Journal of Pharmacognosy and Phytochemistry 2019; 8(5): 2404-2408

Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

**E-ISSN:** 2278-4136
**P-ISSN:** 2349-8234
JPP 2019; 8(5): 2404-2408
Received: 10-07-2019
Accepted: 12-08-2019

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# Effect of zinc and thiourea application on growth, yield and nutrient uptake of greengram [*Vigna radiata* (L.) Wilczek]

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**Abstract**
A field experiment was conducted at Agronomy farm, S.K.N. College of Agriculture, Jobner (Rajasthan) during *kharif*¸ 2016 on loamy sand soil. The experiment comprising four levels of zinc (0, 2.0, 4.0 and 6.0 kg/ha) and five treatments of thiourea application (control, seed soaking with 500 ppm, foliar spray at branching (500 ppm), foliar spray at flowering initiation (500 ppm) and foliar spray at branching and flowering initiation with 500 ppm) thereby making 20 treatment combinations was laid out in randomized block design and replicated thrice. Results showed that being at par with 6.0 kg/ha zinc fertilization at 4.0 kg/ha significantly increased the growth and yield attributing characters of greengram *viz*., plant height, branches/plant and dry matter accumulation at most of stages, chlorophyll content, LAI, number and weight of nodules/plant, number of pods/plant, number of grains/pod, test weight, maximum yield, higher uptake of N, P and Zn over preceding levels. Foliar spray of thiourea (500 ppm) was found significantly superior among all the treatments with respect to growth and yield determining characters, nutrient concentration and their uptake in greengram.

**Keywords:** Mungbean, Thiourea, Zinc, Nutrient, Yield

## Introduction

Pulses, also known as grain legumes, are next to cereals in terms of agricultural importance and have been considered best options for diversification and intensification of agriculture across the globe because of their intrinsic values such as nitrogen fixing ability (15-35 kg N/ha), high protein content and ability to thrive well in less endowed environment. Pulses account 24.89 m ha area with production of 17.38 million tonnes in the country. Greengram [*Vigna radiata* (L.) Wilczek], also known as mungbean, stands third after chickpea and pigeonpea among pulses. It occupies 29.36 lakh hectare area and contributes 13.90 lakh tonnes in pulse production in the country (Anonymous, 2015-16) [2]. Pulses are the main source of dietary protein particularly for vegetarians and contribute about 14 per cent of the total protein of average Indian diet. Production of pulses in the country is far below the requirement to meet even the minimum level of per capita consumption. The per capita availability of pulses is dwindling fast from 70 g in 1959 to 31.6 g/capita/day in 2011 as against the minimum requirement of 84 g/capita/day prescribed by Indian Council of Medical Research, which is causing malnutrition among the growing population (Anonymous, 2011) [1]. Greengram is an excellent source of protein (24.5%) with high quality of lysine (460 mg/g) and tryptophan (60 mg/g). It also has remarkable quantity of ascorbic acid when sprouted and contains riboflavin (0.21 mg/100 g) with good amount of minerals (Gopalan *et al*., 1995) [8]. Being a short duration crop, it suits well in various multiple and intercropping systems. After picking of pods, greengram plants may be used as green fodder or green manure.

Micronutrients are essential for the normal growth of plants, deficiencies of which adversely affect the growth, metabolism and reproductive phase in plants. In many parts of the country, zinc (Zn) as a plant nutrient stands third in importance i.e. next to nitrogen and phosphorus (Katyal and Sharma, 1991) [12]. In the recent years, zinc is considered as one of the constraint in the optimum production of crops. It plays a vital role in synthesis of chlorophyll, protein and nucleic acid and helps in the utilization of nitrogen and phosphorus by plants as it acts as an activator of dehydrogenase and proteinase enzymes, directly or indirectly in synthesis of carbohydrates and protein. Zinc is constituent of tryptophan which is a precursor of auxin hormone. Besides, it is associated with water uptake and water relations. Light textured soils of tract (zone-III A) are inherently deficient in zinc (0.43 ppm). Further, availability of zinc decreases with rise in soil pH. Even fertile soils have become deficient in zinc because of little or no use of organic matter, use of high analysis fertilizers and intensive cropping systems. Zn is an essential component of synthetic and natural organic complexes in plants. It is mainly involved in many enzymatic activities, synthesis of tryptophan and compounds needed for the production of growth hormones.

