Production potential and economics of maize (Zea mays) intercropped with legumes as influenced by weed control

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ABSTRACT

A study was undertaken during the rainy seasons of 2001 and 2002 at Udaipur, to evaluate effect of weed control on production potential and economics of maize (Zea mays L.)-legume intercropping system. Cowpea [Vigna unguiculata (L.) Walp.] and soybean [Glycine max (L.) Merr.] as intercrops reduced the weed dry matter. Introduction of different rainy season legumes did not affect yield attributes and yield of maize but significantly increased maize-equivalent yield. All weed-control treatments resulted in significant reduction in weed dry matter and helped in significant enhancement in maize yield attributes and yield. Weed control through metolachlor recorded higher maize-equivalent yield which was at par with alachlor and hand-weeding. Higher net returns and benefit:cost ratio were obtained by maize + cowpea intercropping system, but it was at par with other intercropping system, while in terms of net returns and benefit:cost ratio—metolachlor, alachlor and hand-weeding were statistically equivalent.

Key words: Maize, Intercropping, Legumes, Weed control

In maize-based intercropping system, selection of an appropriate intercrop having desirable plant type and growth pattern which does not coincide with the peak period of growth of main crop is important, as research on intercropping has indicated how niche differences in crop species can lead to resource capture and conversion leading to increased biological efficiency and yield advantage (Willey, 1979). Maize-based intercropping systems are often subjected to severe stress offered by weeds. Though intercropping has a potential to suppress weeds it offers the possibility of capturing a greater share of available resources than sole crop (Altier and Liebman, 1986). However, intercropping alone is not sufficient to prevent weed infestation during rainy season. Though tradition bound agriculture does pre include manual weeding in crop husbandry but such an operation in maize based intercropping system is difficult due to closely spaced plants of components and continuous rains. Therefore, pre-emergence herbicides, which are selective to maize and intercrops, can hold a key for weed control. Hence experiment was conducted to investigate production potential and economics of weed control in maize + legume intercropping system.

MATERIALS AND METHODS

A field experiment was conducted at Rajasthan College of Agriculture, Udaipur, during rainy season of 2001 and 2002. The soil of the experimental site was clay loam in texture and slightly alkaline in reaction (pH 8.1). It was medium in available NPK status. The experiment comprised 25 treatment combinations of 5 intercropping systems (sole maize and maize intercropped with blackgram, greengram, cowpea and soybean) in main plots and 5 weed-control methods (control, hand-weeding, pendimethalin 1 kg/ha, alachlor 2 kg/ha and metolachlor 1 kg/ha) in subplots and replicated 4 times in split plot design. Maize 'Deccan 103' was planted in rows 60 cm apart with a row of legume in between maize rows as per treatment. Plant-to-plant distance within maize rows was kept as 25 cm and for legume as 10 cm.

The main crop was fertilized with 100 kg N and 40 kg P₂O₅/ha. One-third N and whole P₂O₅ were drilled at the time of sowing, while remaining two-thirds N was top-dressed in 2 splits, at knee height and tasseling stage. The herbicides were sprayed as per treatment, 1 day after sowing with the help of knap-sac sprayer using 700 litres/ha water. In hand-weeding plots, weeds were removed manually 30 days after sowing.

RESULTS AND DISCUSSION

Weed density and dry matter

The weed density was brought down significantly by intercropping maize with soybean and cowpea as compared to others in both the years. Maize + soybean and maize + cowpea were statistically at par with each other.
Table 1. Effect of intercropping and weed control on weed density, weed drymatter, weed-control efficiency, yield attributes and yield of maize

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Weed density* (No/m²)</th>
<th>Weed dry matter (kg/ha)</th>
<th>Weed-control efficiency (%)</th>
<th>Cobs/ plant</th>
<th>Test weight (g)</th>
<th>Grain yield (q/ha)</th>
<th>Stover yield (q/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intercropping system</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sole maize</td>
<td>12.6</td>
<td>13.2</td>
<td>544</td>
<td>665</td>
<td>1.1</td>
<td>1.2</td>
<td>228.0</td>
</tr>
<tr>
<td>(158.5)</td>
<td>(174.1)</td>
<td></td>
<td>(168.5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize + blackgram</td>
<td>12.3</td>
<td>12.5</td>
<td>529</td>
<td>648</td>
<td>2.7</td>
<td>2.5</td>
<td>227.4</td>
</tr>
<tr>
<td>(149.9)</td>
<td>(158.1)</td>
<td></td>
<td>(160.1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize + greengram</td>
<td>12.2</td>
<td>12.6</td>
<td>525</td>
<td>640</td>
<td>3.5</td>
<td>3.8</td>
<td>226.8</td>
</tr>
<tr>
<td>(147.6)</td>
<td>(156.4)</td>
<td></td>
<td>(157.4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize + cowpea</td>
<td>9.7</td>
<td>10.2</td>
<td>360</td>
<td>447</td>
<td>33.8</td>
<td>32.7</td>
<td>225.7</td>
</tr>
<tr>
<td>(93.2)</td>
<td>(103.6)</td>
<td></td>
<td>(110.6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize + soybean</td>
<td>9.4</td>
<td>9.9</td>
<td>339</td>
<td>416</td>
<td>37.7</td>
<td>37.3</td>
<td>224.1</td>
</tr>
<tr>
<td>(87.9)</td>
<td>(98.0)</td>
<td></td>
<td>(99.0)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CD (P=0.05)</td>
<td>0.7</td>
<td>0.7</td>
<td>33</td>
<td>42</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

