LETTERS IN BIOMATHEMATICS
An International Journal

RESEARCH ARTICLE

OPEN ACCESS

Effect Bulky and non-Bulky organic fertilizers on Growth and Yield of Potato

D. Mohammed Abdullah[1]*, Q. Jamal Abdalrasool[2]

Department of Soil Science and Water Resources, College of Agriculture, University of Baghdad, Iraq
dalia.humadi2307p@coagri.uobaghdad.edu.iq, Kahtan.j@coagri.uobaghdad.edu.iq

ABSTRACT

A field experiment was conducted on the Arizona potato variety (Solanum tuberosum L.), during the spring season of 2025 in one of the research fields belonging to the College of Agricultural Engineering Sciences, University of Baghdad. The aim of this study is to determine the optimal fertilizer combination of Bulky and non-Bulky organic fertilizers for potato yield and growth indicators. The results showed that treatment (NG2B2) gave the highest indicators of high plant , number of shoot , chlorophyll , dry wight m in value (88.00 cm , 7.11 plant-1 ,40.20 SPAD ,4.56 mg h-1) respectively and treatment B2M2 give the highest value of tuber yield 59.9 mg h-1, These results highlight the importance of integrating both Bulky and non-Bulky organic fertilizers with mineral fertilizers to achieve an optimal combination that supplies essential nutrients to the plants while maintaining soil health.

ARTICLE HISTORY
Received September 17, 2026
Accepted October 28, 2026

KEYWORDS
Organic fertilizers, Bone meal , Tuber yield. Blood meal

1. Introduction

Bulky fertilizers refer to organic amendments characterized by low nutrient concentrations and high application volumes, such as farmyard manure and compost. Their primary role is to improve the physical, chemical, and biological properties of soil rather than to serve as direct sources of plant nutrition. Several studies have evaluated the use of these fertilizers either alone or in combination with mineral fertilizers, focusing on their effects on soil fertility, crop productivity, and the efficiency of handling and field application.(Chen,et al ,.2024)

Non-bulky fertilizers are derived from natural organic materials capable of supplying readily available nutrients to plants. They can be in the form of powder, irregular granules, or liquid and are obtained from plant and animal residues, organic waste, and by-products from slaughterhouses and industrial processes, including blood, bones, horns, hooves, fish residues, molasses processing, food manufacturing, livestock and poultry manure, ash, and other organic materials. These organic fertilizers contain essential nutrients such as nitrogen, phosphorus, and potassium (Gaudutis et al., 2023) In 2024, Taki investigated a set of fertilizer combinations containing dried blood fertilizer, plant-based organic residues, rock phosphate, and animal bone. The results showed increases in most essential soil nutrients, including 7.21% nitrogen, 2.71% phosphorus, 10.78% potassium, 1174 mg/kg iron, 4.53 mg/kg manganese, 29.43% organic carbon, 2.95% humic acid, and 3.55% fulvic acid. The study recommended the use of these combinations due to their effectiveness in supplying nutrients for organic farming systems.

Potato (Solanum tuberosum L.) belong to the family solanaceae and its crops have international important because it's a nutritive value and ability of acclimatation. potato one of the most vegetable widespread in the world and one of the major mills because it has roles in facing global challenge like Malnutrition , poverty, climate change . (Siamalube, et al., 2025)

The low productivity microregulated to decrease in soil fertility and involved use for fertilizers, pests , disease quality and low yielding cultivars through all this factor effect on potato growth and yield the, agriculture lands productivity it is one of the important requirements of sustainable agriculture and these the basic things too increase this value is organic fertilization we can define organic fertilization it is a neutral materials like plant residue, animal, food residue, industry waste, it's in a different state of decomposition this material promote plant growth due to contain a difference in nutrients are added to soil to improvement the chemical and physical and biological properties .the research problem lies in lack of clarity and differences between type of fertilizers in effect on potato yield ,growth indicators, growing in calcareous soil as well as the research on non-bulky fertilizers is low this is promoted as to constitute comparative study of bulky and non-bulky fertilizer (Mugo,et al .2020)

