Effect of Bio-Fertilizers and Flumioxazin on Microflora and Yield of Groundnut (*Arachis hypogaea* L.) in Alfisol of West Bengal

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**Abstract**

Herbicide is the most important input in the modern agriculture. The use of herbicides has been expanding more rapidly than that of other pesticides. The injudicious application of herbicides in agriculture causes the contamination of the soil with toxic chemicals and become harmful to the microorganisms, plant, wildlife and man. In view of the above a field experiment was conducted during rabi season of 2015-16 with the groundnut variety TAG-24 with twenty four treatment combination in three replications. The result of this experiment showed that the application of herbicide Flumioxazin along with different combinations of biofertilizers PSB, *Rhizobium* and *Azotobacter* have no significant adverse effects in the physico-chemical properties of soil (pH and EC), available nitrogen content, microflora population (NFB, PSB, fungi, actinomycetes) and pod yield of Groundnut.

**Keywords**

Biofertilizers, Flumioxazin, Groundnut, Herbicide, Microflora

**Introduction**

Groundnut (*Arachis hypogaea* L.) is one of the principal economic oilseed crops in the world. It contains about 50% oil, 25-30% protein, 20% carbohydrate and 5% fibre and besides this, it also contains vitamin E, niacin, folacin, calcium, phosphorus, magnesium, zinc, iron, riboflavin, thiamine and potassium (Savage and Keenan, 1994), which make a substantial contribution to human nutrition. The oils not only acts as the essential part of human diet but also serve as an important raw materials for the agro-based industries and for the manufacturing of various sophisticated products.

The new approach for farming often referred to as ‘sustainable agriculture’ advocates the use of renewable inputs like biofertilizers, green manure, vermicompost etc. This is also important both from the view point of environmentally safe technologies and providing some sort of fertilizer to the resource-poor and marginal farmers. Seed inoculation with biofertilizer is a low cost
input which plays a significant role in crop yields and enhances nutrient availability to the crop plants.

Among the various biotic stresses resulting in low productivity, weeds are considered as a major constraint; especially under rainfed ecosystems. Weeds cause serious problems to the groundnut crop during the first 45 days of its growth. The most critical period of weed competition is from 3-6 weeks after sowing. The average yield loss due to weeds is about 30%, whereas under poor management yield loss by weeds may be 60% (Dayal et al., 1987).

Use of herbicides for weed control in legumes and especially in groundnut has certainly contributed to the increased yield and improved quality. However, detrimental effects caused by these herbicides on soil microorganisms growth and metabolism have also been reported in several studies. Experiments carried out to evaluate the effect of different herbicides on the Rhizobium growth and nitrogen fixation activity revealed that the effect depends on the herbicide, its concentration, crop, nature and type of microorganisms and different weather conditions (Sawicka and Selwet, 1998). Hence, unique combination of the above factors, which are very specific for a region, needs to be studied to predict the influence of the herbicides used on the growth and metabolism of microorganisms. With this view, the present study was taken up to study the “Effect of Biofertilizers and Flumioxazin on microflora and yield of Groundnut (Arachis hypogaea L.) in alfisol of West Bengal”.

Materials and Methods

Site of experiment

A field trial was conducted during rabi season of 2015-16 in Agricultural Research Farm, Institute of Agriculture, Visva-Bharati, Sriniketan located at 23°39’N latitude and 87°42’E longitude with an altitude 58.9 m AMSL. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH 4.8) with low level of organic carbon (0.42%) but medium level of available nitrogen (225.79 kg ha⁻¹), available P₂O₅ (43.68 kg ha⁻¹), available K₂O (138.7 kg ha⁻¹) and contained 9.37 × 10⁴, 18.5 × 10⁴, 16 × 10⁴, 3 × 10⁴ cfu g⁻¹ NFB, PSB, fungi and actinomycetes, respectively. The groundnut crop variety TAG-24, a bunch type, Spanish, variety which is improved through selection and contains nearly 50% of oil, matures in 110 to 120 days if sown by the first week of February. It was sown during first week of February.

