# EFFECT OF IMAZETHAPYR 10% SL ON SOIL MICRO-ORGANISM AND PHYSICO-CHEMICAL PROPERTIES OF SOIL

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**Abstract**

Micro-organisms decompose herbicides which are biologically active compounds and may acts as a bioindicator of changes of soil properties. Herbicide application may change the soil microbial population, thereby affecting the productivity of soils. Hence, in this study a two year field experiment was conducted during *Kharif* season of 2016 and 2017 at Agriculture Research Farm, Palli Siksha Bhavana, Sriniketan to find out an appropriate dose of herbicide for better management of soil in respect to physico-chemical properties of soil and soil microbial population. The result of this experiment showed that the application of herbicide Imazethapyr 10% SL has no adverse effects in the physico-chemical properties of Groundnut cropped soil when compared to control. Irrespective of doses the Imazethapyr 10% SL increased the population of soil bacteria, fungi and actinomycetes in the range of 13.21-21.68%, 18.56-27.36% and 17.70-21.74 % respectively as against the control of initial population content of that microorganism. The treatment of Imazethapyr 10% SL @ 150g a.i./ha and Imazethapyr 10% SL @ 100g a.i./ha showed the positive trends in increase of all the population of bacteria, fungi and actinomycetes in soil.

**Keywords:** Actinomycetes, Bacteria, Fungi, Imazethapyr, Physico-chemical properties of Soil

## Introduction

Herbicides are the most important input in the modern agriculture. The use of herbicides has been expanding more rapidly than that of other pesticides (Bhan and Mishra, 2001). In India the use of herbicides in pulses and oilseeds is increasing day by day. The unjudicious increased of herbicides in agricultural soils causes the contamination of the soil with toxic chemicals and become harmful to microorganisms, plant, wildlife and man (Amakiri, 1982). But the fate of these chemicals in the soils is becoming very much important since they could be leached and persist on the top soil (Ayansina *et al*., 2003). The herbicide application not only affect the target organism but also disturb the microbial communities present in the soil. These non target effects may reduce the activities of useful soil function and thereby changes the balance of pathogen and beneficial organisms and also creates harmful environment for crop production. So, it is very clear that the activity of micro-flora in soil may plays a great role for maintaining soil physico-chemical

properties as well as productivity of crop in any cropping system. Thus, there is a need to study the influence of herbicide on the microflora and physico-chemical properties of soil of groundnut crop.

Hence, the present investigation was undertaken to find out the effect of Imazethapyr on physico-chemical properties of soil and microbial population for their judicious use.

**Materials and Methods**

A two year field experiment was conducted during *Kharif* season of 2016 and 2017 at Agricultural Research Farm, Institute of Agriculture, Visva-Bharati, Sriniketan located at 23°39'N latitude and87°42'E longitude with an altitude 58.9 m AMSL. The soils of the experimental site was sandy loam in texture having pH 6.2, bulk density 1.39 gm $cm^{-3}$, moisture content 0.53% (w/w), water holding capacity 34.71%, EC 0.71 $dsm^{-1}$, organic carbon 0.42%, available N 255 kg $ha^{-1}$, available $P_2O_5$ 14.48 kg $ha^{-1}$, available $K_2O$ 180.54 kg $ha^{-1}$ along initial content of bacteria (26.13 cfu × $10^4$/g), fungi (11.04 cfu × $10^3$/g) and actinomycetes (10.33 cfu × $10^3$/g). The crop variety JGN-3 was sown during first week of July of both the years of study. The recommended doses of fertilizers were applied as per agronomic recommendation. The experiment was laid out in a randomized block design with five treatments and three replications. The treatments included Imazethapyr 10% SL (Im) @ 100 g a.i. $ha^{-1}$, Imazethapyr 10% SL @ 150 g a.i. $ha^{-1}$, Imazethapyr 10% SL @ 200 g a.i. $ha^{-1}$, Imazethapyr 10% SL @ 300 g a.i. $ha^{-1}$ and control (no application of herbicide). The crop was raised with all the recommended practices and harvested in the first week of November in both years of study.

In order to study the microbial population soil samples from a depth of 0-15 cm were collected from the trial plot conducted at Agricultural Research Farm, Institute of Agriculture, Visva-Bharati, Sriniketan. at initial (before sowing of herbicides), 10days after spraying of herbicides and at harvesting of the groundnut crop and provided to the Department of Soil Science and Agricultural Chemistry, Institute of Agriculture, Visva-Bharati, Sriniketan – 731236, West Bengal, India for analysis. The composite representative samples were analyzed for biological properties (microbial population) by using the following standard methods. Similarly, the physico-chemical properties (pH, EC, Organic C, available N, $P_2O_5$ and $K_2O$) were also analyzed as per standard method (Table-1) at initial and harvest soils of groundnut crop.