**Weed control**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Weed density* (No/m²)</th>
<th>Weed dry matter (kg/ha)</th>
<th>Weed-control efficiency (%)</th>
<th>Cobs/ plant</th>
<th>Test weight (g)</th>
<th>Grain yield (q/ha)</th>
<th>Stover yield (q/ha)</th>
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<tbody>
<tr>
<td>Weedy check</td>
<td>18.5</td>
<td>19.3</td>
<td>1105</td>
<td>1338</td>
<td>1.1</td>
<td>1.1</td>
<td>207.1</td>
</tr>
<tr>
<td>(341.2)</td>
<td>(370.5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>210.1</td>
</tr>
<tr>
<td>HW at 30 DAS</td>
<td>9.0</td>
<td>9.4</td>
<td>266</td>
<td>345</td>
<td>1.3</td>
<td>1.3</td>
<td>233.1</td>
</tr>
<tr>
<td>(81.4)</td>
<td>(88.1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>237.0</td>
</tr>
<tr>
<td>Pendimethalin 1 kg/ha PE</td>
<td>10.8</td>
<td>11.1</td>
<td>374</td>
<td>444</td>
<td>1.1</td>
<td>1.2</td>
<td>230.2</td>
</tr>
<tr>
<td>(117.0)</td>
<td>(122.4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>235.4</td>
</tr>
<tr>
<td>Alachlor 2 kg/ha PE</td>
<td>8.9</td>
<td>9.3</td>
<td>279</td>
<td>349</td>
<td>1.2</td>
<td>1.3</td>
<td>230.2</td>
</tr>
<tr>
<td>(79.3)</td>
<td>(86.3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>238.4</td>
</tr>
<tr>
<td>Metylachlor 1 kg/ha PE</td>
<td>8.8</td>
<td>9.4</td>
<td>273</td>
<td>338</td>
<td>1.2</td>
<td>1.3</td>
<td>231.3</td>
</tr>
<tr>
<td>(77.2)</td>
<td>(87.6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>238.5</td>
</tr>
<tr>
<td>CD (P=0.05)</td>
<td>0.5</td>
<td>0.5</td>
<td>26</td>
<td>32</td>
<td>0.07</td>
<td>0.07</td>
<td>9.1</td>
</tr>
</tbody>
</table>

PE, Pre-emergence; DAS, days after sowing; *values are \(\sqrt{x+\frac{1}{2}}\) transformed and actual values are in parentheses
Introduction of cowpea and soybean as intercrops between rows of maize crop suppressed weeds, as evident from reduced weed dry matter. The range of reduction being 33.8 to 37.7 and 32.7 to 37.3% during 2 successive years (Table 1).

Maximum weed density was recorded in weedy check. The weed-control treatments significantly reduced the total number of weeds. Hand-weeding, metolachlor and alachlor were at par with each other and statistically superior to pendimethalin in both the years.

The dry matter reduced significantly by adopting hand-weeding and herbicidal weed control during both years. Hand-weeding, metolachlor and alachlor were at par with each other and exhibited superiority over pendimethalin. Across years, total weed dry matter was significantly affected by interaction between intercropping systems and weed control. However, variability did exist between the treatment combinations. During the first year, maize + soybean with hand-weeding resulted in minimum dry weight (22.58 g/m²) which was statistically equivalent to maize + soybean or cowpea with hand-weeding or any herbicide. In the second year, minimum dry matter (25.45 g/m²) was recorded in maize + soybean with metolachlor. However, it was at par with maize+soybean or cowpea with hand-weeding and all herbicides except pendimethalin.

The highest weed-control efficiency amongst intercropping systems was recorded by maize + soybean, followed by maize + cowpea. Amongst various weed-control treatments, application of metolachlor and hand-weeding registered highest weed-control efficiency during first and second year respectively.

