

## Impact of Phosphogypsum on Growth of *Perionyx excavatus*, an Earthworm



### Agriculture

**KEYWORDS :** Phosphogypsum, Fertilizer, *Perionyx*, *excavatus* Population

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### ABSTRACT

*Phosphogypsum (PG) is one of the by-product of DI-Ammonium Phosphate (DAP) fertilizer plants and its chemical and physical composition hamper over soil biota in a great extent. Prime goal of this investigation was to observe and determine the impact of PG on growth of earthworm *Perionyx excavatus*. Two forms of PG used for the impact analysis on *Perionyx excavatus* growth i.e solid and soluble form. It was observed in the impact that growth of earthworms decreases with increase of PG dose concentration and exposure period particularly in soluble form although both type of PG found effective. It may be due to leaching effect. Soluble form of PG proved lethal as all the population of *Perionyx* found dead after 30 days of exposure.*

### INTRODUCTION:

Soil biota ranges from the myriad of invisible microbes like bacteria, fungi and protozoa to macro-fauna like ants, termites, earthworms etc. to disrupt the soil by their burrowing and feeding habit and has the most direct effect on soil properties. Earthworms are one of the most impact macro fauna of soil and traditionally considered to be convenient indicators of land use and soil fertility. Substantial research in recent years enhances earthworm potential role towards soil fertility (Lee, 1985) and often used to assess the bioavailability of soil pollutants and monitoring because of their ease of use, short life-cycle, and cosmopolitan in distribution, can bear a wide range of soil fluctuation and an important ecological niche. As earthworms exhibit distinct ecological strategies which results adaptability to access and digest soil organic matter and potentially to accumulate soil-bound pollutants also.

Vast use of chemical fertilizers in agricultural sector to supplement nutrients availability for crop growing and profitable quantity yield. Modern intensification of agriculture assisted by natural phosphate supplementation to soil through the application of the phosphate fertilizers. The Phosphogypsum (PG) is generated from the phosphoric acid plants and its disposal pattern always been a matter of concern towards environmental point of view due to its hazardous impact. In India, total production of phosphoric acid is about 1.2 Million per annum (HAZWAMS/2012-2013). States involved in phosphoric acid production are Andhra Pradesh, Gujarat, Kerala, Maharashtra, Orissa, Tamil Nadu and West Bengal. It is gray colored, damp, fine grained powder, silt material with a maximum size ranges between 0.5 mm and 1.0 mm. The specific gravity of PG ranges from 2.3 to 2.6. The maximum dry bulk density is likely to range from 1470 to 1670 kg/m<sup>3</sup> based on Standard Proctor Compaction (HAZWAMS/2012-2013).

Environmental concerns over PG as a pollutant appeared to be more than expectations in the last ten years because of the presence of potential toxic metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver), radioactive elements (uranium and thorium), fluoride and aluminum. Research on pesticides and fertilizers was many and its impact assessment on various species of earthworms was plenty but scientific research and different aspects over various pollutants or by product of fertilizers must to focus on. Present investigation keen to observe the impact of PG on the growth of the earthworm *Perionyx excavatus* and assess the impact level towards its growth proceedings.

### Material and Methods:

For the study earthworm sample collected from the field. For authentic identification some samples were sent for identification to ZSI (Zoological Survey of India), Calcutta and rest were

cultured for future use.. Phosphogypsum (PG) brought from Paradeep Phosphate Limited (PPL), Paradeep. After identification we went for experiment. PG used in two forms i.e solid form and soluble form to observe any impact variation between two forms of PG on growth of *Perionyx*. As solid form of PG already there we only made soluble form by mixing with water. Different concentrations of PG was 100 g/ kg soil, 200 g/ kg of soil, 300 g/ kg of soil and 400 g/ kg of soil. Two experimental set up was made for two forms of PG. Healthy, active and mature *Perionyx excavatus* earthworms chosen and divided into five groups including control. Each group contains 15 earthworms. Experiment started under different concentrations of PG and impact of PG observed and recorded for 15 days, 20 days, 25 days and 30 days on growth of *Perionyx excavatus*.

