

## Influence of Black Gram Intercropping and Weed Control Measures on Growth and Yield of Maize (*Zea mays* L.)

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### ABSTRACT

A field experiment was conducted at Tamil Nadu Agricultural University, Coimbatore during *kharif* 2013 to investigate the influence of intercropping systems and weed management practices on the growth and yield of maize under irrigated condition. The experiment was laid out in split plot design and replicated thrice. The popular maize hybrid CO6 was used as test variety. Three intercropping systems and four weed management practices were accommodated under main plot and subplots, respectively. The sole crop of maize recorded improved growth parameters, yield attributes and yield than maize under intercropping systems. The reduction in yield under maize + blackgram intercropping at 1:1 ratio was negligible (3.52 %), whereas there was a significant reduction in the grain yield of maize (7.57 %) under maize + blackgram intercropping at 2:2 ratio. The yield attributes *viz.*, cob length, cob girth, number of grain rows cob<sup>-1</sup>, number of grains row<sup>-1</sup>, cob weight and test weight were higher under sole maize among intercropping systems and pendimethalin 0.75 kg ha<sup>-1</sup> as PE 3 DAS + one HW 25 DAS among weed management practices. The treatment combination of sole maize with pendimethalin 0.75 kg ha<sup>-1</sup> as PE + one HW 25 DAS (I<sub>1</sub>W<sub>2</sub>) recorded higher grain yield (5755 kg ha<sup>-1</sup>) followed by maize + blackgram intercropping at 1:1 ratio with pendimethalin 0.75 kg ha<sup>-1</sup> as PE + one HW 25 DAS (I<sub>2</sub>W<sub>2</sub>).

#### Keywords

Maize, Blackgram,  
Intercrop, Weed  
Management, Growth,  
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### Introduction

Maize (*Zea mays* L.) is the third most important cereal next to rice and wheat, in the world as well in India. It is a versatile crop and can be grown in diverse environmental conditions and has multiple uses. Besides its use as food, feed and fodder, maize is now gaining increased importance on account of its potential uses in manufacturing of starch, plastic, rayon, textile, adhesive, dyes, resins, boot polish, syrups, ethanol, etc. The availability of land for agriculture is shrinking

as it is increasingly utilized for non-agricultural purposes. Under this situation, one of the important strategies to increase agricultural output is the development of new high intensity cropping systems including intercropping systems. The main purpose of intercropping is to produce more yield on a given piece of land by making effective use of resources that would otherwise not be utilized by a single crop efficiently. Cereal-legume intercropping is a more productive and

profitable cropping system in comparison with solitary cropping (Evans *et al.*, 2001).

The main aim of intercropping is to augment total productivity per unit area and time, besides judicious and equitable utilization of land resources and farm inputs including labour (Marer *et al.*, 2007). Maize + legume intercropping was found more productive and remunerative compared to sole cropping (Li *et al.*, 2003). Maize-legume intercropping systems are able to lessen the amount of nutrients taken from the soil in comparison to a maize monocrop (Tsubo *et al.*, 2003).

Blackgram (*Vigna radiata* L.) is one of the most important pulse crops in India because of its adaptation to short growth duration, lesser water requirement, low soil fertility and is favoured for consumption due to its easy digestibility (Shil and Bandopadhyay, 2007). Being a leguminous crop, it has the capacity to fix atmospheric nitrogen through symbiotic nitrogen fixation and also used as a green manure crop. As short duration crop, it fits well in various multiple and intercropping systems.

Many factors are responsible for the low yields of maize in India. Of the several factors, most critical for the low yield appears to be the weed growth that competes with the crop for nutrients, water, sunlight and space. They cause yield losses worldwide with an average of 12.8 per cent despite weed control practices and 29.2% in case of unchecked weed growth (Dogan *et al.*, 2004). Hence, the present study is taken up to find out the influence of maize + black gram intercropping system on growth and yield of maize.

