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Interactive effect of vermicompost and zinc on yield and nutrient uptake of greengram (*Vigna radiata* L.) in Typic Ustipsamment soil

Anita Todawat and SR Sharma

Abstract
To study the effect of vermicompost and zinc levels on productivity of Greengram (*Vigna radiata* L.) in Typic Ustipsamment soil of Semi Arid Eastern Plain of Rajasthan. A field experiment was undertaken during *Kharif* 2016 at Agronomy Farm, S. K. N. College of Agriculture, Jobner, Jaipur (Rajasthan). The treatments comprised of four levels of vermicompost (VC) i.e. control, VC @ 2.5, 5.0 and 7.5 t ha^{-1} and four levels of zinc application i.e. control, 2.0, 4.0 and 6.0 kg Zn ha^{-1}.The experiment was laid out in a factorial randomized block design with three replications. The increasing levels of vermicompost and zinc up to 7.5 ha^{-1} and 6.0 kg Zn ha^{-1}, respectively increased significantly (P=0.05) the number of seeds per pod, grain yield and zinc uptake by grain of greengram. However, the combined application of vermicompost @ 7.5 t ha^{-1} and 6.0 kg Zn ha^{-1} was found to record significantly higher number of seeds per pod, grain yield and zinc uptake by grain of greengram. The application of vermicompost @ 7.5 t ha^{-1} and 4.0 kg Zn ha^{-1} along with the recommended dose of fertilizer results in significantly (P=0.05) higher productivity of greengram under Typic Ustipsamment soil.

Keywords: Interactive, vermicompost, zinc, nutrient, Ustipsamment, *Vigna radiata* L.

Introduction

India has made an impressive progress to achieve self sufficiency in food-grain production and reached a growth rate which is sufficient to meet the requirement of increasing population. However, during last decades, pulse production has remained stagnant around 15 to 17 million metric tones/years. Greengram (*Vigna radiata* L.) commonly known as *Mungbean* and *Goldengram*, is one of the important *kharif* pulse crop. It ranks third among all pulses grown in India after chickpea and pigeonpea. It contains 25 percent protein. In India, total pulses are grown on 28.34 million ha area with a production of 25.75 million metric tonnes and an average productivity of 817 kg ha^{-1} (FAI, 2020-21) [4]. Greengram is a rainfed crop predominantly grown in *kharif* in the state of Rajasthan. In Rajasthan, greengram occupy 2.46 lakh ha area with a production of 1.22 lakh tonnes. However, productivity of greengram is low in Rajasthan (495 kg ha^{-1}) (FAI, 2020-21) [4]. One of the important reasons of low productivity is poor fertility of soil. The problem is compounded by the fact that the majority of the farmers in rainfed areas are resource poor with low risk bearing capacity and they generally do not apply recommended dose of fertilizers, either through organic or inorganic sources.

Addition of organic matter into the soil in the form of compost is a feasible strategy to enhance the soil fertility (Zayed and Abdel, 2005) [17]. Hence, conversion of agricultural residues into enriched compost by value-addition through cheap minerals like rock phosphate can improves the soil fertility as well as crop productivity (Gaind *et al*., 2006) [5]. vermicompost is considered a valuable organic fertilizer as it supplies nutrients for the crop which results in saving cost of chemical fertilizers (Erhart *et al*., 2005) [3]. Besides, it provide all the essential nutrients in readily available forms, enhances uptake of these nutrients by the plants and play a major role in improving growth and yield of crops (Sreenivas *et al*., 2000) [15]. Vermicompost also acts as a niche for microbes and enriches the soil with a variety of the indigenous micro-flora and fauna (Paul, 2007) [10].

Micronutrients are essential for crop production and their deficiency affects growth and metabolism especially during reproductive phase of the plant and also in animals and human beings. Among the micronutrients, zinc deficiency in both the plant and soil has been reported across the world (Alloway, 2008) [1].

The critical limit of available zinc in the soil suitable for growth is 0.6 mg kg^{-1}. The available zinc in the Indian soils extracted with DTPA is less than 1per cent of the total zinc content (Takkar and Mann, 1975) [16]. Shukla *et al*. (2021) [12] reported that 36.5, 23.2, 13, 12.8, 7.1 and 4.2% soils of India are deficient in zinc, boron, molybdenum, iron, manganese and copper, respectively. Zinc is one of the essential micronutrient and plays an important role in various enzymatic and physiological activities of the plant. It is also essential for photosynthesis and nitrogen metabolism and important for the stability of cytoplasmic ribosome's, cell division, as co factor to enzymes like dehydrogenase, proteinase and peptidase in the synthesis of tryptophan, a component of some proteins and a compound needed for production of growth hormones (auxin) such as indole acetic acid. Most of the soils of Rajasthan have been found deficient in zinc and assigned low availability of zinc in light textured soils with medium organic carbon content (Singh and singh, 1981) [13]. Therefore, if the soil is in short supply with respect to zinc, crop yields are further adversely affected. Hence, it becomes necessary to pay serious attention to the application and utilization of zinc.