### Maize yield attributes and yield

Variations in yield attributes and yield due to intercropping were not significant. Hand-weeding, metolachlor and alachlor significantly increased cobs/plant. The 1,000-grain weight was also increased significantly owing to control of the weeds by either hand-weeding or herbicides in question with all treatments being statistically at par with each other.

All the treatments applied to control weeds resulted in significant enhancement in maize grain yield. Hand-weeding, alachlor and metolachlor gave significantly higher grain yield over pendimethalin but remained at par with each other during both the years. The pattern of increase in stover yield of maize followed a similar trend of increase owing to weed-control treatment as the grain yield.

### Intercrop and maize-equivalent yield

Variations were observed in grain and stover yields of intercrop due to intercropping system. The maize-equivalent yield varied significantly due to different intercrops. All the intercropping systems were at par with each other and significantly superior to sole maize, accounting for 23.4–31.0% higher maize-equivalent grain yield on mean basis (Table 2). Maize + soybean and maize+cowpea intercropping gave significantly higher maize-equivalent stover yield compared to sole maize in both years, but maize+blackgram intercropping gave significant variation only in the second year. Patra et al. (1999) also reported similar observations. Hand-weeding, alachlor and metolachlor resulted in significantly higher maize-equivalent grain yield during both years. Similar trend of results

| Table 2. Effect of intercropping and weed control on intercrop yield, maize-equivalent yield and economics |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| **Treatment**                  | **Intercrop yield** | **Maize-equivalent yield** | **Net return ('000 Rs/ha)** | **Benefit : cost ratio** |
|                                | (q/ha)            | (q/ha)          | 2001  | 2002  | 2001  | 2002  | 2001  | 2002  |
| Intercropping system           | Grain    | Stover |         |         | Grain   | Stover |         |         |       |
| Sole maize                     |                      |                | 44.14 | 45.57 | 96.57 | 99.37 | 20.89 | 28.97 | 2.29  |
| Maize + blackgram              | 3.43    | 3.77  | 10.13 | 10.47 | 54.10  | 56.33 | 105.39| 108.51| 24.83 |
| Maize + greengram              | 4.23    | 4.75  | 11.27 | 11.75 | 55.52  | 59.02 | 104.58| 107.25| 25.40 |
| Maize + cowpea                 | 5.09    | 5.45  | 14.71 | 15.64 | 56.40  | 61.08 | 107.22| 109.75| 26.08 |
| Maize + soybean                | 5.83    | 6.33  | 16.06 | 17.09 | 54.17  | 57.62 | 106.86| 109.49| 24.55 |
| CD (P=0.05)                    | 4.21    | 4.90  | 8.94  | 8.09  | 4.21   | 4.90  | 8.94  | 8.09  | 2.11  |
| Weed control                   |                      |                |       |       |       |       |       |       |       |
| Weedy check                    | 2.90    | 3.42  | 10.50 | 11.44 | 34.15  | 36.72 | 78.15 | 81.76 | 14.53 |
| HW at 30 DAS                   | 5.11    | 5.53  | 13.87 | 14.55 | 59.61  | 62.62 | 115.19| 117.74| 28.04 |
| Pendimethalin 1kg/ha PE 4.87   | 5.14    | 12.99 | 13.66 | 14.28 | 53.35  | 56.54 | 102.71| 105.15| 23.91 |
| Alachlor 2 kg/ha PE 5.03       | 5.49    | 13.60 | 14.28 |
| Metolachlor 1 kg/ha PE 5.33    | 5.78    | 14.27 | 14.75 |
| CD (P=0.05)                    | 3.43    | 3.54  | 6.45  | 6.70  | 1.60   | 2.20  | 0.15  | 0.20  |

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for maize-equivalent stover yield was also observed. The results are in conformity of those obtained by Thakur (1994).

Net returns and benefit : cost ratio

Across years maize intercropping with legumes gave significantly higher net returns than sole maize. In respect of benefit : cost ratio, non-significant difference was observed between sole maize and maize intercropped with legumes in the first year, but maize + cowpea was found significantly superior to sole maize in the second year (Table 2). Highest net returns were obtained by applying metolachlor, but it was at par with alachlor and hand-weeding during both years. Sharma (1998) also reported better economics of maize-based intercropping system with weed control.

Based on 2 years study, it can inferred that maize should be intercropped with legumes, viz. cowpea, greengram, blackgram or soybean, and weed control be done by either pre-emergence application of metolachlor 1.0 kg/ha or alachlor 2 kg/ha or hand-weeding 30 days after sowing depending on the availability and prevailing condition.

REFERENCES