## **Materials and Methods**

Experiment was conducted in field No.37 at Eastern Block of the Department of Farm

Management, Tamil Nadu Agricultural University, Coimbatore during *kharif* 2013. The experiment was laid out in split plot design with three replications. Three intercropping systems *viz.*, maize alone (I<sub>1</sub>), maize + blackgram (1:1 ratio) (I<sub>2</sub>) and maize + blackgram (2:2 ratio) (I<sub>3</sub>) were evaluated under main plot and four weed management practices *viz.*, unweeded check (Control) (W<sub>1</sub>), Pendimethalin 0.75 kg ha<sup>-1</sup> as pre emergence (PE) 3 DAS + one hand weeding 25 DAS (W<sub>2</sub>), Imazethapyr 75 g ha<sup>-1</sup> as post emergence (POE) 25 DAS (W<sub>3</sub>) and Pendimethalin 0.75 kg ha<sup>-1</sup> as PE 3 DAS + Imazethapyr 75 g ha<sup>-1</sup> as POE 25 DAS (W<sub>4</sub>) were accommodated under subplot treatments. Five plants in each treatment in the net plot were selected at random as sample plants and tagged for taking observations *viz.*, plant height, leaf area index, Dry matter production (DMP) and Days taken to 50 % tasseling and silking. Yield components such as Cob length (cm), Cob girth (cm), Number of grain rows cob<sup>-1</sup>, Number of grains row<sup>-1</sup>, Weight of individual cob, Hundred grain weight, Grain yield and Stover yield were recorded.

## **Results and Discussion**

### **Growth and yield attributes**

Plant height which represents the time trend of growth was recorded at different phenophases of maize. Significant difference in plant height was observed with intercropping systems and weed management practices. Among the intercropping systems, taller plants (229.0 cm) were recorded under sole maize followed by maize + blackgram intercropping (1:1). Increase in plant height under sole maize treatment was due to the fact that the optimum space available in sole maize reduced the competition for light and nutrients, which probably provided favourable physical environment and helped the plants to

grow taller. Increase in plant height under sole maize was also observed by Hugar and Palled (2008). With regard to weed management practices, pendimethalin 0.75 kg ha<sup>-1</sup> as PE + one HW 25 DAS recorded taller plants (218.4 and 249.7 cm at 60 and 90 DAS, respectively) followed by pendimethalin 0.75 kg ha<sup>-1</sup> + imazethapyr 75 g ha<sup>-1</sup> as POE 25 DAS. Better weed control with favourable soil environment might have resulted in reduced crop weed competition for the growth factors such as light, space and nutrients which in turn helped in efficient photosynthetic activity recording taller plants. The plots having higher weed control efficiency got more resources and produced taller plants as earlier reported by Nadeem *et al.* (2010) (Table 1).

Sole maize registered higher LAI than maize intercropped with blackgram irrespective of the planting pattern. The smothering effect of blackgram was greater in the form of yellowing of older leaves of maize in blackgram intercropped plots and that might have reduced the leaf duration and the number of functional leaves thereby causing a reduction in LAI (Choudhary *et al.*, 2012).

With regard to weed management practices, pendimethalin 0.75 kg ha<sup>-1</sup> as PE + one HW 25 DAS recorded higher leaf area index (1.94, 6.02 and 5.06 cm at 30, 60 and 90 DAS, respectively) followed by pendimethalin 0.75 kg ha<sup>-1</sup> + imazethapyr 75 g ha<sup>-1</sup> as POE 25 DAS and both were comparable with each other. Lesser weed competition resulting in higher availability of plant nutrients and moisture favouring higher leaf area index and vigorous crop growth of maize with pre emergence application of pendimethalin might be the reason for higher LAI recorded under treatments involving pendimethalin. Generally, the leaf area index was higher in all weed control treatments compared with that of unweeded control (W1). Similar result

of higher LAI under pendimethalin treatments reported by Shenbagam (2011) is in support of the present findings.

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The dry matter production (DMP) increased with the age of the crop and reached the highest at harvest. Among the intercropping systems, higher dry matter production (6442 and 13603 kg ha<sup>-1</sup> at 60 and 90 DAS, respectively) was recorded under sole maize followed by maize + blackgram intercropping (1:1) and both were comparable. The least dry matter production was observed under maize + blackgram intercropping (2:2) at all the stages of observation.

