PERFORMANCE OF INTERCROPPING GROUNDNUT WITH SESAME

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Key words: Intercropping, productivity, equivalent yield, land equivalent ratio and harvest index

Abstract

The experiment was carried out at the farmers’ field of On-Farm Research Division, Bangladesh Agricultural Research Institute (BARI), Mymensingh during two consecutive years 2015 and 2016 to find out the suitable intercropping system for increasing crop productivity and profitability of groundnut with sesame intercropping system. The treatments were $T_1$=sole groundnut, $T_2$=sole sesame, $T_3$= Two rows of groundnut in between paired rows of sesame and $T_4$= Three rows of groundnut in between paired rows of sesame. Treatments were arranged in a randomized complete block design with six dispersed replications. Between intercropped treatments, three rows of groundnut within paired rows of sesame showed higher sesame equivalent yield (2.33 t ha$^{-1}$) and groundnut equivalent yield (2.14 t ha$^{-1}$) which provided the yield advantages of 108 and 32% over the respective sole crops. The highest land equivalent ratio (1.64), gross return (Tk 1,28,350 ha$^{-1}$) and benefit cost ratio (2.15) were also achieved in three rows of groundnut within paired rows of sesame compared to other intercropping and sole cropping systems. The result showed that three rows of groundnut in between paired rows of sesame is found most productive and profitable than sole sesame or sole groundnut for maximum profit in Mymensingh region.

Introduction

Bangladesh is an agriculture based country and about 14.75 % gross domestic product (GDP) comes from agriculture in Bangladesh (AIS, 2017). The main challenge of the new millennium is to increase yield of per unit area by at least 50 % through manipulating the limited land resource. Sesame (Sesamum indicum L.) is an important oilseed crop ranked second-in terms of acreage (38057 ha) of land and produces 36,000 metric tons of sesame seeds with an average yield of 860 kg ha$^{-1}$ (BBS, 2015). It can be cultivated both in kharif and rabi seasons. Sesame is a drought resistant crop. It cannot tolerate water logging or excess moisture in the field. Seeds contain 42-45 % oil and 20 % protein (Mondal and Wahhab, 2001). The cultivation of sesame is drastically declining due to widely increasing of rice, maize and mungbean cultivation in kharif season. Moreover, sesame competes with jute and different vegetables in the season. Intercropping plays an important role in increasing the productivity and stability of yield in order to improve resource utilization and environmental factors (Alizadeh et al., 2010). Research in different countries reveals that intercropping has several benefits to the farmers including reduction in farm inputs, diversification of diet, addition of cash crops, increased labour utilization efficiency, reduced risk of crop failure, more efficient use of water resources, nutrients and reduced problems caused by pests, diseases and weeds (Awal et al., 2006). So, intercropping of sesame with groundnut could help to retain oilseed crops and ensure highest productivity per unit area as well as supply of oil . Groundnut (Arachis hypogaea L.) is the third
most important legume crop in Bangladesh which grown on 31,579 ha of land and produces 56713 metric tons of nut with an average yield of 1.79 t ha\(^{-1}\) (BBS, 2015). Recently the area of groundnut is being decreased due to the competition with \textit{rabi} crops like wheat, potato, \textit{boro} rice and mustard (Alom \textit{et al.}, 2009). Moreover, most of the char land of Bangladesh become inundated in \textit{kharif} season which also one of the causes the decline of groundnut production area. Some experimental evidences showed that in the sesame field groundnut can be grown as intercrop. Groundnut var. BARI Chinabadam-8 is short in stature and suitable for early \textit{kharif} and late \textit{kharif} planting. Groundnut can withstand excessive rainfall. So, if sesame crop is damaged due to heavy rainfall, groundnut crop will thrive and farmers will not lose their crops fully. The research findings stated that nitrogen fixation in groundnut and the residual benefits through incorporation of stover to subsequent crops were estimated in farmers’ fields (Mondal and Wahhab, 2001). Better intercrop production could be achieved with the choice of appropriate crops population density and planting geometry of component crops (Santalla \textit{et al.}, 2001). Groundnut and sesame in intercropping systems may increase their production and profit. In this context, the experiment was conducted to find out the suitable intercrop combination of sesame with groundnut for higher productivity and profitability.