Since there is little scope for horizontal growth in acreage, the only alternative left is to achieve vertical growth through increasing the existing level of production. This emphasizes to think over for the use of thiourea, bioregulator and micronutrients like zinc to break the stagnation in greengram production. Thiourea plays a vital role in the physiology of plants both as sulphydryl compound and as an amino compound like urea. Foliar applied thiourea improves the CO2 uptake by stomata. Thiourea plays a vital role in maintaining redox state of membrane proteins as it can quench reactive oxygen species (ROS) generated during heat stress. This was also associated with greater total antioxidant activity under heat stress. The foliar spray of thiourea increased the plant photosynthetic efficiency and canopy photosynthesis due to presence of S-H group as an integral constituent of these thiols. Its beneficial effect appears to be due to delayed senescence of both vegetative and reproductive organs as thiourea has cytokinin like activity, particularly delaying senescence (Halmann, 1980) [9].

## Material and Methods

A field experiment was conducted during *kharif* season 2016 at Plot No.3-D at Agronomy Farm, S.K.N. College of Agriculture, Jobner (Rajasthan) to find out the “Effect of Zinc and Thiourea Application on Growth and Yield of Greengram [*Vigna radiata* (L.) Wilczek]”. Geographically, jobner is situated 45 km west of Jaipur at $26^0$ 05' North latitude, $75^o$ 28 East longitude and at an altitude of 427 meters above mean sea level. The average annual rainfall of this tract varies from 400 mm to 500 mm and is mostly received during the months of July to September. Soils are loamy sand with 0.21% organic carbon, 126.3 kg ha-1 N, 19.23 kg/ha $P_2O_5$ and 150.26 kg/ha $K_2O$. The experiment comprising four levels of zinc (0, 2.0, 4.0 and 6.0 kg/ha) and five treatments of thiourea application (control, seed soaking with 500 ppm, foliar spray at branching (500 ppm), foliar spray at flowering initiation (500 ppm) and foliar spray at branching and flowering initiation with 500 ppm) thereby making 20 treatment combinations was laid out in randomized block design and replicated thrice. Zinc was applied as per treatment through zinc sulphate ($ZnSo4.7H_2O$) containing 21 per cent zinc. Thiourea treatments were administered as seed soaking and foliar spray. Seed soaking involved dipping the seeds in 500 ppm thiourea solution for 8 hours prior to sowing. Different growth attributes studied *viz*., plant height and dry matter accumulation/plant at all the growth stages, number of branches/plant, leaf area index, chlorophyll content were counted in five randomly selected one meter row length in each plot at physiological maturity of the mungbean. The mungbean RMG-492 was sown at 30 cm row spacing on 13 july 2016.

The uptake of nitrogen by crop was calculated by following formula (Snell and Snell, 1949) [22]:

$$\text{N uptake (kg/ha)} = \frac{\text{Per cent N in seed x Seed yield (kg/ha)} + \text{Per cent N in stalk/straw x stover/straw yield (kg/ha)}}{100}$$

The uptake of phosphorus by crop was calculated by following formula (Jackson, 1967) [10]:

$$\text{P uptake (kg/ha)} = \frac{\text{Per cent P in seed x Seed yield (kg/ha)} + \text{Per cent P in stalk/straw x stover/straw yield (kg/ha)}}{100}$$

$$\text{Total uptake (kg/ha)} = \frac{\text{Nutrient conc. in seed (\%) x Seed yield (kg/ha)} + \text{Nutrient conc. in stalk/straw (\%) x stover/straw yield (kg/ha)}}{100}$$

## Result and Discussion

### Effect of Zinc

#### *Growth attributes*

A perusal of data presented in table 1,2&3 revealed that application of 40 kg N had favourable effect on growth and yield. Increasing levels of zinc up to 4.0 kg/ha significantly increased the plant height and number of branches/plant at 50 DAS and at harvest and dry matter accumulation at all the stages over lower levels. Chlorophyll content, LAI, number and weight of root nodules also increased significant due to zinc. The maximum values of these parameters were observed at 6.0 kg Zn/ha. The favourable influence of applied zinc on these characters may be explained with its catalytic or stimulatory effect on most of the physiological and metabolic processes of plant. These results are in close conformity with the findings of Baskar *et al*. (2000) [4], Choudhary (2006) [7], Jain (2007) [11], Usman *et al*. (2014) [25] and Upadhyay and Singh (2016) [24].

