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# Effect of Placement and Foliar Application of Urea, KCl & Zn (Supplementary Nourishment) on Growth and Yield of Cowpea (*Vigna unguiculata* L.) under Guava (*Psidium guajava* L.) based Agri-horti System

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***Authors' contributions***

*This work was carried out in collaboration among all authors. Authors SD and SP designed the study, performed the statistical analysis and wrote the protocol. Authors SD and ARC managed the analyses of the study, wrote the first draft of the manuscript and managed the literature searches. All authors read and approved the final manuscript.*

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## ABSTRACT

**Aims:** To investigate the effect of the placement and foliar application of Urea, KCl & Zinc on growth and yield of cowpea under guava based agri-horti system in Vindhyan region, India.
**Study Design:** RBD with nine treatments and three replications.
**Place and Duration of Study:** Agricultural Research Farm, Barkachha, Mirzapur (UP), India during *kharif* season (June-Oct) of 2017.
**Methodology:** This experiment consisted nine different treatments *viz*; Control ($T_1$), 2% Urea spray ($T_2$), 30 kg KCl ha$^{-1}$ ($T_3$), 2% KCl spray ($T_4$), 2% Urea spray + 2% KCl spray ($T_5$), 5 kg Zn ha$^{-1}$ ($T_6$), 2% Urea spray + 5 kg Zn ha$^{-1}$ ($T_7$), 30 kg KCl ha$^{-1}$+ 5 kg Zn ha$^{-1}$ ($T_8$), 2% Urea spray + 2% KCl spray + 1.5% Zn spray ($T_9$). Various growth parameter, yield attributes, N, P, K and nutrients contents were recorded and compared.

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**Results:** Significantly higher growth parameters like plant height$^{-1}$, no of branches plant$^{-1}$, fresh weight$^{-1}$ and dry weight$^{-1}$, yield attributes like number of seeds pod$^{-1}$, pod length, pod yield plant$^{-1}$, green pod yield were recorded in 2% Urea spray + 2% KCl spray + 1.5% Zn spray ($T_9$). Maximum N, K and protein content in straw and seed also observed in $T_9$.
**Conclusion:** foliar spray of 2% Urea + 2% KCl spray + 1.5% Zn spray was best method for supplementary nourishment of cowpea under guava based Agri-horti system. The experiment should be reported for one to two seasons more in order to reach final conclusion.

*Keywords: Cowpea; foliar application; agri-horti system; supplementary nourishment; foliar spraying and fertilizer placement.*

## ABBREVIATIONS

*CD- Critical difference*
*DAP- Diammonium Phosphate*
*DAS- Days after sowing*
*IAA- Indole Acetic Acid*
*K- Potassium*
*N- Nitrogen*
*OC- Organic carbon*
*P- Phosphorus*
*SE- Standard Error*
*Zn- Zinc*

