

## **Production and economic potential of chickpea (*Cicer arietinum* L.) and mustard (*Brassica juncea* L.) crop in chickpea-mustard intercropping system under Patiala region**

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### **Abstract**

*A field experiment was conducted at Campus for Research and Advanced Studies, Dhablan, P.G. Department of Agriculture, G.S.S.D.G.S. Khalsa college, Patiala during rabi season of 2021-22 to evaluate the production and economic potential of chickpea (*Cicer arietinum* L.) and mustard (*Brassica juncea* L.) crop in chickpea-mustard intercropping system. The study included ten treatments with two sole crops (chickpea and mustard) and eight different row ratios of chickpea: mustard (3:1, 4:1, 5:1, 6:1, 3:2, 4:2, 5:2 and 6:2). The experiment was conducted in randomized block design with three replications. Results revealed that, sole chickpea recorded higher yield components viz. no. of pods plant<sup>-1</sup>, no. of seeds pod<sup>-1</sup>, seed, straw, biological yield and harvest index. Among the intercropping, these components were found higher under chickpea: mustard (6:1) row ratio. With respect to mustard crop, the yield components viz. seed, straw, biological yield and harvest index were found higher in sole mustard and no. of siliquae plant<sup>-1</sup>, no. of seeds siliquae<sup>-1</sup> were found maximum under chickpea: mustard (6:1) row ratio. The highest gross return (Rs. 117046.00 ha<sup>-1</sup>), net return (Rs. 83317.62 ha<sup>-1</sup>), B:C ratio (2.47) and land equivalent ratio (1.24) was obtained from chickpea: mustard (5:2) row ratio.*

**Key words:** Chickpea, Intercropping, Mustard, Row ratio, Return

### **Introduction**

Chickpea is the most important pulse crop and is cultivated in almost all parts of the country. It is the second important pulse crop in the world. With its high nutritional value and high-quality protein content, it is suited both for animal feed and as human diet. Chickpea being a leguminous crop has the ability to fix atmospheric nitrogen with the help of biological nitrogen fixation bacteria which is beneficial economically and environmentally. Mustard is the major oilseed crop of semi-arid areas of India. It is a taller plant with broader canopy. The seeds and oil are the valuable parts of mustard crop.

Mustard oil is used for cooking, frying purposes and for the preparation of hair oils. Mustard has been found successfully intercropped with chickpea under various agro climatic zones of the country. Chickpea cultivation with mustard crop increases the production and profitability.

Intercropping is growing of two or more crops simultaneously on the same piece of land with a definite row proportion (Reddy and Reddy 2007). Spatial arrangements plays an important role with respect to the competition between the components crops and their productivity. (Pandhi and Panigaragi,

2006). Mustard plant due to its taller nature imposed greater competition for light than chickpea plant so a tall plant at top for high light intensity and a compact chickpea at bottom for low light intensity can lead to efficient use of light for higher yield. Basically, intercropping system helps in reducing risk from epidemic of insect and disease, and overcoming the effect of unfavourable environmental conditions in agro-climatologically less stable regions along with better utilization of solar radiation and inputs like fertilizer and water compared to crops in sole system.

#### Materials and Methods

The field experiment was conducted at Campus for Research and Advanced studies, Dhablan, P.G. Department of Agriculture, G.S.S.D.G.S. Khalsa college, Patiala during *rabi* season of 2021-2022. The experiment was laid out in randomized block design with 10 treatments comprising two sole crops (chickpea and mustard) and eight row ratios of chickpea: mustard (3:1, 4:1, 5:1, 6:1, 3:2, 4:2, 5:2 and 6:2) with three replications. The soil sample was taken from the experimental field before the sowing of crops and analysed for physical and chemical properties. Soil was clayey in texture with basic pH of (7.4), medium organic carbon (0.53 %), medium available nitrogen (290.04 kg ha<sup>-1</sup>), medium available phosphorous (17.3 kg ha<sup>-1</sup>) and medium available potassium (156.15 kg ha<sup>-1</sup>). The area received average rainfall of 22.9 mm during the cropping period. The crops were sown on 26 October 2021 with ideal spacing of 30 cm row to row and 10 cm plant to plant. Common fertilizer dose of 32:123:0 (N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O kg ha<sup>-1</sup>) to chickpea and 214:185:0 (N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O kg ha<sup>-1</sup>) to mustard was applied based on population in each treatment. The cultivars used in the study were PBG 5 (chickpea) and T 59 (mustard) with seed rate of 59 kg ha<sup>-1</sup> for chickpea and 3.7 kg ha<sup>-1</sup> for mustard crop. Crops were raised under protective irrigation. Chickpea was protected with coragen against pod borer during heavy attack. The crops were harvested depending on their maturation period on 4 March 2022 for mustard and 8 April 2022 for chickpea.

