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# Effect of Different Level of Sulphur and Zinc on Soil Health and Yield of Blackgram (*Vigna mungo* L.) Var. Barkha

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**A B S T R A C T**

To improve the soil quality, production, productivity and maximizing profit with higher economic returns through application levels of zinc and sulphur. Factorial randomized block design fallowed here with 9 treatment combinations replicated 3 times. Recommended dose of fertilizers i.e. nitrogen, phosphorus and potassium, was applied @ 20:40:20 kg $ha^{-1}$as urea (46% N), single super phosphate (16% $P_2O_5$), muriate of potash (60% $K_2O$) and zinc sulphate (33% Zn). Application levels of sulphur 0, 15 and 30 kg $ha^{-1}$ and zinc 0, 1.5 and 3.0 kg $ha^{-1}$ at 5 cm depth in furrows, before seed sowing was done with spacing of 30 X 10 cm. The accumulative mean of low soil pH (6.85) by $T_9$ - (Zinc@100%+ Sulphur@100%), electrical conductivity (0.22 dS $m^{-1}$) by $T_6$ - (Zinc@50% + Sulphur@100%), particle density (2.64 $mg^{-3}$) by $T_5$ - (Zinc@50%+ Sulphur@50%) and bulk density (1.16 $mg^{-3}$) by $T_4$ - (Zinc@50%+Sulphur@0%), the higher available nitrogen (273.67 kg $ha^{-1}$) by $T_9$ - (Zinc@100% + Sulphur@100%), available phosphorus (16.49) by $T_8$ - (Zinc@100% + Sulphur@50%), available potassium (128.34) by $T_9$ - (Zinc@100% + Sulphur@100%), available zinc (1.30) by $T_9$ - (Zinc@100% + Sulphur@100%) and available sulphur (19.83) by $T_9$ - (Zinc@100% + Sulphur@100%). The combined application of zinc and sulphur along with control, has led to improvement in soil health potential, nutrient availability and yield sustenance under Black gram crop cultivation in which found that the treatment ($T_9$) consisting of zinc (100%) + sulphur (100%) give best result among other treatments.

## Introduction

Pulses are the main source of dietary protein particularly for vegetarians and contribute about 14 % of total protein of an average Indian diet. Pulses covers an area of about 23.63 million hectares with an annual production of 14.76 million tonnes and productivity of 708 kg/ha in our country (GOI, 2011-12). Production of pulses in the country is far below the requirement to meet even the minimum level per capita consumption. The per capita availability in pulses is dwindling fast from 70.0 g in 1959 to 33.0 g in 2008 as against the minimum requirement of 84 g per capita per day as prescribed by ICMR which is causing malnutrition among the growing people

(Anonymous, 2007). Hence, it is necessary for agricultural scientists to evolve strategy of increasing production and productivity of pulses to meet out the protein requirement of increasing population of the country.

Pulses are grown globally covering large dimension of about 70.50 million hectares in area with a total production of 57.27 million tonnes. Among different pulse producing countries, India ranks first having 29.96% of the total pulse acreage (2003-2004) though it contributes only 22.52% of the global pulse production. Over a dozen pulse crops are grown in the country and among these, Chickpea (Chana), Pigeon pea (Arhar), Mungbean (Moong) and Urdbean (Urd) are the most important, contributing total 86.00% (45.00% of chickpea, 20.00% of pigeon pea, 10.00% of mungbean and 11.00% of urdbean) of the total pulses production (http://www.iipr.res.in/pe/introduction.asp).

Available sulphur in soils of Jammu region ranges between 2.42 and 5.1 mg $kg^{-1}$, which is below the critical limit (Kour *et al.,* 2010). In fact, sulphur is the second most important plant nutrient after phosphorus for legume crops. Sulphur interacts with phosphorus as phosphate ion is more strongly bound than sulphate (Hegde and Murthy, 2005).

Black gram [*Vigna mungo* (L.) Hepper] is one of the important pulse crops grown throughout India. It is a protein rich (25%) food containing almost three times that of cereals, thus, it is a major source of protein to vegetarian populace. In Jammu and Kashmir, the total area under legume crops is 28.7 thousand hectares with an average productivity of 584 kg $ha^{-1}$, which is well below the national level of productivity- 905 kg $ha^{-1}$ (Anonymous, 2016).

