Bioassay techniques for determination of the dose of Atrazine and Pendimethalin as pre and post-emergence for Maize (Zea mays) in Terai region of West Bengal

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Abstract: Field experiment was carried out during the rabi season of 2013 in the research farm of Uttar Banga Krishi Viswavidyalaya located at Pundibari, Coochbehar, (W.B). The soil of the experimental site was sandy loam in character. Ten treatments under each herbicide were setup with plot size of 2X3 m in maize variety Zea mays (W.B). The dose of different herbicides (kg/ha) for the both treatment [Post-emergence application (PPSA) and Pre- emergence application (PE)].

I. Introduction

In weed research, bioassay is used to measure the biological response of living plant to herbicide and to quantify its concentration in a substrate. Bioassay is usually conducted with sensitive plant species also referred to as indicator or test species. Bioassay is being used widely as a useful tool to regulate herbicide doses in a particular crop. This technique also leads to identify the herbicide that is safe for a crop in terms of phytotoxicity and growth reduction by relating the different herbicidal doses with percent reduction in fresh weight as individual plants. (Tag et. Al.1981). The bioassay experiment has been conducted at the research farm of Uttar Banga Krishi Viswavidyalaya in maize with the following objectives.

- To find out the dose of Atrazine and Pendimethalin in Maize and their time of application.
- To measure selectivity index (SI) of the herbicides.
- To study the comparative performance of the herbicides based on SI, time of application and dose.

II. Methodology

Field experiment was carried out during the rabi season of 2013 in the research farm of Uttar Banga Krishi Viswavidyalaya located at Pundibari, Coochbehar, (W.B). The soil of the experimental site was sandy loam in character. Ten treatments under each herbicide were setup with plot size of 2X3 m in maize variety (JKMH-1001). The dose of different herbicides (kg/ha) for the both treatment [Post-emergence application (PPSA) and Pre- emergence application (PE)].

<table>
<thead>
<tr>
<th>Herbicide doses</th>
<th>Pendimethalin</th>
<th>Atrazine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-emergence</td>
<td>Pre-emergence</td>
</tr>
<tr>
<td></td>
<td>application</td>
<td>application</td>
</tr>
<tr>
<td>1</td>
<td>0.00</td>
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<tr>
<td>2</td>
<td>0.10</td>
<td>0.10</td>
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<tr>
<td>3</td>
<td>0.20</td>
<td>0.20</td>
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<tr>
<td>4</td>
<td>0.30</td>
<td>0.30</td>
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<tr>
<td>5</td>
<td>0.40</td>
<td>0.40</td>
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<tr>
<td>6</td>
<td>0.60</td>
<td>0.60</td>
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<tr>
<td>7</td>
<td>0.80</td>
<td>0.80</td>
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<tr>
<td>8</td>
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<tr>
<td>9</td>
<td>1.50</td>
<td>1.50</td>
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<tr>
<td>10</td>
<td>2.00</td>
<td>2.00</td>
</tr>
</tbody>
</table>

The per cent growth inhibition values obtained at different herbicidal doses both in case of Maize and weed were transformed to probit values and regressed against log values of doses. The linear regression equation was computed by using excel programmed Y=bX+a, where Y indicates probit value of per cent dry weight reduction, b is regression coefficient, X is log dose of herbicide and a is intercept of Y. Selectivity index (S.I.) value was calculated by using the following formula:

S.I. = Maximum dose tolerated by crop(Maize)/Minimum dose required to control weed

Maximum dose of herbicide tolerated by maize was equal to dose that caused 15% growth reduction of Maize (GR15) at initial stages and minimum dose required to control the weeds was equal to the dose that resulted in 80% growth reduction in weed (GR80) or 80% weed control efficiency of herbicide. Selectivity index
value greater than 1 is always desirable to get selective control over weeds without any lethal effect on crop plant. The proportional increase of plant response in terms of growth reduction to herbicidal doses led to identify the level at which the plant produce 50% response which is known as GR$_{50}$ (dose of herbicide that led to 50% growth reduction).

The following weed flora were recorded during the experimentation

*Cynodon dactylon, Cyperus rotundus, Cyperus iria, Oxalis spp*

III. Result

- **ATRAZINE**
  
  Pre-emergence Probit value of crop

  \[ y = 1.707x + 3.349 \]
  
  \[ R^2 = 0.893 \]

  Probit value of crop

  Calculation of GR$_{15}$
  
  \[ Y = \text{Probit Value of 15\% growth reduction of Maize i.e. 3.50} \]

  \[ 3.50 = 1.7079x + 3.349 \]

  Then \( x = 0.0883 \)

  Anti log of 0.0883 = 1.2, then GR$_{50}$ = 1.2 kg/ha. dose of Atrazine

  Calculation of GR$_{50}$
  
  \[ Y = \text{Probit Value of 50\% growth reduction of maize i.e. 5.22} \]

  \[ 5.22 = 1.7079x + 3.349 \]

  Then \( x = 1.0954 \)

  Anti log of 1.0954 = 12.5, then GR$_{50}$ = 12.5 kg/ha dose of Atrazine.

