Results further revealed that different zinc treatments provided better results in the seed and straw of green gram. Potassium application significantly improved the nutrient content and uptake by green gram. The content of Zn, Mn and Cu was not significantly influenced by the application of potassium and zinc levels. It was observed that the availability of particular nutrient increased by its application to the soil. Significantly maximum available K (176.40 kg ha⁻¹) and Zn (38.70 kg ha⁻¹) content and uptake of N (5.23 kg ha⁻¹) and K (12.43 kg ha⁻¹) in seed as compared to control. Similar in case of straw, K (12.43 and 13.25 kg ha⁻¹) and K (17.17 and 19.69 kg ha⁻¹) in straw over the control. The content of Zn, Mn and Cu were not significantly influenced by the application of potassium except Fe whereas the uptake of all the micronutrients under consideration was significantly increased with the potassium application. Results further revealed that different zinc treatments significantly influenced only Zn content in seed and straw while the uptake of both macro and micronutrients except phosphorus in both seed and straw were found to be influenced significantly by different zinc levels.

It was observed that the availability of particular nutrient increased by its application to the soil. Significantly maximum available K and Zn (176.40 kg ha⁻¹ and 1.60 mg kg⁻¹, respectively) was recorded with the application of potassium @ 30 kg ha⁻¹ and zinc @ 37.5 kg ha⁻¹. Due to the K and Zn application the soil fertility status was found to improve. After the harvest of the crop, availability of all the nutrients increased with the fertilization of potassium and zinc.

Keywords: Green gram, potassium, zinc, nutrient content, uptake, soil fertility

Introduction
Green gram (Vigna radiata L. Wikzek) commonly known as moong belongs to the Family Fabaceae. It is grown all around the globe including Southern and Eastern Asia, South and North America, Central Africa, Australia and some parts of China particularly for its protein enriched grains (Dahiya et al., 2015) [11]. India stands first in both area and production of green gram all around the globe with production of 2.02 million tonnes. In Haryana, during 2017-18 green gram was grown in an area of 29.60 thousand ha producing 24.39 thousand tonnes with an average productivity of 824 kg ha⁻¹ (Anonymous, 2018a) [4]. In Haryana, it can be grown in kharif as well as in summer season due to wide adaptability and short duration. Green gram has wider adaptability, better palatability, higher market price and easy digestibility, so it can play a key role in increasing the economy of India (Reddy, 2009) [24]. Green gram is also proved to have antioxidant, antimicrobial and insecticidal properties due to presence of bioactive compounds (Ahmad et al., 2018) [2]. Being a leguminous crop, it has the capability of utilizing and fixing atmospheric nitrogen with the help of nodules. It not only restores soil fertility but also improves the soil physical properties.

Fertilizers are one of the vital inputs required in production of any crop. The supply of nutrients in adequate amount by the chemical fertilizers is found very intimately linked to the plant growth and development. Potassium is widely regarded as the “quality element” for crop

Satender Kumar, MK Jat, PS Sangwan, Rishav Bhatia and Priyanka

DOI: https://doi.org/10.22271/chemi.2020.v8.i2u.8959
production (Usherwood, 1985; Pettigrew, 2000) [29], [31]. Potassium as a macronutrient plays a dynamic role in plant growth and sustained production of crops. Potassium (K⁺) has significant effect on stomatal movement, photosynthesis, synthesis of proteins and water-relations (osmotic adjustment and turgor regulation) in plants (Marschner, 2002) [33]; activation of about 60 enzymes (Bukhsh et al., 2011) [35], in grain development, plant metabolism as well as drought, pest and disease resistance (Egila et al., 2001) [32].