With regard to weed management practices, pendimethalin 0.75 kg ha<sup>-1</sup> as PE + one HW 25 DAS recorded higher dry matter production (7335 and 14142 kg ha<sup>-1</sup> at 60 and 90 DAS, respectively) followed by pendimethalin 0.75 kg ha<sup>-1</sup> + imazethapyr 75 g ha<sup>-1</sup> as POE 25 DAS.

This might be due to better weed control by optimum dosage of herbicide and hand weeding which produced conducive environment favouring higher uptake of nutrients that reflected on higher leaf area index and better source sink relationship for accumulating higher dry matter.

**Table.1** Effect of intercropping and weed management practices on growth parameters of maize hybrid

| Treatment  | Plant height (cm) |            | Leaf area index |             | Dry matter production (kg ha <sup>-1</sup> ) |            | Days taken for 50% tasseling | Days taken for 50% silking |
|--|-------------------|------------|-----------------|-------------|--|------------|------------------------------|----------------------------|
|  | 60 DAS            | 90 DAS     | 60 DAS          | 90 DAS      | 60 DAS                                       | 90 DAS     |                              |                            |
| <b>Intercropping system</b>  |                   |            |                 |             |  |            |                              |                            |
| I <sub>1</sub> - Sole maize  | 201.1             | 229.0      | 5.50            | 4.54        | 6442   | 13603      | 58.6                         | 66.7                       |
| I <sub>2</sub> - Maize + Black gram (1:1) (60 x25 cm)  | 199.8             | 225.7      | 5.37            | 4.46        | 6307   | 13273      | 59.0                         | 66.9                       |
| I <sub>3</sub> - Maize + Black gram (2:2) (30/90 cm)   | 193.2             | 217.2      | 5.13            | 4.26        | 6005   | 12515      | 59.6                         | 67.1                       |
| <b>SEd</b>   | <b>2.2</b>        | <b>2.4</b> | <b>0.08</b>     | <b>0.06</b> | <b>65</b>                                    | <b>140</b> | <b>0.7</b>                   | <b>1.2</b>                 |
| <b>CD (P=0.05)</b>   | <b>6.4</b>        | <b>7.0</b> | <b>0.23</b>     | <b>0.17</b> | <b>190</b>                                   | <b>409</b> | <b>NS</b>                    | <b>NS</b>                  |
| <b>Weed management practices</b>   |                   |            |                 |             |  |            |                              |                            |
| W <sub>1</sub> - Weedy check   | 162.4             | 175.3      | 4.09            | 3.09        | 4067   | 7719       | 59.9                         | 67.2                       |
| W <sub>2</sub> -Pendimethalin 0.75 kg ha <sup>-1</sup> + one HW 25 DAS                                   | 218.4             | 249.7      | 6.02            | 5.06        | 7335   | 14142      | 57.5                         | 65.4                       |
| W <sub>3</sub> -Imazethapyr 75 g ha <sup>-1</sup> as POE 25 DAS  | 199.7             | 229.6      | 5.36            | 4.55        | 6461   | 12913      | 59.1                         | 66.9                       |
| W <sub>4</sub> -Pendimethalin 0.75 kg ha <sup>-1</sup> + Imazethapyr 75 g ha <sup>-1</sup> as POE 25 DAS | 211.6             | 241.2      | 5.86            | 4.99        | 7043   | 13747      | 58.3                         | 66.1                       |
| <b>SEd</b>   | <b>2.6</b>        | <b>2.7</b> | <b>0.08</b>     | <b>0.05</b> | <b>79</b>                                    | <b>212</b> | <b>06</b>                    | <b>0.7</b>                 |
| <b>CD (P=0.05)</b>   | <b>6.1</b>        | <b>6.4</b> | <b>0.18</b>     | <b>0.11</b> | <b>163</b>                                   | <b>437</b> | <b>1.3</b>                   | <b>1.4</b>                 |
| <b>Interaction</b>   | <b>NS</b>         | <b>NS</b>  | <b>NS</b>       | <b>NS</b>   | <b>NS</b>                                    | <b>NS</b>  | <b>NS</b>                    | <b>NS</b>                  |

