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Assessment of soil microbial population dynamics and their correlation with pod yield in herbicidal treated groundnut

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Abstract
The present set of experiment was carried out in the Central farm, OUAT, Bhubaneswar during Rabi 2014-15 with five treatment such as control(without weeding), Butachlor, Alachlor, Oxyflurofen as pre-emergence herbicides and weed free (manual weeding) having three replication under RBD design to study the impact of pre-emergence herbicides on microbial populations. The application of herbicides have tremendous on impacts population of bacteria and fungi in the rhizospheric soil and their enzyme activities and cause qualitative and quantitative alterations. At 90 DAHT the population of the bacteria and fungus became at par with the initial population i.e. 0 DAHT. Among the control and weed free, the population of bacteria was found highest whereas, the fungal population was moderate in the weed free as compared to other treatments. Application of pre-emergence herbicide affected the microflora population specially bacterial and fungal population. The bacterial population was found to be highest ($9x10^5$ cfu/g) in weed free where on fungal population was highest ($7x10^3$ cfu/g) in control treatment. These three herbicides showed drastic reduction in the bacterial as well as fungal population within seven days after the application. An increasing trend of the bacterial and fungal population was observed after seven days and the trend continue up to 90 DAHT. The study confirmed that the herbicides (Butachlor, Alachlor and Oxyflurophen) altered the microbial populations hence to influence pod yield by affects the different soil enzyme activities.

Keywords: Fungi, herbicide, microflora population, Rhizospheric bacteria

Introduction
Groundnut is considered as 'King' of oil seed crops. It's dual characteristics such as leguminous and oil seeds, makes this crop unique. Properties of this crop such as high oil content (40-50%), high protein content (20-50%), carbohydrates content (10-20%), and several beneficial nutrients and vitamins makes this crop even more special for human consumption. Due to its leguminous nature, soil micro-organisms plays very crucial role for the growth and development. Although, it has several benefits to human being, weed infestation in this crop is a major concern. Further, several reports mentioned that use of herbicides can potentially influence microbial soil populations, which is highly correlated with yield potential of the crop.

The uses of herbicides have been expanding more rapidly than the use of pesticides (Bhan and Mishra, 2001) [2]. Earlier, herbicides use confined to plantation crops but now it expanded in to several crops (Yadaraju and Mishra, 2002) [15]. The application of herbicides can cause qualitative and quantitative alterations in the soil microbial populations and their enzyme activities (Min *et al*., 2002; Saeki and Toyota, 2004) [8, 10]. Herbicide application may also kill species of bacteria, fungi and protozoa resulted into upsetting the balance of pathogens and beneficial organisms and allowing the opportunist, disease causing organisms to become a problem (Kalia and Gupta, 2004) [6]. Application of herbicides can potentially influence microclimate that impairs pod yield in groundnut (Sahoo *et al*., 2017a) [12].

Microorganisms play very essential role in maintaining soil fertility: cycling nutrients, influencing their availability by improving soil structure; supporting healthy plant growth; degrading organic pollutants. Some soil bacteria and fungi cause plant diseases; others are antagonistic to plant pathogens and invertebrate pests. The rhizosphere provides a region for increase microbial activity in which certain groups of bacteria and fungi are more likely to proliferate than the bulk soil. Some rhizospheric microorganisms originate from the seed but the majority are derived from the soil in which a plant is growing, and they will be returned to the soil thus bulk soil and rhizosphere reciprocate impact on microbial communities (Chauhan *et al*, 2006) [3]. Any one group of microbes is unlikely to perform with maximum efficiency under all circumstances, so genetically diverse populations are needed to provide continuation of important soil processes. Since the relationship between the size, diversity and activity of microbial populations and soil 'quality' is unclear, also how these properties fluctuate throughout the seasons with crop rotations, and the scale (temporal and spatial) on which they vary, it is difficult to predict effects of changes in agricultural practice, land use, climate, introduction of novel plants, microbial inoculants and pollution on soil quality. A healthy population of soil microorganisms can potentially stabilize the ecological system of soil due to their ability to regenerate nutrients to support plant growth. Any change in microbial population and their activities may affect nutrient cycling as well as availability of nutrients, which indirectly affect productivity and other soil functions (Wang *et al.*, 2008) [14].