(Martirosyan , et al., 2024) in his study about effects of use mineral fertilizers and organic fertilizers(poultry and sheep manure) on

potato yield results show that the addition of organic fertilizers give a significant difference for a plant heigh also as soil healthy and productivity increase with use organic fertilizers in combination with soil traits with manual fertilizers in which the organic matter has an effect on soil properties like water conductivity, soil pH change, so combined fertilization necessary to save soil healthy and productivity consequently it's increase economic return .

Gelaye, (2023) Mentioned that farmers use a different quantity from nitrogen and organic fertilizers when they cultivate potato and this will lead to improving growth parameters and protection like number and weight tuber quality such as starch content was also affected by this addition .based on research reports worldwide 31 ton H-1 of organic fertilizers and 187.5 kg of nitrogenous fertilizers H-1 constitute the optimal combination for achieving the highest potato yield. a study was conducted to evaluate moisture content, proteins, fiber content ,vitamin A , mineral content in potato with use 130 kg H-1 for mineral fertilizers and 3ton kg H-1 from organic fertilizers it was found that organic fertilizers increase all these indicator and chemical fertilizers increase only carbohydrates content in tuber therefore we can conclude organic fertilizers application and increased from quantitative and qualitative traits of potato tuber(Kareem, et al.,2020)

(Jaafar, 2025)motioned in his study about effect of different type of fertilizers on availability and redness of some nutrients NPK the results show that application organic and mineral fertilizers with agriculture sulfur and increase the availability of mineral nutrients this treatment achieved on construction of P 0.47% , 7% N 1.29% K1.56% in potato tuber. A previous study indicated that the use of Bulky fertilizers enhances added value and agricultural income in a sustainable and environmentally friendly manner, due to their slow solubility and reduced susceptibility to runoff in irrigated or wet soils. Furthermore, strengthening farmers' institutions and their skills in managing these fertilizers supports green economy initiatives and promotes sustainability in rural areas(Hatta, et al .,2024)

The main objective of this study was to evaluate the performance of a locally prepared organic fertilizer mixture of blood, bone, and date residues in comparison with chemical and conventional organic fertilizers. Specific objectives were to: Measure plant growth and potato yield response.

2. Materials and methods

The field experiment was conducted at the Agricultural Research Station, College of Agriculture, University of Baghdad, during the 2025 spring season. And the field the field was divided into plots 4m2 for every plot Our representative soil sample was taken from the field, and all analysis was connected to determined soil fertility Table 1show the result of it. Organic materials were collected locally, dried, and ground before mixing. Samples were analyzed for total N (Kjeldahl method), available P (Olsen method), and K (flame photometry). As shown in Table 2, potato tuber (Arizona) was planted, and standard agronomic practices were followed. Growth parameters (plant height, yield ,dry weight , SPAD Chlorophyll content content)

Table 1 : soil properties

Property	Value	Measurement unit
1:1(pH)	**7.50**	**---**
1:1(EC)	**1.90**	dS m^{-1}
(CEC)	**9.6**	$cmol_{(c)}$ kg^{-1} soil
Organic matter	**2.3**	**gm kg $^{-1}$ soil**
Organic Carbone	**1.3**	
Available nitrogen	**91.0**	**ppm**
Available phosphor	**27.0**	
Available potassium	**272.0**	
sand	**516**	**gm kg $^{-1}$ soil**
Salt	**400**	
clay	**84**	
Texture	**Loamy**	--

Table 2 : properties of non-Bulky fertilizer

unit	Fertilizers			Property
	date residue	dry blood	Bone meal	
-	6.7	6.5	7.5	pH $_{1:5}$
dS m^{-1}	3.6	7.5	1.5	$EC_{1:5}$
%	33.1	48.7	35.0	Organic carbon
	57.1	84.0	60.3	Organic matter
	1.4	9.0	2.9	Total nitrogen

