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**Archana Verma**
Department of Soil Science and Agricultural Chemistry, Bihar Agricultural University, Bihar, India

**Uday Pratap Shahi**
Department of Soil Science and Agricultural Chemistry, SVPUA&T, Meerut, India

**Pankaj Chaurasia**
Department of Soil Science and Agricultural Chemistry, SVPUA&T, Meerut, India

**Satdev**
Department of Soil Science and Agricultural Chemistry, Bihar Agricultural University, Bihar, India

**Shruti Kumari**
Department of Soil Science and Agricultural Chemistry, Bihar Agricultural University, Bihar, India

**Rakesh Kumar**
Department of Soil Science and Agricultural Chemistry, Bihar Agricultural University, Bihar, India

**Corresponding Author:**
**Satdev**
Department of Soil Science and Agricultural Chemistry, Bihar Agricultural University, Bihar, India

# Effect of mode of micronutrient application on the yield of pigeon pea (*Cajanus cajan* L.) in sandy loam soil

**Archana Verma, Uday Pratap Shahi, Pankaj Chaurasia, Satdev, Shruti Kumari and Rakesh Kumar**

## Abstract
A field experiment was carried out during the *kharif* season 2018 at Crop Research Centre of Sardar Vallabhbhai Patel of Agriculture and Technology, Meerut (U.P) to evaluate the effect of mode of micronutrients application on yield of pigeon pea (*Cajanus cajan* L.) in sandy loam soil. Nine treatments consisting of micronutrients (Zn, Fe and B) *viz* $T_1$ [Control (NPK)], $T_2$ ($ZnSO_4$@ 25 kg/h), $T_3$ (Fe $SO_4$@ 40 kg/ha), $T_4$ (Borax@ 10 kg/ha), $T_5$ ($ZnSO_4$+ $FeSO_4$+ Borax), $T_6$ (foliar spray $ZnSO_4$@0.5%), $T_7$ (foliar spray $FeSO_4$ @1%), $T_8$ (foliar spray Borax@0.2%), $T_9$ (foliar spray $ZnSO_4$+ $FeSO_4$+ Borax) were tested in randomized block design with three replications. Recommended doses of NPK was commonly applied in all the plots**.** The experimental results revealed that yields *viz.*, grain, straw and biological pigeon pea differ significantly among different treatments and were maximum with the foliar spray of $ZnSO_4$+ $FeSO_4$+ Borax followed by soil application of $ZnSO_4$+ $FeSO_4$+ Borax. Therefore, the combined application of various micronutrients should be taken into consideration.

**Keywords:** Micronutrients, foliar spray, borax, grain yield, straw yield and biological yield etc.

## Introduction
In India, pulses are an integral part of the diet. India is the largest producer of pulse in the whole world which produces 19.98 million tonnes per annum from 30-million-hectare area. India contributes 35% area for total global pulse production which is 25% of world's pulse producing area**.** An area of 85.19 million hectares is occupied by pulses all over world hence it contributes 77.43 million tonnes to global food basket (Annual report 2016-17, GOI) [2]. The scenario of productivity in India for pulses lies between 600-650 kg $ha^{-1}$ (Gowda *et al.*, 2014) which is far below, compared to average global productivity of pulses which is 909 kg $ha^{-1}$ (Annual report 2016-17, GOI) [2]. Pigeon pea had originated in South Asia and it is now growing in tropical and sub-tropical regions also. It is grown throughout the tropical and sub-tropical regions of the world, between $30^0$ N and $35^0$ S latitudes. However, major area under pigeon pea in India is lying between $14^0$ S and $28^0$ N latitudes. After chickpea, pigeon pea is the second most important pulse crop in India, grown in an area of 56.02 lakh hectare with 32.90 lakh tones production (Annual Report 2016-17, GOI) [2]. It is to be noted that in our country, the productivity of pigeon pea is quite low due to number of factors i.e. agronomic, genetic, pathogenic and entomological as well as their interaction with environment. Inclusion of legumes especially in the monsoon (rainy season) are, however, very limited in the Upper Gangetic Plain (UGP) transect of the Indo-Gangetic Plain (IGP), where rice–wheat is the dominant cropping system. With the development of short duration varieties of pigeon pea [*Cajanus cajan* (L.) Millsp.] In recent years, it has become possible to introduce this crop to substitute rice especially in upland and water scarcity situations (Mandal *et al.*, 2013) [13]. Although India stands first in area and production of this crop, still there is need to import this pulse crop from other countries, it is mainly due to the higher domestic consumption demands in our country. In pulses, the limited nitrogen fixation by legume- rhizobium symbiosis is the result of mineral nutrient deficiencies. There is deficiency of both macronutrients as well as micronutrients (Zn, Fe, B, Mo etc.) take place which inhibits or limits the legume production (Bhuiyan *et al.*, 1999) [3]. These deficiencies of micronutrients in the crop also causes deficiency in human populations (Adhikary *et al.*, 2020) [1] and Zn deficiency in human is one of the most widespread and Zn deficiency can cause serious health problems in countries like India (Ray *et al.*, 2016) [18]. Zinc (Zn) is one of the most deficient micronutrients all over the world (Oliver and Gregory 2015) [16].