Experimental details

The experiment was carried out in a Randomized Block Design with factorial concept (FRBD) having two factor. Factor A having 3 treatments i.e. No herbicide (Ho), Recommended dose of herbicide (H₁) and Double dose of herbicide (H₂) and Factor B having 7 treatments i.e. Noinoculation (B₀), PSB (B₁), Rhizobium (Rhizo) (B₂), (B₃), Azotobacter (Azo) (B₄), PSB+Rhizobium (B₅), PSB+ Azotobacter (B₆), Rhizobium + Azotobacter (B₇), PSB+ Rhizobium +Azotobacter (B₈). The interaction between two factor AxB gives 24 treatments which is replicated thrice. Each plot was 3m x 4m surrounded by ridges. Adequate number of irrigation channels was constructed to provide irrigation independently to each plot.

Sampling and analysis

Ten plants were randomly selected from each plot and the number of pods from those plants, number of grains per pod and harvest index was determined after harvest. Soil samples were collect from the experimental plot after final harvest of the crop. Then the soil samples were dried in shade and processed in the laboratory and finally the individual test for
soil pH and EC, available nitrogen content and microbial population were estimated accordingly.

**Results and Discussion**

**Effect of biofertilizers and flumioxazin on pod yield of groundnut**

The result showed that the single inoculation of Azotobacter @ 80 g kg\(^{-1}\) of seed without any application of herbicide gave the remarkably highest pod yield (3416.67 kg ha\(^{-1}\)) after harvest of groundnut crop in alfisol of West Bengal followed by single inoculation of Rhizobium along with double the recommended dose of herbicide @ 500 g ha\(^{-1}\) (3175 kg ha\(^{-1}\)) and then followed by single inoculation of Azotobacter, single inoculation of Rhizobium, dual inoculation of Rhizobium + Azotobacter, and dual inoculation of Rhizobium + PSB were 28.39, 24.05, 14.96 and 1.54%, respectively, over uninoculated control (2172.11 kg ha\(^{-1}\)), 32.80, 28.31, 18.91 and 5.03%, respectively, over dual inoculation of Azotobacter + PSB (2099.99 kg ha\(^{-1}\)), 42.61, 37.78, 27.69 and 12.78%, respectively, over combined inoculation of Rhizobium + Azotobacter + PSB (1955.55 kg ha\(^{-1}\)) and 67.33, 61.67, 49.83 and 32.33%, respectively, over single inoculation of PSB (1666.66 kg ha\(^{-1}\)) at harvest of the crop.

Single inoculation of seeds with Azotobacter significantly increased the mean pod yield (2788.88 kg ha\(^{-1}\)) in groundnut. This was followed by seed inoculation with Rhizobium alone (2694.44 kg ha\(^{-1}\)) and dual inoculation of Rhizobium + Azotobacter (2497.11 kg ha\(^{-1}\)), irrespective of herbicide application. The yield increments might be due to improvement in number of different microbial as well as total microbial population, improvement of favourable soil physico-chemical properties and increase of available nitrogen. Shashidhar et al., (2009), Narula et al., (2000) reported significantly higher yield and total microbial population due seed inoculation with biofertilizers and their different combinations along with recommended dose herbicide (Table 1).

**Effect of biofertilizers and flumioxazin on physico-chemical properties of groundnut cropped soil**

**Effect on soil pH and EC**

The result showed that either in the single seed inoculation of Rhizobium, PSB and Azotobacter or the different combinations of Rhizobium, PSB and Azotobacter inoculation combined with different levels of herbicide \(H_0, H_1, H_2\) gave more or less same results of soil pH after harvest of groundnut. There was no significant difference found among the treatments.

The result showed that single inoculation of Azotobacter @ 80 g kg\(^{-1}\) seeds along with double RD of herbicide @ 500 g ha\(^{-1}\) increased the EC of soil after harvest of groundnut crop in alfisol of West Bengal followed by combined inoculation of PSB + Rhizo + Azotobacter along with double RD of herbicide and PSB + Rhizo + Azotobacter along with RD of herbicide and then followed by uninoculated control (Table 2). These results corroborated with the earlier findings of Sumathi et al., (2012).