The Plates were incubated at 28 ± $1^0$C for different durations between 3-5 days in BOD incubator and observations in terms of counting of number of colonies $plate^{-1}$ were made with the help of colony counter.

The plates were incubated at 28 ± 1° C upto 3days in BOD incubator and observation in terms of counting number of colonies per plate were made periodically with the of colony forming unit (CFU) per gram of soil.

All the data obtained from the above experiments were subjected to statistical analysis as per method detailed by Panse and Sukhatme (1985).

**Table 1: Methods used for analysis of chemical and biological parameters of cropped soil**

| **Chemical composition of soil:** | **Methods followed** |
|---|---|
| pH (soil: water :: 1:2.5) | pH meter (Sparks,1996) |
| Electrical Conductivity ($dSm^{-1}$) | Electrical conductivity meter (Sparks,1996) |
| Organic carbon (%) | Walkely and Black method,1934 |
| Available N ($kgha^{-1}$) | Alkaline permanganate method (Subbiah and Asija,1956) |
| Available $P_2O_5$ ($kgha^{-1}$) | Olsen's method (Olsen *et al*.,1945) |
| Available $K_2O$ ($kgha^{-1}$) | Flame photo meter method(Toth and Prince,1949) |
| **Microbial population** | |
| Total Bacteria | Thornton's agar medium, 1922 at $10^{-4}$ dilutions |
| Total fungi | Martin' Rose Bengal Streptomycin agar medium, 1950 at $10^{-4}$ dilutions |
| Total actinomycetes | Jensen's agar medium, 1930 at $10^{-3}$ dilutions |

## Results and Discussion

### Effect of Imazethapyr on Soil properties

The results showed that there was no adverse effects in the trial plots of the field experiment on physical properties of soil after application of this herbicide in both the seasons (Table 2).

It may be commented that the initial soil pH was slightly acidic in reaction but actually it may be called tending to become neutral. The total soluble salt was more or less in normal range for crop cultivation. The initial nutrient content was medium in available N, very low in $P_2O_5$ and medium in $K_2O$ content with organic carbon content was medium in status. The impacts of the herbicide on chemical properties of soil in the trial plot have not been found any remarkable change in both the seasons after application of this herbicide (Table 3 and 4).

**Table 2: Impacts of herbicide on physical properties of soil.**

| Treatments | Bulk density ($g\ cm^{-3}$) | | | | Moisture content (%)(w/w) | | | | Water holding capacity (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2016** | | **2017** | | **2016** | | **2017** | | **2016** | | **2017** | |
| | Initial | Harvest | Initial | Harvest | Initial | Harvest | Initial | Harvest | Initial | Harvest | Initial | Harvest |
| Im@100g a.i/ha | 1.39 | 1.38 | | 1.38 | 0.53 | 0.32 | 0.55 | 0.33 | 34.71 | 34.09 | 33.87 | 33.52 |
| Im@150g a.i/ha | | 1.39 | | 1.40 | | 0.33 | | 0.34 | | 32.74 | | 33.14 |
| I@200g a.i/ha | | 1.42 | | 1.43 | | 0.33 | | 0.33 | | 32.05 | | 32.48 |
| Im@300g a.i/ha | | 1.38 | | 1.40 | | 0.39 | | 0.41 | | 32.31 | | 33.27 |
| Control | | 1.45 | | 1.47 | | 0.45 | | 0.39 | | 31.37 | | 30.91 |
| CD at 5% | | 0.04 | | 0.04 | | 0.11 | | 0.01 | | 1.30 | | 1.42 |
| CV (%) | | 1.73 | | 1.41 | | 16.44 | | 15.42 | | 2.27 | | 2.50 |

N.B. Im indicates Imazethapyr 10% SL

**Table 3: Influence of herbicides on chemical properties (pH, EC and Organic carbon) of soil**

| Treatments | pH (1:2.5 ratio) | | | | EC ($dsm^{-1}$) | | | | Organic carbon (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Initial | | Harvest | | Initial | | Harvest | | Initial | | Harvest | |
| | **2016** | **2017** | **2016** | **2017** | **2016** | **2017** | **2016** | **2017** | **2016** | **2017** | **2016** | **2017** |
| Im@100g a.i/ha | 6.2 | 6.4 | 6.24 | 6.73 | 0.71 | 0.83 | 0.51 | 0.57 | 0.42 | 0.46 | 0.53 | 0.59 |
| Im@150g a.i/ha | | | 6.59 | 6.89 | | | 0.79 | 0.53 | | | 0.49 | 0.44 |
| Im@200g a.i/ha | | | 6.66 | 7.16 | | | 0.69 | 0.58 | | | 0.52 | 0.37 |
| Im@300g a.i/ha | | | 6.87 | 6.71 | | | 1.04 | 0.73 | | | 0.53 | 0.40 |
| Control | | | 6.74 | 6.74 | | | 0.67 | 0.53 | | | 0.45 | 0.35 |
| CD at 5% | | | 0.28 | 0.38 | | | 0.16 | 0.17 | | | 0.07 | 0.07 |
| CV (%) | | | 3.29 | 3.88 | | | 5.84 | 13.06 | | | 7.62 | 9.92 |