%	0.82	0.80	4.7	Total phosphor
	1.2	0.53	0.35	Total Potasium
	0.2	0.8	0.3	Total iron
mg kg-1	90	70	60	Total manganese
-	23.6	5.4	12.1	C/N
%	290	385	165	Water holding capacity

Experimental factor

first factor : Non - Bulky organic fertilizers

* Competition one (500 kg ha -1 bone mail +100 kg ha -1 dried blood +500 kg ha -1 date residue powder)

*Competition tow (100 kg ha -1 bone mail +100 kg ha -1 dried blood +500 kg ha -1 date residue powder)

Second factor: Bulky organic fertilizers

*Control treatment

*10 megagram h-1 sheep manure

**10 megagram h-1 cow manure

Third factor : mineral fertilization

*Control treatment

*50% from fertilization commendation

*75% from fertilization recommendation

3. Results and Discussion

1- Plant Hight :

Table 3 :plant Hight (cm)

NG * B		Mineral fertilizers M			Bulky organic fertilizers	Non-Bulky organic fertilizers
		M2	M1	M0	B	NG
61.78		65.00	61.67	58.67	B0	NG 1
71.44		74.33	71.67	68.33	B1	
73.44		77.00	73.00	70.33	B2	
65.00		68.00	64.67	62.33	B0	NG 2
77.56		82.67	77.67	72.33	B1	
88.00		93.67	87.00	83.33	B2	
1.976	LSD	N.S			LSD 0.05	
NG * M						
Mean of the non-Bulky treatment		M2	M1	M0	Non-Bulky organic fertilizers	
68.89		72.11	68.78	65.78	NG 1	
76.85		81.44	76.44	72.67	NG 2	
1.141	LSD	N.S			LSD	
B * M						
Mean of the Bulky fertilizers		M2	M1	M0	Bulky organic fertilizers	
63.39		66.50	63.17	60.50	B0	
74.50		78.50	74.67	70.33	B1	
80.72		85.33	80.00	76.83	B2	
1.397	LSD	N.S			LSD	
M						
		M2	M1	M0	Mineral fertilizers	
		76.78	72.61	69.22	Mean of Mineral fertilizers	

	1.397	LSD

Table 3 indicates effect of additional Bulky organic fertilizers, non -Bulky organic fertilizers and mineral fertilizers in potato plant height , results showed the presence of significant difference with addition the second combination from non-Bulky organic fertilizers NG2 reaching 76.83cm compared with NG1 reaching 68.89 cm. As for the Bulky organic fertilizer's treatment B2 which represents second level reaching 80.72 cm of Bulky organic fertilizers compared with B0 which represents control treatment reaching 63.39 cm , as for mineral fertilizer treatment M2 significantly outperformed reaching 76.78 cm compared with control treatment (69.22 cm) .The result of the two- way interaction indicated between organic Bulky and non-Bulky fertilizers NG2B2 significantly outperformed (88.00 cm)compared with N G1 B0 (61.78 cm) for non-Bulky organic mineral fertilizers on the Bulky organic and mineral fertilizers the results show that they are not significantly. The third- way interaction indicated between Bulky and non-Bulky fertilizer with mineral fertilizers no significant between were among the treatments.