**Materials and Methods**

The experiment was carried out at the farmers’ field of On-Farm Research Division, Bangladesh Agricultural Research Institute (BARI), Mymensingh during two consecutive years 2015 and 2016 to find out the suitable intercropping system for increasing crop productivity and profitability of groundnut sesame intercropping system. The experimental soil was sandy loam to silty loam of the medium highland having pH 6.2 to 6.5 under the Agro-ecological Zone-9 (AEZ-9). The treatments were as T\(_1\) = sole groundnut, T\(_2\) = sole sesame, T\(_3\) = Two rows of groundnut in between paired rows of sesame and T\(_4\) = Three rows of groundnut in between paired rows of sesame. Groundnut var. BARI Chinabadam-8 and Sesame var. BARI Til-4 were used. The experiment was laid out in a randomized complete block design with six dispersed replications. The unit plot size was 8.0 m x 5.0 m. The seeds of sesame were sown in 30 cm apart paired rows and 75 cm between two pairs with 5 cm between the plants. The spacing maintained for sole groundnut was 25 cm x 10 cm for intercropping system, the plant population of sesame plots remained same as sole plot but it varied for groundnut. The seed germination of both crops was 95 percent. Seeds of both crops were sown on 07 to 14 March 2015 and 2016. Fertilizers were applied at the rate of 15-32-42-27-2-2 kg NPKSZnB ha\(^{-1}\) in the form of urea, triple super phosphate, muriate of potash, gypsum, zinc sulphate and boric acid, respectively (Mondal and Wahhab, 2001). All fertilizers were applied as basal during final land preparation by broadcasting method. Additional 20 kg ha\(^{-1}\) of urea applied as top dressed in between two rows of sesame at 25-30 DAS. Thinning was done after 15-20 days of seed germination in both the years. Mulching and hand weeding were done as and when necessary to keep the field reasonable weed free. Dursban 2ml L\(^{-1}\) water was sprayed at 15-20 days intervals as precautionary measure against insects attack. Dithane M-45 2g L\(^{-1}\) water was sprayed at 15 days intervals at the later stages of groundnut as precautionary measure from prevalence of disease. Seed, pod and straw yields at harvest were converted into tha\(^{-1}\) after proper drying. Sesame was harvested on 07-10 June 2015 and 08-12 June 2016 and groundnut on 07-14 July 2015 and 15-21 July 2016 at physiological maturity.
**Pest and disease incidence:** Nitro @ 2mlL\(^{-1}\) water was sprayed twice at 10 days interval for successful controlling the hairy caterpillar and thrips. Stem rot of sesame was observed sporadically in the flowering stage of sesame; Baiting @ 2gL\(^{-1}\) water was sprayed twice at 7 days interval for controlling fungal disease. No other disease and insects infestation was observed during the cropping period. The yield contributing characters of sesame and groundnut were recorded from 10 randomly selected plants in both the years. Harvest index (HI) was calculated as per following equation:

\[
HI(\%) = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100
\]

Yield of individual crop was converted into equivalent yield on the basis of the prevailing market price of individual crop (Prasad and Srivastava, 1991).

Sesame equivalent yield (SEY) = Yield of intercrop sesame + \(\frac{Y_{ig} \times P_g}{P_s}\) and

Groundnut equivalent yield (GEY) = Yield of intercrop groundnut + \(\frac{Y_{is} \times P_s}{P_g}\)

Where, \(Y_{ig}\) = Yield of intercrop groundnut, \(P_g\) = Price of groundnut, \(P_s\) = Price of sesame and \(Y_{is}\) = Yield of intercrop sesame

In intercropping systems, relative yield was quantified by (Jokinen, 1991).