In India, Andhra Pradesh occupied 555 thousand hectares (18 percent) of area and the largest producer of Black gram accounting for 30 percent (390 thousand tonnes) of the total production, during 2000-2001 in country, followed by Maharashtra, 574 thousand hectares (19 percent) with production 205 thousand tonnes (16 percent). The area under Black gram in Uttar Pradesh was 385 thousand hectares (13 percent) with production 163 thousand tonnes (13 percent), whereas in Tamil Nadu, the area and production was 276 thousand hectares (9 percent) and 127 thousand tonnes (10 percent) respectively. Similarly, in Madhya Pradesh, the area under the crop was 420 thousand hectares (14 percent) with the production of 106 thousand tonnes (8 percent). These five major states together contribute about 73 percent of total area and 76 percent of total production, under the Black gram, during the said period. However, in case of productivity, Sikkim stood first (737 $Kgha^{-1}$), followed by Andhra Pradesh (703 kg $ha^{-1}$), West Bengal (522 $Kgha^{-1}$), Punjab (485 $Kgha^{-1}$), Tamil Nadu (462 $Kgha^{-1}$), Uttar Pradesh (423 $kgha^{-1}$), Maharashtra (357 $kgha^{-1}$) and Madhya Pradesh (252 $kgha^{-1}$) during the period 2000-2001 (Directorate of Pulses Development, Bhopal).

Blackgram (*Vigna mungo* L.) is one of the major rainy season pulse crop of India. Urdbean or Black gram is a native of India and originated from *Phaseolus sublobatus* a wild plant. In India Black gram is very popularly grown in Maharashtra, Andhra Pradesh, Uttar Pradesh, Madhya Pradesh, Tamilnadu, Bihar. Among these black gram or urd (*Vigna mungo* L.) is pulse crop of many Asian countries and it belongs to tribe phaseolus family leguminoseae.

Sulphur is one of the essential secondary nutrients required for proper plant growth. Its significance is more pronounced in pulse crops, which are deficient in sulphur containing amino acid *viz*, methionine and cysteine. In recent years, introduction of high yielding varieties under intensive cropping systems coupled with use of sulphur free fertilizers viz, urea and diammonium phosphate and progressive decline in the use of organic manures/compost, has led to widespread deficiency of sulphur in soils. The recent statistics showed that sulphur deficiency is pronounced in 87 districts (Ali and Kumar, 2005).

Sulphur is essential for synthesis of proteins, vitamins and S-containing essential amino acids and is also associated with nitrogen metabolism. Sulphur improves both yield and quality of crops. Deficiency of sulphur is increasing due to continuous use of S- free fertilizers and increasing cropping intensity with high yielding cultivars and is more conspicuous in coarse textured soils low in organic matter (Sipai *et al.*, 2016).

Sulphur containing amino acids like cysteine, cysteine and methionine and promotes nodulation in legumes, also helps in increasing protein percent in legumes and oil percent in oilseeds and involved in the formation of chlorophyll that permits photosynthesis (Patel *et al.*, 2012).

This might be due to known role of sulphur in stimulation of cell division, photosynthetic process as well as formation of chlorophyll. It also promotes the root nodules in legumes, which cause the more Sulphur available during vegetative growth period and development of plant occurs (Yadav *et al.*, 2004).

Zinc in plants required for biosynthesis of hormone. They recommended combined application of soil and foliar when high concentration of grain Zn is aimed along with high grain yield. Alternatively, sowing Zn enriched seeds together with foliar application of Zn is also an effective way to improve both yield and grain Zn concentration. The micro nutrients including Zn and B are the most important nutrients to maintain proper and optimal plant growth. The presence of Zn and B in the soil helps plant to uptake NPK properly and in adequate amount to maintain crop plant growth and production. The application of Zn and B in the intercropping of maize with legumes helps to improve soil nitrogen availability to plants. The presence of Zn and B in soil improved the soil fertility. Zn is also involved in the activation of various metabolic enzymes in the roots and plant body (Shojaei and Makariian, 2015).

## Materials and Methods

The investigation on Effect of Different level of Sulphur and Zinc on Soil Health and Yield of Blackgram (*Vigna mungo* L.) Var. Barkha comprise of a field experiment which was carried out at the Soil Science Central Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during kharif season 2019-20. The details about the experiment site, soil and climate is described in this chapter together with the experimental design, layout plan, culture practice, particulars of treatments, planting material and techniques employed for the parameters. It is located at 25°58' North latitude and 81°52' East longitude with an altitude of 98 meter above mean sea level. The area of Prayagraj district comes under subtropical belt in the South east of Uttar Pradesh, which experience extremely hot summer and fairly cold winter. The maximum temperature of the location reaches up to $46^0$C – $48^0$C and seldom falls as low as $4^0$C – $5^0$C. The relative humidity ranged between 20 to 94 percent. The average rainfall in this area is around 1100 mm annually.