2-Number of shoots

Table 4 : Number of shoots(plant-1)

NG * B	M Mineral fertilizers			Bulky organic fertilizers	Non-Bulky organic fertilizers
	M2	M1	M0	B	NG
4.444	5.000	4.333	4.000	B0	NG 1
4.889	5.333	5.000	4.333	B1	
5.111	5.667	5.000	4.667	B2	
3.889	4.333	3.667	3.667	B0	NG 2
6.000	6.667	6.000	5.333	B1	
7.111	7.667	7.333	6.333	B2	
0.647 LSD	N.S			LSD 0.05	
NG * M					
Mean of the non-Bulky	M2	M1	M0	Non-Bulky organic fertilizers	
4.815	5.333	4.778	4.333	NG 1	
5.667	6.222	5.667	5.111	NG 2	
0.374 LSD	N.S			LSD	
B * M					
Mean of the Bulky fertilizers	M2	M1	M0	Bulky organic fertilizers	
4.167	4.667	4.000	3.833	B0	
5.444	6.000	5.500	4.833	B1	
6.111	6.667	6.167	5.500	B2	
0.458 LSD	N.S			LSD	
M					
	M2	M1	M0	Mineral fertilizers	
	5.778	5.222	4.722	Mean of Mineral fertilizers	
	0.458			LSD	

Results shown in Table 4 are significantly outperformed when we used the second combination from non-Bulky organic fertilizers in number of shoots NG2 give the height value r Reaching 5.667 shoot plant-1 compare with treatment control NG 1 reaching 4.815 shoot plant-1, As for the organic Bulky fertilizers treatment B2 reaching 6.111 shoot plant-1 significantly performed compared with B0 4.167 shoot plant-1 .

The results showed there is significantly when we use mineral fertilizers M2 significantly outperformed reaching 5.778 shoot plant-1 compare with treatment control M0 reaching 4.7 22 shoot plant-1 , As for the two -way interaction between Bulky and non-Bulky organic fertilizers treatment NG2B2 significantly outperformed reaching 7.111 shoot plant-1 compare with NG1B0 give us the low value 4.444 shoot plant-1

As for the tow- way and interaction indicated between organic non-Bulky organic fertilizers and mineral fertilizers, results show there is no significant between these treatments in number of shoots for each plant, on the 3rd- way introduction indicated between Bulky , non-Bulky and mineral the effect was not significant.

3-Chlorophyll content

Table 5: Chlorophyll content SPAD

NG * B		M Mineral fertilizers			Bulky organic fertilizers	Non-Bulky organic fertilizers
		M2	M1	M0	B	NG
28.50		30.10	28.50	27.00	B0	NG 1
32.60		34.10	32.80	31.00	B1	
36.20		38.60	35.80	34.10	B2	
31.30		32.90	30.70	30.30	B0	NG 2
38.20		40.40	37.40	36.80	B1	
40.20		42.40	39.80	38.30	B2	
0.96	LSD	N.S			LSD 0.05	
NG * M						
Mean of the non-Bulky		M2	M1	M0	Non-Bulky organic fertilizers	
32.40		34.30	32.40	30.70	NG 1	
36.60		38.60	36.00	35.10	NG 2	
0.56	LSD	N.S			LSD	
B * M						
Mean of the Bulky fertilizers		M2	M1	M0	Bulky organic fertilizers	
29.90		31.50	29.60	28.70	B0	
35.40		37.20	35.10	33.90	B1	
38.20		40.50	37.80	36.20	B2	
0.68	LSD	N.S			LSD	
M						
		M2	M1	M0	Mineral fertilizers	
		36.40	34.20	32.90	Mean of Mineral fertilizers	
		0.68			LSD	

Result in Table 5 showed there is significant effect for study factors in Chlorophyll content content value in the plant, the treatment NG 2 When we used 2nd combination of non -Bulky organic fertilizers - it gives the high value reaching 36.60 SPAD . and when we use second Combination of Bulky fertilizers there is significant effect in Chlorophyll content value in plant B2 give the high value reaching 38.20 SPAD compared with control treatment B0 reaching 29.90 SPAD . As for the mineral fertilizer's treatment, M2 outperformed significantly compared with M0 reaching 36.40, 32.90 SPAD Respectively

As for the two- way interaction between Bulky and non-Bulky organic fertilizers NG2B2 have the highest value reaching 40.20 SPAD compared with NG 1B0 reaching to 28.50 SPAD.