Materials and Methods

Experimental site and soil: The experiment was conducted during *Kharif* 2016 at the Agronomy Farm, S. K. N. College of Agriculture, Jobner, Jaipur situated at an altitude of 427 metres above mean sea level and at $26^0$05' latitude and $75^0$28' longitude. The region falls under agro-climatic zone-IIIa (Semi Arid Eastern Plain) of Rajasthan. Soil of the experiment was loamy sand in texture, saline in reaction (8.10+0.11), normal in electrical conductivity (0.90+0.02 dSm^{-1}), medium in organic carbon (0.18+0.01%), low in available N (136.60+4.45 kg ha^{-1}), P (17.50+0.30 kg ha^{-1}), medium in available K (149.50+4.10 kg ha^{-1}) and low in available zinc (0.430+0.010 mg kg^{-1}).

Experimental design and treatments: The experiment was laid out in factorial randomized block and replicated thrice in the plot size of 4.0 m x 3.0 m (12 m^2). The treatments comprised of four levels of vermicompost *viz*., control, 2.0, 5.0 and 7.5 t ha^{-1} and four levels of zinc application *viz*., control, 2.0, 4.0 and 6.0 Zn ha^{-1}. The greengram var. SML-668 was sown in lines 30 cm apart. As per the treatments, whole quantity of VC was broadcasted and incorporated in to the soil at the time of sowing. there commended dose of nitrogen (20 kg ha^{-1}) was applied in two equal splits, the half as basal and the remaining half was top dressed at the time of first irrigation. The basal dose was applied through urea after adjusting the quantity supplied through diammonium phosphate. The whole quantity of phosphorus (30 kg ha^{-1}) through diammonium phosphate and potassium (10 kg ha^{-1}) through muriate of potash and zinc through $ZnSO_4.7H_2O$ was drilled as basal dose at 8-10 cm depth along with half dose of nitrogen prior to sowing.

Observations recorded: The observations on yield character were recorded as per the standard method.

- **Number of seeds per pod:** Ten pods were randomly selected from each plot from previously selected plants and number of seeds per pod was counted and mean value for number of seeds per pod was calculated.
- **Grain yield:** The material was threshed manually and winnowed. The clean grain obtained from individual plots was weighed and the weight recorded as grain yield in terms of kg ha^{-1}. The data obtained from various characters under study were analyzed by the method of analysis of variance as described by Panse and Sukhatme (1985) [9].

Nutrient uptake: The uptake of Zn at harvest in grain and straw was estimated by using the following formula:

$$\text{Zn uptake (g ha}^{-1}) = \frac{\text{Nutrient content in grain/straw (ppm)} \times \text{Grain/straw yield (kg ha}^{-1})}{1000}$$

Statistical analysis: The data recorded for different parameters were analyzed with the help of analysis of variance (ANOVA) technique for a factorial randomized block design. The results are presented at 5% level of significance (P=0.05).

Results and Discussion

Interactive effect of vermicompost and zinc

Number of seeds per pod: The data presented in **Table 1 and Figure 1** revealed that the interactive effect of vermicompost and zinc on number of seeds per pod was found significant. The number of seeds per pod increased with increasing levels of zinc under all the levels of vermicompost except $VC_{7.5}$ over $VC_{5.0}$ under Zn_0 and Zn_6 level of zinc. The highest value of number of seeds per pod was obtained under $VC_{7.5}Zn_6$ (12.61) treatment combination. The meticulous observations of the data indicated that the extent of increase in number of seeds per pod under all the levels of zinc was more at $VC_{7.5}$ level of vermicompost. Similarly, under all the level of vermicompost the extent of increase in number of seeds per pod increased with the application of zinc. These results are in conformity to those of Jat *et al.* (2013) [6] and Meena *et al.* (2021) [8].