#### *yield*

Significant increase in grain and straw yields were also recorded in greengram due to increasing levels of zinc fertilization up to 4.0 kg/ha (3). The increase in yield with the application of zinc might be due to its important role in regulating the auxin concentration in plants. Results of the present investigation corroborate with the findings of Saini (2003) [21] in mothbean, Jain (2007) [12] in mothbean, Sammauria (2007) [23] in fenugreek, Singh and Mann (2007) [25] in groundnut.

#### *Nutrient uptake*

phosphorus concentration in grain and straw of greengram decreased with increasing levels of zinc through, it was not significant (Table 4). This reduction in the P concentration owing to higher levels of zinc application might be due to the antagonistic relationship existing between zinc and phosphorus (Olsen, 1954) [17]. The significant increase in the phosphorus uptake in grain and straw was probably due to increase in grain and straw yield of the crop. The results obtained get support from the findings of Jain (2007) [11] and Sharma. Application of Zn to deficient soil increased the availability of Zn in rhizosphere at a level below where the optimum requirement of crop is fulfilled. The favourable effect of zinc on photosynthesis and metabolic processes augmented the production of photosynthates and their translocation to different plant parts including seed and straw, which ultimately increased the concentration of nutrients in the grain and straw. Similar findings were also reported by Aruna *et al*. (2001) [3] in groundnut, Mali *et al*. (2003) [14] in pigeonoea, Choudhary (2006) [7] in clusterbean Jain (2007) [11] in mothbean and chavan *et al*. (2013) [6] in cowpea. Since, total uptake is the function of nutrient concentration in grain and straw and their respective yields, thereby, resulting into the significant increase in uptake of zinc. These results are incongnizance with the findings of Saini (2003) [18] in mothbean, Sammauria (2007) [20] in fenugreek and Usman *et al*. (2014) [25] in greengram.

**Effect of thiourea**

***Growth attributes***

Results (Table1,2&3) showed that foliar application of 500 ppm thiourea at branching or flowering initiation or at both stages as well as seed soaking, significantly increased the growth parameters of greengram *viz*., plant height, number of branches, dry matter accumulation, chlorophyll content, LAI, total and effective nodules/plant, fresh and dry weight of nodules/plant over control. Significant increase in plant height and dry matter accumulation as a result of thiourea application provided ample support to such effects (Sahu *et al*., 1993) [19].

***yield***

Foliar spray of thiourea @ 500 ppm at branching remained at par with thiourea spray at flowering initiation. The increase in yield due to application of thiourea might be the result of concomitant increase in number of pods/plant, number of grains/pod per plant and growth parameters mainly the dry matter accumulation. These results are in accordance with the findings of Bamaniya (2009) [5] in mungbean and Meena *et al*. (2016) [16] in clusterbean.

***Nutrient uptake***

Application of 500 ppm thiourea either as foliar spray or as seed soaking also significantly increased the N, P and Zn concentration in grain and straw and as well as their uptake by greengram (Table 4) compared to control. It might be due to the fact that thiourea seed soaking enhanced the germination of seeds earlier as observed visually in the present investigation. Thus, the higher availability of nitrogen, phosphorus and zinc in the rhizosphere coupled with better root development led to greater absorption of nutrients from the soil. The higher uptake of nutrients was also a consequence of increased seed and straw yield and their concentration in seed and straw under better treatments. These findings are in the line with those of Meena and Sharma (2005) [15], Singh and Mann (2007) [21], Bamaniya (2009) [5] and Kumawat *et al*. (2014) [13].