Application of Potassium (K⁺) is very rarely done in pulses despite field studies that suggested the application of K₂O to the tune of 20-40 kg ha⁻¹ to be helpful in attaining higher levels of pulse production (Ali and Srinivasarao, 2001) [35]. Among various micronutrients, Zinc is one of the seven important elements for plant growth and it activates many enzymes which are involved in metabolic processes and biochemical pathways. It acts as a functional, structural and regulatory co-factor for many enzymes and has key role in DNA transcription. Nijra and Nabwami (2015) [39] reported that it influences the formation of chlorophyll and auxins which resulted in formation of the growth promoting compounds. About 43% of the soil samples collected from different parts of India were found to be deficient in zinc (Shkula et al., 2014) [37]. By the year 2025, it is assumed that the zinc deficiency is likely to increase from 49 to 63% as most of the cultivated soils are showing the symptoms of zinc deficiency (Arunachalam et al., 2013) [6]. Zinc deficiency resulted as stunted growth, chlorosis, smaller leaves and spikelet sterility. Hence, zinc application is must for keeping adequate amount of available zinc in soil solution, maintaining sufficient zinc transport to seeds and for increasing crop produce. Keeping the above views in mind the current studies were planned to decipher the effects of different levels of potassium and zinc application on content and uptake of nutrients in green gram.

Materials and methods

The field experiment was conducted at research area of Regional Research Station, Bawal situated in district Rewari in the south-west Haryana. The research station is located at latitude 28.10° N, longitude 76.50° E and 266 m above mean sea level. The initial soil properties of the experiment site were analysed and it was found that the soil was loamy sand in texture containing 102.37, 11.18 and 170.10 kg ha⁻¹ available nitrogen, phosphorus and potassium, respectively as macronutrients and 0.97, 7.64, 6.24 and 0.52 available zinc, iron, manganese and copper, respectively as micronutrients in 0-15 cm depth with pH 8.17, EC 0.16 dS m⁻¹ and organic carbon 0.17 per cent. The experiment was laid out in split plot design in triplications on green gram cultivar MH-421 with plot size of 4.0 m x 3.6 m. Sixteen treatments were assigned consisting of four potassium application levels (0, 10, 20 and 30 kg K₂O ha⁻¹) and four zinc application levels (0, 12.5, 25 and 37.5 kg ZnSO₄). The treatments were allotted to various plots with the help of random table as advocated by Fisher (1950). The recommended dose of fertilizer (RDF) was 6:16 kg for N and P₂O₅ ha⁻¹ (Anonymous, 2018b) [5]. The fertilizers (RDF, K₂O and ZnSO₄) were applied at the time of sowing through soil application. Diammonium phosphate (DAP), Muriate of potash (MOP) and zinc sulphate were used to provide desired levels of nutrients to the crops. The crop was raised with all the standard package of practices and protection measures also timely carried out as they required (Anonymous, 2018b) [5].

The soil samples were collected at random from the experiment area up to the depth of 0-15 cm from selected plots before overlaying the treatments and after harvesting the crop and analysed for its various chemical properties. The methods given below were adopted for analysis of physicochemical properties of soil. Electrical conductivity (EC) and soil reaction (pH) were determined in (1: 2) Soil: Water Suspension using digital pH meter and direct read type conductivity meter (Jackson, 1973). Soil organic carbon content was determined by Walkley and Black (1934) [30] method. Available Nitrogen (N) was determined by alkaline permanganate method (Subbaiah and Asija, 1956) [28]. Available P content was determined by extracting the soil samples using 0.5 NaHCO₃ (pH 8.5) and analyzed by spectrophotometer at 420 nm as described by Olsen et al. (1954) [30]. Available K was extracted by using 1N ammonium acetate (pH 7.0) using a flame photometer as described by Jackson (1973) [31]. Available-Mn, Zn, Cu and Fe content in soil samples was determined by DTPA methods devised by Lindsay and Norvell (1978) [37].

Samples of seed and straw were collected at the time of harvesting and dried (65 ± 2°C for 48 hrs). The dried samples thus obtained were ground to a fine powder and processed further for estimation of various macronutrients (N, P and K) as well as micronutrients (Zn, Fe, Mn and Cu) content in them.

