Effect of Foliar Application of Water Soluble Fertilizers on Growth and Yield of Chickpea (*Cicer arietinum* L.)

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**ABSTRACT**

**Background:** Foliar application or foliar nutrition is a technique of feeding plants by applying liquid fertilizer directly to their leaves. Water soluble fertilizers have been introduced exclusively for foliar feeding and fertilization. There is very little information about the foliar application of water soluble fertilizers on growth and yield of chickpea (*Cicer arietinum* L.).

**Methods:** The field experiment was conducted during *rabi* season of 2017-18, 11 different treatments were laid out in a randomized block design on clay loam soil. In the field, the data was collected and analyzed and the final result was concluded.

**Results:** The experiment revealed that the growth attributes such as plant height (60.28 cm), number of primary branches (5.22), number of secondary branches (22.93) and dry matter accumulation (241.61 g) were maximum with 75% RDF + foliar application of 2% DAP + 2% Urea + 2% WSF at 60 and 80 DAS (T10) and minimum in control (T1) at harvest stage. Further, seed yield (24.26 q ha⁻¹), stover yield (31.38 q ha⁻¹) and biological yield (55.65 q ha⁻¹) was maximum with 75% RDF + foliar application of 2% DAP + 2% Urea + 2% WSF at 60 and 80 DAS (T10) and minimum in control (T1).

**Key words:** Chickpea, Fertilization, Foliar application, Growth attributes, Water soluble fertilizers.

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**INTRODUCTION**

Chickpea (*Cicer arietinum* L.) is being considered the third most important pulse crop after dry beans and dry peas in the world, being widely grown in many subtropical and warm temperate regions. The nutrients applied through soil application are difficult to absorb due to losses of nutrients either by leaching, denitrification or volatilization. Nitrate leaching is also a significant source of soil acidification. Nutrient losses through leaching are generally higher in humid climate than in dry climate (Havlín *et al*, 1999).

Foliar application or foliar nutrition is a technique of feeding plants by applying liquid fertilizer directly to their leaves. Application of nutrients through foliar sprays along with soil application has several advantages in supplementing the nutritional requirements of crops. Recently, water soluble fertilizers have been introduced exclusively for foliar feeding and fertilization. Water soluble fertilizers are a better source for foliar application (Vibhute, 1998). More flowers were possible through foliar application of growth regulators as well as macro nutrients during flower initiation and pod development stages along with soil application of nutrients (Chaurasia *et al*., 2005). The significantly higher grain yield of chickpea was recorded under foliar application of 2% WSF at flowering as well as pod development which was on par with 1.5% WSF at same stage over control. There was an increase of 24.4% (with 2% WSF) and 23.16% (with 1.5% WSF) in grain yield over control (Mudalagiriypappa *et al*., 2016). Application of 125% RDF along with 2% DAP spray at flowering and pod formation stages recorded significantly higher growth attributes resulted in increased pod yield of cowpea as compared to 100% RDF (Kavitha *et al*., 2019). Therefore, foliar nutrition is being recognized as an important method of fertilization in modern agriculture.

