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Response studies and productivity of greengram (*Vigna radiata* L.) as influenced by vermicompost and zinc fertilization

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Abstract
The effect of vermicompost and zinc levels on response study and 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 5.0 t ha^{-1} and 4.0 kg Zn ha^{-1}, respectively increased significantly (P=0.05) the grain and straw yield 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 grain and straw yield of greengram. The economic optimum level of vermicompost and zinc was found to be 4.12 t ha^{-1} and 4.86 kg ha^{-1} with grain yield of greengram 1158.24 and 1197.54 kg ha^{-1}, respectively.

Keywords: Productivity, greengram, vermicompost, fertilization, *Vigna radiata* L.

Introduction
Pulses are an important ingredient in the vegetarian diet of Indian masses. These are important because these have a high value for maintaining the optimal blood sugar levels and also restoring energy over a long period of time after the meals because the carbohydrates provided by pulses are released slowly as compared to cereals. In general, pulses are one of the most sustainable crops as it utilizes only 359 liter of water to produce one kg of pulses as compared to 1,802 liter for soybeans and 3,071 liters for groundnut. They play a significant role in contributing to soil quality by fixing nitrogen in the soil. India is one of the largest producer as well as consumer of a wide variety of pulses that is dominated by the tropical and sub-tropical crops such as chickpea, blackgram, pigeon pea, greengram and lentil. 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) [7]. 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) [7]. 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.

Vermicompost is created by vermicomposting of organic material through interactions between earthworm and microorganisms. The vermicompost can be economically and environmentally suitable and also maintenance of soil environment. The continued use of chemical fertilizers causes health and environmental hazards such as ground and surface water pollution by nitrate leaching (Eswaran and Mariselvi, 2016) [6]. Stimulation of plant growth may depend mainly on the biological characteristics of vermicompost, the plant species used, and the conditions of cultivation. The increased amount of humus in soil through application of vermincompost by earthworms would certainly help favorable change in physical, chemical and biological properties of soil, and in enhancing the water-holding capacity (Singh *et al*., 2011) [15].

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. Shukla *et al*. (2021) [14] 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) [16].

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. 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) [12].

Response studies: Optimum level of vermicompost and zinc was worked out with the help of quadratic equation. Using the least square technique as described by Croxton *et al.* (1973) [4].

$$Y = b_0 + b_1X + b_2X^2$$

Where,
Y= Expected grain yield (kg ha^{-1})
X = Level of vermicompost (t ha^{-1}) and zinc (kg ha^{-1})
b_0 = constant
b_1 and b_2= Regression coefficients

After fitting response curve, optimum level of vermicompost and zinc were worked out by the following formula:

$$X_{opt} = \frac{Q/P - b_1}{2\ b_2}$$

Where,
X_{opt} = Optimum level of vermicompost (t ha^{-1}) and zinc (kg ha^{-1})
P = Price per kg of grain yield (₹)
Q = Cost of vermicompost and zinc per kg (₹)
b_1 and b_2 = Coefficients of response equation

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).