The treatment consisted of nine combination of inorganic source of fertilizers $T_1$ ($Zn_0$+$S_0$)

control, $T_2$ ($Zn_0 + S_{15}$), $T_3$ ($Zn_0 + S_{30}$), $T_4$ ($Zn_{1.5} + S_0$), $T_5$ ($Zn_{1.5} + S_{15}$), $T_6$ ($Zn_{1.5} + S_{30}$), $T_7$ ($Zn_3 + S_0$), $T_8$ ($Zn_3 + S_{15}$), $T_9$ ($Zn_3 + S_{30}$). The trial was laid out in a factorial randomized block design with three replication; plot size was 2 x 2 m for crop seed rate 15-20 kg ha$^{-1}$ (*Vigna mungo* L.) Cv. Barkha. Barkha RBU-38 is a variety of Black gram, having a source of RAU, Bansawara that were released/notified in the year 1999, into the area of adoption zone in the state of Madhya pradesh, Maharastra and central part of Rajasthan which is having yield area 12.0 (Q ha$^{-1}$) with 75 days of time period for maturity that have remarks as bold seeded and resistant to Crecospora leaf spot disease. (dpd.gov.in/VARIETIES). The source of sulphur and zinc were SSP, $ZnSO_4$, respectively. Basal dose of fertilizer was applied in respective plots according to treatment allocation unfurrows opened by about 5 cm. All the agronomic practices were carried out uniformly to raise the crop. Soil samples were collected from the soil 0-15 cm depth and kept in an oven at 105$^0$ C for 48 hrs for drying, then pass through 2 mm sieve after that soils were analysis by using standard procedures as described for pH 1:2 (m\v) (Jackson 1958), electrical conductivity (dS m$^{-1}$) (Wilcox 1950), organic carbon % (Walkley and Black 1947), available nitrogen kg ha$^{-1}$ (Subbiah and Asija 1956), phosphorus kg ha$^{-1}$ (Olsen *et al.*, 1954) and potassium kg ha$^{-1}$ (Toth and Prince 1949). The physico-Chemical properties at the start of experiment are presented in Table 1 and 2, respectively.

## Results and Discussion

### Physico-chemical properties of soil after post-harvest

The result given in table 3: indicate some of the important parameter on physical properties on black gram crop. Inorganic fertilizers in conjunction on bulk density, particle density and pore space to be significant. The bulk density (1.16 Mg m$^{-3}$), Particle density (2.64 Mg m$^{-3}$), and pore space (56.39%) of post-harvest soil was recorded. The similar findings were also reported byKumar *et al.*, (2015). The slight decreased in bulk density pore space and increased in particle density may be due to tillage operations and plant growth.

**Table.1** Physical properties of soil (pre- sowing)

| Particulars | Results | Method employed |
|---|---|---|
| Sand (%) | 62.71 | Bouyoucous (1927) |
| Silt (%) | 23.10 | |
| Clay (%) | 14.19 | |
| Textural class | Sandy loam | |
| Bulk density (Mg m$^{-3}$) | 1.19 | Black (1965) |
| Particle density (Mg m$^{-3}$) | 2.64 | Black (1965) |
| Pore space (%) | 54.92% | Black (1965) |
| Water holding capacity (%) | 51.36 | Black (1965) |

**Table.2** Chemical properties of soil (pre-sowing)

| Particulars | Results | Method employed |
|---|---|---|
| Soil EC (dS $m^{-1}$) | 0.22 | Wilcox (1950) |
| Soil pH | 7.21 | Jackson (1958) |
| Organic Carbon (%) | 0.36 | Walkley and Black (1947) |
| Available Nitrogen (kg $ha^{-1}$) | 272.18 | Subbiah and Asija (1956) |
| Available Phosphorus (kg $ha^{-1}$) | 17.29 | Olsen *et al.*, (1954) |
| Available Potassium (kg $ha^{-1}$) | 125.68 | Toth and Prince (,1949) |
| Available Sulphur (kg $ha^{-1}$) | 25.57 | Bardsley and Lancaster (1960) |
| Available Zinc (mg $kg^{-1}$) | 1.25 | Lindsay and Norvell (1969) |

**Table.3** Interaction effect of different levels of Sulphur and Zinc of soils physical after harvest of Black gram

| Treatment Combination | BD (Mg $m^{-3}$) | PD (Mg $m^{-3}$) | Pore space (%) | Water holding capacity (%) |
|---|---|---|---|---|
| $T_1$ ($Zn_0S_0$) | 1.20 | 2.66 | 54.88 | 48.20 |
| $T_2$ ($Zn_0S_1$) | 1.17 | 2.66 | 56.01 | 55.30 |
| $T_3$ ($Zn_0S_2$) | 1.17 | 2.65 | 55.84 | 56.54 |
| $T_4$ ($Zn_1S_0$) | 1.16 | 2.66 | 56.39 | 53.78 |
| $T_5$ ($Zn_1S_1$) | 1.18 | 2.64 | 55.30 | 51.77 |
| $T_6$ ($Zn_1S_2$) | 1.18 | 2.66 | 55.63 | 56.64 |
| $T_7$ ($Zn_2S_0$) | 1.19 | 2.67 | 55.43 | 54.42 |
| $T_8$ ($Zn_2S_1$) | 1.17 | 2.66 | 56.01 | 50.68 |
| $T_9$ ($Zn_2S_2$) | 1.18 | 2.66 | 55.63 | 58.38 |
| F- test | NS | NS | NS | NS |
| S. Em (±) | 0.02 | 0.02 | 0.70 | 2.34 |
| C.D. at 5% | 0.05 | 0.07 | 2.09 | 7.02 |