### Results and Discussion

#### Yield attributes (Chickpea)

##### Number of pods plant<sup>-1</sup>

The data related to number of pods plant<sup>-1</sup> in Table 1 revealed that significantly higher number of pods plant<sup>-1</sup> was recorded in sole chickpea which was statistically at par with chickpea: mustard (6:1) row ratio. Among intercropping treatments, chickpea: mustard (6:1) row ratio shows significantly higher results but statistically at par with chickpea: mustard (5:1) row ratio. The lowest number of pods plant<sup>-1</sup> was recorded in chickpea: mustard (3:2) row ratio. This might be due to lesser inter-crop competition, higher photosynthetic active radiation available to the crops leading to higher production of photosynthates which together favourably influenced the yield attributing parameters. This finding is in conformity with the results of Tripathi *et al.* (2005b).

##### Number of seeds pod<sup>-1</sup>

The data revealed that the number of seeds pod<sup>-1</sup> was not influenced significantly by different intercropping row ratios. The data related to number of seeds pod<sup>-1</sup> was presented in Table 1. These results are similar with the findings of Abraham *et al.* (2010).

Table 1: Effect of intercropping system on yield attributes of chickpea.

| Treatments                                | Yield attributes                |                                |
|-------------------------------------------|---------------------------------|--------------------------------|
|                                           | No. of pods plant <sup>-1</sup> | No. of seeds pod <sup>-1</sup> |
| T <sub>1</sub> : Sole Chickpea            | 39.61                           | 2.45                           |
| T <sub>3</sub> : Chickpea: mustard (3:1)  | 28.72                           | 1.54                           |
| T <sub>4</sub> : Chickpea: mustard (4:1)  | 30.17                           | 1.57                           |
| T <sub>5</sub> : Chickpea: mustard (5:1)  | 34.99                           | 1.88                           |
| T <sub>6</sub> : Chickpea: mustard (6:1)  | 36.09                           | 2.22                           |
| T <sub>7</sub> : Chickpea: mustard (3:2)  | 24.60                           | 1.36                           |
| T <sub>8</sub> : Chickpea: mustard (4:2)  | 29.39                           | 1.56                           |
| T <sub>9</sub> : Chickpea: mustard (5:2)  | 31.05                           | 1.62                           |
| T <sub>10</sub> : Chickpea: mustard (6:2) | 32.50                           | 1.77                           |
| SEm (±)                                   | 0.35                            | 0.12                           |
| CD (5%)                                   | 1.02                            | NS                             |

#### Yield characters (Chickpea)

##### Seed yield (q ha<sup>-1</sup>)

The maximum seed yield was recorded in sole chickpea which was significantly higher than

all other treatments of chickpea: mustard row ratios. Among all the intercropping combinations, (6:1) chickpea: mustard row ratio showed significantly higher seed yield and was at par with chickpea: mustard (5:1) row ratio. Lowest seed yield was recorded in chickpea: mustard (3:2) row ratio. The data related to seed yield was presented in Table 2. Maximum seed yield was recorded under sole chickpea because of a greater number of plant population in sole Chickpea, better nodule formation, no competition from intercrop, less disturbance of habitat and also due to higher yield attributes. These results are similar with findings of Kumar and Nandan (2007).

#### **Straw yield ( $q\ ha^{-1}$ )**

Straw yield of chickpea was recorded maximum in sole chickpea (Table 2) and was significantly higher than all other treatments of chickpea: mustard row ratios. Among all the intercropping treatments, chickpea: mustard (6:1) row ratio recorded highest straw yield and was at par with chickpea: mustard (5:1) row ratio. Lowest straw yield was recorded in chickpea: mustard (3:2) row ratio. Higher straw yield was due to higher population and total dry matter production per unit area of chickpea. Similar findings are reported by Kumar and Nandan (2007).

