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Research Article

# PERFORMANCE OF MUNGBEAN [*VIGNA RADIATA* L. WILCZEK] UNDER DIFFERENT RSC WATER AND SOURCES OF ZINC

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**Abstract:** In a pot experiment at S.K.N. College of Agriculture, Jobner during *kharif* 2016 on mungbean to investigate the effect of different RSC water and sources of zinc on growth and yield of mungbean [*Vigna radiata* (L.) Wilczek] with three levels of RSC (Residual sodium carbonate) water $W_2$, $W_4$, and $W_6$ (2, 4 and 6 mmol $L^{-1}$) and four levels of sources of zinc (0, $ZnSO_4.7H_2O$, zinc enriched vermicompost and zinc enriched FYM). The study revealed that the number of totals, effective nodules and nodule index, total chlorophyll content, plant height, number of pods per plant, number of seeds per pod, seed index, root mass, seed and straw yield of mungbean decreased significantly with increasing levels of RSC waters and maximum reduction was recorded with the application of 6 mmol $L^{-1}$ of RSC water. The significantly higher results were obtained with application of zinc enriched vermicompost over other sources of zinc.

**Keywords:** *Mungbean, RSC water, Zinc sources and Yield*

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## Introduction

In India pulses accounts 24.79 m ha area with production of 19.77 million tonnes. Mungbean stands third after chickpea and pigeanpea. It occupies 29.36 lakh hectare areas and contributes 13.90 lakh tonnes production in the country [1]. It is an excellent source of protein (24.5%) with high quality lysine (460 mg/g N) and tryptophan (60 mg/g N) and can be consumed as grain and dal in variety of ways for table purposes. In sprouted grains the ascorbic acid (vitamin C) is synthesized and the amount of riboflavin (0.2 mg/100 g), thiamin and minerals also gets increased. In arid and semi-arid regions, use of saline and sodic water for irrigation without proper soil-water-crop management practices, often leads to the builds-up of salinity and sodicity in soil profile which adversely affect the crop productivity. Each year approximately 10 million hectares of the world's irrigated land is abdoned mainly due to secondary salinization and sodification as consequence of adverse effects of irrigation [2]. This problem becomes more serious when the carbonate and bicarbonate of sodic water occur in association with sodium creating the problem of residual sodium carbonate (RSC). High RSC irrigation water is characterized by low total salt concentration and the proportions of calcium and magnesium salts are less than sodium salts. Such waters usually have sodium carbonate as a predominant salt. The prolonged use of such water immobilizes soluble calcium and magnesium in the soil by precipitating them as carbonates consequently the concentration of sodium in the soil solution and exchangeable complex increases which leads to the development of sodic conditions. The increased exchangeable sodium percentage (ESP) and pH of soil resulting regular use of sodic water leads to break down of soil structure because of swelling and dispersion of clay particles and deficiency of organic carbon and available nitrogen adversely affects the uptake of phosphorus [3]. Chemical degradation by salinization (5.50 M ha) and alkalization (4.5 M ha) is reported to the extent of 10.00 M ha [4], of which Rajasthan occupies 1.18 M ha [5] and the problem is increasing at an alarming rate in arid and semi-arid region.

Zinc is a plant nutrient now stands third in importance *i.e*. next to nitrogen and phosphorus [6]. In the recent years, zinc is considered as one of the constraints in the optimum production of crops. Zinc plays a vital role in synthesis of chlorophyll, protein and nucleic acid and helps in 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 a constituent of tryptophan which is a precursor of auxin hormone. Besides, it is associated with water uptake and water relations. Mungbean crop is fairly tolerant to drought and can be grown successfully on well drained loamy to sandy loam soil in areas of erratic rainfall. Its productivity particularly in areas having sodic irrigation water is quite low because crop is not so tolerant to sodicity and information on the combined effect of FYM and vermicompost and Zn levels in such conditions is scanty.