Most of the Zn fertilizer studies have focused on increasing grain yield, although grain Zn concentration is also starting to be addressed (Cakmak, 2009) [4]. The boron improves the grain and straw yield, nutrient content, nutrient uptake and quality in legume crops (Singh *et al*., 2004 [21] and Singh *et al*., 2006 [22]). Boron deficiency limits the production of pulse crops (Mani and Haldar, 1996) [14]. The symptoms of iron deficiency in pigeon pea growing in solution culture have been discussed by Nichols (1964) [15]. Since iron is immobile in the plant, the youngest leaves showed the symptoms first and interveinal areas also became pale green. In severe cases, the entire area of the leaflet became chlorotic and small necrotic patches developed. The low yield of pigeon pea is mainly attributed to their cultivation on poor soils with inadequate and imbalanced macronutrients as well as micronutrients like zinc, iron and boron application. Among the micronutrients Zn, Fe and B are supposed to improve the yield appreciably and foliar spray of micronutrients proved to be economical in pulses (Savithri *et al*., 2001) [20].

**Material and Methods:**

In order to study the the effect of mode of micronutrients application on yield of pigeon pea *(Cajanus cajan* L.) in sandy loam soil a field experiment was carried out during the *kharif* season 2018 at Crop Research Centre of Sardar Vallabhbhai Patel of Agriculture and Technology, Meerut (U.P) which is situated at $29^0 8^1$ NE latitude and $77^0 40^1$E longitude at an altitude of 237 m above the mean sea level. Mean weakly data on mean temperature, relative humidity, and total rainfall recorded during the crop season, i.e. summer season 2018, at the meteorological observatory located at the Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.), are shown graphically in Fig. I. In general, maximum temperature exhibited a gradual decline with advancement in crop age. The mean weakly lowest and highest temperature recorded during the crop growth period were 6.5$^0$C and 40.0$^0$C in the month of July and December. The mean weakly lowest and highest relative humidity recorded during the crop growth period varied from 45.4 to 96.6 per cent. The cop received 36.95 mm of rainfall during its growing period. It shows the impact of climate on the growth and yields of the pigeon pea crop in the experiment.

UPAS-120, which is a short duration variety of pigeon pea was grown in randomized block design with three replications. Total 9 treatments were used *viz*. $T_1$ [Control (NPK)], $T_2$ ($ZnSO_4$@ 25 kg/h), $T_3$ (Fe $SO_4$@ 40 kg/ha), $T_4$ (Borax@ 10 kg/ha), $T_5$ ($ZnSO_4$+ $FeSO_4$+ Borax), $T_6$ (foliar spray $ZnSO_4$@0.5%), $T_7$ (foliar spray $FeSO_4$ @1%), $T_8$ (foliar spray Borax@0.2%), $T_9$ (foliar spray $ZnSO_4$+ $FeSO_4$+ Borax). In order to mechanism of growth and development of plant, it was necessary to study the behaviour of the developing plant under the influence of different treatment. An area was marked for recording various growth observations on crop. Yield attributes were recorded at harvest. After harvesting, the pigeon pea crop was sun dried and then weight of net plot area harvested was recorded in kg and expressed as kg ha$^{-1}$. The weight of grains harvested from net plot area was recorded and finally expressed as kg ha$^{-1}$. Straw yield from net plot area was computed by subtracting the grain yield from the biological yield and later converted into kg ha$^{-1}$. The harvest index, an index to partitioning of dry matter towards grains was calculated by fallowing formula:

$$\text{Harvest index} = \frac{\text{Economic yield}}{\text{Biological yield}} \text{x100}$$

