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# Impact of Steel Industry Slag as Soil Amendment on Nodulation in Vigna radiata (L.) R. Wilczek

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**Abstract:** ***The use of metallurgical solid wastes such as steel slag in agricultural activity, has become very important to contribute to reducing the accumulation of such wastes in the environment and to increase crop production. The use of steel slag in agriculture produces not only economic but also ecological advantages. The Vigna radiata alternately known as the green gram and it is a plant species belongs to family Fabaceae. It is very important pulse which is consumed all over the world. It has the source of protein, fiber, minerals, vitamins, etc. It can be cultivated on a very wide range of soil. For the best result, when grown on well drained loamy soils are not suitable for cultivation. Rourkela is an industrial area and there is growing concern in the air pollution. Rourkela Steel Plant generates waste slag in huge amount for about 772,476 tonnes per year. it is considered as an environmental problem. It can have adverse effect impacts on crops on their growth stage. The present work is to study the root nodule formation in different concentration of slag treatment resulted variable impact in the root nodule formation but it is insignificant.***

**Keywords:** Rourkela Steel Plant, Steel Slag, *Vigna radiata* (Green Gram), Root Nodule, Crop Production

## 1. Introduction

Industrial wastes and agricultural byproducts are increasingly used in crop production as fertilizers. Silicon is the second most abundant element in soil after oxygen. The clay soil contains 40-70 % Silicon, while the sandy soil contains 90-98%. Basic slag is used in this study as a potential source of certain nutrients is a byproduct of the production of steel slag [1,2]. Thus, steel slag can be considered as a sustainable alternative to agricultural practice. Root nodules are the knob-like structures. These are found on the roots of plants, primarily in legumes which form a symbiosis with nitrogen fixing bacteria *Rhizobia* [3,4]. These bacteria fix atmospheric nitrogen into organic compounds of nitrogen. Effective nodulation takes place approximately four weeks after crop planting, with different size and shape of nodules dependent on the crop [5]. Nodulation is controlled by a variety of processes, both external and internal. It is an effective way to supplement the soil and increase its nitrogen content. It can be used as biofertilizer and reduce the use of chemical fertilizers. Mung bean is suitable for biological nitrogen fixation (BNF) through association with native rhizobia which decreases the demand for the nitrogen fertilizer application. Moong plant belongs to Fabaceae pea family of flowering plants [6].

## 2. Literature Survey

This research was conducted in the Garden of Municipal College, Uditnagar Rourkela. (22°13′30″N and 84°51′50.76″E) Odisha, India.

## 3. Materials and Method

Materials used for the study are moong beans, six earthern pots, steel slag, ground soil. To study the effects of Steel Plant waste slag on nodule formation in different concentration of slag in Vigna radiata plant in garden soil "Pot Experiment" was conducted. The experiment was carried using rounded design six pots. Six earthern pots (size r.23cm and h.28.5cm) were taken each containing 7 kg of dried garden soil. The experiment was started on 27th. April,2022, and it was considered as the day zero. After the addition of garden soil in the pot, the waste steel slag was added in each pot (except the control pot) separately slag at the rate of 125g, 250g, 500g, 750g and 1000g per pot i.e; 5% slag, 10% slag, 20% slag, 30% slag and 50% slag. One untreated pot was kept as control. On the next day 10 Green Gram (*Vigna radiata*) seeds were sown in each pot and on the next day plumule and radicle was risen and after one-week thin plants were grown in the pot. Throughout at a uniform level by watering at every alternative day. Ten seeds were sown in each pot and in the control pot 8 plants grown and 2 halt, 5% steel slag 9 plants grown and 1 halt, 10% steel slag 7 plants grown and 3 halt, 20% steel slag 8 plants grown and 2 halt, 30% steel slag 10 plants grown, 50% steel slag 8 plants grown and 2 halt. As this green gram grows very rapidly at 7 days, we have counted the root nodules of different concentration after the maturity of plant for different analysis [7]