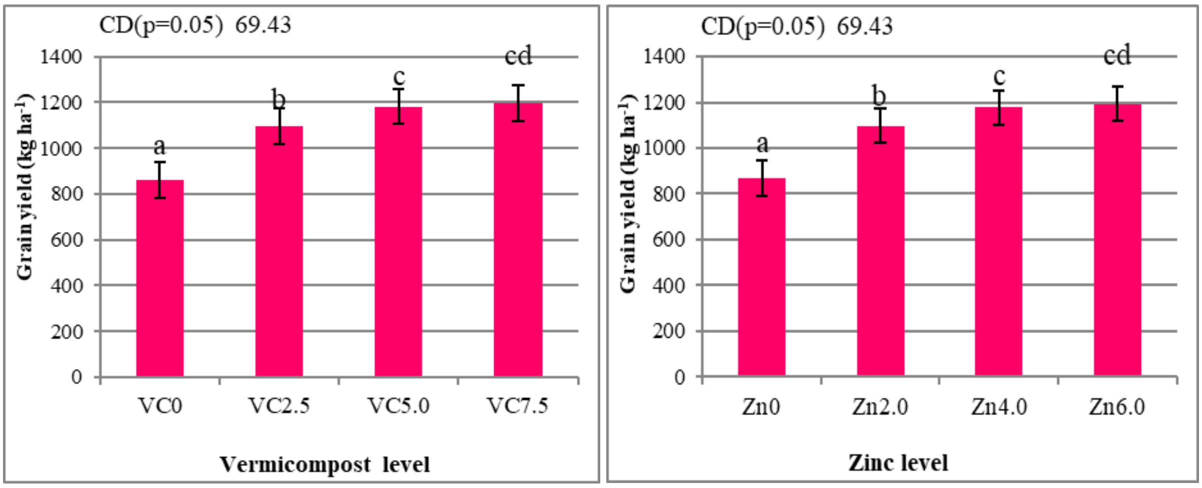
Results and Discussion

Effect of vermicompost

The application of vermicompost enhanced the grain and straw yield of greengram. The significant increase in grain and straw yield under the influence of vermicompost was largely a function of improved growth and yield attributes (Figure 1). The application of vermicompost @ 7.5 t ha^{-1} recorded the maximum value of these parameters. However, the increase was significant upto VC_2 which was also found to be statistically at par with VC_3. The significant increase in grain and straw yield under the influence of vermicompost was largely a function of improved growth and yield attributes which eventually contributed in increased grain and straw yield. The increase in yield due to addition of vermicompost might be the result of overall improvement in soil physico-chemical properties of soil due to decrease in bulk density, pH, electrical conductivity and increase in particle density, porosity, water holding capacity and cation exchange capacity (Biswas, 2011) [1]. The beneficial response of vermicompost to yield attributes and yield might also be attributed to the availability of sufficient amounts of plant nutrients throughout the growth period and especially at critical growth periods of crops resulting in better uptake, plant vigour and superior yield attributes. The higher availability of nutrients in soil due to vermicompost application during seed development might have retarded senescence and resulted in large filling period for greater seed, stover and biological yield (Biswas and Narayansamy, 2006) [2]. The gradual release and steady supply of nutrients from vermicompost throughout the growth and development of plants maintained the photosynthetic efficiency and production of metabolites at higher level and later on the translocation of photosynthates to various sinks resulting into higher yield attributes, grain and straw yield (Patil *et al.*, 2011) [13]. The interrelationship between various yields attributes of the crop and its grain and straw and biological yield had also been observed by Biswas (2011) [1] and Kharche *et al*. (2020) [9].

Effect of zinc

The grain and straw yield were also significantly increased by the application of zinc (Figure 2). However, the increase was significant upto Zn_2 which was also found to be statistically at par with Zn_3. The favourable influence of applied zinc on grain and straw yield may be due to catalytic or stimulatory effect of zinc on most of the physiological and metabolic processes of plants. The increase in grain and straw yield with zinc fertilizer application might be due to the fact that zinc plays an important role in biosynthesis of indole acetic acid and initiation of primordial for reproductive part which have favored the metabolic reaction within plant (Tak *et al*., 2014) [17]. The increase in the yield due to zinc application may be attributed to the fact that the initial status of available zinc in the experimental soil was low. The increase in yield attributes may be due to increased supply of available zinc to plants by way of its addition to soil which resulted in proper growth and development. The significant increase in straw yield due to zinc fertilization could be attributed to the increased plant growth and biomass production, possibly as a result of the uptake of nutrients (Mahilane and Singh, 2018) [10]. Datta and Dhiman (2001) [5] reported that increase in seed and stover yield may be due to the fact that the zinc exerts a great influence on basic plant life processes such as nitrogen metabolism uptake of N and protein quality.