**Table.2** Effect of intercropping and weed management practices on yield attributes and yield of maize hybrid

| Treatment  | Cob weight (g) | Cob length (cm) | Cob girth (cm) | Number of grain rows cob <sup>-1</sup> | Number of grains row <sup>-1</sup> | Test weight (g) | Grain Yield (kg ha <sup>-1</sup> ) | Stover Yield (kg ha <sup>-1</sup> ) |
|--|----------------|-----------------|----------------|--|------------------------------------|-----------------|------------------------------------|-------------------------------------|
| <b>Intercropping system</b>  |                |                 |                |  |                                    |                 |                                    |                                     |
| I <sub>1</sub> - Sole maize  | 168.0          | 16.5            | 13.2           | 12.2                                   | 28.5                               | 31.4            | 4543                               | 8800                                |
| I <sub>2</sub> - Maize + Black gram (1:1) (60 x25 cm)  | 161.1          | 16.3            | 13.0           | 12.0                                   | 28.3                               | 30.6            | 4383                               | 8624                                |
| I <sub>3</sub> - Maize + Black gram (2:2) (30/90 cm)   | 150.2          | 16.0            | 12.6           | 11.6                                   | 27.3                               | 29.6            | 4199                               | 8191                                |
| <b>SEd</b>   | 2.4            | 0.1             | 0.1            | 0.1                                    | 0.2                                | 0.4             | <b>60</b>                          | <b>208</b>                          |
| <b>CD (P=0.05)</b>   | <b>7.0</b>     | <b>0.3</b>      | <b>0.3</b>     | <b>0.3</b>                             | <b>0.6</b>                         | <b>1.2</b>      | <b>175</b>                         | <b>607</b>                          |
| <b>Weed management practices</b>   |                |                 |                |  |                                    |                 |                                    |                                     |
| W <sub>1</sub> - Weedy check   | 110.2          | 11.6            | 9.2            | 9.9                                    | 24.1                               | 27.6            | 2007                               | 4010                                |
| W <sub>2</sub> -Pendimethalin 0.75 kg ha <sup>-1</sup> + one HW 25 DAS                                   | 177.8          | 18.9            | 15.2           | 12.8                                   | 31.4                               | 33.3            | 5546                               | 11060                               |
| W <sub>3</sub> -Imazethapyr 75 g ha <sup>-1</sup> as POE 25 DAS  | 163.0          | 16.7            | 13.2           | 11.8                                   | 29.8                               | 28.8            | 4863                               | 9036                                |
| W <sub>4</sub> -Pendimethalin 0.75 kg ha <sup>-1</sup> + Imazethapyr 75 g ha <sup>-1</sup> as POE 25 DAS | 169.7          | 18.0            | 14.1           | 12.3                                   | 30.8                               | 30.9            | 5085                               | 10048                               |
| <b>SEd</b>   | <b>2.6</b>     | <b>0.2</b>      | <b>0.2</b>     | <b>0.2</b>                             | <b>0.3</b>                         | <b>0.5</b>      | <b>78</b>                          | <b>218</b>                          |
| <b>CD (P=0.05)</b>   | <b>6.1</b>     | <b>0.5</b>      | <b>0.4</b>     | <b>0.4</b>                             | <b>0.7</b>                         | <b>1.1</b>      | <b>183</b>                         | <b>513</b>                          |
| <b>Interaction</b>   | <b>NS</b>      | <b>NS</b>       | <b>NS</b>      | <b>NS</b>                              | <b>NS</b>                          | <b>NS</b>       | <b>Sig.</b>                        | <b>Sig.</b>                         |

