The Pharma Innovation Journal 2022; 11(10): 849-853

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(10): 849-853

www.thepharmajournal.com
Received: 23-08-2022
Accepted: 27-09-2022

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# Yield and economics of chickpea (*Cicer arietinum* L.*)* as influenced by different chickpea based intercropping system in Chhattisgarh plains

**Sumit, GP Banjara, Sunil Kumar, Amit, Mahanand Sahu and Pallavi Porte**

**Abstract**
A field experiment was conducted during two consecutive *Rabi* seasons of 2020-21 and 2021-22 at Instructional-cum-Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur, (C.G.). The experiment field was laid out in Randomized Block Design, having four replications, each containing 9 treatments *i.e.* sole chickpea, sole linseed, sole safflower, sole wheat, sole mustard, chickpea + linseed (6:2), chickpea + safflower (6:2), chickpea + wheat (6:2) and chickpea + mustard. Results revealed that the maximum seed and Stover yield, harvest index, chickpea equivalent yield was registered under sole chickpea as compared to others during both the years and on mean basis. Among the intercropping the maximum land equivalent yield, gross return, net return and benefit cost ratio was noted under chickpea + linseed (6:2) intercropping system as compared to other intercropping system during both the years and on mean basis.

**Keywords:** Chickpea, intercropping, seed yield, gross return, net return, B: C ratio

## Introduction
Chickpea (*Cicer arietinum* L.) is the most important winter season pulse crop. It is a source of protein and it plays an important role in human nutrition for large population in the developing world. Chickpea valued for its nutritive seeds with high protein content 18-22%, carbohydrate 52-70%, fat 4-10%, minerals like (calcium, phosphorus and iron) and vitamins. Chickpea is the second most important pulse crop after pigeon pea in the world for human diet and other use. It is cultivated in area of 149.66 lakh ha with a total production of 162.25 lakh tonnes and average productivity of 1252 kg $ha^{-1}$ (FAO, 2020). Chickpea is an important pulse crop in India grown as a dry pulse crop or as a green vegetable with the farmer use being most common. In India it is grown over an area of 99.96 lakh hectare during 2021 with production of 119.11 lakh tonnes and average productivity of 1092 kg $ha^{-1}$ (Anonymous, 2021) [2]. Madhya Pradesh, Uttar Pradesh, Rajasthan, Maharashtra, Gujarat, Andhra Pradesh and Karnataka are the major chickpea producing states sharing over 95% area. Chhattisgarh state has good agro-ecological situation for chickpea production. In state it is grown over an area of 3.01 lakh hectares with an annual production of 2.67 lakh tonnes and an average productivity of 887 kg $ha^{-1}$ (Anonymous, 2021) [2]. Chickpea additionally performs a major function in improving soil fertility because of its nitrogen fixing ability. Chickpea can restore as much as a 140 kg N $ha^{-1}$ in a crop growing period (Poonia and Pithia, 2013) [17]. Chickpea is historically grown as a mixed crop with numerous plants like wheat, mustard, linseed, barley, spices etc. In Chhattisgarh, chickpea is main crop growing after rice. Major chickpea growing districts in Chhattisgarh are Rajnandgaon, Bemetara, Mungeli, Balod, Janjgir-champa Raipur, Durg, Kawardha, Korba, Bilaspur, Balod, Dhamtari, Baloda Bazar and Raigarh. Intercropping has gained interest because of potential advantages it offers over yielding, i.e. improved utilization of growth resources by the crops and improved reliability from season to season (Lithourgidis *et al.*, 2011) [12]. The principal gain of intercropping is the greater green usage of the to be had sources and the accelerated productiveness as compared with every sole crop of the mixture (Jannasch and Martin, 1999, Willey, 1979;; Li *et al.*, 1999; Mucheru *et al.*, 2010 and Hauggaard and Jensen, 2001) [6, 26, 11, 16, 5]. A possibility to yield for assessing the benefits of intercropping is to use units together with monetary units or nutritional values which may be in addition applied to component crops (Willey, 1985) [25]. Yield benefit happens due to the fact growth sources together with light, water, and vitamins are greater absolutely absorbed and

transformed to crop biomass via way of means of the intercrop over the time and space because of variations in aggressive capacity for growth sources among the component crops, which make the most the variation of the mixed crop in characteristics together with rates of canopy development, very final canopy size (width and height), photosynthetic adaptation of canopies to irradiance conditions, and rooting depth depth (Midmore, 1993; Morris and Garrity, 1993) [14, 15].

**Material and Methods**

A field experiment was conducted during *Rabi* season 2020-21 and 2021-22 at Instructional-cum-Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). Raipur comes under the Chhattisgarh plains agro climatic sub zone and having dry moist to sub humid climatic condition. It gets an annual rainfall of 1326 mm (Based on 80 years mean). About 85% of that is obtained at some stage in middle of June to end of September and little amount in October to May. May and December are the most hot and coolest months, respectively. The soil of the experimental field was clay *(Vertisols)* in texture. The soil was neutral (7.1 and 7.1 pH) reaction during 2020-21 and 2021-22. It had low in nitrogen (213.34 and 213.89 kg ha$^{-1}$) medium in phosphorus (13.78 and 13.96 kg ha$^{-1}$) and high potassium (315.45 and 316.20 kg ha$^{-1}$) contents during both years of experiment. The test consist of nine treatment. the test variety used in experiment Indira Chana -1 of chickpea, RLC-153 of linseed, CG Kusum-1 of safflower, GW366 of wheat and Pusa bold of mustard. The crop was sown during last week of November and harvesting is done in second week of March.

