.1	24.5	31.4	39.3	45.2
T ₉ -Recommended NP + gypsum @ 500 kg ha ⁻¹	14.0	21.3	28.2	33.6	41.3
T ₁₀ -Control	12.7	18.3	25.5	31.5	36.5
SEm±	1.0	1.7	2.2	2.7	3.0
CD at 5%	3.0	5.0	6.5	8.1	8.9

(VS: Vegetative stage, FS: Flowering stage, PS: Pegging stage, PFS: Pod formation stage, HS: Harvest stage)

FIG 1: Effect of POLY4 on plant height of groundnut at different stages

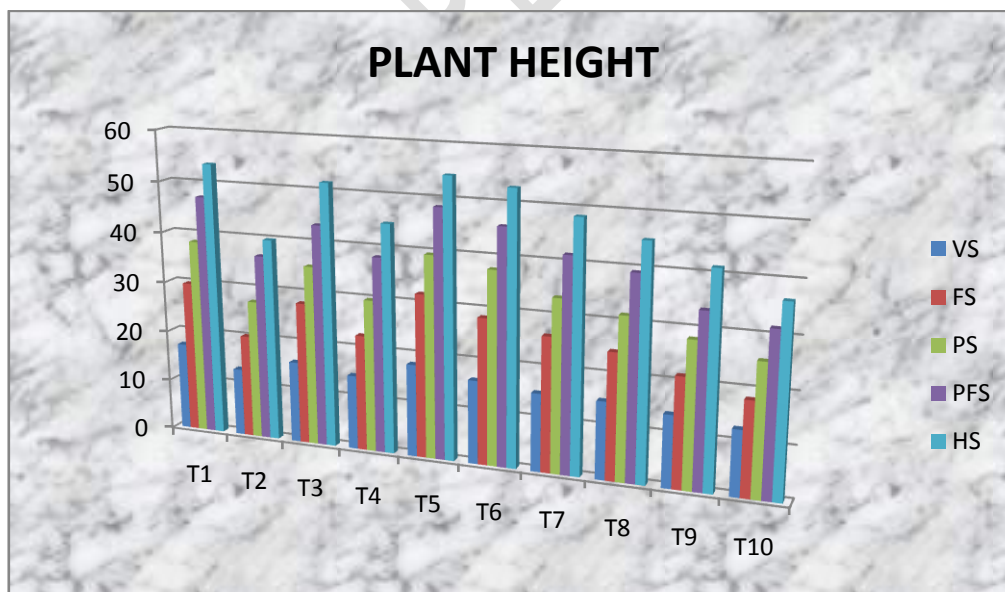


Table 2: Effect of POLY4 fertilization on leaf area (cm² plant⁻¹) of groundnut

Treatment	Crop stage				
	VS	FS	PS	PFS	HS
T ₁ -Recommended NPK (20:40:50 kg ha ⁻¹) + gypsum @ 500 kg ha ⁻¹	314.5	541.4	759.6	1052.6	332.3
T ₂ -Recommended NP only	208.9	452.9	589.1	861.3	245.0
T ₃ -Recommended NPK	276.7	509.9	729.7	999.8	304.0
T ₄ -Recommended NP + 50% K through MOP	226.8	486.3	611.6	911.7	268.0
T ₅ -Recommended NP + 100% of rec. K through Poly4	320.4	554.7	785.3	1088.5	359.5
T ₆ -Recommended NP + 100% of rec. K through Poly4 + gypsum @ 310 kg ha ⁻¹	299.3	515.8	731.2	1020.0	317.0
T ₇ -Recommended NP + 50% of rec. K through Poly4	263.7	504.8	715.2	971.4	288.7
T ₈ -Recommended NP + 50% of rec. K through Poly4 + gypsum @ 310 kg ha ⁻¹	236.3	491.3	667.8	950.0	270.7
T ₉ -Recommended NP + gypsum @ 500 kg ha ⁻¹	217.5	476.5	597.5	907.4	253.0
T ₁₀ -Control	182.4	418.6	575.2	792.3	227.7
SEm±	19.4	21.2	31.1	39.0	19.3
CD at 5%	57.6	63.0	92.4	115.9	57.5

(**VS**: Vegetative stage, **FS**: Flowering stage, **PS**: Pegging stage, **PFS**: Pod formation stage, **HS**: Harvest stage)