Relative Yield of Sesame (RYs): \(\frac{Y_{is}}{Y_{ss}}\), Relative Yield of Groundnut (RYg): \(\frac{Y_{ig}}{Y_{sg}}\) and

Relative yield total (RYT): \(R_{Ys} + R_{Yg}\),

Where \(Y_{ss}\) = Yield of sole sesame, \(Y_{is}\) = Yield of intercrop sesame, \(Y_{sg}\) = Yield of sole groundnut and \(Y_{ig}\) yield of intercrop groundnut.

On the other hand, land equivalent ratio (LER) was used for measuring the efficiency of intercropping advantages using the resources of environment compared to monoculture. Land equivalent ratio (LER) were calculated by adding the partial LER for each crop and it was calculated by the following formula (Mead and Willey, 1980)

\[
LER = \frac{Y_{is}}{Y_{ss}} + \frac{Y_{ig}}{Y_{sg}}
\]

Where, \(Y_{is}\) = yield of intercrop sesame, \(Y_{ss}\) = yield of sole sesame, \(Y_{ig}\) = yield of intercrop groundnut and \(Y_{sg}\) = yield of sole groundnut

Pooled analysis was done as because there was no significant difference in yield and yield contributing characters between two years. Data were statistically analyzed using analysis of variance technique with the help of computer package MSTAT-C and mean comparison among the treatments was made by LSD test at 5% level of significance.
Results and Discussion

Yield and yield attributes of sesame: It was observed that the seed yields of sesame significantly influenced intercropping systems but other yield attributes were not insignificant (Table 1). The highest seed yield (1.12 t ha\(^{-1}\)) was recorded from T\(_2\) (sole sesame) which was statistically different with T\(_3\) (Two rows of groundnut in between paired rows of sesame) and T\(_4\) (Three rows of groundnut in between two paired rows of sesame). Lower seed yield (0.89 t ha\(^{-1}\)) was obtained from T\(_3\) which was statistically significant with other treatments. Higher seed yield of sesame was observed in monoculture compared to intercropping systems might be due to no intercrop competition for light, nutrients, moisture and space. This result corroborates with the findings of Uddin et al., (2003). Sesame gave 13 to 21 % lower yield in intercropping treatments as compared to their corresponding monoculture, though the plant population of sesame was constant regardless of treatment. The seed yield of sesame was reduced probably due to intercrop competition between sesame and groundnut. However, additional yield from groundnut not only compensated the deficit but also gave extra income. This finding is in conformity with Islam et al., (2016). The harvest index (HI) of sesame did not differ by the intercropping systems; it had higher values in T\(_4\)>T\(_3\)>T\(_2\) (Table 1).

Table 1. Seed yield, yield attributes and harvest index of sesame under sesame + groundnut intercropping systems in Mymensingh, 2015 and 2016 (Pooled)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Plant height (cm)</th>
<th>Branch plant(^{-1}) (no.)</th>
<th>Capsules plant(^{-1}) (no.)</th>
<th>1000-seed wt. (g)</th>
<th>Seed yield (t ha(^{-1}))</th>
<th>Harvest index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T(_2)</td>
<td>149.0</td>
<td>5.1</td>
<td>86.2</td>
<td>3.2</td>
<td>1.12</td>
<td>37</td>
</tr>
<tr>
<td>T(_3)</td>
<td>150.4</td>
<td>5.1</td>
<td>89.8</td>
<td>3.4</td>
<td>0.89</td>
<td>50</td>
</tr>
<tr>
<td>T(_4)</td>
<td>151.8</td>
<td>5.0</td>
<td>90.8</td>
<td>3.4</td>
<td>0.97</td>
<td>51</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>0.20</td>
<td>ns</td>
</tr>
<tr>
<td>CV (%)</td>
<td>5.11</td>
<td>8.73</td>
<td>5.32</td>
<td>7.44</td>
<td>6.42</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: T\(_2\) = Sole sesame, T\(_3\) = Two rows of groundnut in between paired rows of sesame and T\(_4\) = Three rows of groundnut in between paired rows of sesame.

