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Influence of zinc sulphate and potassium nitrate on biochemical parameters, yield and yield attributes of lathyrus

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Abstract
A field experiment was conducted during *rabi* 2021-22, to study the influence of zinc sulphate and potassium nitrate on morpho-physiological parameters, yield and yield contributes of lathyrus cv. ratan. The experiment was laid down in randomized block design with nine treatments and three replications at research farm of Botany Section College of Agriculture, Nagpur. The aim of this work was to study the effect of foliar application of zinc sulphate at 0.25, 0.50, 0.75 and 1% and potassium nitrate at 0.20, 0.40, 0.60 and 0.80% on biochemical parameters and yield in lathyrus. Spraying of zinc suphate and potassium nitrate was done two times i.e. on 20 and 40 DAS. Observations about biochemical parameters like leaf chlorophyll, nitrogen content in leaves and protein content in seed were also estimated. Observation on yield contributing parameters like 100 seed weight (g), number of pods plant^{-1}, grain yield plant^{-1}, plot^{-1}, ha^{-1}, harvest index recorded. Foliar sprays of 0.80% KNO_3 followed by 0.60% KNO_3 significantly enhanced biochemical parameters and yield contributing parameters when compared with control and rest of the treatments under study.

Keywords: Lathyrus, $ZnSO_4$, KNO_3, foliar spray, biochemical parameters

Introduction
Lathyrus sativus, also known as grass pea, cicerchia, blue sweet pea, chickling pea, chickling vetch, Indian pea, white pea and white vetch, is a legume (family Fabaceae)commonly grown for human consumption and livestock feed in Asia and East Africa. It is a particularly important crop in areas that are prone to drought and famine, and is thought of as an 'insurance crop' as it produces reliable yields when all other crops fail.

The edible *Lathyrus sativus* originated in the West Central Asia Mediterranean region and North India was its centre of domestication. The states which cultivate lathyrus are Maharashtra, Madhya Pradesh, Bihar, West Bengal and Eastern Uttar Pradesh contributing about 4.5% total pulse production of the country. In Maharashtra it is cultivated in Bhandara, Chandrapur, Gadchiroli, Gondia and Nagpur districts of eastern Vidarbha.

Zinc sulphate is the inorganic compound with equation $ZnSO_4$. It was generally known as "white vitriol". It is a powder that is colourless and totally water solvent. It is a fundamental part of catalysts engaged with metabolic reaction. Zinc sulphate is most ordinarily utilized source of zinc in granular fertilizer due to its high solvency in water and it is relatively low cost of production. They are responsible for use in a wide range of soils. It influences a few biochemical cycles in the plant, like cytochrome and nucleotide synthesis, chlorophyll production, enzyme activation, membrane integrity and hormone regulation (e.g., Tryptophan synthesis, a precursor of IAA).Sulphur assumes urgent part in controlling metabolic and enzymatic cycles including photosynthesis, respiration and legume rhizobium symbiotic nitrogen fixation, energy transformation, activation of enzymes and also in carbohydrate metabolism which reflected in expanded yield. (Nalini *et al.,* 2013) [10].

Potassium is known to be taken up by plant roots at high rates and is quickly transported to the upper plant parts. The downward transport of K from tops to roots is also a rapid process, so that once K is absorbed, it is readily distributed throughout the entire plant. Potassium is taken up from the soil solution by root epidermal and cortical cells. Once K is inside the root symplast, it may be sorted in vacuoles, where it fulfills osmotic functions, or is transported to the shoot via xylem (Pardo and Rubio, 2011) [12].

Material and Methods

The project entitled "influence of zinc sulphate and potassium nitrate on morpho-physiological parameters, yield and yield contributes of lathyrus" was conducted during *rabi* season 2021-22 at research farm of Botany Section College of Agriculture, Nagpur in a Randomized Block Design with nine treatments and three replications. Treatment consists of T_1 (control), T_2 ($ZnSO_4$ 0.25%), T_3 ($ZnSO_4$ 0.50%), T_4 ($ZnSO_4$ 0.75%), T_5 ($ZnSO_4$ 1.0%), T_6 (KNO_3 0.20%), T_7 (KNO_3 0.40%), T_8 (KNO_3 0.60%) and T_9 (KNO_3 0.80%) were tested. The gross plot size was 2.70 m x 2.20 m and net plot size was 2.10 m x 2.00 m with spacing of 30 cm x 10 cm. Five plants from each plot were selected randomly and data were collected at 25, 45 and 65 DAS on total chlorophyll content, nitrogen content in leaves and protein content in seeds were calculated 65 DAS. Total chlorophyll content of oven dried leaves was estimated by colorimetric method as suggested by Bruinsma (1982) [3]. Nitrogen content in leaves was estimated by micro kjeldahl's method as given by Somichi *et al*, 1972 [18]. Protein content in seed plant^{-1}, test weight, number pods, grain yield plant^{-1}, plot^{-1}, ha^{-1}, harvest index and B:C ratio were calculated after harvest. Data was estimated by to statastical analysis as per method suggested by Panse and Sukhatme (1954) [11].