**MATERIALS AND METHODS**

The experiment was conducted during *rabi* season of 2017-18 at Experimental Farm, Department of Agriculture, Mata Gujri College, which is located in the central plain region of Punjab. The soil of the experimental field is clay loam in texture. The experiment was laid out in randomized block design (RBD) with three replications and eleven treatments viz., T1 - Control, T2 - 100% RDF, T3 - 75% RDF + 2% DAP spray at 60 DAS and 80 DAS, T4 - 75% RDF + 2% DAP spray at 60 DAS and 80 DAS, T5 - 75% RDF + 2% Urea spray at 60 DAS and 80 DAS, T6 - 75% RDF + 2% WSF spray at 60 DAS and 80 DAS, T7 - 50% RDF + 2% DAP spray at 60 DAS and 80 DAS, T8 - 50% RDF + 2% Urea spray at 60 DAS and 80 DAS, T9 - 50% RDF + 2% WSF spray at 60 DAS and 80 DAS, T10 - 75% RDF + 2% DAP + 2% Urea spray at 60 DAS and 80 DAS, T11 - 75% RDF + 2%
The data on number of primary and secondary branches per plant were recorded separately and presented in Table 2. At 30 DAS, number of primary and secondary branches per plant were found non-significant. Maximum number of primary branches and secondary branches (1.13 and 3.80, respectively) were recorded with application of 100 % RDF (T_1). At 60 DAS, 90 DAS and harvest stage number of primary and secondary branches per plant showed that there was significance. Application of 75 % RDF + foliar application of 2 % DAP + 2 % Urea + 2 % WSF at 60 DAS and 80 DAS (T_{10}) produced maximum number of primary branches and secondary branches at 60 DAS (2.80 and 8.13, respectively), 90 DAS (4.73 and 17.07, respectively) and harvest stage (5.22 and 22.93, respectively). These were at par with application of 75% RDF + foliar application of 2% WSF at 60 DAS and 80 DAS (T_9) and application of 50 % RDF + foliar application of 2% DAP + 2% Urea + 2% WSF at 60 DAS and 80 DAS (T_{11}). The data on dry-matter of plant recorded and analyzed is presented in Table 1. At 30 DAS, dry matter accumulation was found non-significant and higher dry matter accumulation (4.54 g) was recorded with harvest stage plant height showed that there was significance. Application of 75 % RDF + foliar application of 2 % DAP + 2 % Urea + 2 % WSF at 60 DAS and 80 DAS (T_{10}) recorded higher plant height at 60 DAS (21.11 cm), 90 DAS (49.79 cm) and harvest stage (60.28 cm). It was at par with application of 75 % RDF + foliar application of 2 % WSF at 60 DAS and 80 DAS (T_9) and application of 50 % RDF + foliar application of 2% DAP + 2% Urea + 2% WSF at 60 DAS and 80 DAS (T_{11}). The increase in plant height was due to additional supply of nutrients through foliar application which might have increased nutrient uptake and better translocation. This increases the cell division, elongation and photosynthesis. Similar results were reported by Dey et al. (2017) and Verma et al., (2009).

The data on plant height recorded and analyzed is presented in Table 1. At 30 DAS, plant height was found non-significant and higher plant height (9.70 cm) was recorded with application of 100 % RDF (T_1). At 60 DAS, 90 DAS and harvest stage plant height showed that there was significance. Application of 75 % RDF + foliar application of 2 % DAP + 2 % Urea + 2 % WSF at 60 DAS and 80 DAS (T_{10}) recorded higher plant height at 60 DAS (21.11 cm), 90 DAS (49.79 cm) and harvest stage (60.28 cm). It was at par with application of 75 % RDF + foliar application of 2 % WSF at 60 DAS and 80 DAS (T_9) and application of 50 % RDF + foliar application of 2% DAP + 2% Urea + 2% WSF at 60 DAS and 80 DAS (T_{11}). The increase in plant height was due to additional supply of nutrients through foliar application which might have increased nutrient uptake and better translocation. This increases the cell division, elongation and photosynthesis. Similar results were reported by Dey et al. (2017) and Verma et al., (2009).

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Table 2: Effect of Foliar application of water soluble fertilizers on number of branches per plant of chickpea.