Total Nitrogen content in the digested plant material was determined by colorimetric method using Nessler’s reagent as described by Lindner (1944) [16]. Total Phosphorus in plant sample was determined by Vanado-molybdophosphoric acid yellow colour method as proposed by Koenig and Johnson (1942) [14]. Potassium in the acid digest of plant samples was determined by using flame photometer. The Zn, Fe, Cu and Mn of plant samples were determined by using plant digestion obtained from digestion by HNO₃ and HClO₄ with the help of Atomic Absorption Spectrophotometer (AAS) as described by Lindsay and Norvell (1978) [37].

The data on concentration of NPK, grain yield and straw yield was used to determine the uptake of Nitrogen (N), Phosphorus (P) and Potassium (K) using the following formula:

\[\text{Nutrient uptake (kg ha}^{-1}\text{) = \frac{\text{Nutrient conc. in grain yield (kg ha}^{-1}\text{) \times grain yield (kg ha}^{-1}\text{)}}{100}}\]

The uptake of micronutrients (Zn, Cu, Fe and Mn) by seed and straw of green gram were calculated with the help of following formula:

\[\text{Nutrient uptake (g ha}^{-1}\text{) = \frac{\text{Nutrient conc. in grain yield (g ha}^{-1}\text{) \times grain yield (g ha}^{-1}\text{)}}{1000}}\]

The data recorded during the experiment was subjected to statistical analysis by proper methods using online statistical package OPSTAT developed by Sheoran et al. (1998) [26].

Results and discussion

Effect of potassium

Nutrient content and uptake by seed
Potassium application caused significant increase in the nutrient content (N, P, K and Fe) in seed of green gram (Table 1). However, the content of nutrients increased with the highest level i.e. 30 kg K₂O ha⁻¹ but it was at par with 20 kg K₂O ha⁻¹. Results showed that total nitrogen, phosphorous and potassium uptake and content in seed was significantly influenced by different potassium levels. Both K₃₀ and K₅₀ treatments recorded significantly higher N (3.55 and 3.67%), P (0.48 and 0.50%) and K (1.14 and 1.16%) content and uptake of N (38.70 and 41.91 kg ha⁻¹), P (5.23 and 5.71 kg ha⁻¹) and K (12.43 and 13.25 kg ha⁻¹) in seed as compared to control. The increase in concentration of N and P might be

http://www.chemjournal.com
due to the synergistic effect of potassium on these nutrients and the increase in K concentration and uptake is due to the direct application of potassium which increases its availability to plants. However, in case of micronutrients i.e. Zn, Mn and Cu the concentrations were not significantly influenced by the potassium application except Fe (Table 2). This may be due to the higher initial level of available Fe in soil but the uptake of all micronutrients was significantly influenced by potassium levels. Similar trend was observed with the application of 20 kg K₂O ha⁻¹ for the uptake of micro-nutrient like zinc (24.88 g ha⁻¹), iron (140.24 g ha⁻¹), manganese (25.20 g ha⁻¹) and copper (5.28 g ha⁻¹) uptake by straw which was found statistically at par with the higher level of potassium 30 kg K₂O ha⁻¹. This might be due to the increasing pattern of seed yield with graded levels of fertilizers and due to the dilution effect. Similar findings were observed by Kannan et al. (2014) and Ranpatriya and Polara (2018) [23].