**Root Nodule Formation in Different Concentration of Slag in Moong Plant**


CONTROL


5% SLAG


10% SLAG

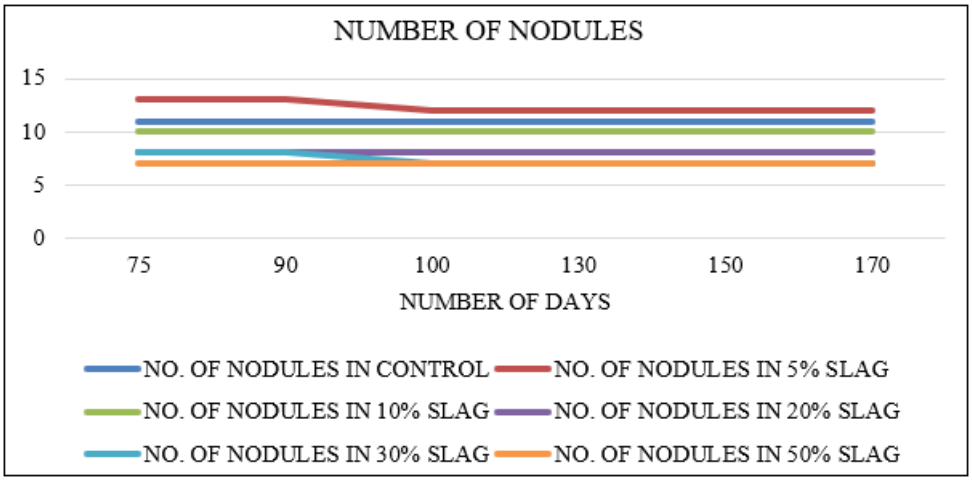

20% SLAG


30% SLAG


50% SLAG

**Table 1:** Total number of nodules appeared per plant in 3 months of culture.

| Pot Experiment | | | | | | |
|---|---|---|---|---|---|---|
| Days | Number of nodules in control | Number of nodules in 5% slag | Number of nodules in 10% slag | Number of nodules in 20% slag | Number of nodules in 30% slag | Number of nodules in 50% slag |
| 75 | 11 | 13 | 10 | 8 | 8 | 7 |
| 90 | 11 | 13 | 10 | 8 | 8 | 7 |
| 100 | 11 | 12 | 10 | 8 | 7 | 7 |
| 130 | 11 | 12 | 10 | 8 | 7 | 7 |
| 150 | 11 | 12 | 10 | 8 | 7 | 7 |
| 170 | 11 | 12 | 10 | 8 | 7 | 7 |




## 4. Results and Discussion

After maturation of the plant, we started counting the number of nodules formed in different concentration of the slag. After 75 days interval, we have observed that in the control pot only 11 numbers of nodule formed, in 5% slag 13 nodules formed, in 10% slag 10 nodules formed, in 20% slag 8 nodules formed, in 30% slag 8 nodules formed and in 50% slag 7 number of nodules formed. After 90 days interval we have observed that in control pot same 11 number of nodules, in 5 % slag 13 nodules, in 10% slag 10 nodules, 20% slag 8 nodules, 30% slag 8 nodules and in 50% slag 7 nodules are formed. After 100 days, we counted the nodules in control pot was 11, in 5% slag 12 nodules, in 10% slag 10 nodules, in 20% slag 8 nodules, in 30% slag 7 nodules and in 50% slag 7 number of nodules formed. After 130 days interval we have observed that in control pot same 11 number of nodules, in 5 % slag 12 nodules, in 10% slag 10 nodules, 20% slag 8 nodules, 30% slag 7 nodules and in 50% slag 7 nodules are formed. After 150 days, we counted the nodules in control pot was 11, in 5% slag 12 nodules, in 10% slag 10 nodules, in 20% slag 8 nodules, in 30% slag 7 nodules and in 50% slag 7 number of nodules formed. Again, after 170 days, we counted the nodules in control pot was 11, in 5% slag 12 nodules, in 10% slag 10 nodules, in 20% slag 8 nodules, in 30% slag 7 nodules and in 50% slag 7 number of nodules formed. This result indicates unfavorable soil condition in slag treated in pots for plant flower and the result is quite insignificant (f=0.132). Steel plant slag, a byproduct of steel manufacturing, can influence the growth of *Vigna radiata*

(mung bean) both positively and negatively depending on its concentration and composition [8]. When applied in moderate amounts, slag can enhance plant growth by improving soil pH, increasing nutrient availability—especially calcium, magnesium, and silicon—and providing essential micronutrients. This can lead to improved seed germination, root development, and biomass accumulation. However, excessive application may introduce heavy metals such as chromium, lead, or cadmium, which can accumulate in plant tissues, disrupt physiological processes, and inhibit growth [9]. High concentrations of these toxic elements may impair chlorophyll synthesis, reduce photosynthetic efficiency, and cause oxidative stress in plant cells. Therefore, while steel slag holds potential as a soil amendment to support *Vigna radiata* cultivation, careful assessment of its chemical composition and application rate is critical to prevent phytotoxicity and ensure sustainable use in agriculture [10].

## 5. Conclusion

This experiment indicated that the number of root nodules formation in leguminous plants (*Vigna radiata*) is slightly higher in soil treated with low concentration of slags (insignificant) but in soil treated with higher concentration of slag such as 10%, 20%,30% and 50% gradually decreases. It might be due to inhibitory effect of some components of steel plant slags.

## 6. Future Scope

This is very useful in agricultural field. Slags were also used in the crop production of Rice, Pea, Maize. This will help to reduce, reuse of industrial slag waste.

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