## 1. INTRODUCTION

Cowpea [*Vigna unguiculata* (L.) Walp] is one of the important pulse crop grown for grain, forage, green manuring and commercial vegetable having considerable promise as an alternative pulse crop in dry land farming in all the types of soils [1]. It was estimated that cowpea green pods of an average 100 g contain 84.6 g water, 4.3 g protein, 0.2 g fat, 0.9 g minerals, 2.0 g fibre, 8.0 g carbohydrates approximately [2]. Due to high protein and carbohydrate contents cowpea is valued as a nutritional supplement to cereals and a source of proteins [3]. Cowpea occupy over 9.8 mha of lands in world and it is grown over 58 thousands ha of area in India, accounting 48.94 M tonnes of production especially in semiarid and arid areas of Rajasthan, Uttar Pradesh, Tamil Nadu, Kerala, Karnataka and Gujarat [4].The acreage under pulses is increased in India, whereas productivity is declined year after year due to reducing soil fertility especially macro and micronutrients [5]. Further immense use of fertilizer and intensified cropping leads to loss of nutrients. Therefore supplementary nourishment through the foliar application may be a solution to this problem, playing a crucial role in the cultivation of legumes by providing immediate nutrition to the crop during peak vegetative and reproductive growth of the cowpea crop. Thus, it provides the vigour by stimulating root development, nodulation, energy transformation, various metabolic processes and increasing pod setting and thereby increasing the yield as well as recovery of nutrients losses [6,7]. Pulses need a small basal dose of N fertilizer for a quick and better start besides $N_2$ fixation [8]. As a major component of protoplasm, N increased the growth of the plant by enhancing metabolic rate, cell division and cell elongation [9]. Next to N, P is an important plant nutrient required for rapid and healthy root development in turn promotes nodulation. P increased protein content probably by increasing fixed N in plants [1]. Zn playing important role in the formation of IAA thereby indirectly promoting stem elongation [10]. Yadav and Choudhary [11] studied the effect of fertility levels and foliar application of fertilizers on growth and yield of cowpea in loamy sand soil of Rajasthan and found that application of 100% recommended dose of fertilizers along with 2% foliar application either of urea, DAP and KCl increases cowpea yield and profitability of cowpea production due to enhanced nutrient supply and translocation of nutrients to reproductive parts like pods, seeds and other parts of plant. foliar application of 2% DAP, urea and KCl at branching and flowering stages under dryland condition significantly increases straw and biological yields and harvest index than control [12]. Sivakumar et al. [13] studied influence of foliar application of P on growth and yield of red gram and revealed that pod setting percentage, yield and economics of red gram increased due to foliar application.

Zn and P deficiency are regarded as the most limiting factor for cowpea production [14]. The importance of Zn for cowpea production and the current void of knowledge on the interactions of various nutrients on cowpea production under agroforestry systems prompted this study**.** Realizing the importance of above-mentioned facts, this investigation was, therefore, undertaken to evaluate the effect of placement and foliar application of Urea, KCl & Zinc either

separately or combined on growth and yield of cowpea (*Vigna unguiculata* L.*)* under guava (*Psidium guajava L)* based agri-horti system in Vindhyan region, India to find out the optimum nutrients level of urea, KCl and zinc and the best method of fertilizers application.

## 2. MATERIALS AND METHODS

This study was carried out during *kharif* season of 2017 at the Agricultural Research Farm, RGSC-BHU, Barkachha, Mirzapur (UP), which is situated in *Vindhyan* region, India. The experimental site falls under the sub-tropical zone and is located on 25º 10'N latitude 82º 37' E longitude and an altitude of 427 m above MSL. The soil of the experimental field was acidic in pH (5.9) and sandy loam in texture with low drainage. It was, poor in N as well as P and moderate in K. It was moderately fertile, being low in OC (0.35 %), available N (225.63 kg/ha), medium in available P (20.97 kg/ha) as well as available K (243.38 kg/ha). The experiment was conducted in 11 years old guava orchard which was planted in August 2006 at the spacing of 7x7 $m^2$. Cowpea (*Kashi kanchan* variety) was sown as a test crop.

### 2.1 Treatment Details

The experimental trial conducted in simple RBD with a nine treatments randomly assigned to three replication each as follows; Control ($T_1$), 2% Urea Spray ($T_2$), KCl @ 30 kg $ha^{-1}$ ($T_3$), 2% KCl spray($T_4$), 2% Urea Spray + 2% KCl spray ($T_5$), 5 Kg Zinc $ha^{-1}$($T_6$), 2% Urea Spray+ 5 Kg Zinc $ha^{-1}$ ($T_7$), KCl+ Zinc ($T_8$), (2% Urea +2% KCl 1.5 % Zinc) spray ($T_9$). 60 kg $ha^{-1}$ DAP applied to control treatment as RDF. The requisite quantity of seed at the rate of 20 kg $ha^{-1}$ of cowpea was sown in rows with a spacing of 30 cm x 15 cm apart [12]. 60 kg $ha^{-1}$ DAP was applied to all treatments and later Urea, murate of potash (KCl) & zinc sulphate ($ZnSO_4$) was applied according to the treatment allocation to the respective plots. Placement of fertilizers was done at sowing and foliar application of 2% urea, 2% KCl, 1.5% $ZnSO_4$ was applied according to the treatment combination at 20 & 40 DAS.