As well as the results show there is no significance effect in two interactions between non-Bulky organic fertilizers with mineral fertilizers and no significant effect with third interaction between Bulky and non - Bulky fertilizers with mineral fertilizers in Chlorophyll content between treatments.

Analysis of the three Tables indicated that the two-way and three-way interactions among the studied factors had significant effects on plant height, number of shoots, and Chlorophyll content. This was attributed to differences in plant responses to the interaction between fertilizer type and rate, accompanied by improved nutrient availability and enhanced uptake efficiency the application of bone meal at different rates resulted in a noticeable increase in soil pH, organic matter content, and improved availability of phosphorus and calcium, which positively reflected on potato growth parameters. Furthermore, the addition of organic matter through Bulky and non-Bulky organic fertilizers in combination with mineral fertilizers improved soil chemical properties and contributed to enhanced plant growth, These findings are consistent with previous studies reporting that bone meal application increases soil pH, organic matter content, and enhances phosphorus and calcium availability, thereby promoting plant growth (Amin et al.,2025 ; Rafiif et al., 2024 ; Zaidan, 2024)

4- Dry weight

Table 6 : dry weight mg h-1

NG * B		M Mineral fertilizers			B Bulky organic fertilizers	NG Non-Bulky organic fertilizers
		M2	M1	M0		
3.33		3.46	3.30	3.23	B0	NG 1
3.74		3.88	3.76	3.59	B1	
3.96		4.17	3.93	3.78	B2	
3.51		3.60	3.51	3.41	B0	NG 2
4.19		4.33	4.23	4.02	B1	
4.48		4.56	4.48	4.41	B2	
0.05	LSD	0.086			LSD 0.05	
NG * M						
Mean of the non-Bulky		M2	M1	M0	Non-Bulky organic fertilizers	
3.68		3.83	3.66	3.53	NG 1	
4.06		4.16	4.08	3.95	NG 2	
0.029	LSD	0.05			LSD	
B * M						
Mean of the Bulky fertilizers		M2	M1	M0	Bulky organic fertilizers	
3.42		3.53	3.41	3.32	B0	
3.97		4.10	3.99	3.80	B1	
4.22		4.36	4.21	4.09	B2	
0.035	LSD	N.S			LSD	
M						
		M2	M1	M0	Mineral fertilizers	
		4.00	3.87	3.74	Mean of Mineral fertilizers	
		0.035			LSD	

Table 6 indicates the effect of factors study in dry weight results show there is significant effect when we add the first combination from non - Bulky organic fertilizers NG 2 amounting to 4.06 mg h-1

As for the Bulky organic fertilizer's retreatment B2 was the height value 4.22 mg h-1 compared with control treatment amounting to 3.42 mg h-1 then treatment M2 gives the height value amounting to 4.00 mg h-1 when we use the height level of fertilizer compared with control treatment 3.47 mg h-1

two -way interaction between Bulky and non-Bulky organic fertilizers in value of dry weight for potato plant treatment NG2B2 gives the high volume amounting to 4.4 8 mg h-1 ,as for the two- way interaction between Bulky organic and mineral fertilizers treatment NG2M2 give the high value 4.16 mg h-1 this is attributed to the application of varying levels of organic and mineral fertilizers significantly influences the availability of nitrogen, phosphorus, and potassium in the soil, thereby enhancing soil fertility. A clear relationship exists between the availability of these nutrients in the soil and their concentration in plant tissues, which provides valuable insight into how combined fertilization strategies can improve crop productivity and nutritional quality, that's agree with (Jaafar. and Abdul Rasool, 2025),The interaction between Bulky organic and mineral fertilizers the effect was not significant in dry weight value but the three-way interaction between study factors the results show in NG2B2M2 give the high value amounting to 4.56 mg h-1 compared with control treatment NG1B0M0 amounting to 3.23 mg h-1 this is attributed to "The complementary role of organic and mineral sources in improving soil structure, increasing organic matter content and the availability of nutrients, and stimulating microbial activity has been shown to enhance nutrient uptake efficiency, thereby promoting better plant growth and higher crop yield , This is consistent with the findings of (Linda et al., 2025)