#### **Biological yield ( $q\ ha^{-1}$ )**

The maximum biological yield was recorded in sole chickpea and was significantly higher than all other treatments of chickpea: mustard row ratios. Among all the intercropping treatments, maximum biological yield was found in chickpea: mustard (6:1) row ratio and was at par with chickpea: mustard (5:1) row ratio. Lowest biological yield was recorded in chickpea: mustard (3:2) row ratio (Table 2). The results were supported by Kumar and Nandan (2007).

#### **Harvest index (%)**

The harvest index of chickpea was found maximum in sole chickpea and was significantly higher than all other intercropping treatments (Table 2). This was mainly due to higher seed and straw yield of chickpea possibly due to better growth, increased number of pods  $plant^{-1}$ , seeds  $pod^{-1}$  and increased plant density per unit area as compared to other intercropping treatments. Among different intercropping treatments, chickpea: mustard (6:1) gives highest harvest index and was at par with chickpea: mustard (5:1) row ratio. Lowest harvest index was recorded in chickpea: mustard (3:2) row ratio. Similar results were found by Tripathi *et al.* (2005b).

Table 2: Effect of intercropping system on yield characters of chickpea

| Treatments                                | Yield characters               |                                 |                                      |                      |
|-------------------------------------------|--------------------------------|---------------------------------|--------------------------------------|----------------------|
|                                           | Seed yield<br>( $q\ ha^{-1}$ ) | Straw yield<br>( $q\ ha^{-1}$ ) | Biological yield<br>( $q\ ha^{-1}$ ) | Harvest index<br>(%) |
| T <sub>1</sub> : Sole Chickpea            | 17.85                          | 20.17                           | 38.02                                | 46.95                |
| T <sub>3</sub> : Chickpea: mustard (3:1)  | 15.20                          | 17.57                           | 32.77                                | 46.39                |
| T <sub>4</sub> : Chickpea: mustard (4:1)  | 16.28                          | 18.64                           | 34.92                                | 46.62                |
| T <sub>5</sub> : Chickpea: mustard (5:1)  | 16.73                          | 19.07                           | 35.80                                | 46.73                |
| T <sub>6</sub> : Chickpea: mustard (6:1)  | 16.79                          | 19.11                           | 35.90                                | 46.77                |
| T <sub>7</sub> : Chickpea: mustard (3:2)  | 12.75                          | 15.19                           | 27.94                                | 45.63                |
| T <sub>8</sub> : Chickpea: mustard (4:2)  | 13.90                          | 16.32                           | 30.22                                | 45.99                |
| T <sub>9</sub> : Chickpea: mustard (5:2)  | 15.30                          | 17.65                           | 32.95                                | 46.44                |
| T <sub>10</sub> : Chickpea: mustard (6:2) | 15.09                          | 17.48                           | 32.57                                | 46.33                |
| Sem ( $\pm$ )                             | 0.02                           | 0.02                            | 0.04                                 | 0.03                 |
| CD (5%)                                   | 0.06                           | 0.06                            | 0.10                                 | 0.10                 |

**Yield attributes (Mustard)****Number of siliquae plant<sup>-1</sup>**

The maximum number of siliquae plant<sup>-1</sup> was found in chickpea: mustard (6:1) row ratio which was significantly higher than all the other intercropping treatments (Table 3). As in intercropping, mustard has the advantage as it is

Table 3: Effect of intercropping system on yield attributes of mustard

| Treatments                                | Yield attributes                    |                                     |
|-------------------------------------------|-------------------------------------|-------------------------------------|
|                                           | No. of siliquae plant <sup>-1</sup> | No. of seeds siliquae <sup>-1</sup> |
| T <sub>2</sub> : Sole Mustard             | 239.84                              | 10.08                               |
| T <sub>3</sub> : Chickpea: mustard (3:1)  | 243.86                              | 10.54                               |
| T <sub>4</sub> : Chickpea: mustard (4:1)  | 248.18                              | 11.28                               |
| T <sub>5</sub> : Chickpea: mustard (5:1)  | 249.68                              | 11.60                               |
| T <sub>6</sub> : Chickpea: mustard (6:1)  | 250.70                              | 11.80                               |
| T <sub>7</sub> : Chickpea: mustard (3:2)  | 241.87                              | 10.38                               |
| T <sub>8</sub> : Chickpea: mustard (4:2)  | 244.98                              | 10.68                               |
| T <sub>9</sub> : Chickpea: mustard (5:2)  | 246.12                              | 10.80                               |
| T <sub>10</sub> : Chickpea: mustard (6:2) | 247.26                              | 11.12                               |
| Sem (±)                                   | 0.05                                | 0.08                                |
| CD (5%)                                   | 0.15                                | 0.19                                |

more exposed to the sun and component crop suffers more as it grows under the mustard canopy. Lowest number of siliquae plant<sup>-1</sup> was obtained from sole mustard. Similar results were reported by Kumar and Singh (2006).