**Table 1:** Effect of Zinc and Thiourea on growth parameters at different stages

| Treatments | Plant stand/meter row length | | Plant height (cm) | | | Leaf area index | Chlorophyll content (mg/g) |
|---|---|---|---|---|---|---|---|
| | 20 DAS | At harvest | 25 DAS | 50 DAS | At harvest | | |
| **Zinc levels (kg/ha)** | | | | | | | |
| Control | 10.5 | 10.0 | 15.8 | 34.3 | 50.0 | 2.95 | 3.52 |
| 2.0 | 10.6 | 10.2 | 18.0 | 37.6 | 54.0 | 3.36 | 3.95 |
| 4.0 | 10.7 | 10.4 | 18.7 | 39.9 | 57.2 | 3.69 | 4.11 |
| 6.0 | 11.3 | 10.5 | 19.0 | 40.9 | 58.0 | 3.81 | 4.21 |
| SEm± | 0.2 | 0.2 | 0.33 | 0.73 | 1.09 | 0.08 | 0.09 |
| CD (P=0.05) | NS | NS | 0.95 | 2.08 | 3.12 | 0.22 | 0.25 |
| **Thiourea application** | | | | | | | |
| Control | 10.4 | 9.8 | 17.1 | 34.4 | 49.7 | 3.00 | 3.44 |
| Seed soaking with 500 ppm | 10.5 | 10.0 | 18.9 | 37.1 | 53.9 | 3.39 | 3.79 |
| Foliar spray at branching (500 ppm) | 10.7 | 10.4 | 17.9 | 39.7 | 57.4 | 3.54 | 4.08 |
| Foliar spray at flowering initiation (500 ppm) | 11.0 | 10.3 | 17.7 | 38.6 | 54.2 | 3.46 | 4.02 |
| Foliar spray at branching and flowering initiation (500 ppm) | 11.1 | 10.8 | 18.0 | 41.0 | 59.0 | 3.88 | 4.41 |
| SEm± | 0.3 | 0.3 | 0.37 | 0.81 | 1.22 | 0.09 | 0.10 |
| CD (P=0.05) | NS | NS | 1.06 | 2.32 | 3.48 | 0.24 | 0.28 |

NS= Non- significant, DAS= Days after sowing, ppm= parts per million

**Table 2:** Effect of Zinc and Thiourea on growth parameters at different stages

| Treatments | N0. of nodules/plant | | Weight of nodules (mg/plant) | |
|---|---|---|---|---|
| | Total nodules | Effective nodules | Fresh weight | Dry weight |
| **Zinc levels (kg/ha)** | | | | |
| Control | 16.24 | 14.02 | 91.02 | 34.3 |
| 2.0 | 18.33 | 16.13 | 97.59 | 37.6 |
| 4.0 | 20.11 | 18.19 | 103.88 | 39.9 |
| 6.0 | 20.99 | 18.33 | 104.78 | 40.9 |
| SEm± | 0.42 | 0.37 | 2.15 | 0.73 |
| CD (P=0.05) | 1.20 | 1.06 | 6.17 | 2.08 |
| **Thiourea application** | | | | |
| Control | 16.64 | 14.38 | 88.67 | 50.05 |
| Seed soaking with 500 ppm | 18.28 | 16.23 | 96.68 | 55.29 |
| Foliar spray at branching (500 ppm) | 19.66 | 17.56 | 103.71 | 59.93 |
| Foliar spray at flowering initiation (500 ppm) | 19.35 | 17.50 | 103.61 | 59.63 |
| Foliar spray at branching and flowering initiation (500 ppm) | 20.66 | 17.67 | 103.91 | 61.27 |
| SEm± | 0.47 | 0.42 | 2.41 | 1.43 |
| CD (P=0.05) | 1.34 | 1.19 | 6.90 | 4.09 |