5-Tuber yield mg h-1

Table 7: Tuber yield mg h-1

NG * B	M Mineral fertilizers			Bulky organic fertilizers B	Non-Bulky organic fertilizers NG
	M2	M1	M0		
31.9	36.2	34.4	25.1	B0	NG 1
42.8	50.4	42.6	35.4	B1	
47.3	54.3	48.3	39.5	B2	
41.2	48.9	39.5	35.2	B0	NG 2
48.8	61.1	47.6	37.7	B1	
56.0	65.6	56.6	45.8	B2	
1.9 LSD	N.S			LSD 0.05	
NG * M					
Mean of the non-Bulky	M2	M1	M0	Non-Bulky organic fertilizers	
40.7	47.0	41.8	33.3	NG 1	
48.6	58.5	47.9	39.5	NG 2	
1.1 LSD	1.9			LSD	
B * M					
Mean of the Bulky fertilizers	M2	M1	M0	Bulky organic fertilizers	
36.5	42.6	37.0	30.1	B0	
45.8	55.8	45.1	36.5	B1	
51.7	59.9	52.4	42.6	B2	
1.4 LSD	2.3			LSD	
M					
	M2	M1	M0	Mineral fertilizers	
	52.7	44.8	36.4	mean of Mineral fertilizers	
	1.4			LSD	

Table 7 showed that effect of factors study in tuber yield that effect of non-Bulky organic fertilizers was significant in yield the second level NG2 give the height yield amounting to 48.6 mg h-1 and the effect of Bulky organic fertilizers was significant too with treatment B2 give the high volume amounting to 51.7 mg h-1 As for the mineral fertilizers quantity significant effect in tuber yield M2 give the Hight value of tuber yield amounting to 52.7 mg h-1 Table 6 evolve revolve revolt revealed the two- way interaction between non Bulky and Bulky fertilizers was significant treatment Ng 2B2 give the high volume amounting to 56.0 mg h-1 Theis attributed to the presence of Bulky fertilizers, as they are characterized by slow solubility and resistance to leaching Consequently, nutrients remain available for a longer period to the plant, leading to higher yield, which is consistent with previous studies reporting improved crop performance under Bulky fertilization(Hatta et al.,2024) .the two- way interaction between not the Bulky and mineral fertilizers was significant right As for the treatment NG2M2 give the high yield from tuber amounting to 58.5 mg h-1 on the interaction between Bulky and mineral fertilizers was significant treatment B2M2 give the high tuber amounting to 59.9 mg h-1 this is attributed to combination of Bulky organic with mineral fertilizers improved soil environment and increased the activity of biomass Can you watch it uptake on achieving nutritional balance therapy enhancing potato yield and that agree with (Blecharczyk et al., 2023) the third way instruction has no significant effect in tuber yield

4. Conclusion

The combined application of Bulky organic and mineral fertilizers produced the highest growth indices and yield in potato plants, reflecting the complementary benefits of these nutrient sources. Bulky organic fertilizers provide a gradual release of nutrients, ensuring their availability throughout critical growth stages, while mineral fertilizers supply readily available nutrients that enhance nutrient uptake efficiency and promote plant development. In parallel, non-Bulky organic fertilizers derived from blood and bone residues and date by-products stimulated the activity of beneficial soil microorganisms, improving soil fertility through organic matter decomposition, humus formation, and sustained nutrient supply. These inputs not only supported plant growth and physiological regulation but also contributed to

overall crop health in a natural and sustainable manner. Furthermore, the use of non-Bulky organic fertilizers helps mitigate environmental impacts and offers a practical strategy for managing surplus livestock waste, thereby promoting agricultural sustainability and environmentally sound recycling practices. Collectively, these findings highlight that integrating organic and mineral fertilization with consideration for soil microbial activity and sustainability maximizes potato productivity while maintaining soil health and environmental balance.