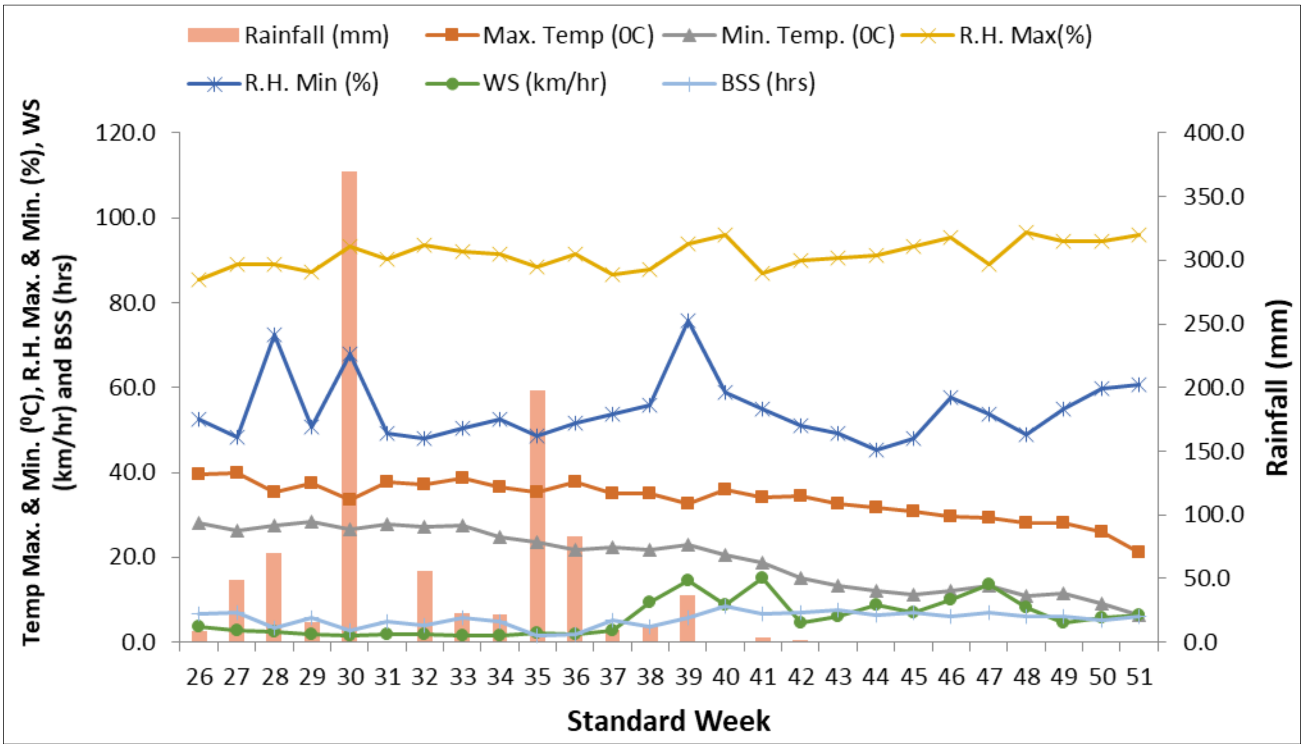


**Fig 1:** Mean weakly data on mean temperature, relative humidity, and total rainfall recorded during the crop season, i.e. summer season 2018

**Result**

In the present study soil and foliar application of micronutrients *viz*. Zn, Fe and B exhibited a significant impact on yield of pigeon pea crop. Biological, grains and straw yields were significantly affected by soil and foliar application of Zn, Fe and B.