| Treatments                                      | No. of primary branches per plant | No. of secondary branches per plant |
|------------------------------------------------|-----------------------------------|-------------------------------------|
|                                                 | 30 DAS | 60 DAS | 90 DAS | At harvest | 30 DAS | 60 DAS | 90 DAS | At harvest |
| T<sub>1</sub>, Control                          | 1.00   | 1.80   | 2.87   | 3.27       | 2.47   | 5.80   | 10.27  | 14.50      |
| T<sub>2</sub>, 100 % RDF                         | 1.13   | 1.93   | 3.73   | 4.04       | 3.80   | 6.33   | 11.13  | 15.40      |
| T<sub>3</sub>, 75 % RDF + 2 % DAP FA at 60 DAS and 80 DAS | 1.07   | 2.20   | 3.87   | 4.31       | 3.13   | 6.73   | 12.67  | 17.60      |
| T<sub>4</sub>, 75 % RDF + 2 % Urea FA at 60 DAS and 80 DAS | 1.07   | 2.13   | 3.80   | 4.24       | 3.07   | 6.60   | 11.93  | 16.93      |
| T<sub>5</sub>, 75 % RDF + 2 % WSF FA at 60 DAS and 80 DAS | 1.07   | 2.60   | 4.53   | 5.01       | 3.00   | 7.80   | 16.33  | 22.00      |
| T<sub>6</sub>, 50 % RDF + 2 % DAP FA at 60 DAS and 80 DAS | 1.00   | 2.13   | 3.80   | 4.20       | 2.93   | 6.53   | 11.87  | 16.60      |
| T<sub>7</sub>, 50 % RDF + 2 % Urea FA at 60 DAS and 80 DAS | 1.00   | 2.07   | 3.73   | 4.09       | 2.87   | 6.40   | 11.27  | 15.93      |
| T<sub>8</sub>, 50 % RDF + 2 % WSF FA at 60 DAS and 80 DAS | 1.00   | 2.27   | 3.93   | 4.38       | 2.80   | 6.87   | 13.73  | 18.87      |
| T<sub>9</sub>, 75 % RDF + 2 % DAP + 2 % Urea + 2 % WSF FA at 60 DAS and 80 DAS | 1.07   | 2.33   | 4.07   | 4.53       | 3.00   | 7.20   | 14.67  | 20.07      |
| T<sub>10</sub>, 75 % RDF + 2 % DAP + 2 % Urea + 2 % WSF FA at 60 DAS and 80 DAS | 1.00   | 2.80   | 4.73   | 5.22       | 3.00   | 8.13   | 17.07  | 22.93      |
| T<sub>11</sub>, 50 % RDF + 2 % DAP + 2 % Urea + 2 % WSF FA at 60 DAS and 80 DAS | 1.00   | 2.47   | 4.40   | 4.87       | 2.80   | 7.53   | 15.53  | 21.13      |

SEm±
CD @ 5%

Effect of Foliar application of water soluble fertilizers on yield attributing characters and yield of chickpea.

Table 3: Effect of Foliar application of water soluble fertilizers on yield attributing characters and yield of chickpea.

| Treatments                                      | No. of pods per plant | No. of seeds per pod | Seed index (g) | Seed yield (q ha<sup>-1</sup>) | Stover yield (q ha<sup>-1</sup>) | Biological yield (q ha<sup>-1</sup>) | Harvest index (%) |
|------------------------------------------------|-----------------------|----------------------|----------------|-------------------------------|---------------------------------|-------------------------------------|-------------------|
| T<sub>1</sub>, Control                          | 44.00                 | 1.70                 | 11.26          | 17.40                         | 24.62                           | 42.02                              | 41.43             |
| T<sub>2</sub>, 100 % RDF                         | 45.33                 | 1.78                 | 11.37          | 19.14                         | 26.36                           | 45.50                              | 42.05             |
| T<sub>3</sub>, 75 % RDF + 2 % DAP FA at 60 DAS and 80 DAS | 46.22                 | 1.87                 | 11.87          | 20.67                         | 27.86                           | 48.53                              | 42.58             |
| T<sub>4</sub>, 75 % RDF + 2 % Urea FA at 60 DAS and 80 DAS | 46.14                 | 1.85                 | 11.68          | 20.14                         | 27.51                           | 47.65                              | 42.24             |
| T<sub>5</sub>, 75 % RDF + 2 % WSF FA at 60 DAS and 80 DAS | 50.77                 | 2.08                 | 12.18          | 23.34                         | 30.46                           | 53.80                              | 43.39             |
| T<sub>6</sub>, 50 % RDF + 2 % DAP FA at 60 DAS and 80 DAS | 46.00                 | 1.82                 | 11.56          | 20.01                         | 27.25                           | 47.26                              | 42.33             |
| T<sub>7</sub>, 50 % RDF + 2 % Urea FA at 60 DAS and 80 DAS | 45.89                 | 1.80                 | 11.41          | 19.38                         | 26.50                           | 45.88                              | 42.23             |
| T<sub>8</sub>, 50 % RDF + 2 % WSF FA at 60 DAS and 80 DAS | 46.67                 | 1.89                 | 11.93          | 21.13                         | 28.10                           | 49.23                              | 42.91             |
| T<sub>9</sub>, 75 % RDF + 2 % DAP + 2 % Urea FA at 60 DAS and 80 DAS | 49.00                 | 1.92                 | 11.99          | 21.58                         | 28.45                           | 50.02                              | 43.13             |
| T<sub>10</sub>, 75 % RDF + 2 % DAP + 2 % Urea + 2 % WSF FA at 60 DAS and 80 DAS | 51.89                 | 2.13                 | 12.30          | 24.26                         | 31.38                           | 55.65                              | 43.60             |
| T<sub>11</sub>, 50 % RDF + 2 % DAP + 2 % Urea + 2 % WSF FA at 60 DAS and 80 DAS | 50.33                 | 2.03                 | 12.12          | 22.67                         | 29.59                           | 52.26                              | 43.35             |