### Table 1: Effect of Potassium and Zinc application on content and uptake of macro nutrients in seed of green gram

| Treatments (kg ha⁻¹) | Seed content (%) | Seed uptake (kg ha⁻¹) |
|----------------------|------------------|-----------------------|
|                      | N (%)            | P (%)                 |
|                       | K (%)            | N (%)                 |
|                       | K (%)            | K (%)                 |
| K₀                   | 3.21             | 0.43                  |
| K₁₀                  | 3.36             | 0.44                  |
| K₂₀                  | 3.55             | 0.48                  |
| K₃₀                  | 3.67             | 0.50                  |
| S.Em±                | 0.05             | 0.01                  |
| CD (p=0.05)          | 0.13             | 0.03                  |

### Table 2: Effect of Potassium and Zinc application on content and uptake of micronutrients in seed of green gram

| Treatments (kg ha⁻¹) | Seed content (mg kg⁻¹) | Seed uptake (mg kg⁻¹) |
|----------------------|------------------------|-----------------------|
|                      | Zn (%)                 | Fe (%)                |
|                      | Mn (%)                 | Cu (%)                |
|                      | Zn (%)                 | Fe (%)                |
|                      | Mn (%)                 | Cu (%)                |
| K₀                   | 22.92                  | 45.30                 |
| K₁₀                  | 23.75                  | 58.12                 |
| K₂₀                  | 24.87                  | 77.44                 |
| K₃₀                  | 25.38                  | 83.60                 |
| S.Em±                | 0.13                   | 2.28                  |
| CD (p=0.05)          | 7.10                   | NS                    |

### Table 3: Effect of Potassium and Zinc application on content and uptake of macronutrients in straw of green gram

| Treatments (kg ha⁻¹) | Straw NPK content (%) | Straw NPK uptake (kg ha⁻¹) |
|----------------------|-----------------------|----------------------------|
|                      | N (%)                 | P (%)                     |
|                      | K (%)                 | N (%)                     |
|                      | K (%)                 | K (%)                     |
| K₀                   | 1.00                 | 0.16                      |
| K₁₀                  | 1.14                 | 0.18                      |
| K₂₀                  | 1.33                 | 0.22                      |
| K₃₀                  | 1.43                 | 0.24                      |
| S.Em±                | 0.06                 | 0.01                      |
| CD (p=0.05)          | 0.17                 | 0.03                      |

### Table 4: Effect of Potassium and Zinc application on content and uptake of micronutrients in straw of green gram

| Treatments (kg ha⁻¹) | Straw content (mg kg⁻¹) | Straw uptake (mg ha⁻¹) |
|----------------------|-------------------------|------------------------|
|                      | Zn (%)                  | Mn (%)                 |
|                      | Fe (%)                  | Cu (%)                 |
|                      | Zn (%)                  | Fe (%)                 |
|                      | Mn (%)                  | Cu (%)                 |
| K₀                   | 18.74                  | 88.95                  |
| K₁₀                  | 19.96                  | 95.39                  |
| K₂₀                  | 20.28                  | 114.32                 |
| K₃₀                  | 21.99                  | 117.36                 |
| S.Em±                | 2.13                   | 2.56                   |
| CD (p=0.05)          | 7.64                   | NS                     |

### Nutrient content and uptake by straw

In case of straw, K₃₀ and K₅₀ treatments recorded significantly higher N (1.33 and 1.43%), P (0.22 and 0.24%) and K (1.40 and 1.47%) content and uptake of N (16.32 and 19.10 kg ha⁻¹), P (2.70 and 3.21 kg ha⁻¹) and K (17.17 and 19.69 kg ha⁻¹) in straw over the control (Table 3). This increase in the concentration of N and P may be possibly due to the synergistic effect of potassium on these nutrients and the increase in K concentration and uptake is due to the direct application of potassium which increases its availability to plants.

However, the micronutrients (Zn, Mn and Cu) concentration in straw were not significantly influenced by the potassium application except Fe (Table 4). This may be due to the higher initial level of available Fe in soil but the uptake of all nutrients by straw was significantly influenced by potassium levels. Similar trend was observed with the application of 20 kg K₂O ha⁻¹ for the uptake of micro-nutrient like zinc (24.88 g ha⁻¹), iron (140.24 g ha⁻¹), manganese (25.20 g ha⁻¹) and copper (5.28 g ha⁻¹) uptake by straw which was found statistically at par with the higher level of potassium 30 kg K₂O ha⁻¹. This might be due to the increasing pattern of seed yield with graded levels of fertilizers and due to the dilution effect. Similar findings were observed by Kannan et al. (2014) and Ranpatriya and Polara (2018) [23].