Yield and yield attributes of groundnut: The variation was found in branches plant\(^{-1}\), kernel plant\(^{-1}\), shelling percent and nut yield hectare while plant height and 100-kernel weight were found insignificant (Table 2). The highest nut yield was recorded in T\(_1\) (sole groundnut) mainly due to the higher kernel number plant\(^{-1}\), 100-kernel weight and shelling percent of groundnut. The nut yield of groundnut was reduced 23 to 46 % in intercropping system than sole crop of groundnut. This result corroborates with the findings of Razzaque et al., (2007) who reported that less groundnut yield was obtained from intercropping system than sole crop due to shading effect of chilli on groundnut. In T\(_4\) (Three rows of groundnut in between paired rows of sesame) had higher nut yield due to paired rows planting system of sesame favoured the growth of intercropped groundnut and judicious use of growth resources compared to others. These results are in conformity with the findings of Islam et al., (2006). Higher harvest index (HI) of groundnut was slightly higher in T\(_4\) (Three rows of groundnut in between two paired rows of sesame) possibly owing to use of more assimilates to the reproductive organs (Table 2).
Table 2. Nut yield, yield attributes and harvest index of groundnut under sesame + groundnut intercropping systems in Mymensingh, 2015 and 2016 (Pooled)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Plant height (cm)</th>
<th>Branch plant(^{1}) (no.)</th>
<th>Kernel plant(^{1}) (no.)</th>
<th>100-kernel wt. (g)</th>
<th>Shelling (%)</th>
<th>Nut yield (t ha(^{-1}))</th>
<th>Harvest index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T(_1)</td>
<td>38.2</td>
<td>7.8</td>
<td>17.2</td>
<td>90.2</td>
<td>66.4</td>
<td>1.62</td>
<td>52</td>
</tr>
<tr>
<td>T(_3)</td>
<td>35.0</td>
<td>6.8</td>
<td>13.2</td>
<td>88.4</td>
<td>64.4</td>
<td>0.88</td>
<td>48</td>
</tr>
<tr>
<td>T(_4)</td>
<td>36.0</td>
<td>6.6</td>
<td>14.2</td>
<td>89.6</td>
<td>66.0</td>
<td>1.25</td>
<td>53</td>
</tr>
</tbody>
</table>

LSD (0.05) ns 1.01 2.14 ns 1.74 0.32 -
CV (%) 6.77 9.84 9.90 5.32 8.33 7.62 -

Note: T\(_1\)=Sole groundnut, T\(_3\)=Two rows of groundnut in between two paired rows of sesame and T\(_4\)= Three rows of groundnut in between two paired rows of sesame.

Equivalent yield and relative yield: All the intercropping systems gave higher sesame and groundnut equivalent yield than that of their corresponding sole crops (Table 3). The highest sesame equivalent yield (2.33 t ha\(^{-1}\)) as well as groundnut equivalent yield (2.14 t ha\(^{-1}\)) were recorded from T\(_4\) (three rows of groundnut in between two paired rows of sesame) which covered the yield advantages of 133 and 37 % over their respective sole crops. Such yield advantage might be due to combined yield of both the crops. The results are in agreement with the finding of Islam et. al., (2016) who reported that highest turmeric equivalent yield was found from turmeric (100 %) + 3 rows of sesame in between turmeric lines. The partial relative yields of intercropped sesame varied from 0.79 to 0.87 and intercropped groundnut ranged from 0.54 to 0.77 (Table 3). Sesame yield was reduced (13 to 21 %) and groundnut yield reduced (23 to 46 %) among the intercropping system. The yield was reduced due to lower plant population. The result showed that T\(_4\) was well accommodative in competitiveness in sesame + groundnut intercropping system (Table 3).