N.B. Im indicates Imazethapyr 10% SL

**Table 4: Influence of herbicides on chemical properties (Available N, $P_2O_5$ and $K_2O$) of soil**

| Treatments | Available N in Kg/ha | | | | Available $P_2O_5$ (kg $ha^{-1}$) | | | | Available $K_2O$ (kg $ha^{-1}$) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Initial | | Harvest | | Initial | | | | Initial | | Harvest | |
| | **2016** | **2017** | **2016** | **2017** | **2016** | **2017** | **2016** | **2017** | **2016** | **2017** | **2016** | **2017** |
| Im@100g a.i/ha | 255 | 251.36 | 359.93 | 276.33 | 14.48 | 14.74 | 12.56 | 13.58 | 180.54 | 182.63 | 183.22 | 178.66 |
| Im@150g a.i/ha | | | 382.27 | 267.97 | | | 15.52 | 14.69 | | | 194.07 | 176.28 |
| Im@200g a.i/ha | | | 393.40 | 272.17 | | | 16.11 | 14.84 | | | 208.14 | 177.29 |
| Im@300g a.i/ha | | | 405.93 | 234.50 | | | 14.40 | 14.25 | | | 189.68 | 219.45 |
| Control | | | 260.63 | 247.03 | | | 14.43 | 13.84 | | | 185.94 | 155.18 |
| CD at 5% | | | 28.77 | 35.57 | | | 0.88 | 1.10 | | | 19.34 | 36.19 |
| CV (%) | | | 3.52 | 5.51 | | | 3.28 | 4.28 | | | 3.71 | 7.25 |

N.B. Im indicates Imazethapyr 10% SL

**Effect of Imazethapyr on Total Bacteria, Fungi and Actinomycetes**

The impacts of the testing herbicide Imazethapyr 10 % SL on soil micro-flora viz. Total bacteria, Fungi and Actinomycetes as recorded in different time of observations (initial & at harvest) are presented Table 5.

Irrespective of doses the treatments of herbicide Imazethapyr 10 % SL showed influence on the population of total bacteria in *Rhizosphere* soil of groundnut at harvest stage (Table 4). The bacterial population increased more or less in the range of 15.74-33.74% in both the years of study. The bacterial population increased 21.95 & 26.92 % in 2016 and 16.68 & 21.18 % in 2017 in the $T_3$ and $T_4$ treatment, respectively as compared to initial population ($27.33x10^4$ & $26.00x10^4$ cfu $g^{-1}$of soil in $T_3$ and $28.00x10^4$

&28.33x$10^4$ cfu $g^{-1}$of soil in $T_4$, respectively). The bacterial population increased 15.58 & 21.32 % in 2016 and 37.04 & 45.58 % in 2017 in the $T_5$ and $T_6$ treatment, respectively as compared to initial population (25.67x$10^4$ & 25.00x$10^4$ cfu $g^{-1}$of soil in $T_5$ and 27.00x$10^4$ & 26.33x$10^4$ cfu $g^{-1}$of soil in $T_6$, respectively). The bacterial population was found to be lower trend at 10 days after spraying (DAS) but higher at harvest of the crop as compared with initial population due to using the herbicides most frequently as sources of carbon (Radosevich *et al*.,1995) or nitrogen (Cook and Hutter,1981). The significant increasing trends' of bacterial population were found between the treated with Imazethapyr 10 % SL and non treated plots.

From the results in table 5 it was found that there was significant adverse effect on the population of fungi in *Rhizosphere region* after application of the herbicide Imazethapyr 10 % SL but at harvest the data showed slightly higher than the initial population. The fungal population increased more or less in the range of 16.91-27.36% in both the years of study. The fungal population increased 22.79 & 18.74 % in 2016 and 31.36 & 22.25 % in 2017 in the $T_3$ and $T_4$ treatment, respectively as compared to initial population (11.67x$10^3$ & 11.67x$10^3$ cfu $g^{-1}$of soil in $T_3$ and 10.67x103 & 12.00x$10^3$ cfu $g^{-1}$of soil in $T_4$, respectively).