FIG 2: Effect of POLY4 on leaf area of groundnut at different stages

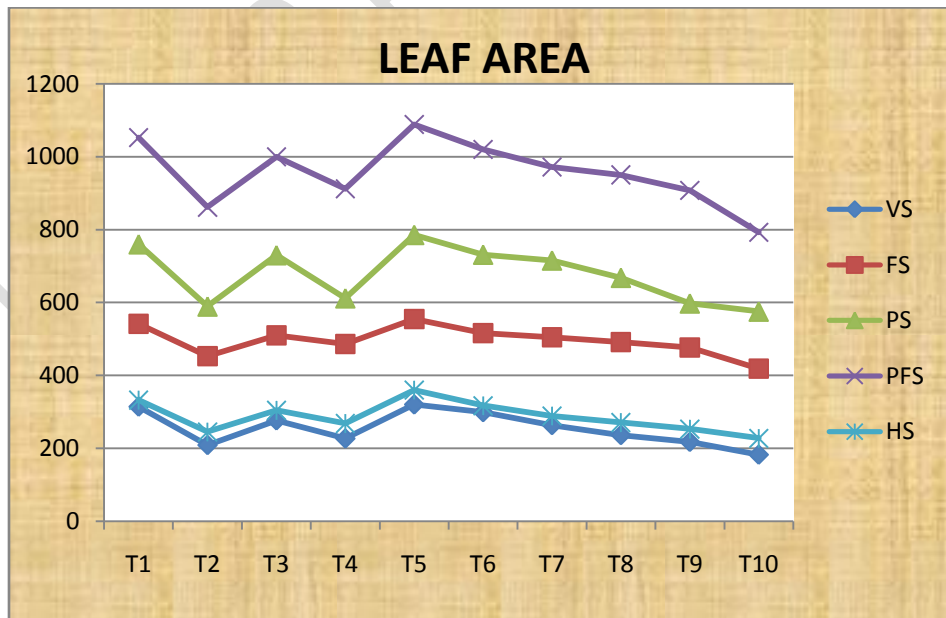


Table 3: Effect of POLY4 fertilization on yield attributes and yield of groundnut

Treatment	Pods plant ⁻¹	Test weight (g)	Pod yield (kg ha ⁻¹)	Haulm yield (kg ha ⁻¹)
T ₁ -Recommended NPK (20:40:50 kg ha ⁻¹) + gypsum @ 500 kg ha ⁻¹	35.7	33.1	1549	1939
T ₂ -Recommended NP only	32.3	31.6	1248	1854
T ₃ -Recommended NPK	35.0	33.2	1479	1911
T ₄ -Recommended NP + 50% K through MOP	32.7	32.0	1386	1944
T ₅ -Recommended NP + 100% of rec. K through Poly4	36.7	33.6	1556	1782
T ₆ -Recommended NP + 100% of rec. K through Poly4 + gypsum @ 310 kg ha ⁻¹	36.0	33.7	1544	1916
T ₇ -Recommended NP + 50% of rec. K through Poly4	33.7	32.9	1461	1915
T ₈ -Recommended NP + 50% of rec. K through Poly4 + gypsum @ 310 kg ha ⁻¹	34.7	33.4	1456	1853
T ₉ -Recommended NP + gypsum @ 500 kg ha ⁻¹	32.3	31.7	1318	1737
T ₁₀ -Control	27.3	30.7	844	1668
SEm±	1.0	0.7	47.6	115.8
CD at 5%	2.8	NS	142	NS

4. CONCLUSION

Polyhalite, also known as POLY4, is a highly effective fertilizer that provides potassium (K), sulfur (S), magnesium (Mg), and calcium (Ca) in a more efficient manner compared to equivalent soluble salts. Based on the findings of the current study that application of 100% K through polyhalite (POLY4) along with recommended doses of nitrogen and phosphorus (20:40 kg ha⁻¹) (T₅) in sandy loam soil was found the best performing treatment in increasing growth and yield of groundnut.

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REFERENCES

1. Baraker B, Jha S K, Wani S P, Garg K K. Effect of balanced fertilizer management practices on factor of productivity on Groundnut (*Arachis hypogaea* L.) cultivation. *International Journal of Chemical Studies*.2017; 5(4):1288-1291.
2. Beer Y, Peled-Lichter L, Sapir G. 2020. Effects of polyhalite fertilizers on lettuce development on a soilless culture. *Electronic International Fertilizer Correspondent (e-ifc)*.2020; 59:10-17.
3. Chandrakala M, Bhoora P, Niranjana K V, Sujatha K, Rajendra H, Chandran P. Application of soil fertility capability classification (FCC) in dry semi-arid land of

south Telangana Plateau, Andhra Pradesh. *Communications in Soil Science Plant Analysis*. 2021; 52: 161-171.