References

Amin, A.E.E.A.Z., 2025. Incubation time effect on releasing available phosphorus in saline sandy soil as a function of bone char application. Scientific Reports, 15(1), p.29491.

Blecharczyk, A., Kowalczewski, P.Ł., Sawinska, Z., Rybacki, P. and Radzikowska-Kujawska, D., 2023. Impact of crop sequence and fertilization on potato yield in a long-term study. Plants, 12(3), p.495.

Chen, G., Wang, Q., Li, H., He, J., Lu, C., Sheng, S. and Zhang, X., 2024. Rapid acquisition method of discrete element parameters of granular manure and validation. Powder Technology, 431, p.119071.

Gelaye, Y., 2023. Effect of combined application of organic manure and nitrogen fertilizer rates on yield and yield components of potato: A review. Cogent Food & Agriculture, 9(1), p.2217603.

Gaudutis, A., Jotautienė, E., Mieldažys, R., Bivainis, V. and Jasinskas, A., 2023. Sustainable use of biochar, poultry and cattle manure for the production of organic granular fertilizers. Agronomy, 13(5), p.1426.

Jaafar, A.A. and Abdul Rasool, K.J., 2025. Effect of organic and mineral fertilizers and agricultural sulfur on concentration of N, P and K in soil and potato tubers. Iraqi J. Agricultural Sci. , 56(2), pp.838-849.

Hatta, M., Aziz, H., Permana, D., Rohaeni, E.S. and Ahmad, S.N., 2024, February. Bioindustry Development of Environment Friendly Organic Fertilizer at Farming Groups in West Kalimantan Indonesia. In IOP Conference Series: Earth and Environmental Science (Vol. 1297, No. 1, p. 012074). IOP Publishing.

Linda, R., David, A. A., & Thomas, T. (2025). Influence of Different Levels Organic and Inorganic Fertilizer Growth and Yield of Potato (Solanum tuberosum L.). International .J . Plant & Soil Sci , 37(1), 502-509

Martirosyan, H., Galstyan, M., Aloyan, T., Gasparyan, N., Terteryan, K., Sahakyan, N. and Avagyan, G., 2024. The impact of mineral and organic fertilizers on potato yield, quantitative and qualitative indicators, and functional value. Functional Food Sci -Online ISSN: 2767-3146, 4(8), pp.309-324.

Mugo, J. N., Karanja, N. N., Gachene, C. K., Dittert, K., Nyawade, S. O., & Schulte-Geldermann, E. (2020). Assessment of soil fertility and potato crop nutrient status in central and eastern highlands of Kenya. Scientific Reports, 10(1), 1-11, https://doi.org/10.1038/s41598-020-64036-x

Siamalube, B., Lambert, E., Anyaji, C. and Ehinmitan, E., 2025. Advancements in potato sci: agronomy, genetics, and biotechnology for sustainable food security. Potato J. of India.

Šarauskis, E., Naujokienė, V., Lekavičienė, K., Kriaučiūnienė, Z., Jotautienė, E., Jasinskas, A. and.

Taki, L., Joseph, B., Gladis, R., Rani, B., Sajitha Rani, T. and Rafeekher, M., 2024. Development and Characterization of Multi-Nutrient Formulations for Organic Farming. International Journal of Plant & Soil Science, 36(4), pp.224-234.

Zaidan, G., Aied, K.Y. and Alkurtany, A.E., 2024. Assessing the compost of Prosopis farcta and Alhagi maurorum as organic fertilizer for potato growth and yield (Solanum tuberosum L.). Tikrit .J . Agricultural Sci s, 24(2), pp.178-196.