A B

Fig 1: Effect of A) VC and B) zinc application on grain yield of greengram *Error bars indicates the standard error of mean **Columns marked with same letters are statistically similar at p=0.05

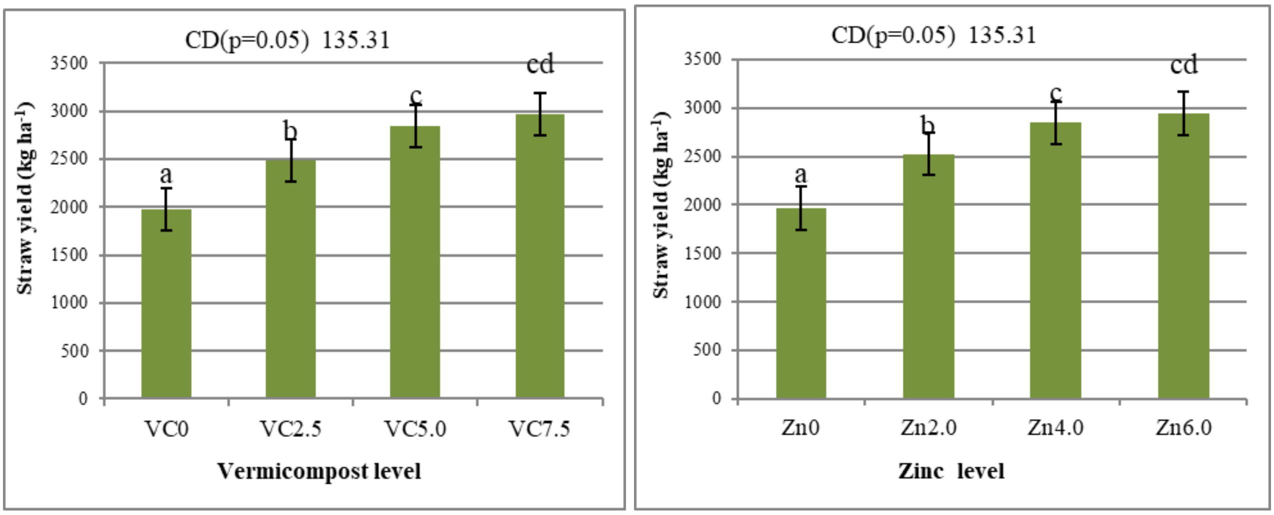


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Fig 2: Effect of A) VC and B) zinc application on straw yield of Greengram *Error bars indicates the standard error of mean **Columns marked with same letters are statistically similar at p=0.05

Interaction effect of vermicompost and zinc application on 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 1 and Figure 3). 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 might have resulted in improved nutritional environment of rhizosphere as well as physico-chemical properties of soil thereby improving the efficiency of utilization of native as well as applied nutrients (Chitdeshwari and Krishnaswami, 1998) [3]. The increase in seed yield and stover yield might be due to the fact that vermicompost and zinc had an additive effect. Since the experimental soil was deficient in nutrients especially Zn the supplementation of Zn with VC incorporation improved the availability of both nutrients as well as water by increased water and nutrient retention in the root zone by reducing infiltration and percolation. The applied vermicompost and zinc might have reacted synergistically in increasing the availability and steady supply of plant nutrients for plant metabolism and photosynthetic activity resulting into optimum growth and development which increased ultimately the grain and straw yield of blackgram substantially (Meena, 2021) [11]. These findings are in agreement with those of Jat *et al.* (2015) [8] on mustard.