**Effect on available nitrogen content**

The effect of herbicide and seed inoculation on available nitrogen content was found significant (Table 3). Interaction effect of Azotobacter @ 80 g kg\(^{-1}\) seed along with double recommended dose of herbicide @ 500 g ha\(^{-1}\) gives significantly higher nitrogen
content (561.97 kg ha\(^{-1}\)) followed by combined inoculation of PSB+Rhizobium +Azotobacter @ 80 g kg\(^{-1}\) seed without application of any herbicide (549.43 kg ha\(^{-1}\)) and Single inoculation of Rhizobium @ 80 g kg\(^{-1}\) seed along with recommended dose of herbicide @ 250 g ha\(^{-1}\) and Single inoculation of Azotobacter @ 80 g kg\(^{-1}\) seed along with recommended dose of herbicide @ 250 g ha\(^{-1}\) (524.34 kg ha\(^{-1}\)) in respect of all the treatments of herbicides irrespective of doses.

Based on these results obtained from the study it could, thus, be concluded that seed inoculation with different strains of biofertilizers along with herbicide may be an effective recommendation for better nitrogen management in groundnut plot. These results corroborated with the earlier findings of Usha et al., (2004) in Kinnow mandarin.

**Effect on fungi population in soil**

The effect of interaction between herbicide and seed inoculation on fungal population was not found significant (Table 6) particularly at 15 DAS and 90 DAS onward of groundnut. The highest number of fungal population (46.50 x 10\(^4\) cfu g\(^{-1}\)) was recorded in the treatment of PSB @ 80 g kg\(^{-1}\) of seed inoculation without any herbicide application at 30 DAS as compared to uninoculated control (31.52 x 10\(^4\) cfu g\(^{-1}\)) followed by dual inoculation of PSB+Azotobacter @ 80 g kg\(^{-1}\) seed along with recommended dose of herbicide @ 250g ha\(^{-1}\) (42.9x 10\(^4\) cfu g\(^{-1}\)). Based on these results obtained from the study it could, thus, be concluded that seed inoculation with different strains of biofertilizers with or without recommended dose of herbicide would be an effective recommendation for better crop management in groundnut in respect of better decomposition of organic matter as well as fertilizers due to increase of fungal population.

**Effect on actinomycetes population in soil**

The results showed that single inoculation of Azotobacter along with recommended dose of Flumioxzin @ 250 g ha\(^{-1}\) (Fig. 1) gave the highest number of Actinomycetes population at 30 DAS of groundnut in alfisol of West Bengal followed by without any application of biofertilizers along with recommended dose of herbicide @ 250 g ha\(^{-1}\) at 60 DAS and without any application of biofertilizers along with double recommended dose of herbicide @ 500 g ha\(^{-1}\) at 30 DAS (Table 7). Based on these results obtained from the study it could, thus, be concluded that seed inoculation with different strains of biofertilizers with recommended dose of herbicide would be an
effective recommendation for better crop management in groundnut in respect of better decomposition of organic matter as well as fertilizers due to increase of actinomycetes population is soil. These results were in agreement with the earlier findings of Kunc et al., (1985) and Taiwo and Oso (1997) in soil in respect to increase of actinomycetes population.

Effect on total microflora in soil

The results showed that dual inoculation of Rhizobium + Azotobacter gave significantly highest number of microflora at 60DAS of groundnut in the alfisol of West Bengal without application of herbicide followed by dual inoculation of biofertilizer of Rhizobium + Azotobacter along with double the recommended dose of Flumioxzin @ 500 g ha⁻¹ and dual inoculation of Rhizobium +PSB along with recommended dose of Flumioxzin @ 250 g ha⁻¹ (Table 8). These results were in agreement with the earlier findings of Kunc et al., (1985) and Taiwo and Oso (1997) in soil in respect to increase of total microbial population.