Results and Discussion

Total chlorophyll content (mg g^{-1})

At 25 DAS, total chlorophyll content in leaves ranged between 1.50 –1.96 mg g^{-1}. Significantly highest chlorophyll content was observed in T_9 KNO_3 @0.80% (1.96 mg g^{-1}) followed by T_8 KNO_3 @0.60% (1.91 mg g^{-1}) and T_5 $ZnSO_4$ @ 1% (1.90 mg g^{-1}). However, these three treatments were found at par with each other. T_4 $ZnSO_4$ 0.75% (1.87 mg g^{-1}), T_5 KNO_3 0.40% (1.84 mg g^{-1}) and T_6 KNO_3 0.20% (1.77 mg g^{-1}) recorded moderately higher total chlorophyll content than rest of the treatments. However, both of these treatments were found at par with each other. T_1 control (1.50 mg g^{-1}) recorded significantly lowest total chlorophyll content among all other treatments under study.

At 45 DAS, total chlorophyll content in leaves varied from 1.72 - 2.38 mg g^{-1}. The significantly highest chlorophyll noticed in T_9 KNO_3 @ 0.80% (2.38 mg g^{-1}) followed by T_8 KNO_3 @ 0.60% (2.22 mg g^{-1}) and T_5 $ZnSO_4$ @ 1% (2.13 mg g^{-1}). T_4 $ZnSO_4$ 0.75% (2.09 mg g^{-1}), T_7 KNO_3 0.40% (1.98 mg g^{-1}), whereas, T_6 KNO_3 0.20% (1.93 mg g^{-1}) recorded moderately higher total chlorophyll content than rest of the treatments. Treatments, T_1 control (1.72 mg g^{-1}) recorded lower total chlorophyll content among all other treatments and were found at par with each other.

At 65 DAS, significantly highest total chlorophyll content in leaves was registered in total chlorophyll content in leaves ranged between 3.41 – 4.13 mg g^{-1}. Significantly highest chlorophyll content was observed in T_9 KNO_3 @ 0.80% (4.13 mg g^{-1}) followed by T_8 KNO_3 @ 0.60% (4.03 mg g^{-1}) and T_7 $ZnSO_4$ @ 1% (3.75 mg g^{-1}). However, these three treatments were found at par with each other. T_4 $ZnSO_4$ 0.75% (3.89 mg g^{-1}), T_7 KNO_3 0.40% (3.75 mg g^{-1}) and T_6 KNO_3 0.20% (3.52 mg g^{-1}) recorded moderately higher total chlorophyll content than rest of the treatments. T_1 control (3.41 mg g^{-1}) recorded significantly lowest total chlorophyll content among all other treatments under study.

Higher total chlorophyll content recorded in T_9 KNO_3 @ 0.80% (4.13 mg g^{-1}) due to enhancement of photosynthetic pigments (chlorophyll *a* and chlorophyll *b*).

These results are in accordance with the findings of Sale and Nazirkar (2013) [14] observed that application of micronutrients significantly increased chlorophyll content of soybean over the control. The average chlorophyll content of soybean was maximized by the application of Zn @ 0.5% at 30, 50 and 70 DAS @ 0.66 g kg^{-1}. Similar result recorded by Gowthami *et al*. (2017) [4] recorded potassium and zinc as a foliar spray on quality parameters in soybean. The @ 2% + zinc sulphate @ 1% (T_7) at 30 and 60 DAS was found to be superior in increasing the quality parameters like total chlorophyll content (20.60% over control). Whereas, Krishna and Kaleeswari (2018) [5] did pot investigate on red gram var. CO(Rg)7. The Chlorophyll 'a', 'b' and total chlorophyll contents were found to be the highest in the treatment that received from foliar spray of 0.5% KNO_3. Also Shahi *et al.* (2019) [17] reported that the response of black gram to potassium under water stress condition. Chlorophyll content was increased with foliar application of @ 400 ml water + 200 ppm KNO_3