Table 1: 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		

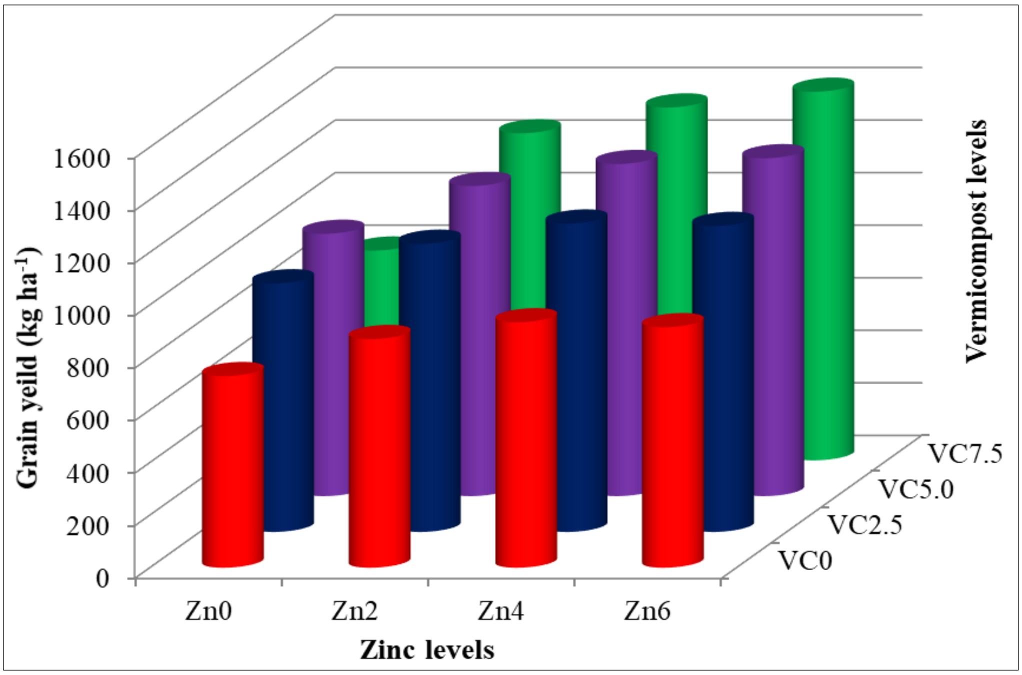

Fig 3: Interactive effect of vermicompost and zinc on grain yield (kg ha^{-1}) of greengram

Response studies: the data regarding effect of vermicompost and zinc on response study of crop is being summarized in Table 2 and diagrammatically in Figure 4 and 5. To describe the relationship between grain yield (y) and vermicompost and zinc fertilization (x_1), multiple regression studies were undertaken by relationship of the type $y = b_0 + b_1x + b_2 x^2$. Data presented Table 2 revealed that a level of vermicompost 4.12 t ha^{-1} and zinc 4.86 kg ha^{-1} was found to be optimum with grain yield of 1158.24 and 1197.54 kg ha^{-1}, respectively.

Table 2: Grain yield (Y) as a function of vermicompost and zinc fertilization ($Y = b_0 + b_1X + b_2X^2$)

S. No.	Study Parameters	Values	
		Vermicompost	Zinc
1.	Regression coefficients		
	b_0	857.15	863.65
	b_1	107.46	131.57
	b_2	-8.36	-12.937
2.	Coefficient of		
(i)	Determinations (R^2)	0.9953	0.9938
(ii)	Multiple correlation (R)	0.9977	0.9969
3.	Maximum level	6.4270	5.0850
4.	Yield at maximum level (kg ha^{-1})	1202.47	1198.18
5.	Optimum level	4.126	4.862
6.	Yield at optimum level (kg ha^{-1})	1158.24	1197.54
7.	Response at optimum level (kg ha^{-1})	301.09	333.89

*Significant at 5 per cent level of significance.
**Significant at 1 per cent level of significance.

Note:

- Vermicompost and zinc levels are in tonnes and kg ha^{-1}, respectively.
- Responses intercept (b_0) and yields are given in kg ha^{-1}.
- In case of zinc the partial regression coefficient (b_1 & b_2) are based on 10 units equal to 1 unit.