### 2.2 Statistical Analysis

Crops response to the treatments were measured in terms of various quantitative indices, viz., plant height$^{-1}$, dry matter accumulation plant$^{-1}$, number of branches plant$^{-1}$, number of trifoliate leaves plant$^{-1}$ & yield components viz., number of pods plant$^{-1}$, number of seeds pod$^{-1}$, pod length (cm), pod yield plant$^{-1}$ (g), green pod yield (q $ha^{-1}$). Observations on growth attributes were recorded at maturity. N (Colorimetric (Nessler's reagent) method), P (Vanadomolybdate yellow colour method), K (Flame-photometric method) and protein contents estimated by the Kjeldahl Total nitrogen determination (crude protein % = Total N % x 6.25) were recorded and compared. Data collected during the course of experimentation were subjected to statistical analysis to draw valid conclusion [15]. The data were then analyzed by the 'F' test for significance at 0.05 level by using MS Excel$^{TM}$ (2007).

## 3. RESULTS AND DISCUSSION

### 3.1 Growth Characters

Highest plant height (52.97cm) was recorded under $T_9$, which was significantly superior among all the treatments, however, $T_2$ $T_3$, $T_4$, $T_5$ $T_6$ ,$T_7$ & $T_8$ were at par with each other and significantly lowest plant height (34.63 cm) was recorded with $T_1$ (control). This might be due to the supply of the required amount of nutrients through foliar application and soil which brought about equivalent growth and development of plants [16, 17, 18]. The maximum number of branches plant$^{-1}$ (22.31) was recorded in $T_9$, which was significantly superior to all, however, $T_7$ was statistically at par with the rest of the treatments. Maximum fresh weight plant$^{-1}$ (46.90 g) was recorded in $T_9$, which was significantly superior among all the treatments followed by $T_7$, $T_5$, $T_2$, and $T_1$ respectively and $T_4$ was statistically at par with $T_8$, $T_3$ & $T_6$. Significantly maximum dry weight plant$^{-1}$ (10.05g) was recorded in $T_9$, followed by $T_7$, $T_5$ & $T_8$. Dry weight in $T_5$ was at par with $T_2$ and $T_4$ & dry weight production in $T_8$ was at par with $T_3$, $T_6$ and $T_1$. The effect of foliar spray provides immediate nutrition to the crop during peak growth, promotes vegetative growth. Thus, helpful in giving the vigour to the crop, and also acts as a yield booster. Foliar application of fertilizers at the time of pre-flowering gave better response in terms of a higher number of trifoliate leaves and branches which made the plant photosynthetically more active resulting into taller plants and more dry matter production [19] as compared to control.

### 3.2 Yield Attributes and Yield

Longest pods plant$^{-1}$ (25.47cm) was recorded in $T_9$ which was at par with $T_2$, $T_5$, $T_7$, $T_4$, $T_8$, $T_3$, & $T_6$. Significantly shortest pod length (15.39 cm)

**Table 1. Effect of placement and foliar application of Urea, KCl & Zinc (supplementary nourishment) on growth attributes and yield attributes of cowpea (*Vigna unguiculata* L.) under guava (*Psidium guajava* L.) based agri-horti system in Vindhyan region, India during *kharif* season of 2017**