**Table 3:** Effect of Zinc and Thiourea on No. of branches, dry matter accumulation and yield

| Treatments | No of branches/plant | | Dry matter accumulation (g) | | | Yield (kg/ha) | |
|---|---|---|---|---|---|---|---|
| | 50 DAS | At harvest | 25 DAS | 50 DAS | At harvest | Seed yield | Straw yield |
| **Zinc levels (kg/ha)** | | | | | | | |
| Control | 6.35 | 7.38 | 7.7 | 46.1 | 94.3 | 853 | 1485 |
| 2.0 | 7.46 | 8.55 | 8.6 | 51.2 | 102.1 | 1086 | 1848 |
| 4.0 | 8.32 | 9.52 | 9.4 | 54.3 | 108.4 | 1180 | 2088 |
| 6.0 | 8.52 | 9.62 | 9.7 | 56.1 | 1197 | 1020 | 2157 |
| SEm± | 0.14 | 0.19 | 0.2 | 1.0 | 2.0 | 21 | 40 |
| CD (P=0.05) | 0.40 | 0.55 | 0.6 | 2.8 | 5.8 | 60 | 113 |
| **Thiourea application** | | | | | | | |
| Control | 6.48 | 7.33 | 8.3 | 46.2 | 87.2 | 893 | 1580 |
| Seed soaking with 500 ppm | 7.52 | 8.51 | 9.3 | 49.9 | 101.5 | 1020 | 1824 |
| Foliar spray at branching (500 ppm) | 8.05 | 9.31 | 8.8 | 53.4 | 108.2 | 1125 | 1974 |
| Foliar spray at flowering initiation (500 ppm) | 7.87 | 8.82 | 8.8 | 53.2 | 107.9 | 1103 | 1956 |
| Foliar spray at branching and flowering initiation (500 ppm) | 8.39 | 9.87 | 9.0 | 57.0 | 115.1 | 1253 | 2139 |
| SEm± | 0.16 | 0.21 | 0.2 | 0.24 | 0.27 | 23 | 44 |
| CD (P=0.05) | 0.45 | 0.61 | 0.6 | 0.69 | 0.78 | 67 | 127 |

NS= Non- significant, DAS= Days after sowing, N= Nitrogen, P= Phosphorous, Zn= Zinc

**Table 4:** Effect of Zinc and Thiourea on N, P and Zn concentration and uptake

| Treatments | N concentration (%) | | Total N uptake (kg/ha) | P concentration (%) | | Total P uptake | Zn concentration (ppm) | Total Zn uptake (g/ha) | |
|---|---|---|---|---|---|---|---|---|---|
| | Seed | Straw | | Seed | Straw | | Seed | Straw | |
| **Zinc levels (kg/ha)** | | | | | | | | | |
| Control | 3.04 | 1.10 | 42.45 | 0.448 | 0.174 | 6.44 | 25.15 | 20.05 | 21.53 |
| 2.0 | 3.55 | 1.30 | 62.96 | 0.437 | 0.170 | 7.94 | 28.44 | 21.93 | 31.03 |
| 4.0 | 3.89 | 1.38 | 75.50 | 0.432 | 0.167 | 8.68 | 30.58 | 22.95 | 36.34 |
| 6.0 | 3.95 | 1.44 | 79.19 | 0.423 | 0.165 | 8.73 | 30.81 | 23.15 | 37.18 |
| SEm± | 0.07 | 0.03 | 1.61 | 0.009 | 0.003 | 0.16 | 0.59 | 0.39 | 0.67 |
| CD (P=0.05) | 0.20 | 0.09 | 4.60 | NS | NS | 0.45 | 1.70 | 1.13 | 1.93 |
| **Thiourea application** | | | | | | | | | |
| Control | 3.12 | 1.07 | 45.17 | 0.344 | 0.151 | 5.46 | 25.85 | 20.28 | 23.24 |
| Seed soaking with 500 ppm | 3.61 | 1.31 | 61.32 | 0.430 | 0.163 | 7.35 | 28.64 | 21.79 | 29.46 |
| Foliar spray at branching (500 ppm) | 3.74 | 1.37 | 70.03 | 0.460 | 0.174 | 8.60 | 29.47 | 22.43 | 33.50 |
| Foliar spray at flowering initiation (500 ppm) | 3.65 | 1.32 | 66.97 | 0.452 | 0.172 | 8.33 | 28.85 | 22.14 | 32.13 |
| Foliar spray at branching and flowering initiation (500 ppm) | 3.93 | 1.45 | 81.65 | 0.488 | 0.184 | 10.01 | 30.91 | 23.46 | 39.27 |
| SEm± | 0.08 | 0.03 | 1.80 | 0.010 | 0.004 | 0.18 | 0.021 | 0.44 | 0.75 |
| CD (P=0.05) | 0.22 | 0.10 | 5.14 | 0.029 | 0.011 | 0.50 | 0.061 | 1.26 | 2.16 |

NS= Non- significant, N= Nitrogen, P= Phosphorus, Zn= Zinc

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