### Table 1. Effect of biofertilizers and flumioxazin on pod yield of groundnut

<table>
<thead>
<tr>
<th>Treatments</th>
<th>*HARVEST</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H₀</td>
<td>H₁</td>
<td>H₂</td>
<td>Mean</td>
<td></td>
</tr>
<tr>
<td>Biofert/Herbicide</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>2441.33</td>
<td>1633.33</td>
<td>2441.67</td>
<td>2172.11</td>
<td></td>
</tr>
<tr>
<td>PSB</td>
<td>958.33</td>
<td>2741.67</td>
<td>1300.00</td>
<td>1666.66</td>
<td></td>
</tr>
<tr>
<td>Rhizo</td>
<td>1816.67</td>
<td>3091.67</td>
<td>3175.00</td>
<td>2694.44</td>
<td></td>
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<tr>
<td>Azo</td>
<td>3416.67</td>
<td>2216.67</td>
<td>2733.33</td>
<td>2788.88</td>
<td></td>
</tr>
<tr>
<td>PSB+Rhizo</td>
<td>2191.67</td>
<td>2675.00</td>
<td>1750.00</td>
<td>2205.55</td>
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</tr>
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<td>1933.33</td>
<td>1841.67</td>
<td>2525.00</td>
<td>2099.99</td>
<td></td>
</tr>
<tr>
<td>Azo+Rhizo</td>
<td>2408.22</td>
<td>2350.00</td>
<td>2733.11</td>
<td>2497.11</td>
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</tr>
<tr>
<td>PSB+Azo+Rhizo</td>
<td>1450.00</td>
<td>1366.67</td>
<td>3050.00</td>
<td>1955.55</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>2077.03</td>
<td>2239.58</td>
<td>2463.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.Em(±)</td>
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<td>110634.76</td>
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<td></td>
</tr>
<tr>
<td>CD 5% for H</td>
<td></td>
<td>193.20</td>
<td></td>
<td></td>
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</tr>
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<td>B</td>
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<td>315.62</td>
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<td></td>
</tr>
<tr>
<td>HB</td>
<td></td>
<td>546.60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CV %</td>
<td></td>
<td>14.72</td>
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</tbody>
</table>

*Average of the three replication
Table 2. Effect of biofertilizers and flumioxazin on pH and EC of soil after harvest of groundnut

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Soil pH</th>
<th>*Initial</th>
<th>*HARVEST</th>
<th>Soil EC (msm⁻¹)</th>
<th>*Initial</th>
<th>*HARVEST</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>H₀</td>
<td>H₁</td>
<td>H₂</td>
<td>Mean</td>
<td>H₀</td>
</tr>
<tr>
<td>Biofert/Herbicide</td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td>4.53</td>
<td>4.45</td>
<td>4.53</td>
<td>4.50</td>
<td></td>
</tr>
<tr>
<td>PSB</td>
<td></td>
<td>4.50</td>
<td>4.41</td>
<td>4.75</td>
<td>4.55</td>
<td></td>
</tr>
<tr>
<td>Rhizo</td>
<td></td>
<td>4.37</td>
<td>4.64</td>
<td>4.44</td>
<td>4.48</td>
<td></td>
</tr>
<tr>
<td>Azo</td>
<td></td>
<td>4.53</td>
<td>4.48</td>
<td>4.35</td>
<td>4.45</td>
<td></td>
</tr>
<tr>
<td>PSB+Rhizo</td>
<td></td>
<td>4.79</td>
<td>4.38</td>
<td>4.48</td>
<td>4.54</td>
<td></td>
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<tr>
<td>PSB+Azo</td>
<td></td>
<td>4.47</td>
<td>4.41</td>
<td>4.43</td>
<td>4.43</td>
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<tr>
<td>Azo+Rhizo</td>
<td></td>
<td>4.47</td>
<td>4.51</td>
<td>4.46</td>
<td>4.48</td>
<td></td>
</tr>
<tr>
<td>PSB+Azo+Rhizo</td>
<td></td>
<td>4.43</td>
<td>4.38</td>
<td>4.37</td>
<td>4.39</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>4.51</td>
<td>4.45</td>
<td>4.47</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*S. Em(±) | 0.213 | 0.02
CD 5% for H | NS | 0.02
B | NS | 0.134
HB | NS | 0.232
CV % | 10.30 | 12.42