### Result and Discussion:

Present investigation observed the impact of PG with keeping the control as benchmark. It was advent that chemical and physical nature of PG adversely affects the biological processes of *Perionyx excavatus*. Impact Varies between two forms of PG on growth. Soluble form of PG affects more than suspended form. It may be due to leaching of various chemicals present as soluble form in soil. Laverack (1963), reported that Zn participates in the metabolism of earthworms as an activator of several enzymes like carboxy peptidase, carbonic anhydrase, DNA polymerase etc. but, when present at elevated levels in body tissue, Zn may produce harmful effects on earthworms. Growth of *Perionyx excavatus* was recorded highest in both the control groups but under PG growth diminishes as concentration increases. According to Van Hook (1974), Beyer and Cromartie (1978), Ireland (1979), Morgan and Morgan (1988) and Neuhauser *et al.*, (1995), earthworms living in a soil type containing high concentrations of heavy metals have been shown to concentrate these elements from the soil into their tissues and as a consequence growth and reproduction declined immensely. In suspended form of PG, *Perionyx* growth under 100 mg dose of PG i.e in 15 days was good followed by control. It may be due to increase phosphorous level as it present in adequate range in PG. It was noticed that 200 and 300 g concentration had no significantly impact variation but influence of 400 gm concentration was noticeably varies from both concentrations and impact was maximum on growth of *Perionyx*. Under soluble form of PG, it was observed that growth rate hamper rapidly particularly in 25 and 30 days of duration under 400 gm concentration of PG and maximum population was dead. Maximum accumulation of chemicals may be the fact behind this population loss. In vitro experiments revealed the influence of Pb<sup>2+</sup> (0.63 - 0.75 mg/l<sup>-1</sup>) and Cd<sup>2+</sup> (0.32 - 0.43 mg/l<sup>-1</sup>) can be measured after the 7th day of growth and after 21 days 100% of the test population is dead. The pattern of accumulation differs between metals and also between species for the same metal (Ireland and Wootton, 1976; Morgan *et al.*, 1986;

Morgan and Morgan, 1992 and Reinecke *et al.*, 1997). As PG exist in a bunch of chemicals it is solely responsible for alternation of chemical and physical nature of soil which directly affects soil fauna and its biotic factors. According to Usha and Babyshakila (2009), chemicals such as sodium carbonate, sodium chloride and other compounds of chloride causes soil alkalization resulting increase of soil pH. It is recommended by Hazardous Waste Management Board of India that the soil samples should be analyzed for pH, EC, heavy metals (As, Cd, Cr, Hg, Ni, Pb and Zn), P and F regularly for areas which are very much prone towards PG pollution particularly agricultural and terrestrial ecosystem point of view. Panda *et al.*, (1999) reported, Zn treated soil biotic reproduction aspects was significantly reduced when Zn concentration in soil exceeded 200 mg/kg and the drop in reproduction at elevated concentrations of Zn apparently results delay in completion of the life cycle and a decline in the total soil fauna population. It is also recommended to monitor surface water samples for pH, EC, Turbidity, SS, TDS, BOD, COD, heavy metals (As, Cd, Cr, Hg, Ni, Pb and Zn), Fe, P, F, Cl, NO<sub>3</sub>, SO<sub>4</sub>, Total Alkalinity and Total hardness before agricultural use. Nahmani and Rossi (2003) reported that confounding factors generating spurious relationships between the values of species like Earthworms as bioindicators and the pollution status they are supposed to indicate.

**Table – 1: Growth responses of Perionyx exhavatus towards solid concentration of PG**

Duration in days	PG Concentration in gm/kg				
	Control	100	200	300	400
15	9.5 ± 0.11	9.6 ± 0.10	8.2 ± 0.09	8.2 ± 0.05	7.59 ± 0.56
20	9.9 ± 0.37	8.83 ± 0.35	7.5 ± 0.11	7.11 ± 0.6	7.11 ± 0.01
25	10.6 ± 0.87	7.52 ± 0.12	7.12 ± 0.01	6.9 ± 1.25	6.01 ± 0.85
30	12.5 ± 0.22	6.7 ± 0.25	6.38 ± 0.38	6.22 ± 0.96	5.36 ± 0.53

**Table – 2: Growth responses of Perionyx exhavatus towards soluble concentration of PG**

Duration in days	PG Concentration in gm/kg				
	Control	100	200	300	400
15	9.2 ± 1.65	9.1 ± 0.04	7.9 ± 1.51	7.01 ± 0.83	7.01 ± 0.02
20	9.91 ± 0.80	7.04 ± 0.35	6.82 ± 0.68	6.62 ± 0.01	6.02 ± 0.68
25	10.58 ± 0.81	6.82 ± 0.2	6.01 ± 0.43	5.87 ± 1.17	5.1 ± 1.02
30	13.01 ± 0.21	6.21 ± 0.03	5.69 ± 0.86	5.43 ± 1.83	3.57 ± 0.87

**CONCLUSION:**

It was very much transparent and there is no obscure from the results of our study that how much fatal PG can be over soil and its biotic factors. Although earthworm accumulates toxic matters and indicates levels of pollution and its pollutant but it never impose a healthy indication towards earthworm diversity, distribution and a healthy dominancy role over terrestrial ecosystem. In order to produce fertilizer and its accomplish application, we must concern about its negative consequences towards natural, agricultural and biotic factors (like physiological tolerance range, optimal earthworm population survival, the interaction of pollutants, soil quality assessment and the pollutants bioavailability to the organisms, the interaction of the test organisms with other living organisms) must taking into consideration. It will be adorn if fertilizers and its pollution source like Phosphogypsum handle adroitly towards human welfare.

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