**Number of seeds siliquae<sup>-1</sup>**

Number of seeds siliquae<sup>-1</sup> was found maximum in chickpea: mustard (6:1) row ratio and was significantly higher than all the other intercropping treatments and was statistically at par with Chickpea: mustard (6:1) row ratio. Lowest number of seeds siliquae<sup>-1</sup> of was found in sole mustard. The results of this investigation also get supported from those obtained by Kumar and Singh (2006). The data related to number of siliquae plant<sup>-1</sup> of mustard was shown in Table 3.

**Yield characters (Mustard)****Seed yield (q ha<sup>-1</sup>)**

The highest seed yield was recorded in sole mustard and was significantly higher than all other treatments of chickpea: mustard row ratios (Table 4). This might be due to higher plant population under sole mustard and limited disturbance of habitat. Among all the intercropping treatments, chickpea: mustard (3:2) row ratio recorded highest seed yield. The higher yield in (3:2) row ratio might be due to higher population per unit area of mustard at maturity. Lowest seed yield was recorded in chickpea: mustard (6:1) row ratio. These results are

Table 4: Effect of intercropping system on yield characters of mustard

| Treatments                                | Yield characters                 |                                   |                                        |                   |
|-------------------------------------------|----------------------------------|-----------------------------------|----------------------------------------|-------------------|
|                                           | Seed yield (q ha <sup>-1</sup> ) | Straw yield (q ha <sup>-1</sup> ) | Biological yield (q ha <sup>-1</sup> ) | Harvest index (%) |
| T <sub>2</sub> : Sole mustard             | 18.74                            | 44.95                             | 63.69                                  | 29.43             |
| T <sub>3</sub> : Chickpea: mustard (3:1)  | 5.30                             | 15.86                             | 21.16                                  | 25.05             |
| T <sub>4</sub> : Chickpea: mustard (4:1)  | 3.78                             | 12.05                             | 15.83                                  | 23.88             |
| T <sub>5</sub> : Chickpea: mustard (5:1)  | 3.51                             | 11.36                             | 14.87                                  | 23.60             |
| T <sub>6</sub> : Chickpea: mustard (6:1)  | 3.07                             | 10.12                             | 13.19                                  | 23.27             |
| T <sub>7</sub> : Chickpea: mustard (3:2)  | 8.10                             | 22.85                             | 30.95                                  | 26.17             |
| T <sub>8</sub> : Chickpea: mustard (4:2)  | 7.20                             | 20.34                             | 27.54                                  | 26.14             |
| T <sub>9</sub> : Chickpea: mustard (5:2)  | 7.12                             | 20.14                             | 27.26                                  | 26.11             |
| T <sub>10</sub> : Chickpea: mustard (6:2) | 5.60                             | 16.20                             | 21.80                                  | 25.69             |
| SEm (±)                                   | 0.02                             | 0.01                              | 0.02                                   | 0.09              |
| CD (5%)                                   | 0.05                             | 0.02                              | 0.05                                   | 0.28              |

similar with the findings of Kumar and Nandan (2007).

**Straw yield ( $q\ ha^{-1}$ )**

Maximum straw yield was obtained from sole mustard which was significantly higher than all the other intercropping treatments (Table 4). It was obvious due to a greater number of plant population in sole than intercropping. Among the intercropping row ratios, chickpea: mustard (3:2) row ratio recorded highest straw yield. Minimum straw yield was found in chickpea: mustard (6:1) row ratio. Similar results were obtained by Ahlawat *et al.* (2005a).

**Biological yield ( $q\ ha^{-1}$ )**

Sole mustard produced maximum biological yield which was significantly higher than all the other intercropping treatments (Table 4). Among the intercropping combinations, highest biological yield was recorded in chickpea: mustard (3:2) row ratio. Lowest biological yield was obtained in chickpea: mustard (6:1) row ratio. Similar results were also recorded by Thakur *et al.* (2000).