*Average of the three replication

Table 3. Effect of biofertilizers and flumioxazin on available soil nitrogen

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Available Nitrogen (kg ha⁻¹) [Average of the three replication]</th>
<th>Harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initial</td>
<td>Harvest</td>
</tr>
<tr>
<td>Biofert/Herbicide</td>
<td>225.79</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>402.24</td>
<td>436.53</td>
</tr>
<tr>
<td>PSB</td>
<td>486.71</td>
<td>373.81</td>
</tr>
<tr>
<td>Rhizo</td>
<td>436.53</td>
<td>524.34</td>
</tr>
<tr>
<td>Azo</td>
<td>411.44</td>
<td>524.34</td>
</tr>
<tr>
<td>PSB+Rhizo</td>
<td>411.44</td>
<td>361.27</td>
</tr>
<tr>
<td>PSB+Azo</td>
<td>348.72</td>
<td>386.36</td>
</tr>
<tr>
<td>Azo+Rhizo</td>
<td>411.44</td>
<td>398.90</td>
</tr>
<tr>
<td>PSB+Azo+Rhizo</td>
<td>549.43</td>
<td>449.08</td>
</tr>
<tr>
<td>Mean</td>
<td>432.24</td>
<td>431.82</td>
</tr>
</tbody>
</table>

*S. Em (±) | 3296.38
CD 5% for H | 33.36
B | 54.48
HB | 94.36
CV % | 13.52
**Table 4** Effect of biofertilizers and flumioxazin on NFB population

<table>
<thead>
<tr>
<th>Treatments</th>
<th><em>Initial</em> (No.×10^4 cfug⁻¹)</th>
<th><em>15 DAS</em> (No.×10^4 cfug⁻¹)</th>
<th><em>30 DAS</em> (No.×10^5 cfug⁻¹)</th>
<th><em>60 DAS</em> (No.×10^5 cfug⁻¹)</th>
<th><em>90 DAS</em> (No.×10^5 cfug⁻¹)</th>
<th><em>Harvest</em> (No.×10^4 cfug⁻¹)</th>
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<tr>
<td>Biofert/Herbicide</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>9.37</td>
<td>6</td>
<td>13</td>
<td>58.25</td>
<td>25.75</td>
<td>30.07</td>
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<tr>
<td>PSB</td>
<td>36.25</td>
<td>11.25</td>
<td>45.72</td>
<td>31.08</td>
<td>15.85</td>
<td>33.70</td>
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<td>Rhizo</td>
<td>4</td>
<td>40.5</td>
<td>23.5</td>
<td>22.67</td>
<td>24.50</td>
<td>39.65</td>
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<tr>
<td>AzO</td>
<td>20.75</td>
<td>45.5</td>
<td>36.25</td>
<td>34.17</td>
<td>13.80</td>
<td>22.70</td>
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<td>PSB+Rhizo</td>
<td>10.25</td>
<td>21.5</td>
<td>13.5</td>
<td>15.08</td>
<td>31.07</td>
<td>39.75</td>
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<tr>
<td>PSB+AzO</td>
<td>74</td>
<td>11.5</td>
<td>15.25</td>
<td>33.58</td>
<td>17.60</td>
<td>23.80</td>
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<td>AzO+Rhizo</td>
<td>14.75</td>
<td>39.75</td>
<td>50</td>
<td>34.83</td>
<td>19.97</td>
<td>24.47</td>
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<tr>
<td>PSB+AzO+Rhizo</td>
<td>25.25</td>
<td>56.5</td>
<td>25.75</td>
<td>35.83</td>
<td>42.58</td>
<td>23.02</td>
</tr>
<tr>
<td>Mean</td>
<td>23.91</td>
<td>29.94</td>
<td>33.53</td>
<td>4.50</td>
<td>5.64</td>
<td>4.46</td>
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<tr>
<td>S.Em(±)</td>
<td>2.28</td>
<td>0.358</td>
<td>0.451</td>
<td>2.449</td>
<td>1.012</td>
<td>1.133</td>
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<td>CD 5% for H</td>
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<tr>
<td>B</td>
<td>0.711</td>
<td>0.282</td>
<td>0.737</td>
<td>0.474</td>
<td>0.501</td>
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<tr>
<td>HB</td>
<td>1.233</td>
<td>0.488</td>
<td>1.277</td>
<td>0.821</td>
<td>0.869</td>
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<tr>
<td>CV %</td>
<td>5.185</td>
<td>12.30</td>
<td>6.23</td>
<td>14.13</td>
<td>6.87</td>
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</table>

*Average of the three replication
Table 5 Effect of biofertilizers and flumioxazin on PSB population