Table 1: Interactive effect of vermicompost and zinc on number of seeds per pod of greengram

Treatments	VC_0	$VC_{2.5}$	$VC_{5.0}$	$VC_{7.5}$
Zn_0	9.77	9.09	9.96	9.66
Zn_2	8.28	9.68	10.61	11.19
Zn_4	9.00	10.52	11.53	12.09
Zn_6	9.51	11.12	12.18	12.61
S.Em±		0.189		
CD (P=0.05)		0.55		

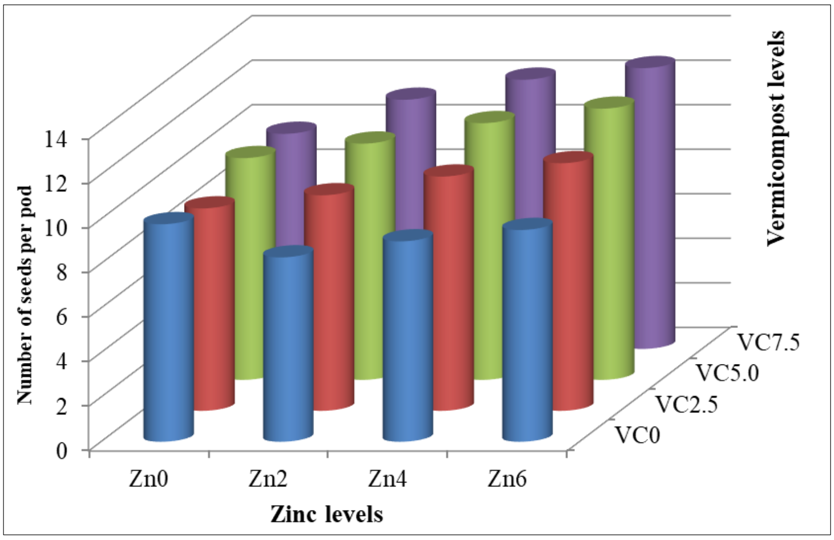

Fig 1: Interactive effect of vermicompost and zinc on number of seeds per pod of greengram

Grain yield: The interactive effect of vermicompost and zinc on grain yield was found significant; however, it was non-significant in case of straw yield (Table 2 and Figure 2). The grain yield increased with increasing levels of zinc under all the levels of vermicompost except $VC_{7.5}$ over $VC_{5.0}$ under Zn_4 and Zn_6 levels of zinc. The highest value of grain yield was obtained under $VC_{7.5}Zn_6$ (1402.85 kg ha^{-1}) and the lowest under VC_0Zn_0 (729.20 kg ha^{-1}) treatment combination. The meticulous observations of the data indicated that the extent of increase in grain yield under all the levels of zinc was more at $VC_{7.5}$ level of vermicompost. Similarly, under all the level of vermicompost the extent of increase in grain yield increased with the application of zinc. It further showed that at highest level of vermicompost along with zinc ($VC_{7.5}$ Zn_6) increase the grain yield maximum extent. The increase in grain yield might be due to the fact that vermicompost and zinc had an additive effect and the experimental soil was deficient in nutrients *viz.*, Zn and Fe, supplementation of zinc and vermicompost incorporation improved the overall physical conditions of soil and increased water and nutrient retention in the root zone by reducing infiltration and percolation. Thus, improved the availability of both water and nutrients to plants for their better growth and development and ultimately increased these parameters of greengram. These findings are in agreement with those of Devaranjan and Palaniappan (1995) [2] on soybean, Sharma (2002) [11] on wheat and Jat *et al.* (2015) [7] on mustard, also observed beneficial effect of vermicompost and zinc on yield.

Table 2: Interactive effect of vermicompost and zinc on grain yield (kg ha^{-1}) of greengram

Treatments	VC_0	$VC_{2.5}$	$VC_{5.0}$	$VC_{7.5}$
Zn_0	729.20	946.22	998.43	798.45
Zn_2	870.30	1096.70	1180.30	1244.81
Zn_4	934.04	1173.67	1264.02	1342.95
Zn_6	915.18	1164.46	1285.92	1402.85
S.Em±		48.079		
CD (P=0.05)		138.86		