## Materials and Methods

A pot experiment was conducted at cage house of Department of Plant Physiology, College of Agriculture, Jobner during 2016 in completely randomized design (CRD) with three replications. The soil was loamy sand in texture, to attain the different RSC water level dissolved required amount of $NaHCO_3$, NaCl, $Na_2SO_4$, $CaCl_2$ and $MgCl_2$ in base water (control). The tap water (base water) was used for first irrigation in all pots and later on crop was irrigated 3 times with water of varying RSC levels during experimentation as per treatment. The experiment consisted of three levels of RSC water (2, 4.0 and 6.0 RSC mmol $L^{-1}$) and four levels of sources of zinc (0, $ZnSO_4.7H_2O$, zinc enriched vermicompost and zinc enriched FYM) total of 12 treatment combinations. Entire dose of zinc (12.5 mg/kg soil) was applied through zinc sulphate ($ZnSO_4.7H_2O$) by mixing in soil before sowing of the crop. For zinc enriched FYM/ vermicompost the quantity of 200 mg $ZnSO_4.7H_2O$ /100g FYM/vermicompost was thoroughly mixed and kept into moisture at room temperature.

Table-1 *Composition of irrigation water*

| RSC mmolL$^{-1}$ | EC (dSm$^{-1}$) | SAR | Ionic composition (mmol L$^{-1}$) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | $Na^+$ | $Ca^{2+}$ | $Mg^{2+}$ | $CO_3^{2-}$ | $HCO_3^-$ | $Cl^-$ | $SO_4^{2-}$ |
| 2.0 Base water | 1.31 | 8.2 | 10.0 | 1.5 | 1.5 | 1.0 | 4.0 | 6.5 | 1.5 |
| 4.0 | 3.27 | 16.7 | 26.4 | 2.5 | 2.5 | 2.0 | 7.0 | 11.4 | 11.0 |
| 6.0 | 3.27 | 16.7 | 26.4 | 2.5 | 2.5 | 2.0 | 9.0 | 10.5 | 9.9 |

Table-2 *Effect of different RSC water and sources of zinc on total and effective nodules per plant and nodule index at 45 DAS, total chlorophyll content at 45 DAS and plant height at harvest*

| Treatments | Total nodules | Effective nodules | Nodule index | Total chlorophyll content (mg g$^{-1}$) | Plant height (cm) |
|---|---|---|---|---|---|
| A. RSC water (mmol L$^{-1}$) | | | | | |
| $W_2$ (2) | 26.83 | 21.77 | 2.50 | 3.71 | 26.93 |
| $W_4$ (4) | 24.15 | 19.33 | 2.31 | 3.41 | 24.43 |
| $W_6$ (6) | 20.37 | 17.23 | 2.02 | 3.11 | 22.18 |
| SEm$\pm$ | 0.63 | 0.52 | 0.06 | 0.09 | 0.64 |
| CD (P= 0.05) | 1.83 | 1.51 | 0.18 | 0.26 | 1.86 |
| B. Sources of zinc | | | | | |
| $T_0$ (control) | 21.66 | 17.62 | 2.01 | 3.07 | 23.07 |
| $T_1$ ($ZnSO_4.7H_2O$ ) | 23.62 | 18.75 | 2.17 | 3.24 | 24.12 |
| $T_2$ ( Zinc enriched vermicompost) | 26.02 | 21.87 | 2.68 | 3.89 | 26.64 |
| $T_3$ ( Zinc enriched FYM) | 23.82 | 19.54 | 2.23 | 3.44 | 24.23 |
| SEm$\pm$ | 0.73 | 0.60 | 0.07 | 0.11 | 0.74 |
| CD (P= 0.05) | 2.12 | 1.75 | 0.21 | 0.31 | 2.15 |