<table>
<thead>
<tr>
<th>Treatments</th>
<th><em>Initial</em> (No.×10⁴ cfug⁻¹)</th>
<th><em>15 DAS</em> (No.×10⁵ cfug⁻¹)</th>
<th><em>30DAS</em> (No.×10⁵ cfug⁻¹)</th>
<th><em>60DAS</em> (No.×10⁷ cfug⁻¹)</th>
<th><em>90 DAS</em> (No.×10⁵ cfug⁻¹)</th>
<th><em>Harvest</em> (No.×10⁵ cfug⁻¹)</th>
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</thead>
<tbody>
<tr>
<td>Biofert/Herbicide</td>
<td>H₀</td>
<td>H₁</td>
<td>H₂</td>
<td>Mean</td>
<td>H₀</td>
<td>H₁</td>
</tr>
<tr>
<td>PSB</td>
<td>4.25</td>
<td>3.67</td>
<td>3.6</td>
<td>3.84</td>
<td>14.74</td>
<td>15.34</td>
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<td>Rhizo</td>
<td>4.2</td>
<td>5.05</td>
<td>5.67</td>
<td>4.97</td>
<td>11.50</td>
<td>12.62</td>
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<tr>
<td>Azo</td>
<td>6.58</td>
<td>6.55</td>
<td>4.35</td>
<td>5.83</td>
<td>18.95</td>
<td>10.42</td>
</tr>
<tr>
<td>Azo+Rhizo</td>
<td>5.16</td>
<td>2.87</td>
<td>10.05</td>
<td>6.03</td>
<td>12.76</td>
<td>12.15</td>
</tr>
<tr>
<td>PSB+Azo+Rhizo</td>
<td>3.85</td>
<td>5.85</td>
<td>8.37</td>
<td>6.02</td>
<td>34.17</td>
<td>16.52</td>
</tr>
<tr>
<td>Mean</td>
<td>4.97</td>
<td>5.24</td>
<td>5.60</td>
<td>17.04</td>
<td>16.00</td>
<td>18.07</td>
</tr>
<tr>
<td>S.Em(±)</td>
<td>0.341</td>
<td>1.74</td>
<td>1.566</td>
<td>0.443</td>
<td>0.770</td>
<td></td>
</tr>
<tr>
<td>CD 5% for H</td>
<td>0.168</td>
<td>0.381</td>
<td>0.361</td>
<td>0.192</td>
<td>0.253</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>0.275</td>
<td>0.622</td>
<td>0.590</td>
<td>0.313</td>
<td>0.413</td>
<td></td>
</tr>
<tr>
<td>HB</td>
<td>0.477</td>
<td>1.078</td>
<td>1.021</td>
<td>0.543</td>
<td>0.716</td>
<td></td>
</tr>
<tr>
<td>CV %</td>
<td>11.08</td>
<td>7.75</td>
<td>6.012</td>
<td>7.482</td>
<td>12.245</td>
<td></td>
</tr>
</tbody>
</table>

*Average of the three replication*
### Table 6: Effect of biofertilizers and flumioxazin on fungi population