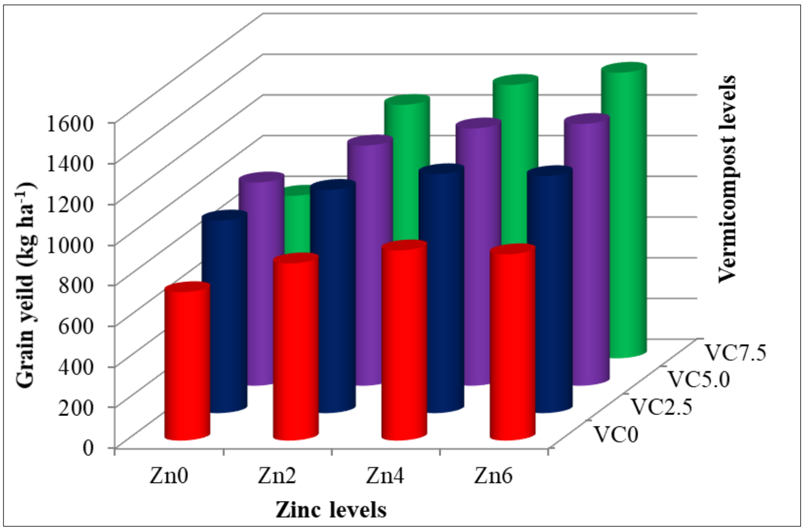

Fig 2: Interactive effect of vermicompost and zinc on grain yield (kg ha^{-1}) of greengram

Zinc uptake: The interactive effect of vermicompost and zinc on Zn uptake by grain was found significant; however, it was non-significant in case of straw (Table 3 and Figure 3). The Zn uptake by grain increased with increasing number of zinc under all the levels of vermicompost except $VC_{5.0}$ over $VC_{2.5}$ under Zn_4 and Zn_6 levels of zinc. However, Zn uptake under Zn_4 and Zn_6 by grain under VC_0, $VC_{2.5}$, $VC_{5.0}$ and $VC_{7.5}$ levels of vermicompost was at par. Irrespective of zinc treatments, the increasing levels of vermicompost increased the Zn uptake by grain significantly. The maximum value was recorded under $VC_{7.5}Zn_6$ (1568.02 g ha^{-1}), while the minimum under VC_0Zn_0 (570.51 g ha^{-1}) treatment combination. The combined application of vermicompost and zinc significantly increased the uptake of zinc in grain. The increased uptake of zinc was due to the synergistic effect of vermicompost in conjunction with zinc. The results of present findings are in line with those of Singh *et al.* (2010) [14] who reported increased uptake of micronutrients due to the effect of H_2SO_4 formed by oxidation of sulphur in the soil on solubilization of bounded micronutrients.

Table 3: interactive effect of vermicompost and zinc on zinc uptake (g ha^{-1}) by grain of greengram

Treatments	VC_0	$VC_{2.5}$	$VC_{5.0}$	$VC_{7.5}$
Zn_0	570.51	810.89	926.63	741.23
Zn_2	724.84	1002.30	1165.07	1267.74
Zn_4	867.52	1188.53	1383.26	1504.95
Zn_6	855.36	1193.02	1424.25	1568.02
S.Em±		54.585		
CD (P=0.05)		157.65		

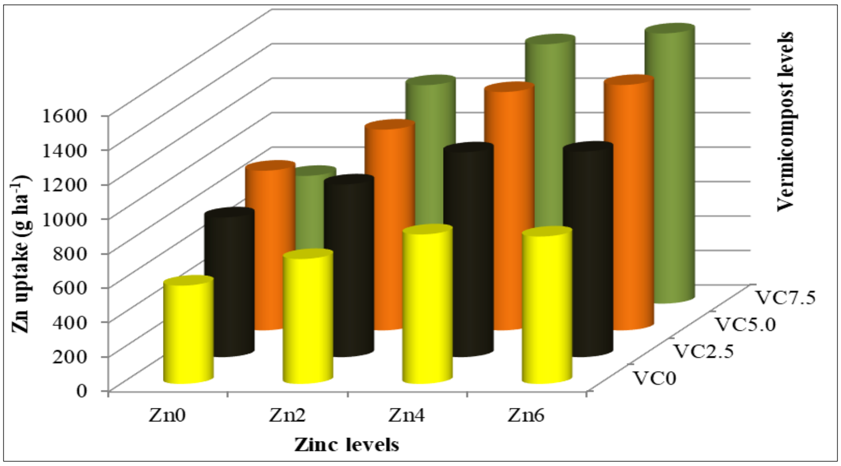

Fig 3: interactive effect of vermicompost and zinc on zinc uptake (g ha^{-1}) by grain of greengram

Conclusion

On the basis of experimental finding, it can be concluded that the application of vermicompost @ 7.5 t and 4.0 kg Zn ha^{-1} along with the recommended dose of fertilizer results in significantly higher productivity of greengram under Typic Ustipsamment soil of Semi Arid Eastern Plain Region of Rajasthan.

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