**Table.3** Interaction effect of intercropping and weed management practices on grain yield and stover yield (kg ha<sup>-1</sup>) of maize hybrid

| Treatment  | Grain yield (kg ha <sup>-1</sup> ) |                       |                |               | Stover yield (kg ha <sup>-1</sup> ) |                       |                |              |
|--|------------------------------------|-----------------------|----------------|---------------|-------------------------------------|-----------------------|----------------|--------------|
|  | I <sub>1</sub>                     | I <sub>2</sub>        | I <sub>3</sub> | Mean          | I <sub>1</sub>                      | I <sub>2</sub>        | I <sub>3</sub> | Mean         |
| W <sub>1</sub> - Weedy check   | 2038                               | 2039                  | 1943           | <b>2007</b>   | 4072                                | 4118                  | 3842           | <b>4010</b>  |
| W <sub>2</sub> -Pendimethalin 0.75 kg ha <sup>-1</sup><br>+ one HW 25 DAS                          | 5755                               | 5737                  | 5147           | <b>5546</b>   | 11468                               | 11444                 | 10268          | <b>11060</b> |
| W3 -Imazethapyr 75 g ha <sup>-1</sup> as<br>POE 25 DAS   | 5051                               | 4798                  | 4740           | <b>4863</b>   | 9037                                | 8961                  | 9113           | <b>9037</b>  |
| W4 -Pendimethalin 0.75 kg ha <sup>-1</sup><br>+ Imazethapyr 75 g ha <sup>-1</sup> as POE<br>25 DAS | 5330                               | 4960                  | 4965           | <b>5085</b>   | 10648                               | 9953                  | 9544           | <b>10048</b> |
| <b>Mean</b>  | <b>4543</b>                        | <b>4383</b>           | <b>4199</b>    | <b>Mean</b>   | <b>8800</b>                         | <b>8625</b>           | <b>8192</b>    |              |
|  | <b>SEd</b>                         | <b>CD</b><br>(P=0.05) |                |               | <b>SEd</b>                          | <b>CD</b><br>(P=0.05) |                |              |
| <b>I</b>   | <b>60</b>                          | <b>175</b>            |                | <b>I</b>      | <b>212</b>                          | <b>618</b>            |                |              |
| <b>W</b>   | <b>78</b>                          | <b>183</b>            |                | <b>W</b>      | <b>218</b>                          | <b>513</b>            |                |              |
| <b>I at W</b>  | <b>131</b>                         | <b>319</b>            |                | <b>I at W</b> | <b>390</b>                          | <b>961</b>            |                |              |
| <b>W at I</b>  | <b>117</b>                         | <b>227</b>            |                | <b>W at I</b> | <b>327</b>                          | <b>635</b>            |                |              |

Note: I<sub>1</sub> - Sole maize ; I<sub>2</sub> - Maize + Black gram (1:1) (60 x25 cm); I<sub>3</sub> - Maize + Black gram (2:2) (30/90 cm)

The findings are in accordance with the view of Kumar (2004) who had observed that effective control of weeds right from germination of crop might have allowed the crop to utilize the resources effectively and this could be the reason for higher dry matter production of maize. There was no significant difference in number of days taken for 50% flowering with intercropping systems and weed management practices

Earlier flowering (tasseling and silking) was noticed under sole maize, which was earlier than maize + blackgram intercropping (1:1). Delayed flowering (tasseling and silking) was observed with maize + greengram intercropping (2:2), which took more number of days for flowering. However, the difference existed between the treatments was not significant.

With regard to weed management practices, pendimethalin 0.75 kg ha<sup>-1</sup> as PE + one HW 25 DAS recorded earlier flowering (57.5 and 65.4 for tasselling and silking, respectively) followed by pendimethalin 0.75 kg ha<sup>-1</sup> + imazethapyr 75 g ha<sup>-1</sup> as POE 25 DAS. The yield attributes viz., cob length, cob girth, number of grain row cob<sup>-1</sup>, number of grains row<sup>-1</sup>, cob weight and test weight were significantly influenced by intercropping systems and weed management practices.