  Probit value of weed

  \[ y = 4.303x + 7.727 \]
  
  \[ R^2 = 0.917 \]

  Probit value of weed

  Calculation of GR$_{80}$
  
  \[ Y = \text{Probit Value of 80\% growth reduction of weed i.e 6.88} \]

  \[ 6.88 = 4.3031x + 7.727 \]

  Then \( x = -0.1969 \)

  Anti log of 0.1969 = 0.6, then GR$_{80}$ = 0.6 kg/ha. dose of Atrazine

- **PENDIMETHALIN**
  
  Pre-emergence Probit value of crop
Bioassay techniques for determination of the dose of Atrazine and Pendimethalin as pre and post

- **Calculation of GR$_{15}$**
  Y=Probit Value of 15% growth reduction of Maize i.e 3.50
  \[3.50 = 1.885x + 3.424\]
  Then \( x = 0.053 \)
  Anti log of 0.053 =1.1, then GR$_{15}$=0.1.1 kg/ha. dose of Pendimethalin

- **Calculation of GR$_{50}$**
  Y=Probit Value of 50% growth reduction of maize i.e. 5.22
  \[5.22 = 1.885x + 3.424\]
  Then \( x = 0.9527 \)
  Anti log of 0.9527=8.9, then GR$_{50}$=8.9 kg/ha dose of Pendimethalin.

**Probit value of weed**

- **Calculation of GR$_{80}$**
  Y=Probit Value of 80% growth reduction of weed i.e 6.88
  \[6.88 = 4.056x + 7.429\]
  Then \( x = -0.1 \)
  Anti log of -0.1 =0.8, then GR$_{80}$=0.8 kg/ha. dose of Pendimethalin.

**ATRAZINE**

Post-emergence (20 DAS)

**Probit value of crop**
Bioassay techniques for determination of the dose of Atrazine and Pendimethalin as pre and post

- **Calculation of GR\textsubscript{15}**
  Y = Probit Value of 15% growth reduction of Maize i.e. 3.50
  3.50 = 1.5992x + 3.3889
  Then x = 0.1
  Anti log of 0.1 = 1.3, then GR\textsubscript{15} = 1.3 kg/ha. dose of Atrazine

- **Calculation of GR\textsubscript{50}**
  Y = Probit Value of 50% growth reduction of maize i.e. 5.22
  5.22 = 1.5992x + 3.3889
  Then x = 1.1
  Anti log of 1.1 = 12.6, then GR\textsubscript{50} = 12.6 kg/ha. dose of Atrazine.

**Probit value of weed**

- **Calculation of GR\textsubscript{15}**
  Y = Probit Value of 80% growth reduction of weed i.e. 6.88
  6.88 = 4.186x + 6.653
  Then x = 0.54
  Anti log of 0.54 = 1.1, then GR\textsubscript{80} = 1.1 kg/ha. dose of Atrazine

**ATRAZINE**

**Post-emergence (40DAS) Probit value of crop**

- **Calculation of GR\textsubscript{15}**
  Y = Probit Value of 15% growth reduction of Maize i.e. 3.50
  3.50 = 1.972x + 3.657
  Then x = -0.1
  Anti log of -0.1 = 0.8, then GR\textsubscript{15} = 0.8 kg/ha. dose of Atrazine.

- **Calculation of GR\textsubscript{50}**
  Y = Probit Value of 50% growth reduction of maize i.e. 5.22
  5.22 = 1.972x + 3.657
  Then x = 0.8
  Anti log of 0.8 = 6.3, then GR\textsubscript{50} = 6.3 kg/ha. dose of Atrazine.
**Bioassay techniques for determination of the dose of Atrazine and Pendimethalin as pre and post**

- Calculation of GR$_{80}$

  $Y=$Probit Value of 80% growth reduction of weed i.e 6.88

  $6.88=1.661x + 4.862$

  Then $x = 1.2$

  Anti log of 1.2 = 15.8, then GR$_{80}$ = 15.8 kg/ha. dose of Atrazine

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Maximum dose (kg/ha) tolerated by crop (GR$_{15}$)</th>
<th>Minimum dose (kg/ha) required to control weed (GR$_{80}$)</th>
<th>Selectivity Index (SI)</th>
<th>GR$_{50}$ value (kg/ha) of Maize</th>
<th>Linear regression equation</th>
<th>R$^2$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrazine Pre-emergence</td>
<td>1.2</td>
<td>0.6</td>
<td>2.00</td>
<td>12.5</td>
<td>$Y=1.707x + 3.349$</td>
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<td>Pendimethalin Pre-emergence</td>
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<tr>
<td>Atrazine post-emergence (20DAS)</td>
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<td>1.1</td>
<td>1.1818</td>
<td>12.6</td>
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<tr>
<td>Atrazine post-emergence (40DAS)</td>
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<td>0.1</td>
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<td>$Y=1.9724x + 3.6574$</td>
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</tbody>
</table>

**IV. Conclusion**

Maximum up to 1.2 kg/ha of Atrazine can selectively be used in Maize under pre-emergence application. However, minimum dose required to control the weed is 0.6 kg/ha with the SI value of 2.00. Whereas in pre-emergence treatment of Pendimethalin, maximum and minimum doses are 1.1 kg/ha and 0.8 kg/ha, respectively, with the SI value of 1.375. Low SI value in pre-emergence treatment of Pendimethalin makes the treatment less selective than that of pre-emergence treatment in atrazine. Therefore, the dose 0.6 kg/ha Atrazine can be applied in Maize safely as pre-emergence for controlling weeds.

Maximum up to 1.3 kg/ha Atrazine can selectively be used for maize under post-emergence application (20DAS). However, minimum dose required to control the weed is 1.1 kg/ha with the SI value of 1.1818. Whereas in post-emergence treatment (40DAS), maximum and minimum doses are 0.8 kg/ha and 15.8 kg/ha respectively, with the SI value of 0.1. Low SI value in post-emergence treatment (40DAS), makes the treatment less selective than that of post-emergence treatment (20DAS). Therefore, the dose of 1.1 kg/ha can be applied in Maize safely as post-emergence application treatment controlling weeds.

**References**