With this background, the present investigation was carried out with a view to understand the effect of herbicides *viz.*, butachlor, alachlor and oxyflurophen soil microorganisms keeping two control plots one with weeds and one without weeds (by manual weeding) in groundnut.

Materials and methods

Study Site

The present study was carried out in the agricultural field of OUAT, Bhubaneswar, Odisha which is situated in 85^0 52' E longitude and 20^0 15'N latitude with an elevation of 25.5 meters above sea level. The experimental field of Central Research Station was well drained and was sandy loam in nature. Composite soil sample to a depth of 0.15 cm was collected before sowing from the experimental site and was analyzed for important physico-chemical characters. The genotype which was chosen for the study was Devi.

Treatments

The experiment was undertaken with following five treatments which are shown in Table 1.

Table 1: Showing details about treatments was given in this experiment

S. No.	Treatment	Description
1	T_0	Weed check (Control),
2	T_1	Butachlor 50% EC) @ 1000ml/ha, with two hand weeding at 21 & 40 DAHT
3	T_2	Alachlor (50% EC) @ 800 ml/ha, with two hand weeding at 21 & 40 DAHT
4	T_3	Oxyflurofen (23.5%EC) @ 80 ml/ha, with two hand weeding at 21 & 40 DAHT
5	T_4	Weed free check (Manual weeding)

Soil sampling and bioassay

To study the effects of herbicides on total aerobic heterotrophic bacterial and fungi population, soil sampling was done by following general methods for soil microbiological study. Top soil sample were collected from a depth of (0-2) cm from each plot (Saeki and Toyota, 2004) [10]. Each plot was divided into 5 blocks, and from each block five soil samples were collected randomly. Samples collected from each block were referred as 'sub-samples', and were thoroughly mixed to form one 'composite sample' The composite samples were homogenized, sieved (0.2 mm) to remove stone and plant debris, and were analyzed. The soil samples were collected in the above manner on 0, 7,14,30,45 and 90 days after herbicide treatments (DAHT).

Microbial enumeration

The microbial populations were enumerated using selective media by standard spread plate and serial dilution technique (Tepper *et al*, 1993) [13]. Total heterotrophic aerobic bacteria were enumerated using nutrient agar supplemented with griseofulvin 50µl/ml to prevent the fungal growth (Gray 1990) [5]. Potatao Dextrose agar with streptomycin 50µl/ml was used for fungal count (Alef and Nannipieri, 1995).

Pod yield

Pod yield was recorded according to methods described by Sahoo *et al*., (2017 b) [11].

Results and discussion

Effect of herbicides on total heterotrophic bacterial and fungal population.

The abundance and distribution of different groups of soil microorganisms were enumerated and expressed in terms of colony forming units per gram soil (cfu/g). Differences could be observed between the different herbicide treated soil profiles based on microbial enumeration. Besides, the variations in microbial population in different herbicides treated soil were presented in terns of log10 transformed of cfu/g soil. The population of total heterotrophic bacteria and fungi counted after application of herbicides is presented in (Tables 2 and 3).

The population of bacteria and fungi in the rhizospheric soil was found to be significantly influenced by the type of herbicides, and the days after application of herbicides. All the three herbicides were showing a drastic reduction in the bacterial as well as fungal population within seven days after the application. An increasing trend of the bacterial and fungal population was observed after seven days and the trend continues upto 90 DAHT. At 90 DAHT the population of the bacteria and fungus became at par with the initial population *i.e.* 0 DAHT. An increase in reproductive ability of bacteria with time after the initial phase of depression, resulting from toxic effect of butachlor was reported by Kole and Dey 1989b [7]; Yu *et al*. 1993; Solomon, 1999. A similar trend was also observed by Latha *et al*. (2010) and Baboo *et al*. (2013). Among the control and the weed free control it was observed that the population of both the bacteria and the fungus is more in the weed free control than the normal control. This could be due to the availability of more nutrients to the microbes due to weed free condition.