**Effect of Soil and Foliar spray of Zn, Fe and B on Biological yield**

After harvesting, the pigeon pea crop was sun dried and then weight of net plot area harvested was recorded and expressed as t ha$^{-1}$. It has been found that maximum biological yield 7.93 t ha$^{-1}$ recorded in $T_9$ where foliar spray $ZnSO_4$+ $FeSO_4$+ Borax was done while minimum yield was observed in control ($T_1$) i.e. 7.04 t ha$^{-1}$. Biological yield significantly ranged from 7.04 to 7.93 t ha$^{-1}$ under different treatments significantly. Maximum biological yield recorded in $T_9$ was at par to the treatments $T_5$ and $T_7$. In the treatment $T_9$ the biological yield was 12.64% higher than the control plot which shows that the biological yield of the pigeon pea crop was significantly influenced with the foliar spray of Zinc, iron and boron micronutrients.

**Effect of Soil and Foliar spray of Zn, Fe and B on straw yield**

The weight of grains harvested from net plot area was recorded and finally expressed as kg ha$^{-1}$. Straw yield varied from 5.87 to 6.47 t ha$^{-1}$ under different treatments. Maximum straw yield 6.47 t ha$^{-1}$ was found in $T_9$ (foliar spray $ZnSO_4$+ $FeSO_4$+ Borax) while minimum 5.87 t ha$^{-1}$ in treatment $T_1$ i.e. control plot. The straw yield differs significantly under the influence of different treatments. Due to foliar spray $ZnSO_4$+ $FeSO_4$+ Borax ($T_9$) straw yield increased by 10% and it was at par to the $T_5$ and $T_7$.

**Effect of Soil and Foliar spray of Zn, Fe and B on grain yield**

Straw yield from net plot area was computed by subtracting the grain yield from the biological yield and later converted into t ha$^{-1}$. Different treatments showed a significant effect on grain yield which ranged from 1.17 to 1.47 t ha$^{-1}$. Maximum grain yield 1.47 t ha$^{-1}$ obtained by $T_9$ (foliar spray of $ZnSO_4$+ $FeSO_4$+ Borax) was significantly higher than remaining treatments except $T_5$, $T_6$, $T_7$. Minimum grain yield i.e. 1.17 t ha$^{-1}$ was recorded in the treatment where only NPK was applied ($T_1$). Combined foliar application of Zn, Fe and B ($T_9$) significantly improved the grain yield over control which was 25.2% higher over control. In treatments $T_5$, $T_6$ and $T_7$ grain yield increment was 17.6%, 13.9% and 15.2% respectively.

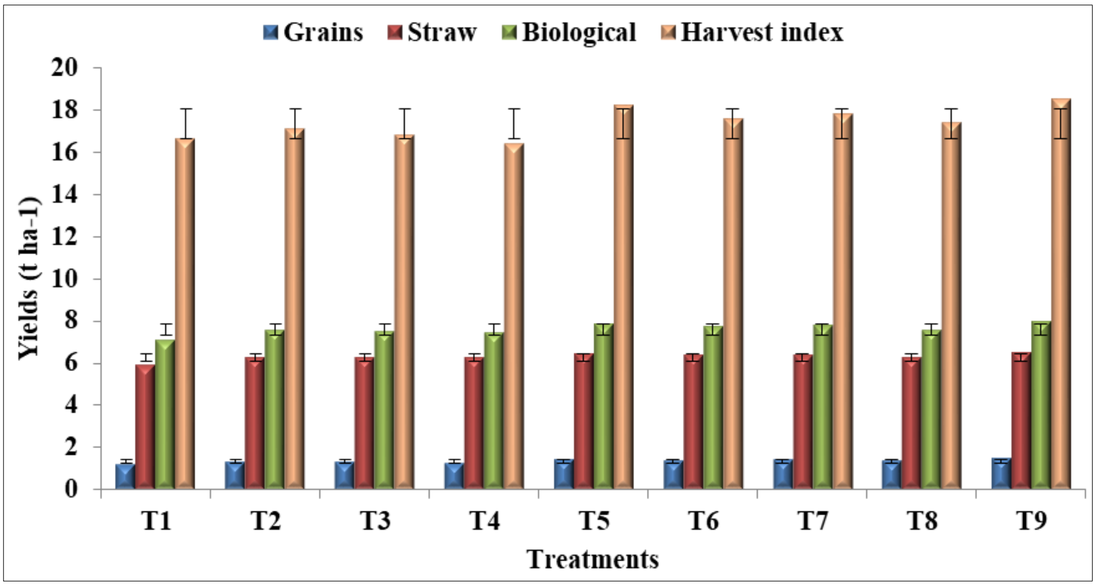


**Fig 2:** Effect of mode of micronutrients (Zn, Fe and B) application on yields (Grains, straw and biological) and harvest index of pigeon pea