<table>
<thead>
<tr>
<th>Treatments</th>
<th><em>Initial</em> (No.×10⁴ cfug⁻¹)</th>
<th><em>15 DAS</em> (No.×10⁴ cfug⁻¹)</th>
<th><em>30DAS</em> (No.×10⁴ cfug⁻¹)</th>
<th><em>60DAS</em> (No.×10⁴ cfug⁻¹)</th>
<th><em>90 DAS</em> (No.×10⁴ cfug⁻¹)</th>
<th><em>HARVEST</em> (No.×10⁴ cfug⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H₀</td>
<td>H₁</td>
<td>H₂</td>
<td>Mean</td>
<td>H₀</td>
<td>H₁</td>
</tr>
<tr>
<td>Biofert/Herbicide</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>6.67</td>
<td>2.67</td>
<td>10</td>
<td>6.44</td>
<td>31.52</td>
<td>2.6</td>
</tr>
<tr>
<td>PSB</td>
<td>3.92</td>
<td>7.33</td>
<td>7.83</td>
<td>6.36</td>
<td>46.50</td>
<td>6.8</td>
</tr>
<tr>
<td>Rhizo</td>
<td>13.25</td>
<td>6.58</td>
<td>6.50</td>
<td>8.78</td>
<td>9.10</td>
<td>14.5</td>
</tr>
<tr>
<td>Azo</td>
<td>4</td>
<td>8.58</td>
<td>5</td>
<td>5.86</td>
<td>3.4</td>
<td>16.7</td>
</tr>
<tr>
<td>PSB+Rhizo</td>
<td>7.5</td>
<td>8.39</td>
<td>5</td>
<td>18.33</td>
<td>14.65</td>
<td>10.75</td>
</tr>
<tr>
<td>PSB+Azo</td>
<td>5.25</td>
<td>3</td>
<td>5.25</td>
<td>4.5</td>
<td>3.5</td>
<td>42.9</td>
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<tr>
<td>Azo+Rhizo</td>
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<td>6</td>
<td>6.75</td>
<td>5.5</td>
<td>16.4</td>
<td>15.13</td>
</tr>
<tr>
<td>PSB+Azo+Rhizo</td>
<td>14</td>
<td>2.25</td>
<td>6.25</td>
<td>7.5</td>
<td>13</td>
<td>13.6</td>
</tr>
<tr>
<td>Mean</td>
<td>7.29</td>
<td>5.55</td>
<td>10.88</td>
<td>17.26</td>
<td>15.37</td>
<td>11.48</td>
</tr>
<tr>
<td>S.Em(±)</td>
<td>1.068</td>
<td>0.950</td>
<td>0.609</td>
<td>0.731</td>
<td>0.442</td>
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</tr>
<tr>
<td>CD 5% for H</td>
<td>0.298</td>
<td>0.281</td>
<td>0.225</td>
<td>0.246</td>
<td>0.191</td>
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</tr>
<tr>
<td>B</td>
<td>0.487</td>
<td>0.459</td>
<td>0.367</td>
<td>0.403</td>
<td>0.313</td>
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</tr>
<tr>
<td>HB</td>
<td>0.843</td>
<td>0.795</td>
<td>0.637</td>
<td>0.698</td>
<td>0.542</td>
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</tr>
<tr>
<td>CV %</td>
<td>13.066</td>
<td>6.628</td>
<td>11.71</td>
<td>11.55</td>
<td>10.97</td>
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</tr>
</tbody>
</table>

*Average of the three replication
Table 7 Effect of biofertilizers and flumioxazin on actinomycetes population

<table>
<thead>
<tr>
<th>Treatments</th>
<th>*Initial (No.×10⁴ cfu g⁻¹)</th>
<th>*15 DAS (No.×10⁴ cfu g⁻¹)</th>
<th>*30 DAS (No.×10⁴ cfu g⁻¹)</th>
<th>*60 DAS (No.×10⁵ cfu g⁻¹)</th>
<th>*90 DAS (No.×10⁴ cfu g⁻¹)</th>
<th>*HARVEST (No.×10⁴ cfu g⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biofert/Herbicide</td>
<td>H₀</td>
<td>H₁</td>
<td>H₂</td>
<td>Mean</td>
<td>H₀</td>
<td>H₁</td>
</tr>
<tr>
<td>Control</td>
<td>8.6</td>
<td>8.25</td>
<td>9.5</td>
<td>8.78</td>
<td>33</td>
<td>28.5</td>
</tr>
<tr>
<td>PSB</td>
<td>7.3</td>
<td>5.45</td>
<td>8.90</td>
<td>7.22</td>
<td>59.50</td>
<td>33.50</td>
</tr>
<tr>
<td>Rhizo</td>
<td>9.65</td>
<td>6.75</td>
<td>8.88</td>
<td>8.43</td>
<td>37.50</td>
<td>19.50</td>
</tr>
<tr>
<td>Azo</td>
<td>12.25</td>
<td>10.05</td>
<td>10.25</td>
<td>10.85</td>
<td>74.50</td>
<td>195</td>
</tr>
<tr>
<td>PSB+Rhizo</td>
<td>6.5</td>
<td>50</td>
<td>14.75</td>
<td>23.75</td>
<td>51.50</td>
<td>17</td>
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<tr>
<td>PSB+Azo</td>
<td>9.65</td>
<td>11.20</td>
<td>17.55</td>
<td>12.8</td>
<td>33.50</td>
<td>37</td>
</tr>
<tr>
<td>Azo+Rhizo</td>
<td>9.85</td>
<td>3.60</td>
<td>49.95</td>
<td>21.13</td>
<td>96.50</td>
<td>61</td>
</tr>
<tr>
<td>PSB+Azo+Rhizo</td>
<td>9.20</td>
<td>8.25</td>
<td>13.50</td>
<td>10.32</td>
<td>62.50</td>
<td>62</td>
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<tr>
<td>Mean</td>
<td>9.12</td>
<td>12.94</td>
<td>16.66</td>
<td>56.06</td>
<td>56.69</td>
<td>45.12</td>
</tr>
<tr>
<td>S.Em(±)</td>
<td>0.669</td>
<td>15.303</td>
<td>0.746</td>
<td>2.993</td>
<td>0.245</td>
<td>0.385</td>
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<td>CD 5% for H</td>
<td>0.236</td>
<td>1.129</td>
<td>0.249</td>
<td>0.499</td>
<td>0.142</td>
<td>0.385</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>HB</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CV %</td>
<td>6.34</td>
<td>7.43</td>
<td>18.51</td>
<td>9.036</td>
<td>8.832</td>
<td>6.34</td>
</tr>
</tbody>
</table>