4. Gangothri N, Dadhich A S. A study on the availability of micro and macro nutrients in red and black agricultural soils of eklaskhampeta, Telangana, India. 2020.
5. Gashti A H, Vishekaei M N S, Hosseinzadeh M H. Effect of potassium and calcium application on yield, yield components and qualitative characteristics of peanut (*Arachis hypogaea* L.) in Guilan Province, Iran. *World Applied Sciences Journal*. 2012; 16(4): 540-546.
6. Gomez K A, Gomez A A. *Statistical procedures for agricultural research*.(1984).
7. Hemeid N M. Effect of different sources and levels of potassium fertilization on productivity of peanut grown under sandy soil conditions. *Journal of Soil Sciences and Agriculture Engineering*. 2015; 6:1441-454.
8. Hoang M T, Duong M M, Truong T T, Ho H C, Pham V B. Agronomic efficiency of polyhalite application on peanut yield and quality in Vietnam. *Electronic International Fertilizer Correspondent (e-Ifc)*. 2016; 47: 3-11.
9. https://agricoop.nic.in/en/Agricultural_Statistics_at_a_Glance
10. <https://pjsau.edu.in/files/AgriMkt/2022/September/groundnut-September-2022.pdf>
11. Karthikeyan P K, Sowmiyan T, Bhuvaneshwari R, Kandasamy R, Muraleedharan A, Gokul D. Influence of potassium on growth, yield and nutrient uptake of groundnut (*Arachis hypogaea*) cv. TMV 13. *Crop Research*. 2022; 57(1&2): 21-27.
12. Kemp S J, Smith F W, Wagner D, Mounteney I, Bell C P, Milne C J, Pottas T L. An improved approach to characterize potash-bearing evaporite deposits, evidenced in North Yorkshire, United Kingdom. *Economic Geology*. 2016; 111(3): 719–742.
13. Kulkarni S, Rao N, Chavan M, Upperi S N. Optimization of Nutrients for Productivity Enhancement of Groundnut (*Arachis hypogaea* L.) in Northern Dry Zone of Karnataka. *Frontiers in Crop Improvement*. 2021; 9: 2810-2813.
14. Kumar V, Shekhawat K, Singh RK, Rathore, SS, Kumar S. Effect of polyhalite on yield, nutrient uptake by wheat and soil properties. *Annals of Plant and Soil Research*. 2023; 25(1): 59-63.
15. Pramanick B, Mahapatra B S, Datta D, Dey P, Singh SP, Kumar A, Paramanik B, Awasthi N. An innovative approach to improve oil production and quality of mustard (*Brassica juncea* L.) with multi-nutrient-rich polyhalite. *Heliyon*. 2023; 9(3).
16. Melgar RJ, Ventimiglia L, Figueroa E, Centurion O, Vale F. Polyhalite for grain in soybean-based production systems in Argentina and Paraguay. *Electronic International Fertilizer Correspondent (e-Ifc)*. 2018; 55: 3-12.
17. Rao CS, Lal R, Prasad JV, Gopinath KA, Singh R, Jakkula VS, Sahrawat, KL, Venkateswarlu B, Sikka AK, Virmani SM. Potential and challenges of rainfed farming in India. *Advances in agronomy*. 2015; 133: 113-181.
18. Sireesha V, Dawson J. Effect of potassium and magnesium on growth and yield of groundnut (*Arachis hypogaea* L.). *The Pharma Innovation Journal*. 2022; 11(5): 591-594.
19. Truong TT, Duong MM, Pham VB, Ho HC, Hoang MT, Tran Q D. Effect of potassium fertilizer types and rates on peanut growth and productivity on coastal sandy soil in south central Vietnam. *Electronic International Fertilizer Correspondent (e-Ifc)*. 2017; 48: 20-26.
20. Xue L, Nianyuan J, Li G. Effects of combined application of NPK compound fertilizer with polyhalite fertilizers on peanut yield, nutrient content and partitioning in Henan Province, China. *e-Ifc. International Potash Institute*. 2021; 64: 3-10.