Among the intercropping systems, higher cob length (16.5 cm), higher cob girth (13.2 cm), higher number of grain rows cob<sup>-1</sup> (12.2), higher number of grains row<sup>-1</sup> (28.5) and higher cob weight (168.0 gm) higher test weight (31.4 g) was recorded under sole maize followed by maize + blackgram intercropping (1:1) and both were comparable. With regard to weed management practices, pendimethalin 0.75 kg ha<sup>-1</sup> as PE + one HW 25 DAS recorded higher cob length (11.6 cm), higher cob girth (15.2 cm), higher number of grain rows cob<sup>-1</sup> (12.8), higher number of grains

row<sup>-1</sup> (31.4) and higher cob weight (177.8 g) higher test weight (33.3g) followed by pendimethalin 0.75 kg ha<sup>-1</sup> + imazethapyr 75g ha<sup>-1</sup> as POE 25 DAS. This increase in yield attributes was due to the least intercrop competition for light, nutrients, moisture and space. This result corroborates with the findings of Karim *et al.*, (1990).

### **Grain and stover yield**

The maize grain and stover yield was significantly influenced by intercropping systems and weed management practices. Sole maize recorded the highest grain and stover yield of 4543 kg ha<sup>-1</sup> 8800 kg ha<sup>-1</sup> and was comparable with maize + blackgram intercropping (1:1) which recorded an yield of 4383 kg ha<sup>-1</sup>. Maize + blackgram intercropping (2:2) recorded lower grain yield. The yield reduction due to intercropping blackgram (1:1) was less (3.52 per cent) comparing the sole maize yield, whereas the yield reduction due to maize + blackgram intercropping (2:2) was 7.57 per cent, indicating least effect of planting pattern of intercrops on the grain yield of maize. The yield increment in sole maize was only due to least competition for sunlight, space, water and nutrients while it was in intercrops having shading effect which curtailed efficient utilization of natural resources and restricted the growth of maize from initial stages to harvest resulted in yield competition in intercrop as reported by Yilmaz *et al.*, (2008). Similar findings were also reported by Dwivedi *et al.*, (2012). With regard to weed management practices, pendimethalin 0.75 kg ha<sup>-1</sup> as PE + one HW 25 DAS recorded higher grain and stover yield (5546 kg ha<sup>-1</sup> and 11060 kg ha<sup>-1</sup>) followed by pendimethalin 0.75 kg ha<sup>-1</sup> + imazethapyr 75g ha<sup>-1</sup> as POE 25 DAS (5085 kg ha<sup>-1</sup>) (Table 2).

The interaction between intercropping systems and weed management practices on maize grain yield was significant. The highest

grain yield ( $5755 \text{ kg ha}^{-1}$ ) was recorded under the treatment combination sole maize with pendimethalin  $0.75 \text{ kg ha}^{-1}$  as PE + one HW 25 DAS ( $I_1W_2$ ) followed by the treatment combination maize + blackgram intercropping at 1:1 ratio with pendimethalin  $0.75 \text{ kg ha}^{-1}$  as PE + one HW 25 DAS ( $I_2 W_2$ ) (Table 3). The least grain yield ( $1943 \text{ kg ha}^{-1}$ ) was obtained under maize + blackgram intercropped at 2:2 ratio without weeding ( $I_3W_1$ ). The yield increase could be attributed to the reason that herbicide application might have killed the weeds at germination phase devoiding competition for crop growth from the inception of germination of the crop and hand weeding on 25 DAS lasting its efficiency at later growth stages. The results are in accordance with the findings of Singh and Singh (2009) who have observed that pre emergence application of pendimethalin  $250 \text{ g ha}^{-1}$  followed by one hand weeding on 45 DAS produced maximum pod and haulm yield of groundnut when compared to farmers practice of hand weeding twice.

Sole maize recorded better growth and higher yield followed by maize intercropped with blackgram at 1:1 ratio and the grain yield obtained under both were comparable under intercroppings systems. Among the weed management practices, pendimethalin  $0.75 \text{ kg ha}^{-1}$  as PE 3 DAS + one HW 25 DAS favourably increased the growth, yield attributes and grain yield of maize. Hence, sole maize with pendimethalin  $0.75 \text{ kg ha}^{-1}$  as PE 3 DAS + one HW 25 DAS recorded higher grain yield followed by maize + blackgram intercropping at 1:1 ratio along with pendimethalin @ $0.75 \text{ kg ha}^{-1}$  as PE on 3 DAS + one hand weeding on 25 DAS and both were comparable with each other.

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