**Table.4** Interaction effect of different levels of Sulphur and Zinc of soil chemical properties after harvest Blackgram

| Treatment Combination | pH 1:2 (w\v) | EC (dSm $^{-1}$) | O. C. (%) | N (kg $ha^{-1}$) | $P_2O_5$(kg $ha^{-1}$) | $K_2O$ (kg $ha^{-1}$) | Sulphur (ppm) | Zinc (mg $kg^{-1}$) |
|---|---|---|---|---|---|---|---|---|
| $T_1$ ($Zn_0S_0$) | 7.22 | 0.25 | 0.31 | 241.67 | 14.36 | 117.61 | 13.06 | 1.21 |
| $T_2$ ($Zn_0S_1$) | 7.10 | 0.27 | 0.35 | 254.88 | 14.47 | 118.18 | 17.47 | 1.19 |
| $T_3$ ($Zn_0S_2$) | 6.91 | 0.29 | 0.41 | 261.67 | 15.66 | 120.46 | 14.34 | 1.20 |
| $T_4$ ($Zn_1S_0$) | 7.00 | 0.26 | 0.36 | 245.33 | 14.98 | 122.98 | 13.65 | 1.23 |
| $T_5$ ($Zn_1S_1$) | 7.16 | 0.24 | 0.38 | 262.33 | 15.40 | 120.77 | 18.69 | 1.25 |
| $T_6$ ($Zn_1S_2$) | 7.12 | 0.22 | 0.34 | 260.67 | 16.20 | 118.41 | 15.70 | 1.24 |
| $T_7$ ($Zn_2S_0$) | 7.05 | 0.24 | 0.42 | 258.33 | 16.39 | 124.74 | 16.46 | 1.27 |
| $T_8$ ($Zn_2S_1$) | 6.97 | 0.23 | 0.43 | 271.67 | 16.49 | 125.78 | 19.57 | 1.28 |
| $T_9$ ($Zn_2S_2$) | 6.85 | 0.24 | 0.44 | 273.67 | 16.38 | 128.34 | 19.83 | 1.30 |
| F- test | S | S | S | S | S | S | S | S |
| S. Em (±) | 0.04 | 0.01 | 0.02 | 6.00 | 0.43 | 1.35 | 0.15 | 0.01 |
| C. D. at 5% | 0.12 | 0.04 | 0.06 | 17.98 | 1.30 | 4.05 | 0.44 | 0.03 |

The results in given table 4: indicate some of the important parameter of chemical properties of soil pH 1:2 (w\v),organic carbon (%), available nitrogen (kg $ha^{-1}$), phosphorus (kg $ha^{-1}$) and potassium (kg $ha^{-1}$) was found significant. Electrical conductivity (0.24 $dsm^{-1}$), organic carbon (0.44%), available nitrogen (273.67 kg $ha^{-1}$), phosphorus (16.49 kg $ha^{-1}$), and potassium (128.34 kg $ha^{-1}$) was recorded and significantly higher as compared to other combination. It was properly due to positive effect of Zinc and Sulphur by increasing the nodulation resulted higher fixation of atmospheric nitrogen and ultimately increased the growth characters. The similar findings were also reported by Abdul *et al.*, (2008). Zinc (1.30 mg $kg^{-1}$) and Sulphur (19.83 kg $ha^{-1}$) was recorded significantly higher as compared to other combination. Zn deficiency leading to a substantial reduction in grain yield and nutritional quality. The similar findings were reported by Cakmak *et al.*,(1999). There was a slight decrease in soil pH and increase in soil electrical conductivity (dS $m^{-1}$), organic carbon (%), available nitrogen (kg $ha^{-1}$), phosphorus (kg $ha^{-1}$) and potassium (kg $ha^{-1}$) it may be due to increase in levels of inorganic fertilizer and plant growth, which increase the plant residue into soil.

In conclusion the present investigation, it was apparent that application of Sulphur and Zinc fertilizer. The combined application of Zinc with Sulphur, has led to improvement in soil health potential, nutrient availability and yield sustenance under Blackgram cultivation in which found that the treatment ($T_9$) consisting of Zinc (100%) + Sulphur (100%) give best result among other treatments.

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