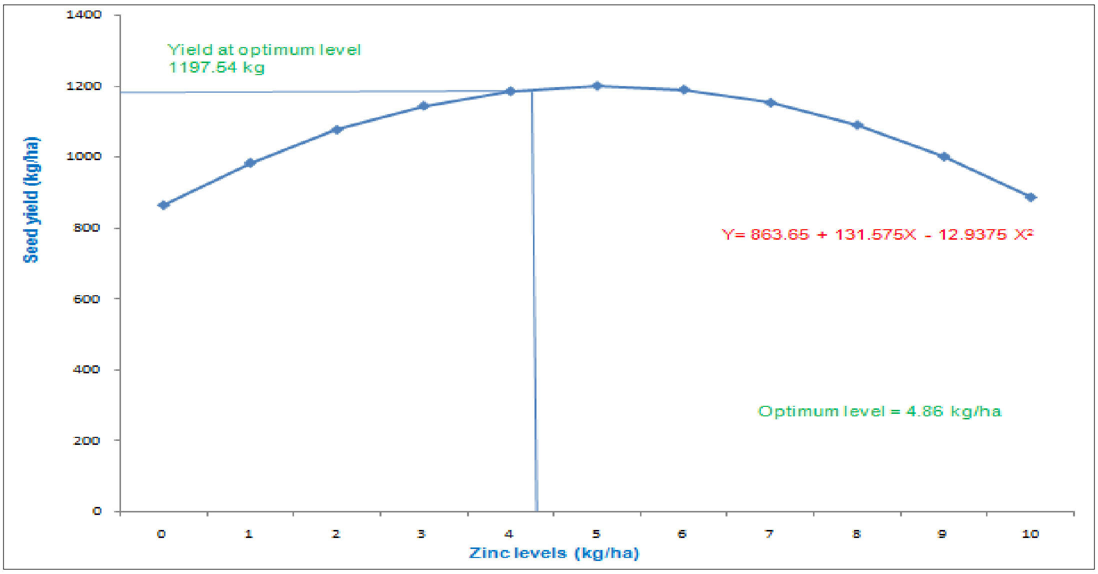

Fig 4: Seed yield (Y) as a function of zinc fertilization ($Y = b_0 + b_1 \cdot X + b_2 . X^2$)

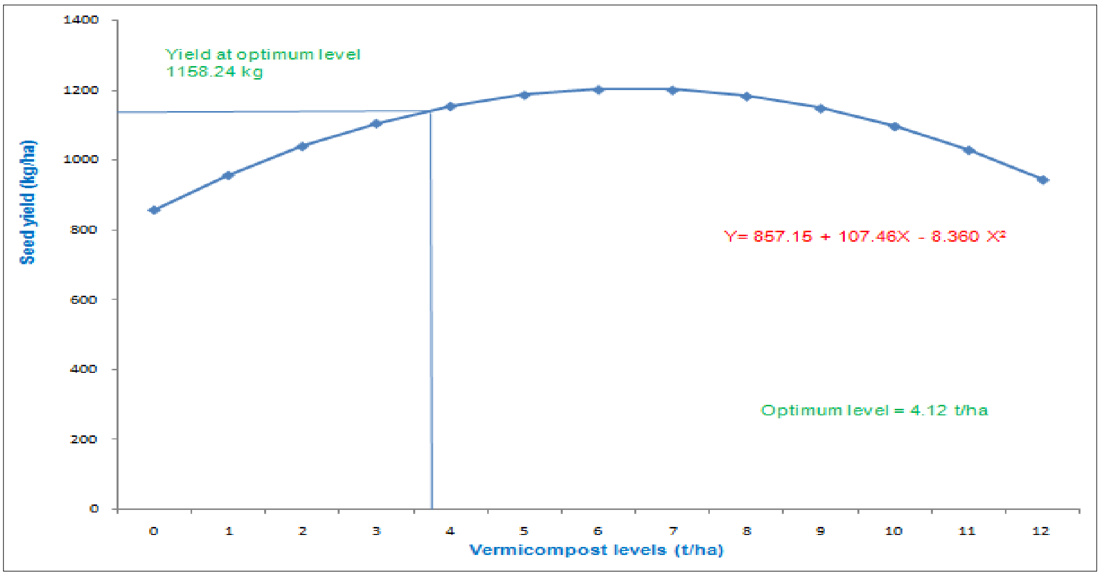

Fig 5: Seed yield (Y) as a function of vermicompost ($Y = b_0 + b_1 \cdot X + b_2 . X^2$)

Conclusion

On the basis of experimental finding, it can be concluded that the application of vermicompost @ 5.0 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. The economic optimum level of vermicompost and zinc was found to be 4.12 t ha^{-1} and 4.86 kg ha^{-1} with grain yield of greengram 1158.24 and 1197.54 kg ha^{-1}, respectively.