Protein content in seeds

Data revealed that significantly higher protein content was observed in treatment T_9 KNO_3 @ 0.80% (30.69%) followed by T_8 KNO_3 @ 0.60% (29.72%) and T_5 $ZnSO_4$ @ 1% (29.49%). However, these three treatments were found at par with each other. T_4 $ZnSO_4$ 0.75% (28.93%), T_7 KNO_3 0.40% (28.65) and T_6 KNO_3 0.20% (27.60%) recorded moderately higher protein content in seeds content than rest of the treatments. T_1 control (25.21%) recorded significantly lowest protein content among all other treatments under study.

Similar results were reported by Anees *et al.* (2016) [1] recorded that application of potassium and zinc had significant effect on protein content of maize. Higher protein content of maize grains was noted with potassium (1%) and zinc (0.1%) as foliar feedings on maize crop by these two treatments applied. However, Theoneste *et al.* (2018) [19] observed that the K_4 (0.6g /pot) significantly obtain highest protein content in mungbean. Also Pise *et al*. (2019) [13] reported that foliar application of $ZnSO_4$ 0.5% 25 and 40 DAS showed a significant increase in protein content in seeds of lathyrus.

Leaf nitrogen content

Scrutiny of the data revealed marked effect of foliar spray of $ZnSO_4$ and KNO_3 on the nitrogen content of lathyrus at 25, 45 and 65 DAS.

At 25 DAS nitrogen content is differed among the treatments and ranged from 1.71 – 2.28%. The best and significant results were obtained in T_9 (KNO_3 0.80%) followed by treatments T_8 (KNO_3 0.60%), T_5 ($ZnSO_4$ 1.0%), T_4 ($ZnSO_4$ 0.75%), T_7 (KNO_3 0.40%), T_6 (KNO_3 0.20%) and T_3 ($ZnSO_4$ 0.50%) had also stimulatory effect on leaf nitrogen content over control. But, only treatment T_2 ($ZnSO_4$ 0.25%) found at par with control.

At 45 DAS nitrogen content in leaves ranged from 2.80 – 4.13%. Significantly maximum increment in N content over control was observed in case of foliar sprays of T_9 (KNO_3 0.80%) followed by treatments T_8 (KNO_3 0.60%), T_5 ($ZnSO_4$ 1.0%), T_4 ($ZnSO_4$ 0.75%), T_7 (KNO_3 0.40%),

T_6 (KNO_3 0.20%) and T_3 ($ZnSO_4$ 0.50%) also showed significantly more nitrogen content over control. While, treatment T_2 ($ZnSO_4$ 0.25%) showed least nitrogen content and found at par with control.

At 65 DAS nitrogen content in leaves ranged from 4.20 – 5.73%. Among all the treatments significantly maximum N content at 65 DAS was recorded in treatment T_9 (RDF + KNO_3 0.80%) followed by treatments T_8 (KNO_3 0.60%), T_5 ($ZnSO_4$ 1.0%), T_4 ($ZnSO_4$ 0.75%), T_7 (KNO_3 0.40%) and T_6 (KNO_3 0.20%) over control and rest of the treatments. But treatments and T_3 ($ZnSO_4$ 0.50%) and T_2 ($ZnSO_4$ 0.25%) showed least nitrogen content and found at par with control.

Krishna and Kaleeswari (2018) [5] did pot investigate on red gram var. CO(Rg)7. The nitrogen contents were found to be the highest in the treatment that received from foliar spray of 0.5% KNO_3. Similarly, Theoneste *et al.* (2018) [19] observed that the K_4 (0.6g/pot) significantly obtain highest nitrogen content in mungbean. Also Pise *et al*. (2019) [13] reported that foliar application of $ZnSO_4$ 0.5%. 25 and 40 DAS showed a significant increase in N content in leaves of lathyrus.

Test Weight

The range of test weight recorded after harvest was 2.70-3.86 g. Significantly highest test weight content was found in T_9 KNO_3 @ 0.80% (3.86 g).