### Post-harvest soil fertility

The result from analysis of soil after harvesting (Table 5) indicated that the available K in soil after crop harvest was significantly increased with the graded levels of potassium. Application of K₃₀ (30 kg K₂O ha⁻¹) recorded significantly the highest available K status (176.40 kg ha⁻¹), followed by K₂₀ (20 kg K₂O ha⁻¹) with the value of 174.95 kg ha⁻¹, both the treatments differing non-significantly. While the lowest potassium status (168.76 kg ha⁻¹) was recorded under no potassium application i.e. K₀ (control).
The available potassium in soil was found to be influenced significantly by potassium application at various levels. The available potassium was recorded significantly higher with the application of 60 kg K₂O ha⁻¹ with respective value of 216 kg ha⁻¹ over that of control while, the application of potassium did not exhibit any significant influence on the pH, EC, OC and available nutrients i.e. N, P, Zn, Mn and Cu in soil after harvest. A slight decrease in soil pH value from initial was observed, however the soil EC, OC and available nutrients i.e. N, P, Zn, Mn and Cu in soil increased from the initial value.

However, the soil available K and Fe increased significantly with the application of potassium up to the level of 20 kg K₂O ha⁻¹. Similar non-significant results on soil pH, EC and organic carbon was reported by Ranpariya and Polara (2018) [22] and similar trend for available K in soil was observed by Kurhade et al. (2015) [15] and Bhuma and Selvakumari (2015) [8] after harvest of crop.

| Treatments (kg ha⁻¹) | Soil pH (1:2) | Soil EC (dSm⁻¹) | Soil O.C. (%) | N (kg ha⁻¹) | P (kg ha⁻¹) | K (kg ha⁻¹) | Zn (mg kg⁻¹) | Fe (mg kg⁻¹) | Mn (mg kg⁻¹) | Cu (mg kg⁻¹) |
|----------------------|--------------|-----------------|--------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| K₀                   | 8.18         | 0.15            | 0.17         | 102.77      | 11.78       | 168.76      | 1.22         | 7.10         | 5.70         | 0.50        |
| K₁₀                  | 8.15         | 0.17            | 0.18         | 103.39      | 11.98       | 170.11      | 1.23         | 7.68         | 5.87         | 0.54        |
| K₂₀                  | 8.08         | 0.17            | 0.18         | 104.03      | 12.65       | 174.95      | 1.25         | 8.46         | 6.29         | 0.56        |
| K₃₀                  | 8.04         | 0.18            | 0.18         | 104.35      | 12.91       | 176.40      | 1.26         | 8.76         | 6.63         | 0.59        |
| S.Emz                | 0.16         | 0.02            | 0.01         | 3.21         | 1.28        | 1.57        | 0.06         | 0.28         | 2.16         | 0.03        |
| CD (p=0.05)          | NS           | NS              | NS           | NS          | NS          | 4.71        | NS          | 0.79         | NS          | NS          |
| Zinc levels (kg ZnSO₄ ha⁻¹) |             |                 |              |             |             |             |             |             |             |             |
| Zn₀                  | 8.19         | 0.18            | 0.17         | 102.46      | 11.85       | 171.34      | 0.85         | 7.80         | 6.04         | 0.53        |
| Zn₁₀                 | 8.09         | 0.16            | 0.17         | 103.23      | 12.17       | 171.51      | 1.10         | 7.95         | 5.89         | 0.55        |
| Zn₂₀                 | 8.08         | 0.17            | 0.18         | 104.37      | 12.57       | 171.87      | 1.40         | 8.05         | 6.25         | 0.56        |
| Zn₃₀                 | 8.08         | 0.17            | 0.18         | 104.40      | 12.74       | 172.22      | 1.60         | 8.19         | 6.31         | 0.57        |
| S.Emz                | 0.14         | 0.01            | 0.01         | 2.25         | 0.83        | 1.32        | 0.02         | 0.16         | 1.18         | 0.01        |
| CD (p=0.05)          | NS           | NS              | NS           | NS          | NS          | NS          | NS          | NS          | NS          | NS          |
| C. V. %              | 7.68         | 8.48            | 12.67        | 12.72       | 9.85        | 13.26       | 12.61        | 13.46        | 12.89        |             |
| Initial value        | 8.17         | 0.16            | 0.17         | 102.37      | 11.18       | 170.10      | 0.97         | 7.64         | 6.24         | 0.52        |