| Treatments | Plant height (cm) | Branches plant$^{-1}$ | leaves plant$^{-1}$ | Fresh weight plant$^{-1}$ (g) | Dry weight plant$^{-1}$ (g) | Length of pod (cm) | No of pods plant$^{-1}$ | No of seeds pod$^{-1}$ | Pod yield (q ha$^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|
| Control ($T_1$) | 34.63 | 13.48 | 7.63 | 20.36 | 4.05 | 15.39 | 6.20 | 7.47 | 68.55 |
| 2% Urea Spray ($T_2$) | 48.18 | 18.65 | 10.13 | 29.42 | 7.38 | 22.98 | 10.20 | 10.47 | 89.86 |
| KCl @ 30 kg ha$^{-1}$ ($T_3$) | 44.81 | 15.54 | 8.42 | 24.47 | 5.27 | 20.81 | 7.80 | 9.07 | 79.24 |
| 2% KCl Spray ($T_4$) | 47.18 | 17.59 | 9.53 | 26.27 | 6.92 | 21.63 | 9.13 | 10.03 | 87.06 |
| 2% Urea Spray + 2% KCl Spray ($T_5$) | 48.51 | 19.55 | 10.83 | 32.53 | 8.13 | 23.27 | 10.80 | 10.79 | 92.73 |
| Zn @ 5kg ha$^{-1}$ ($T_6$) | 43.77 | 14.60 | 8.30 | 24.09 | 4.59 | 20.19 | 7.50 | 8.66 | 78.80 |
| 2% Urea Spray + Zn @ 5kg ha$^{-1}$ ($T_7$) | 50.62 | 20.63 | 11.53 | 37.57 | 9.07 | 24.51 | 11.60 | 11.27 | 94.61 |
| KCl @ 30 kg ha$^{-1}$ +Zn @ 5kg ha$^{-1}$ ($T_8$) | 46.75 | 16.57 | 8.80 | 25.22 | 5.70 | 21.47 | 8.67 | 9.53 | 85.49 |
| 2% Urea Spray + 2% KCl Spray + 1.5% Zn spray ($T_9$) | 52.97 | 22.31 | 12.93 | 46.90 | 10.05 | 25.47 | 12.87 | 11.53 | 101.47 |
| SE (m) | 0.77 | 0.54 | 0.33 | 0.52 | 0.31 | 0.85 | 0.42 | 0.20 | 1.99 |
| cd ($p \leq 0.05$) | 2.31 | 1.62 | 0.99 | 1.55 | 0.93 | 2.54 | 1.25 | 0.60 | 5.98 |

**s- significant at $p \leq 0.05$; ns- non significant at $p > 0.05$*

**Table 2. Effect of Effect of placement and foliar application of Urea, KCl & Zinc (supplementary nourishment) on N, P, K & protein content in grain and straw in cowpea (*Vigna unguiculata* L.) under guava (*Psidium guajava L)* based agri-horti system in Vindhyan region during *kharif* season of 2017**

| Treatments | N content (%) | | Protein (%) | | P content (%) | | K content (%) | |
|---|---|---|---|---|---|---|---|---|
| | Grain | Straw | Grain | Straw | Grain | Straw | Grain | Straw |
| Control ($T_1$) | 4.22 | 2.03 | 26.37 | 12.86 | 0.017 | 0.013 | 0.087 | 0.153 |
| 2% Urea Spray ($T_2$) | 5.09 | 3.20 | 31.79 | 20.59 | 0.015 | 0.014 | 0.093 | 0.180 |
| KCl @ 30 kg $ha^{-1}$ ($T_3$) | 4.61 | 3.03 | 28.78 | 18.89 | 0.014 | 0.016 | 0.163 | 0.283 |
| 2% KCl Spray ($T_4$) | 4.96 | 2.82 | 31.02 | 17.70 | 0.012 | 0.016 | 0.167 | 0.203 |
| 2% Urea Spray + 2% KCl Spray ($T_5$) | 5.36 | 3.38 | 33.52 | 21.20 | 0.013 | 0.015 | 0.180 | 0.233 |
| Zn @ 5kg $ha^{-1}$ ($T_6$) | 4.54 | 3.08 | 28.40 | 19.37 | 0.016 | 0.013 | 0.100 | 0.157 |
| 2% Urea Spray + Zn @ 5kg $ha^{-1}$ ($T_7$) | 5.45 | 3.50 | 34.08 | 21.49 | 0.021 | 0.017 | 0.120 | 0.177 |
| KCl @ 30 kg $ha^{-1}$ +Zn @ 5kg $ha^{-1}$ ($T_8$) | 4.73 | 2.94 | 29.54 | 18.41 | 0.014 | 0.017 | 0.137 | 0.170 |
| 2% Urea Spray + 2% KCl Spray + 1.5% Zn spray ($T_9$) | 5.62 | 3.86 | 35.11 | 24.03 | 0.018 | 0.016 | 0.183 | 0.280 |
| SE (m) | 0.13 | 0.13 | 0.82 | 0.24 | 0.001 | 0.002 | 0.007 | 0.015 |
| cd ($p \leq 0.05$) | 0.39 | 0.38 | 2.47 | 0.71 | ns | ns | 0.022 | 0.045 |