References

1. Biswas DR. Nutrient recycling potential of rock phosphate and waste mica enriched compost on crop productivity and changes in soil fertility under potato-soybean cropping sequence in an Inceptisol of Indo-Gangetic Plains of India. Nutrient Cycling in Agroecosystems. 2011;89:15-30.
2. Biswas DR, Narayanasamy G. Rock phosphate enriched compost: an approach to improve low grade Indian rock phosphate. Bio-resource Technology. 2006;97:2243-2254.
3. Chitdeshwari T, Krishnaswamy R. Effect of zinc and zinc rich organic manures on the available micronutrients status in rice soil. Advance of Plant Science. 1998;11(2):211-219.
4. Croxten EF, Cowdon BJ, Klein S. Applied General Statistics, 3rd Edn. Prentice Hall of India, Pvt. Ltd., New Delhi. 1973.
5. Datta M, Dhiman KR. Yield response of rice (*Oryza sativa*) as influenced by methods and sources of micronutrients application. The Indian Journal of Agricultural Sciences. 2001;71(3):190-192.
6. Eswaran N, Mariselvi S. Efficacy of Vermicompost on growth and yield parameters of Lycopersicum esculentum (Tomato). International Journal of Scientific and Research Publications. 2016;6:95-108.
7. FAI. Fertiliser Statistics. The Fertiliser Association of India, New Delhi. 2020-21.
8. Jat G, Sharma KK, Choudhary R. Effect of FYM and mineral nutrients on yield, content and uptake of nutrients in mustard. Annals of Agricultural Research. 2015;34:236-240.

9. Kharche PP, Bhondave TS, Sawant AC. Effect of organic source of nitrogen on growth, yield and economics of baby corn. Current Journal of Applied Science and Technology. 2020;39(16):66-75.
10. Mahilane C, Singh V. Effect of zinc and molybdenum on growth, yield attributes, yield and protein in grain on summer blackgram (*Vigna mungo*). International Journal of Current Microbiology and Applied Science, 2018;7(1):1156-1162.
11. Meena M, Jat G, Meena RH, Sharma SK, Choudhary R, Yadav SK, *et al*. Effect of phospho enriched compost and zinc on soil properties and productivity of blackgram (*Vigna mungo*), Indian Journal of Agricultural Sciences, 2021;91(9):1333-6.
12. Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers. ICAR, New Delhi. 1985.
13. Patil SV, Halikatti SI, Hiremath SM, Babalad HB, Srinivasa MN, Hesbur NS *et al*. Effect of organic manures and rock phosphate on growth and yield of chickpea (*Cicer arietinum* L.) in Vertisols. Karnataka Journal of Agricultural Sciences. 2011;24(5):636-638.
14. Shukla AK, Behera SK, Prakash C, Patra AK, Rao Ch. S, Chaudhari SK *et al*. Assessing multi-micronutrients deficiency in agricultural soils of India. *Sustainability*, 2021;13:9136.
15. Singh BK, Pathak KA, Verma AK, Verma VK, Deka BC. Effects of vermicompost, fertilizer and mulch on plant growth, nodulation and pod yield of french bean (*Phaseolus Vulgaris* L.). Vegetable Crops Research Bulletin. 2011;74:153-165.
16. Singh M, Singh KS. Zinc and copper status of soil of Rajasthan. Annals of Arid Zone. 1981;20:77.
17. Tak S, Sharma SK, Reager ML. Effect of vermicompost and zinc on yield attributes, yield and quality of Greengram [*Vigna radiate* (L.) Wilezek] in arid Rajasthan. International Journal of Agricultural Science, 2014;10(1):138-141.