### Effect of zinc

**Nutrient content and uptake by seed**

Application of zinc significantly influenced the Zn content and uptake by seed. Significantly higher Zn content in seed (27.11 mg kg⁻¹) was recorded under Zn₂₅ treatment followed by Zn₅₀ (26.06 mg kg⁻¹), both the treatments were found statistically similar but superior over the control (Table 2). The lowest content of Zn in seed (21.00 mg kg⁻¹) were observed under Zn₀ treatment. Similar results were observed in case of uptake by seed, significantly higher uptake (28.24 g ha⁻¹) was found under Zn₃₀ treatment, followed by Zn₁₀ (26.39 g ha⁻¹), both the treatments differing non-significantly but found superior over the control. The minimum Zn uptake by seed (19.34 g ha⁻¹) at harvest was found under Zn₀ treatment.

Results showed that other nutrients content was not found to be influenced significantly by the zinc application but their uptakes were influenced significantly by graded levels of zinc except P because application of Zn did not show any particular trend with respect to P uptake and content. Phosphorus and zinc have antagonistic effect on each other. The application of zinc @ 25 kg ZnSO₄ ha⁻¹ showed significantly higher values of uptake of nitrogen (35.01 kg ha⁻¹) and potassium (10.80 kg ha⁻¹) by seed. Similar trend was observed for the uptake of micro-nutrient like Zn (26.29 g ha⁻¹), Fe (56.13 g ha⁻¹), Mn (13.49 g ha⁻¹) and Cu (6.29 g ha⁻¹) uptake by seed with the application of 25 kg ZnSO₄ ha⁻¹. Similar results were found by Kannan et al. (2014), Khurhade et al. (2015), Ranpariya et al. (2017) [22] and Ahmed et al. (2018).

**Nutrient content and uptake by straw**

Results revealed that different zinc treatments significantly influenced only Zn concentration in straw (Table 4). Both Zn₁₀ and Zn₃₀ treatments recorded significantly higher Zn content (21.35 mg kg⁻¹ and 21.79 mg kg⁻¹) and uptake (25.61 g ha⁻¹ and 26.04 g ha⁻¹), respectively in straw as compared to control (Zn₀). But the concentrations of other nutrients were not significantly influenced by zinc application while the uptake of all the nutrients was significantly influenced by different zinc levels. The uptake of nutrients like N (14.91 kg ha⁻¹), P (2.48 kg ha⁻¹), K (15.38 kg ha⁻¹), Fe (124.82 g ha⁻¹), Mn (25.03 g ha⁻¹) and Cu (5.15 g ha⁻¹) by straw with the application of 25 kg ZnSO₄ ha⁻¹ was at par with the higher level of zinc 37.5 kg ZnSO₄ ha⁻¹. This might be due to the increasing pattern of straw yield with graded levels of fertilizers or may be due to the dilution effect. The results found are in confirmation with the results of Roy et al. (2017) [25], Kurhade et al. (2015) [15], Balpande et al. (2016) [7], Adsure et al. (2018) [1] and Chaudhari et al. (2018) [10].