**Effect of Soil and Foliar spray of Zn, Fe and B on harvest index**

The harvest index, an index to partitioning of dry matter towards grains was numerically highest in the treatment where foliar spray of $ZnSO_4$+ $FeSO_4$+ Borax was done, i.e. harvest index value (18.5%), while lowest harvest index (16.4%) was recorded in control plot ($T_1$). Harvest index express proportion of economic yield in total biological yield shows a non-significant difference by soil and foliar application of Zn, Fe and B during the experimentation.

**Discussion**

It has been observed that the low yield of pigeonpea is mainly attributed to their cultivation on poor soils with inadequate and imbalanced nutrient application, almost without application of micronutrients. (Srikanth Babu *et al.*, 2012) [23]. The foliar application of micronutrients and soil application of the same may boost up the vegetative growth and development as well as help in supply of photosynthetes to reproductive part and ultimately increases the yield.

Yield increase in these treatments may be the result of inhibition in flower and pod abscission, improvement in morpho-physiological characters (stem girth, early vigour and crop establishment) and enhanced dry matter production Reddy *et al.* (2007) [19]. The minimum grain biological and straw yield was obtained in the control but as we added the micronutrients, these yields get improved. Zinc is reported to enhance the absorption of native as well as added macro nutrients which might have been attributed to improvement in the yield. Boron's involvement in hormone synthesis and translocation, carbohydrate metabolism and DNA synthesis probably contributed to additional growth and yield (Ratna Kalyani *et al.* 1993) [8]. Foliar application of iron ($T_7$) showed better results in terms of yield attributes as compare to soil application it might be due to plant utilise iron in reduced form and less usable in oxidised condition in soil. Wankhade *et al.* (1995) [27] said that application of Fe significantly increased the yield of pigeon pea compared to control. Boron also can play major role in augmenting the yield. Similar findings were also reported by Thamke (2017) [25], Gowda *et al.* (2015) [7], Khrogamy and Farnia (2009) [9].

**Table 1:** Effect of mode of micronutrients (Zn, Fe and B) application on yields (Grains, straw and biological) and harvest index of pigeon pea

| Treatments | Yields (t ha$^{-1}$) | | | Harvest index |
|---|---|---|---|---|
| | Grains | Straw | Biological | |
| $T_1$ Control (20:50:40) | 1.17 | 5.87 | 7.04 | 16.6 |
| $T_2$ $ZnSO_4$@ 25 kg/h | 1.28 | 6.23 | 7.51 | 17.1 |
| $T_3$ Fe $SO_4$@ 40 kg/ha | 1.26 | 6.21 | 7.47 | 16.8 |
| $T_4$ Borax@ 10 kg/ha | 1.22 | 6.21 | 7.44 | 16.4 |
| $T_5$ $ZnSO_4$+ $FeSO_4$+ Borax | 1.42 | 6.39 | 7.82 | 18.2 |
| $T_6$ foliar spray $ZnSO_4$@0.5% | 1.36 | 6.35 | 7.70 | 17.6 |
| $T_7$ foliar spray $FeSO_4$ @1% | 1.38 | 6.38 | 7.76 | 17.8 |
| $T_8$ foliar spray Borax@0.2% | 1.31 | 6.23 | 7.54 | 17.4 |
| $T_9$ foliar spray $ZnSO_4$+ $FeSO_4$+ Borax | 1.47 | 6.47 | 7.93 | 18.5 |
| SE m (±) | 0.04 | 0.27 | 0.25 | - |
| C.D. (P=0.05) | 0.13 | 0.49 | 0.71 | NS |

**Summary and conclusion:**

Grain, straw and biological yields were enhanced by the soil and foliar spray of Zn, Fe and B. The highest yields were obtained by $T_9$ followed by $T_5$. Although, soil applied Zn, Fe and B individually gave lower yields but their combined application show the best results. Harvest index remained almost constant with the soil and foliar application of micronutrients although it increased in the micronutrients treated plots with the advancement in crop growth.

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