Application of zinc sulphate and potassium nitrate as foliar spray increased the seed weight due to movement of nutrients in plants for redistribution of minerals to the grains, extend the grain filling period leading to improvement in grain weight.

According to results of Pise *et al.* (2019) [13], who studied the influence of zinc and iron on morpho-physiological parameters and yield of lathyrus (*Lathyrus sativus* L.) and stated that application of $ZnSO_4$ 0.5% foliar spray at 25 and 40 DAS recorded highest test weight over control. However, Singh and Singh (2020) [16] observed that the foliar application of 0.5% KNO_3 showed highest test weight in wheat. Almost similar results were reported by Kumar *et al.* (2022) [7] that effect of potassium level on performance of chickpea and recorded maximum weight of 100 seeds in level 90 kg potassium ha^{-1}. Whereas, Monga and Kumar (2022) [9] observed that the foliar application of 2% KNO_3 showed that the significantly highest number of grain $plant^{-1}$ and weight of 1000 seeds in wheat.

Number of Pod $Plant^{-1}$

At harvest the range of number of pod $plant^{-1}$ was observed in the range of 60.15-78.33. Significantly highest number of pods was found in T_9 KNO_3 @ 0.80% (78.33) followed by T_8 KNO_3 @ 0.60% (75.67) and T_7 $ZnSO_4$ @ 1% (75). The significant increase in number of pods was observed due to spraying of zinc sulphate and potassium nitrate at 25, 45 and 65 DAS.

According to results of Pise *et al.* (2019) [13], who studied the influence of zinc and iron on morpho-physiological parameters and yield of lathyrus (*Lathyrus sativus* L.) and stated that application of $ZnSO_4$ 0.5% foliar spray at 25 and 40 DAS recorded highest number of pods $plant^{-1}$ over control. Almost similar results were reported by Kumar *et al.* (2022) [7] that effect of potassium level on performance of chickpea and recorded maximum weight of 100 seeds and number of pods plant $^{-1}$ in level 90 kg potassium ha^{-1}. However, Monga and Kumar (2022) [9] observed that the foliar application of 2% KNO_3 showed that the significantly highest number of grain $plant^{-1}$ and weight of 1000 seeds in wheat.

Seed Yield $Plant^{-1}$(g), $Plot^{-1}$ (kg) and HA^{-1}(q)

Significantly maximum seed yield $plant^{-1}$, $plot^{-1}$ and $hectare^{-1}$ were produced in treatment T_9 KNO_3 @ 0.80% followed by T_8 KNO_3 @ 0.60%, T_7 $ZnSO_4$ @ 1%, T_6 (KNO_3 0.20%), T_3 ($ZnSO_4$ 0.50%) and T_2 ($ZnSO_4$ 0.25%) over control.

The range of increase in seed yield $plant^{-1}$, $plot^{-1}$ and $hectare^{-1}$ was 2.82 g, 0.44 kg and 10.55 q in treatment T1 (control) and 4.28 g, 0.68 kg and 16.26 q in treatment T_9 KNO_3@0.80% respectively.

The above finding was in corroboration with the findings of Sarkar and Malik (2001) observed foliar spray of KNO_3 and $ZnSO_4$ on yield ascribing characters of grass pea. Foliar spray of KNO_3 at 0.50% during 50% flowering stage showed maximum values of length of pod, seeds pod^{-1} and 1000 seed weight; it was essentially better than water spray and unsprayed control. Whereas, Anitha *et al*. (2005) [2] recorded that the foliar application of micronutrients like iron and zinc had significant Influence on the yield of cowpea. 0.5% $ZnSO_4$, at 45 DAS proved most effective and increased the seed yield by 43.09% when compared with control followed by combined spraying of 0.5% $ZnSO_4$, at 25 DAS (40.14%). The net return and benefit: cost ratio also followed the same trend. However, Mate *et al*. (2020) recorded foliar feeding of zinc sulphate at 0.5% individually and in their combinations. The foliar feeding at 25 and 35 DAS showed significantly increases the seed yield $plot^{-1}$. Singh and Singh (2020) [16] observed that the foliar application of 0.5% KNO_3 showed highest grain yield ha^{-1} and B:C ratio in wheat. Similar results were reported by Kumar *et al.* (2022) [7] that effect of potassium level on performance of chickpea and recorded maximum seed yield $plant^{-1}$, seed yield ha^{-1} in level 90 kg potassium ha^{-1}. Also Monga and Kumar (2022) [9] observed that the foliar application of 2% KNO_3 showed the significantly highest number of grain $plant^{-1}$, harvest index and B:C ratio in wheat.