**Post-harvest soil fertility**

The available zinc in soil after harvest of crop significantly influenced by zinc application (Table 5). The available zinc was recorded significantly higher under the application of 10 kg ZnSO₄ ha⁻¹ with respective value of 0.63 mg kg⁻¹ and 17.94 kg ha⁻¹ over that of control while, the availability of N, P, O₃, K₂O and pH, OC and EC did not influence significantly by zinc application.

The results pertaining to availability of Zn in soil after harvest of crop showed that the status of Zn in soil significantly increased with the application of graded levels of Zn. Application of 37.5 kg ZnSO₄ ha⁻¹ (Zn₃₀) recorded significantly the highest available Zn status (1.60 mg kg⁻¹) followed by Zn₁₀ (1.40 mg kg⁻¹), which remained statistically at par with Zn₃₀ while the lowest Zn status (0.85 mg kg⁻¹) was recorded under control (Zn₀).

While, the application of zinc did not significantly influence the pH, EC, OC and available nutrients i.e. N, P, Zn, Mn and Cu in soil of post-harvest soil. Similar non-significant results was reported by Ranpariya and Polara (2018) [23].
Conclusion
Based on the results, it can be concluded that application of potassium @ 20 kg ha⁻¹, zinc sulphate @ 25 kg ha⁻¹, significantly increase the nutrient content and uptake in seed and straw of green gram and increase the availability of nutrient in coarse textured medium K status soil.

Acknowledgement
The authors are thankful to Regional Director, RRS, Bawal and Professor and Head, Department of Soil Science, Chaudhary Charan Singh, Haryana Agricultural University, Hisar for providing facilities, technical help and necessary guidance for this study.