Table 2: Mean bacterial population of the sample treated with different weedicides X 10 ^{5} cfu/g

Treatments	0 DAHT	7 DAHT	14 DAHT	21 DAHT	30 DAHT	45 DAHT	90 DAHT
H_0 (Control)	8.3	8.5	8.5	8.4	8.3	8.4	8.6
H_1 (Butachlor)	7.8	4.2	6	6.6	8.2	8.6	8.9
H_2 (Alachlor)	8	5.6	6.8	7.2	8.4	8.8	8.9
H_3(Oxyflurophen)	7.9	4.4	4.8	5.2	7	8.5	8.6
H_4 (Weed free)	8.2	8.4	8.8	8.5	8.6	8.8	9

Table 3: Mean fungal population of the sample treated with different weedicides X 10 ^{3}cfu/g

Treatments	0 DAHT	7 DAHT	14 DAHT	21 DAHT	30 DAHT	45 DAHT	90 DAHT
H_0 (Control)	5.9	6.6	6.4	6	6.8	6.8	7
H_1 (Butachlor)	5.8	3.5	4.1	4.6	5	5.8	6.2
H_2 (Alachlor)	5.6	4.4	5.3	5.6	5.8	6	6
H_3(Oxyflurophen)	5.9	3.6	4	4.2	4.8	5.2	5.6
H_4 (Weed free)	5.8	6	6.2	6.2	6.4	6.6	6.9

Corelation study between microbial population and pod yield

Scatter plot analysis between pod yield and microbial population (i.e. bacterial and fungal population) at 90 DAHT shows that bacterial population is highly correlated with pod yield (r =0.589) and contributes 34.71% towards pod yield (Fig 1.) however, fungal population is positively correlated to pod yield (0.389) and contributed only 15.9% towards pod yield (Fig 2.). The bacterial populations such as rhizobium species might be helps to produce root nodules that directly link with growth, development and yield of the groundnut (Asante *et al*., 2020) [1]. The study of Effiong *et al*., 2019) [4] showed that inoculation of fungi *Glomus clarum* contributes towards higher pod yield in groundnut. In this correlation studied it was confirmed that all though both bacterial and fungal population contributes toward pod yield but bacterial population highly and significantly contributes towards pod yield.

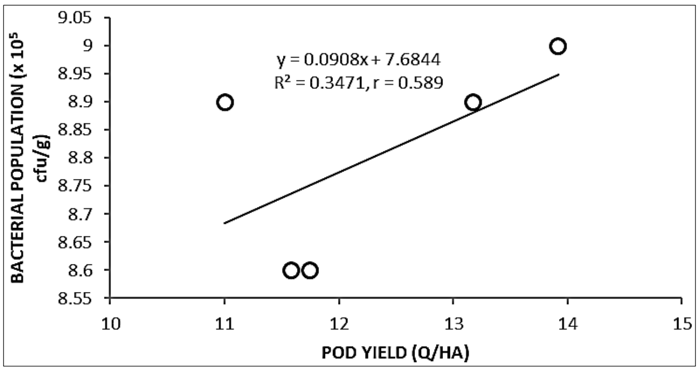

Fig 1: Scatter plot between Bacterial population and Pod yield in groundnut

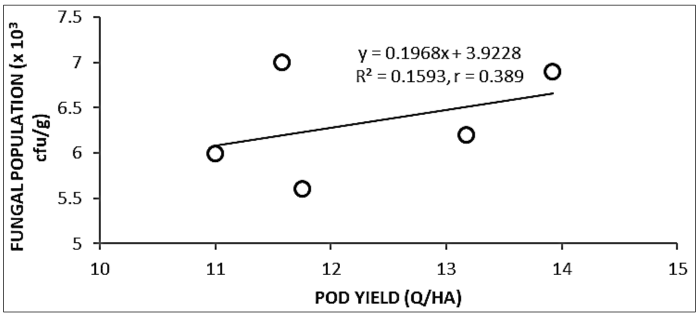

Fig 2: Scatter plot between Fungal population and Pod yield in groundnut

Conclusion

This study confirmed that the use of herbicides (Butachlor, Alachlor and Oxyflurophen) may alter the microbial populations with respect to different days after treatment, and thereby affects the yield of the crop. This studied further revealed that bacterial population significantly correlated to pod yield than fungal population. However, the nutrient management practices like application of organic manures, mineral fertilizers along with judicious use of pre-emergence can be useful for enhancing soil micro-organisms and for pod yield also. Further, it is necessary to strengthen the scientific basis of modern agriculture, because herbicides may be advantageously used only if their persistence, bioaccumulation, and toxicity in agro-ecosystem are strictly controlled.

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