Land equivalent ratio (LER): The land equivalent ratio (LER) was used to assess the performance of an intercrop relative to the corresponding sole crop (Mead and Willey, 1980). The highest LER value (1.55) was obtained from T\(_4\) (three rows of groundnut in between two paired row of sesame) which indicated the superiority of intercropping over monoculture (Table 3). It also expressed that by intercropping groundnut with sesame, a farmer can produce 1.25 tons groundnut and 0.97 tons sesame in one hectare of land instead of cultivate those separately as sole crop.

Table 3. Equivalent yields, relative yields and land equivalent ratio of sesame + groundnut combinations in Mymensingh, 2015 and 2016 (Pooled)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Sesame equivalent yield (t ha(^{-1}))</th>
<th>Groundnut equivalent yield (t ha(^{-1}))</th>
<th>Partial relative yield (t ha(^{-1}))</th>
<th>Land equivalent ratio (LER)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sesame</td>
<td>Groundnut</td>
</tr>
<tr>
<td>T(_1)</td>
<td>1.77</td>
<td>1.62</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>T(_2)</td>
<td>1.12</td>
<td>1.03</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>T(_3)</td>
<td>1.85</td>
<td>1.70</td>
<td>0.79</td>
<td>0.54</td>
</tr>
<tr>
<td>T(_4)</td>
<td>2.33</td>
<td>2.14</td>
<td>0.87</td>
<td>0.77</td>
</tr>
</tbody>
</table>

Note: T\(_1\)=Sole groundnut, T\(_2\)=Sole sesame, T\(_3\)=Two rows of groundnut in between paired rows of sesame and T\(_4\)= Three rows of groundnut in between paired rows of sesame.
Economic return of intercropping groundnut with sesame: On the basis of two years average result, the highest monetary return (Tk. 68,535) was observed in T_4 (three rows of groundnut in between two paired rows of sesame) which gave an additional income of Tk. 27,300 over sole crop of groundnut and Tk. 54,735 over sole crop of sesame (Table 4). Both intercrop combination gave higher monetary advantages over sole groundnut and sesame. The highest BCR (2.15) was found in T_4 (three rows of groundnut in between two paired rows of sesame) over other treatments. These results are in agreement with the findings of Islam et al. (2016) who stated that turmeric (100 %) + 3 rows of sesame (100 %) in between turmeric lines intercropping system gave higher additional income and BCR over the sole crop of turmeric.

Table 4. Economics of intercropping sesame with groundnut in Mymensingh, 2015 and 2016 (average of two years)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Gross return (Tk. ha^{-1})</th>
<th>Total cost (Tk. ha^{-1})</th>
<th>Gross margin (Tk. ha^{-1})</th>
<th>BCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>T_1</td>
<td>97200</td>
<td>55965</td>
<td>41235</td>
<td>1.74</td>
</tr>
<tr>
<td>T_2</td>
<td>61600</td>
<td>47800</td>
<td>13800</td>
<td>1.29</td>
</tr>
<tr>
<td>T_3</td>
<td>101750</td>
<td>57390</td>
<td>44360</td>
<td>1.77</td>
</tr>
<tr>
<td>T_4</td>
<td>128350</td>
<td>59815</td>
<td>68535</td>
<td>2.15</td>
</tr>
</tbody>
</table>

Market price: Groundnut= Tk. 60 kg^{-1} and Sesame= Tk. 55 kg^{-1}

Conclusion

Two years average result indicating that intercropping groundnut with sesame gave maximum productivity as well as economic return than monoculture of component crops. The equivalent yields, relative yields, land equivalent ratio (LER) values and economic return were found highest in T_4 (three rows of groundnut in between two paired rows of sesame) in groundnut + sesame intercropping system. Thus it could be concluded that three rows of groundnut in between paired rows of sesame intercropping system could be adopted for better productivity with maximum profit for the farmers of Mymensingh regions instead of sole crops.

References


**Performance of Intercropping Groundnut with Sesame**