**s- significant at $p \leq 0.05$; ns- non significant at $p > 0.05$*

was found in $T_1$ (control). Maximum number of pods plant$^{-1}$ (12.87) was recorded in $T_9$ which was at par with $T_7$, $T_5$, $T_2$, $T_4$, $T_8$, $T_3$ & $T_6$. The minimum (6.20) pods plant$^{-1}$ was recorded at $T_1$ (control). Number of seeds pods$^{-1}$ was significantly affected by different use of fertilizers and foliar application. Foliar application of fertilizers significantly increased the number of seeds pod$^{-1}$ as compared to basal application. Maximum (11.53) seeds pods$^{-1}$ was recorded in $T_9$ which was at par with $T_7$ $T_5$,$T_2$, $T_4$, $T_8$, $T_3$ & $T_6$ and $T_1$ (control) was significantly minimum (7.47) seeds pods$^{-1}$ was recorded in $T_1$ (control). Maximum fresh pod yield (101.47 q ha$^{-1}$) was recorded in $T_9$ which was significantly superior to the rest of treatments. However $T_7$, $T_5$, $T_2$, $T_4$, $T_8$, $T_6$ and $T_3$ were at par with each other. The significantly minimum fresh pod yield (68.55 q ha$^{-1}$) was recorded at $T_1$ (control).

Reflection of increase in vegetative growth, yield and its components as shown in Table 1 were might be due to foliar spraying or fertilization of N, K with Zn as compared to control. The importance of foliar fertilization with micronutrient Zn can be accounted by its essential role in respiration, their metabolism activation of the enzyme, photosynthesis, chloroplast formation, chlorophyll synthesis and natural hormone biosynthesis [20]. Increased dry matter accumulation in pulse crop through Urea, KCl & Zinc was also observed by Singh and Yadav [21] & Sharma and Abraham [22].

### 3.3 Protein Content and Nutrient Content

Maximum protein content in grain and straw was found in $T_9$, similar trend was also observed in the N and K content in grain and straw. Whereas in respect of P content no significant effect was found in grain and straw. Significantly lowest protein, N and K content was found in control. It was also evident that yields were deciding factors for the content of nutrients. Similar results were also reported by Randhawa et al. [23], Kumar et al. [24] & Gupta and Saxena [25].

## 4. CONCLUSION

Spraying of Urea, KCl at the rate of 2% with combination with Zn (1.5%) significantly increased pod yield which was superior to rest of the treatments. Significant improvement in growth characters, yield attributes of cowpea was recorded in $T_9$ (foliar spray of Urea, KCl & Zn) which was best under guava based Agri-horti system. Nutrient content (%) and protein quality were also improved significantly in $T_9$ (foliar spray of urea, KCl & Zn). In view of the limitations that the results are available for one cropping season only. The experiment should be reported for one to two seasons more in order to reach final conclusion.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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