Harvest index

Harvest index was significantly increased and was highest in treatment T_9 (KNO_3 0.80%) followed by treatments T_8 (KNO_3 0.60%), T_5 ($ZnSO_4$ 1.0%), T_4 ($ZnSO_4$ 0.75%) and T_7 (KNO_3 0.40%) over control and rest of the treatments. But, treatments T_6 (KNO_3 0.20%), T_3 ($ZnSO_4$ 0.50%) and T_2 ($ZnSO_4$ 0.25%) found at par with treatment T_1 (control). This might be due to the physiological index reflecting the percentage of assimilates mobilization from vegetative organs of plant into grains.

Above results are in agreement with the experimental studies of many scientists Singh and Singh (2020) [16]. The effect of foliar application of potassium nitrate on late sown wheat (*Triticum aestivum* L.) in mitigating terminal heat stress revealed that the foliar application of 0.5% KNO_3 showed highest number of grain $plant^{-1}$, test weight, grain yield ha^{-1} and B:C ratio. Almost similar results were reported by Kumar *et al.* (2022) [7] that effect of potassium level on performance of chickpea and recorded highest harvest index in level 90 kg potassium ha^{-1}.

Table 1: Total chlorophyll content in leaves (mg g-1), Nitrogen content in leaves (%) and Protein content in seeds (%) at harvest

Treatments	Biochemical analysis						
	Total chlorophyll content (mg g^{-1})			Nitrogen content in leaves (%)			Protein Content in seeds (%)
	25 DAS	45 DAS	65 DAS	25 DAS	45 DAS	65 DAS	At harvest
T1 Control	1.50	1.72	3.41	1.71	2.80	4.20	25.21
T2 $ZnSO_4$ @ 0.25%	1.56	1.75	3.43	1.77	2.92	4.34	25.99
T3 $ZnSO_4$ @ 0.50%	1.59	1.77	3.47	1.83	3.16	4.58	26.85
T4 $ZnSO_4$ @ 0.75%	1.87	2.09	3.89	1.98	3.77	5.40	28.93
T5 $ZnSO_4$ @ 1%	1.90	2.13	3.93	2.09	3.89	5.52	29.49
T6 KNO_3 @ 0.20%	1.77	1.93	3.52	1.92	3.41	4.94	27.60
T7 KNO_3 @ 0.40%	1.84	1.98	3.75	1.95	3.65	5.25	28.65
T8 KNO_3 @ 0.60%	1.91	2.22	4.03	2.12	4.01	5.67	29.72
T9 KNO_3 @ 0.80%	1.96	2.38	4.13	2.28	4.13	5.73	30.69
SE(m)	0.031	0.054	0.097	0.039	0.055	0.13	0.37
CD	0.093	0.16	0.29	0.11	0.11	0.41	1.13

Table 2: Test weight, Number of pod $plant^{-1}$, Seed yield $plant^{-1}$ (g), Seed yield $plot^{-1}$ (kg), Seed yield ha^{-1} (q) and Harvest index (%).

Treatments	Test weight (g)	Number of pod $plant^{-1}$	Seed yield $plant^{-1}$ (g)	Seed yield $plot^{-1}$ (kg)	Seed yield ha^{-1} (q)	Harvest index (%)
T1 Control	2.70	60.15	2.82	0.44	10.55	30.00
T2 $ZnSO_4$ @ 0.25%	2.80	67.00	2.90	0.46	11.36	31.77
T3 $ZnSO_4$ @ 0.50%	2.91	68.33	3.03	0.49	11.92	32.55
T4 $ZnSO_4$ @ 0.75%	3.53	74.37	3.92	0.60	13.31	34.01
T5 $ZnSO_4$ @ 1%	3.68	75.00	4.03	0.62	14.89	35.95
T6 KNO_3 @ 0.20%	2.99	70.98	3.33	0.51	12.06	32.81
T7 KNO_3 @ 0.40%	3.36	72.63	3.68	0.57	13.18	33.75
T8 KNO_3 @ 0.60%	3.73	75.67	4.18	0.66	15.63	37.01
T9 KNO_3 @ 0.80%	3.86	78.33	4.28	0.68	16.26	38.61
SE(m)	0.21	2.78	0.27	0.044	0.97	1.22
CD	0.65	8.36	0.83	0.13	2.90	3.68