References
1. Adsure VK, Mane SS, Supekar SK. Effect of graded levels of potassium on yield and major nutrient uptake of black gram. International Journal of Chemical Studies. 2018; 6(2):2980-2982.
2. Ahmad F, Ahmad J, Ali Shah M, Iqbal S, Mehmood Z, Abbas W. Influence of Different Levels Phosphorous and Zinc on Yield and Yield Attributes of Mung Bean [Vigna radiata L.]. JOI Material Science. 2018; 5(1):001-004.
3. Ali M, Srinivasarao C. Role of potassium fertilization in improving productivity of pulse crop. Potassium in Indian Agriculture. International symposium on importance of potassium in nutrient management for sustainable crop production in India. N. S Pasricha and S.K. Bansal (Eds), 2001, 261-275.
4. Anonymous. Area, Production and Productivity of Mung bean in India. Ministry of agriculture and Farmer’s welfare, Govt. of India, 2018a.
5. Anonymous. Package and Practices of kharif crops 2018, CCSHAU, Hisar, Astral Publishing Private Limited, New Delhi, 2018b, 288.
6. Arunachalam P, Kannan P, Prabukumar G, Govindaraj M. Zinc deficiency in Indian soils with special focus to enrich zinc in peanut. African Journal of Agricultural Research. 2013; 8(50):6681-6688.
7. Balpande SS, Sarap PA, Ghodpage RM. Effect of potassium and sulphur on nutrient uptake, yield and quality of pigeon pea (Cajanus cajan). Agricultural Science Digest. 2016; 36(4):323-325.
8. Bhuma M, Selvakumari G. Studies on the effect of green gram to potassium humate on soil fertility. Madras Agric. J. 2015; 90(7-9):444-449.
9. Bukhsh MAHAHA, Ahmad R, Malik AU, Hussain S, Ishaque M. Profitability of three maize hybrids as influenced by varying plant density and potassium application. Journal of Animal and Plant Sciences. 2011; 21(1):42-47.
10. Chaudhari AV, Mane SS, Chadar BR. Effect of graded levels of potassium on growth, yield and quality of black gram. International Journal of Current Microbiology and Applied Sciences. 2018; 6:1607-1612.
11. Dahiy PK, Linnemann AR, Van Boekel MAJS, Khetarpaul N, Grewal RB, Nout MJR. Mung Bean: Technological and Nutritional Potential. Critical Reviews in Food Science and Nutrition. 2015; 55:670-688.
12. Egila JN, Davies FTJ, Drew MC. Effect of potassium on drought resistance of Hibiscus rosa-sinensis cv. Lepcha; plant growth, leaf macro and micronutrient content and root longevity. Plant Soil. 2001; 229:213-24.
13. Jackson ML. Soil chemical analysis. Prentice Hall of India Pvt. Ltd. New Delhi, India, 1973, 327-350.
14. Koenig R, Johnson C. Colorimetric determination of phosphorus in biological materials. Industrial & Engineering Chemistry Analytical Edition. 1942; 14(2):155-156.
15. Kurhade PP, Sethi HN, Zadode RS. Effect of different levels of potassium on yield, quality, available nutrient and uptake of blackgram. International Journal of Agricultural Sciences. 2015; 11(1):175-178.
16. Lindner RC. Rapid analytical method for some of the more common inorganic constituents of plant tissues. Plant Physiology. 1944; 19:76-89.
17. Lindsay WL, Norvell WA. Development of a DTPA soil test for zinc, iron, manganese, and copper. Soil Science Society of America Journal. 1978; 42:421-428.
18. Marschner H. Mineral nutrition of higher plants. London: Academic Press, 2002.
19. Nijra K, Nabwami J. A review of effect on nutrient element on crop quality. Africian Journal of Food Agriculture. 2015; 15(1):9777-9793.
20. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. Circular U.S. Department of Agriculture, 1954, 939.
21. Pettigrew WT. Potassium deficiency increased specific leaf weights and leaf glucose levels in field grown cotton. Agronomy Journal. 2000; 91:962-968.
22. Ranparya VS, Polara KB, Hirpara DV, Bodar KH. Effect of potassium, zinc and FYM on content and uptake of nutrients in seed of summer green gram (Vigna radiata L.) and post-harvest soil fertility under medium black calcareous soil. International Journal of Chemical Studies. 2017; 5(5):1055-1058.
23. Ranparya VS, Polara KB. Effect of Potassium, Zinc and FYM on Content and Uptake of Nutrients of Summer Green Gram (Vigna radiata L.) at Different Growth Stages under South Saurashtra Region of Gujarat. International Journal of Pure and Applied Bioscience. 2018; 6(1):997-1002.
24. Reddy AA. Pulses production technology: Status and way forward. Eco. Polt. Weekly. 2009; 44:73-80.
25. Roy PD, Lakshman K, Narwal RP, Malik RS, Saha S. Green Gram (Vigna radiata L.) Productivity and Grain Quality Enrichment through Zinc Fertilization. International Journal of Current Microbiology and Applied Sciences. 2017; 6(6):643-648.
26. Sheoran OP, Tonk DS, Kaushik LS, Hasija RC, Pannu RS. Statistical Software Package for Agricultural Research Workers. In Recent Advances in information theory, Statistics & Computer Applications (Eds.) DS Hooda and RC Hasija, Department of Mathematics Statistics, CCS HAU, Hisar, 1998, 139-143.
27. Shkula AK, Tiwari PK, Chandra P. Micronutrients Deficiencies vis-à-vis Food and Nutritional Security of India. Indian Journal of Fertilisers. 2014; 10(12):94-112.
28. Subbiah BV, Asija GL. A rapid procedure for the determination of available nitrogen in soils. Current Science. 1956; 25:259-60.
29. Usherwood NR. The role of potassium in crop quality. Potassium in agriculture, ed. R.D. Munson, Madison, 1985, 489-514.
30. Walkley AJ, Black CA. Estimation of soil organic carbon by the chromic acid titration method. Soil Science. 1934; 37:29-38.