*Average of the three replication
Table 8 Effect of biofertilizers and flumioxazin on microflora population

<table>
<thead>
<tr>
<th>Biofert/Herbicide</th>
<th>*Initial (No.×10^4 cfug^-1)</th>
<th>*15DAS (No.×10^5 cfug^-1)</th>
<th>*30DAS (No.×10^5 cfug^-1)</th>
<th>*60DAS (No.×10^7 cfug^-1)</th>
<th>*90DAS (No.×10^5 cfug^-1)</th>
<th>*HARVEST (No.×10^5 cfug^-1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>46.87</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>H0</td>
<td>H1</td>
<td>H2</td>
<td>Mean</td>
<td>H0</td>
</tr>
<tr>
<td>Azo</td>
<td>10.28</td>
<td>12.96</td>
<td>9.50</td>
<td>10.92</td>
<td>33.44</td>
<td>36.29</td>
</tr>
<tr>
<td>PSB+Rhizo</td>
<td>7.27</td>
<td>10.47</td>
<td>12.73</td>
<td>10.16</td>
<td>30.44</td>
<td>33.15</td>
</tr>
<tr>
<td>Azo+Rhizo</td>
<td>8.00</td>
<td>7.81</td>
<td>20.72</td>
<td>12.18</td>
<td>29.60</td>
<td>23.84</td>
</tr>
<tr>
<td>Mean</td>
<td>9.00</td>
<td>10.08</td>
<td>11.71</td>
<td>9.50</td>
<td>28.86</td>
<td>28.84</td>
</tr>
<tr>
<td>S.Em(±)</td>
<td>0.902</td>
<td>4.571</td>
<td>6.542</td>
<td>4.335</td>
<td>1.241</td>
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</tr>
<tr>
<td>CD 5% for H</td>
<td>0.274</td>
<td>0.617</td>
<td>0.738</td>
<td>0.601</td>
<td>0.321</td>
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</tr>
<tr>
<td>B</td>
<td>0.447</td>
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<td>1.205</td>
<td>0.981</td>
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</tr>
<tr>
<td>HB</td>
<td>0.775</td>
<td>1.745</td>
<td>2.088</td>
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<tr>
<td>CV %</td>
<td>9.253</td>
<td>7.459</td>
<td>12.11</td>
<td>11.15</td>
<td>11.28</td>
<td></td>
</tr>
</tbody>
</table>

*Average of the three replication
It can be concluded from the result of this experiment, that the application of herbicide Flumioxazin along with different combinations of biofertilizers PSB, Rhizobium and Azotobacter have no significant adverse effects in the physico-chemical properties of soil (pH and EC), available Nitrogen content, microflora population (NFB, PSB, fungi, actinomycetes) and pod yield of Groundnut. Seed inoculation with biofertilizers in combination with different doses of flumioxazin significantly increase NFB, PSB, Fungi and Actinomycetes population -78.67 to 277.33%, -27.03 to 586.49%, -93.75 to 12.5%, -83.33 to 383.33% after harvest of groundnut, respectively as against the initial population counts and the pod yield after harvest of groundnut.

**References**


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