SEm±
CD @ 5%

application of 100 % RDF (T<sub>9</sub>). At 60 DAS, 90 DAS and harvest stage dry matter accumulation showed that there was significance. Application of 75% RDF + foliar application of 2% DAP + 2% Urea + 2% WSF at 60 DAS and 80 DAS (T<sub>8</sub>) produced higher dry matter accumulation at 60 DAS (22.29 g), 90 DAS (106.68 g) and harvest stage (241.61 g). It was at par with application of 75% RDF + foliar application of 2% WSF at 60 DAS and 80 DAS (T<sub>8</sub>) and application of 50% RDF + foliar application of 2% DAP + 2% Urea + 2% WSF at 60 DAS and 80 DAS (T<sub>7</sub>). The improvement in the dry matter production might be due to the instant assimilation of nutrients supplied through the foliar application meeting the required nutrient demand of the crop. Shashikumar et al., (2013) suggested that application of foliar nutrition on blackgram gave higher growth components like plant height, number of branches, leaf area index and total dry matter production. Similar results were recorded by Mudalagiriappa et al. (2016) in chickpea.

Yield and yield attributes

The data on yield attributes showed that there was significance (Table 3). The maximum number of pods per plant (51.89), number of seeds per pod (2.13) and seed index (12.30 g) were recorded with application of 75% RDF + foliar application of 2% DAP + 2% Urea + 2% WSF at 60 DAS and 80 DAS (T<sub>9</sub>) compared to control (44.00, 1.70).
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and 11.26 g respectively). The increase in yield attributes were due to better absorption of nutrients applied through foliage leading to better activity of functional root nodules resulting in more dry-matter production and uptake of nutrients. This could have lead to more flower production and subsequently pod formation and other yield attributing characters. Verma et al. (2009) suggested that the significantly higher yield attributes and yield were found with foliar application of urea @ 1.00% at 50% flowering stage. Similar results were reported by Ravichandra et al. (2015) in groundnut.

The data on yield recorded and analyzed is presented in Table 3. The seed, stover and biological yield data was significantly influenced by different foliar treatments. The maximum seed yield (24.26 q ha$^{-1}$), stover yield (31.38 q ha$^{-1}$) and biological yield (55.65 q ha$^{-1}$) was recorded with application of 75% RDF + foliar application of 2% DAP + 2% Urea + 2% WSF at 60 DAS and 80 DAS (T$_{10}$). It was at par with application of 75% RDF + foliar application of 2% WSF at 60 DAS and 80 DAS (T$_{5}$) and application of 50% RDF + foliar application of 2% DAP + 2% Urea + 2% WSF at 60 DAS and 80 DAS (T$_{11}$). The increase in yield was due to the additional supply of nutrients through foliar application. It ultimately helps in higher dry-matter accumulation which contributes higher yield attributing characters. The higher yield attributing characters increased the crop yield. Similar results were reported by Mudalagiriyappa et al. (2016) in chickpea and Kumar and Salakinkop (2017) in groundnut.

CONCLUSION

From this experiment it can be concluded that different foliar treatments have positive effect on growth and yield of chickpea. Application of 75% RDF + foliar application of 2% DAP + 2% Urea + 2% WSF at 60 DAS and 80 DAS gave higher results in terms of growth and yield, followed by application of 75% RDF + foliar application of 2% WSF at 60 DAS and 80 DAS.

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