**Harvest index (%)**

The harvest index of mustard was found maximum in sole mustard (Table 4). This was mainly due to more plant population of mustard as compared to other intercropping treatments. Among the intercropping treatments, maximum harvest index

was observed in chickpea: mustard (3:2) row ratio and was at par with chickpea: mustard (4:2) and chickpea: mustard (5:2) row ratios. Lowest harvest index was found in chickpea: mustard (6:1) row ratio. These results were similar with the findings of Vinaykant (2005).

**Economics ( $Rs.\ ha^{-1}$ )**

From the different combinations of intercropping of chickpea with mustard, the highest gross return, net return and benefit cost ratio was recorded in chickpea: mustard (5:2) row ratio than all other treatments of sole and intercropping combinations (Table 5). This was mainly due to higher combined economic yield and better price structure for chickpea and mustard. However, lowest gross return, net return and benefit cost ratio was recorded in sole chickpea. Similar results were also reported by Sharma *et al.* (2012).

**Land equivalent ratio (LER)**

Maximum LER was obtained from chickpea: mustard (5:2) row ratio, which was higher than all the other row combinations. Lowest LER was obtained from chickpea: mustard (6:1) row ratio. This was as a result of surge in combined seed yield of component crop in intercroppingsystem with little effect on the yield of main crop. The data related to land equivalent ratio was shown in the Table 5.

Table 5: Effect of inter cropping system on gross return ( $Rs.\ ha^{-1}$ ), net return ( $Rs.\ ha^{-1}$ ), B:C and land equivalent ratio (LER)

| Treatments                                | Economics                                 |                                    |                                  |           |      |
|-------------------------------------------|-------------------------------------------|------------------------------------|----------------------------------|-----------|------|
|                                           | Cost of cultivation<br>( $Rs.\ ha^{-1}$ ) | Gross return<br>( $Rs.\ ha^{-1}$ ) | Net return<br>( $Rs.\ ha^{-1}$ ) | B:C ratio | LER  |
| T <sub>1</sub> : Sole chickpea            | 34496.26                                  | 94605.00                           | 60108.74                         | 1.74      | 1.00 |
| T <sub>2</sub> : Sole mustard             | 31810.20                                  | 94637.00                           | 62826.80                         | 1.98      | 1.00 |
| T <sub>3</sub> : Chickpea: mustard (3:1)  | 33824.61                                  | 107325.00                          | 73500.39                         | 2.17      | 1.13 |
| T <sub>4</sub> : Chickpea: mustard (4:1)  | 33959.00                                  | 105373.00                          | 71414.00                         | 2.10      | 1.11 |
| T <sub>5</sub> : Chickpea: mustard (5:1)  | 34047.76                                  | 106394.50                          | 72346.74                         | 2.12      | 1.12 |
| T <sub>6</sub> : Chickpea: mustard (6:1)  | 34112.15                                  | 104490.50                          | 70378.35                         | 2.06      | 1.10 |
| T <sub>7</sub> : Chickpea: mustard (3:2)  | 33402.48                                  | 108480.00                          | 75077.52                         | 2.25      | 1.15 |
| T <sub>8</sub> : Chickpea: mustard (4:2)  | 33597.92                                  | 110030.00                          | 76432.08                         | 2.27      | 1.16 |
| T <sub>9</sub> : Chickpea: mustard (5:2)  | 33728.38                                  | 117046.00                          | 83317.62                         | 2.47      | 1.24 |
| T <sub>10</sub> : Chickpea: mustard (6:2) | 33824.61                                  | 108257.00                          | 74432.39                         | 2.20      | 1.14 |

Similar results were shown by Kumar *et al.* (2006).

### Conclusion

It can be concluded that, intercropping of chickpea: mustard at (5:2) row ratio was found to be more productive and profitable intercropping system as it recorded higher net return, gross return, benefit cost ratio and land equivalent ratio compared to other intercropping treatments. Thus, by raising intercrops not only gives additional yield but higher net return was also generated. Mustard has been found to be promising and compatible crop for intercropping with chickpea at chickpea: mustard (5:2) row ratio, which increased the income considerably without any additional land.

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