The impact of the testing herbicide Imazethapyr 10 % SL , tested in this experiment, showed that there was significant adverse effect on the population actinomycetes in *Rhizosphere region* after application of the herbicides but at harvest the data showed more or less slightly higher than the initial population. The actinomycetes population increased 25.85, 32.33 & 29.04 % in 2016 and 25.00, 23.57 & 24.27 % in 2017 in the $T_2$, $T_4$ and $T_5$ treatment, respectively as compared to initial population (10.33x$10^3$ , 10.33x$10^3$ & 10.33x$10^3$ cfu $g^{-1}$of soil in 2016 and 12.00x$10^3$ , 11.33x$10^3$ & 11.00x$10^3$ cfu $g^{-1}$of soil in 2017 in the treatment of $T_2$, $T_4$ and $T_5$ respectively).

There were not observed the harmful effect on the soil microbial population. The results showed that the number of microbial populations slightly increased at harvest of the groundnut crop but total number of population is not desirable either at initial or harvest of crop in both the years. The results showed that there was a significant increase in the soil microbial population in this experiment in the rhizosphere zone in most of the doses in both the years. It indicates that the microbial population fixes the atmospheric nitrogen symbiotically as well as solubilize the fixed phosphorous to the soil solution. These results are in agreement with the earlier findings of Changpeng *et al.*, 2010, Murato *et al*., 2004 and Desmukh and Srikhande, 1974. Interestingly, it was found that the bacterial, fungal and actinomycetes population also increased significantly after application of Imazethapyr 10 % SL particularly in the doses of 200 and 300 g a.i./ha . However, the total microbial population (total bacteria, fungi and actinomycetes) in soil increased as compared to the initial population. The microbial population was positively affected in increasing trends by the application of different doses of the herbicide Imazethapyr 10 % SL treatments. These results corroborated with the earlier findings of Latha *et al.*, 2010.

**Conclusions:**

There were no adverse affects on the microbial population of the soil in the *rhizospere* region of the groundnut oilseed crop due to the application of testing herbicide Imazethapyr 10 % SL. The microbial

population at harvest showed more or less higher in number in respect of the initial in most of the doses of the testing herbicide Imazethapyr 10 % SL in both the years. Therefore, the application of herbicide Imazethapyr 10 % SL particularly in the doses of 100 and 150 g a.i./ha may be successfully recommended to the farmers for cultivation of groundnut for availability of nutrients.

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**Table 5: Impact of herbicides on total bacteria, fungi and actinomycetes**

| Treatments | Bacteria (CFU x $10^4$ $g^{-1}$) | | | | | | Fungi (CFU x $10^3$ $g^{-1}$) | | | | | | Actinomycetes (CFU x $10^3$ $g^{-1}$) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Initial | | 10 DAT | | Harvest | | Initial | | 10 DAT | | Harvest | | Initial | | 10 DAT | | Harvest | |
| | **2016** | **2017** | **2016** | **2017** | **2016** | **2017** | **2016** | **2017** | **2016** | **2017** | **2016** | **2017** | **2016** | **2017** | **2016** | **2017** | **2016** | **2017** |
| Im@100g a.i/ha | 26.13 | 27.59 | 27.67 | 29.00 | 30.67 | 30.67 | 11.04 | 12.25 | 13.00 | 13.67 | 14.67 | 14.00 | 10.33 | 10.97 | 13.00 | 14.33 | 13.00 | 14.67 |
| Im@150g a.i/ha | | | 28.00 | 28.67 | 30.00 | 32.33 | | | 13.33 | 12.67 | 15.00 | 16.00 | | | 12.67 | 14.67 | 13.00 | 15.00 |
| Im@200g a.i/ha | | | 22.67 | 24.00 | 33.33 | 32.67 | | | 9.67 | 10.00 | 14.33 | 15.33 | | | 9.33 | 10.00 | 13.67 | 13.00 |
| Im@300g a.i/ha | | | 21.00 | 23.33 | 33.00 | 34.33 | | | 9.33 | 9.33 | 12.67 | 14.67 | | | 8.00 | 10.33 | 13.67 | 14.00 |
| Control | | | 19.67 | 21.67 | 29.00 | 31.00 | | | 8.33 | 8.00 | 12.67 | 13.33 | | | 7.33 | 7.67 | 12.00 | 13.33 |
| CD at 5% | | | 2.64 | 3.17 | 1.87 | NS | | | 1.26 | 2.21 | NS | 2.19 | | | 1.21 | 3.51 | NS | NS |
| CV (%) | | | 5.43 | 5.83 | 3.43 | 7.78 | | | 5.82 | 6.36 | 10.29 | 8.62 | | | 5.84 | 7.17 | 11.16 | 9.31 |

N.B. Im indicates Imazethapyr 10% SL, DAA indicates Days after application and CFU indicates Colony forming unit