References

1. Anees MA, Ali A, Shakoor U, Ahmed F, Hasnain Z, Hussain A. Foliar applied potassium and zinc enhances growth and yield performance of maize under rainfed conditions. Int. J Agric. Biol. 2016;18:1025-1032.
2. Anitha S, Sreenivasan E, Purushotham SM. Response of cowpea (*Vigna unguiculata* (I.) Walp.). To foliar nutrition of zinc and iron in the oxisols of kerala, Legume Res. 2005;28(4):294-296.
3. Bruinsma J. A comment on spectrophotometric determination of chlorophyll. Bio-chem., Bio-phy., Acta. 1982;52:576-578.
4. Gowthami PG, Rama Rao, Rao KLN, Lal Ahamed M. Effect of foliar application of potassium, boron and zinc on quality and seed yield in soybean. IJCS 2017;6(1):142-144.
5. Krishna ON, Kaleeswari RK. Response of Pulses to Foliar Application of Multinutrients on Yield, Quality, Uptake and Soil Nutrient Status. Madras Agric. J. 2018;105(4-6):176-181.
6. Kumar S, Gupta P, Barpete S, Sarkar A, Amri A, Mathur PN, *et al*. Grass pea. In: Singh M, Upadhyaya HD, Bisht IS (eds) Genetic and genomic resources of grain legume improvement. Elsevier, Amsterdam; c2013. p. 269-292.
7. Kumar H, Yadav BS, Singh R, Yadav DD, Chahal VP, Yadav R, Yadav OS. Effect of potassium nitrate levels on performance of chickpea (*Cicer arietinum* L.) under different genotypes. Int. J of Chemical studies 2022;6(6):1675-1677.
8. Mate PR, Deotale RD, Chande KB, Kamdi SR, Shende PV. Morpho-physiological traits and yield in green gram as influenced by foliar feeding of zinc sulphate. J Soils and crops 2020;30(2):279-284.
9. Monga R, Kumar R. Effect of foliar application of potassium nitrate and salicylic acid on yield, yield attributes and economics of wheat (*Triticum aestivum* L.). J Soils and Crops. 2022;32(1):97-101.
10. Nalini P, Gupta B, Pathak GC. Foliar application at flowering stage improves plants performance, yield and yield attributes of blackgram. Indian J of exeperimental biology. 2013;51:548-555.
11. Panse VG, Sukhatme PV. In statistical method for agricultural worker ICAR publication, New Delhi; c1954.
12. Pardo JM, Rubio F. Transporters and pumps in plant signalling; c2011. p. 65-98.
13. Pise SE, Shende PV, Deotale RD, Raut DA, Blesseena A. Hivare VS. Influence of zinc and iron on morpho-physiological parameters and yield of lathyrus (*Lathyrus sativus* L.) J. Soils and Crops 2019;29(2):360-365.
14. Sale RB, Nazirkar RB. Effect of micronutrients application on the growth traits and yield of soybean (*Glycine max* L. Merrill) under rainfed condition in Vertisol. An Asian J. Soil Sci. 2013;8(2):422-425.
15. Sarkar RK, Malik GC. Effect of foliar spray of potassium nitrate and calcium nitrate on grasspea (*Lathyrus sativus* L.) grown in rice fallows. Lathyrus Lathyrism Newsletter 2001;2:47-48.
16. Singh KM, Singh HM. The effect of foliar application of potassium nitrate on late sown wheat (*Triticum aestivum* L.) in mitigating terminal heat stress. J Pharma And Phytochemistry. 2020;SP6:492-495.
17. Shahi S, Kumar R, Srivastava. Response of black gram to potassium under water stress condition. Annals of plants and soil Res. 2019;21(1):93-97.

18. Somichi Y, Doughlus SY, James AP. Laboratory manual. Physiological studies in rice analysis for total nitrogen (organic N) in plant tissue. The Inter Res. Instti. Los Banos, Languna, Phillipine: II; c1972.
19. Theoneste MY, Oo LW, Chiwasa TG, Lee SC. Investigate the response of different potassium application rates on growth, yield, carbohydrates and protein content of mungbean; c2018. IJSR. ISSN:2319-7064.