Table-3 *Effect of different RSC water and sources of zinc on number of pods per plant, number of seeds per pod and test seed index*

| Treatments | Number of pods per plant | Number of seeds per pod | Seed index (g) | Root mass at harvest (g pot$^{-1}$) | Seed yield (g pot$^{-1}$) | Straw yield (g pot$^{-1}$) |
|---|---|---|---|---|---|---|
| A. RSC water (mmol L$^{-1}$) | | | | | | |
| $W_2$ (2) | 7.51 | 6.21 | 3.70 | 0.52 | 4.66 | 6.27 |
| $W_4$ (4) | 5.94 | 5.28 | 3.44 | 0.47 | 3.78 | 5.66 |
| $W_6$ (6) | 4.44 | 3.72 | 3.18 | 0.40 | 3.18 | 5.16 |
| SEm$\pm$ | 0.18 | 0.15 | 0.09 | 0.01 | 0.11 | 0.15 |
| CD (P= 0.05) | 0.51 | 0.44 | 0.25 | 0.04 | 0.31 | 0.44 |
| B. Sources of zinc | | | | | | |
| $T_0$ (control) | 5.19 | 3.82 | 3.27 | 0.42 | 3.11 | 5.07 |
| $T_1$ ($ZnSO_4.7H_2O$ ) | 5.27 | 4.78 | 3.38 | 0.44 | 3.86 | 5.54 |
| $T_2$ ( Zinc enriched vermicompost) | 7.35 | 6.44 | 3.41 | 0.54 | 4.46 | 6.45 |
| $T_3$ ( Zinc enriched FYM) | 6.04 | 5.23 | 3.70 | 0.47 | 4.04 | 5.74 |
| SEm$\pm$ | 0.21 | 0.18 | 0.10 | 0.01 | 0.12 | 0.18 |
| CD (P= 0.05) | 0.59 | 0.51 | 0.29 | 0.04 | 0.36 | 0.51 |

After, enrichment the required quantity of zinc enriched FYM/vermicompost @ 11.2 g/kg soil was thoroughly mixed in soil before sowing the crop. Soil was filled in cylindrical ceramic pots (20 cm diameter and 28 cm height). Each pot had 10 kg of soil. At the time of filling pots, the broken pieces of stone were placed on the bottom hole to allow free drainage. The mungbean (*Vigna radiata* L.) Variety RMG-492 was sown on 11th July, 2016 with a seed rate of 10 seeds per pot. The crop was harvested on 25th September, 2016. Fully mature and developed pods from randomly selected five plants from each plot was plucked and number of seeds were counted. The average number of pods and seeds per plants was worked out. After threshing and winnowing the weight of seeds in each pot was recorded and then converted in to kg/ha. The chlorophyll content in leaves at 45 DAS was determined by taking 50 mg fresh leaves; samples were homogenized in 80 percent acetone and aliquot was centrifuged for 10 minutes at 2000 rpm and the final volume was made to 10 ml. Absorbance of clear supernatant liquid was measured at 652 nm on spectronic-20.

$$\text{Total chlorophyll (mg g}^{-1}) = \frac{\text{A (652) X 29 X Total volume (ml)}}{\text{a X 1000 X weight of sample}}$$

Where, a is the path length = 1 cm

The numbers of nodules were counted from randomly selected two plants from each pot at the time of flowering stage and nodule index (number of nodules per cm. of taproot) was computed by formula [7].

$$\text{Nodule index} = \frac{\text{No. of nodules per plant}}{\text{Length (cm) of tap root}}$$

## Results and Discussion

### RSC Water

The number of totals, effective nodules and nodule index, total chlorophyll content, plant height, number of pods per plant, number of seeds per pod, seed index, root mass, seed and straw yield of mungbean decreased significantly with all levels of RSC waters and maximum reduction was recorded with the application of 6 mmol L$^{-1}$ of RSC water. The $W_4$ and $W_6$ decreased the total nodules per plant and nodule index to the extent of 9.98 and 24.07, 7.60 and 19.20 percent over $W_2$, respectively. The maximum total chlorophyll content (3.71 mg g$^{-1}$) was observed under $W_2$ and minimum total chlorophyll content (3.10 mg g$^{-1}$) under $W_6$. Similarly, the maximum plant height was recorded with $W_2$ (26.93) and minimum (22.18) under $W_6$. Irrigation water containing high RSC *i.e.*, $W_4$ and $W_6$ recorded significantly a smaller number of pods per plant than those obtained at lowest level of RSC *i.e.*, $W_2$. The RSC water of 6 mmol L$^{-1}$ ($W_6$) reduced the number of pods per plant by 25.25 and 40.87 percent over 4 mmol L$^{-1}$ ($W_4$) and 2 mmol L$^{-1}$ ($W_2$), respectively. The RSC levels $W_4$ and $W_6$ significantly decreased the root mass by 10.63 and 23.07 percent over $W_2$ at harvest. Seed yield of mungbean decreased significantly with increasing levels of RSC in irrigation water. The application of $W_4$ and $W_6$ water significantly decreased the seed yield over $W_2$. The decrease in the seed yield with the application of $W_4$ and $W_6$ was 18.88 and 31.75 percent over $W_2$, respectively. Increasing level of RSC water increased the SAR and pH of soil resulting into decreased availability of P, K, Zn, Ca and Mg but increased the uptake of Na which is toxic element. The higher Na may adversely affect the physiological, metabolic and enzymatic activities of the plants and utilization of photosynthates in plant. There are several evidences that cationic (Ca, Mg, Na and K) imbalance could lead to disturbances in photosynthesis and activity of stroma enzymes [8, 9]. The inability of the crop to grow under high RSC water is due to the toxicity of Na itself and Ca and K frequently becomes as limiting factor for plant growth [10]. The cell elongation and cell division may also be adversely affected due to higher accumulation of Na [11]. This cause a reduction in number of pods per plant and plant height. The use of high RSC water increased the exchangeable Na in soil which also has detrimental effect on the physical condition (by breaking soil structure and dispersion of clay particles) of soil resulting into poor root development and plant growth [12] resulted into decrease in seed and straw yield of mungbean. Several workers have also observed the significant yield reduction in different crops *viz*., mungbean [13], chickpea [14] and wheat [15] and [16] with the use of high RSC water.

**Sources of Zinc**

Application of zinc enriched vermicompost significantly increased the total and effective nodules per plant over other sources of zinc ($T_0$, $T_1$ and $T_3$). It increases 20.12, 10.16 and 9.23 percent in total nodules per plant and 24.12, 16.64 and 11.92 percent in effective nodules over, $T_0$, $T_1$ and $T_3$ respectively. Zinc enriched vermicompost recorded significantly higher total chlorophyll content over $T_0$, $T_1$ and $T_3$ to the tune of 26.71, 20.06 and 13.08 percent over $T_0$, $T_1$ and $T_3$, respectively. Plant height, pods/plant and seeds/pod were increased significantly with application of zinc enriched vermicompost over $T_0$, $T_1$ and T3 and showed an increase of 15.47, 10.44 and 9.94, 42.44, 39.46 and 21.68 and 68.58, 34.72 and 23.13 percent, respectively over $T_0$, $T_1$ and $T_3$. Treatment having zinc enriched with vermicompost registered significantly higher seed yield over $T_0$, $T_1$ and $T_3$. It showed an increase of 43.40, 15.54 and 10.39 percent in seed yield over $T_0$, $T_1$ and T3, respectively. Zinc enriched with vermicompost noted significantly higher straw yield over $T_0$, $T_1$ and $T_3$ representing an increase of 27.2, 27.21 and 12.36 percent over $T_0$, $T_1$ and $T_3$, respectively. The application of zinc enriched vermicompost had a significant effect on effective and total nodules, nodule index, height of plant, total chlorophyll content, pods per plant, seeds per pod, seed index, root mass and seed and straw yield of mungbean. It is established fact that vermicompost improves the physical and biological properties of soil including supply of almost all the essential plant nutrients for the growth and development of plants. Thus, balance nutrients under favourable environmental might have helped in production of new tissues and development of new shoots might have ultimately increased the growth and yield attributes. Similar result was also reported [17]. Zinc is a constituent of tryptophan which is a precursor of auxin. Besides, it is associated with water uptake and water relations. 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. Similar results were also reported [18] and [19].

**Conclusion**

Better yield observed under lower level of RSC waters and zinc enriched vermicompost.

**Application of research:** Study shows Zinc plays a vital role in synthesis of chlorophyll, protein and nucleic acid and helps in 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.

**Research Category:** Soil Science and Agricultural Chemistry

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**Cultivar / Variety name:** *Vigna radiata* L. Wilczek

**Conflict of Interest:** None declared

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