**Harvest index (%)**

$$\text{HI (\%)} = \frac{\text{Seed yield kg ha}^{-1}}{\text{Biological yield kg ha}^{-1}} \text{ x } 100$$

**Net monetary returns (Rs. ha$^{-1}$)**

Net return (Rs. ha$^{-1}$) = Gross return – Cost of cultivation

**Benefit: Cost Ratio**

$$\text{B: C ratio} = \frac{\text{Gross returns (Rs ha}^{-1})}{\text{Cost of cultivation (Rs ha}^{-1})}$$

**Result and Discussion**

**Seed yield**

The data with respect to seed yield of chickpea are presented in Table 1. It is clear from the data that seed yield was significantly affected due to different chickpea based intercropping system during both the years and on mean basis. Significantly highest seed yield (1638 and 1673 kg ha$^{-1}$) was registered under the sole chickpea during both the years and on mean basis. As regard to intercropping treatments, they were found at par to each other during both the years and on mean basis. However, among intercropping, the maximum seed yield was noted under chickpea + linseed (6:2) intercropping system during both the years and on mean basis. The lowest seed yield of chickpea was observed under chickpea + mustard (6:2) intercropping system during 2020-21 and on mean basis as well as chickpea + wheat (6:2) intercropping system during 2021-22. This might be due to lesser inter-crop competition, higher nutrient availability, higher photosynthetic active radiation and latent heat available to the crops leading to higher production of photosynthates which together favourable influenced the yield attributing parameters. Similar results were reported by Ahlawat *et al.* (2005) [1], Kumar and Singh (2006) [8] and Kumar and Sharma (2006) [9]. Torkaman *et al.* (2018) [23] also stated that higher seed yield with sole chickpea was mainly due to the higher population per unit area and less disturbance to the microclimate of the chickpea.

**Stover yield**

The data on stover yield was significantly influenced by different chickpea based intercropping system during both the years and on mean basis (Table 1). Significantly highest stover yield (2570 and 2694 kg ha$^{-1}$) was registered under the sole chickpea as compared to other treatments during both the years and on mean basis. All intercropping treatments were found at par to each other during both the years and on mean basis. However, among intercropping, the maximum stover yield was noted under chickpea + linseed (6:2) intercropping system during both the years and on mean basis. The lowest seed yield of chickpea was observed under chickpea + safflower (6:2) intercropping system during 2020-21 and on mean basis as well as chickpea + wheat (6:2) intercropping system during 2021-22.

This might be due to more number of plant population in sole than intercropping. Similar result was found that Kumar and Nandan (2007) [9]. Wasu *et al.* (2013) [28] reported that the increase in stover yields was possibly due to better growth of crop.

**Harvest index (%)**

The data on harvest index as influenced by different treatments are presented in Table 1. The perusal of data reveals that the harvest index of chickpea was found non-significant due to different chickpea based intercropping system during both the years but it was found significant during mean basis. The significantly highest harvest index was recorded under sole chickpea as compared to others. As regard to intercropping treatments, they were found at par to each other on mean basis. However, among intercropping, the maximum harvest index was noted under chickpea + safflower (6:2) intercropping system and the lowest harvest index was recorded under chickpea + mustard (6:2) intercropping system. Similar result was found by Thakur *et al.* (2000) [22] and Tripathi *et al.* (2005) [24]

**Chickpea equivalent yield**

The data on chickpea equivalent yield as influenced by different chickpea based intercropping system during both the years and on mean basis are presented in Table 2. Among different treatments, chickpea + safflower (6:2) intercropping system registered the highest chickpea equivalent yield (1763.14, 1792.15 and 1777.65 kg ha$^{-1}$) as compared to other intercropping system during both the years and on mean basis. However, it was statistically similar to chickpea + linseed (6:2) intercropping system during both the years and on mean basis as well as chickpea + mustard (6:2) intercropping system during 2021-22. The lowest chickpea equivalent yield (930.02, 929.51 and 929.76 kg ha$^{-1}$) was noted under chickpea + wheat (6:2) intercropping system during both the years and on mean basis. This might be due to higher grain yields of

component crops owing to optimum nutrient availability coupled with higher price of both the crops which contributed to higher chickpea equivalent yield. This finding is in conformity with the results of Dubey *et al.* (1991) [3], Sharma *et al.* (2010) [18]. Kaushik *et al.* (2016) [7] also reported that the wheat + chickpea (6:2) intercropping system produced significantly higher wheat equivalent yield. The lowest chickpea equivalent yield was found under sole wheat. This might be due to the poor yield of wheat associated with these intercrops due to more shading effect (Zafaranieh, 2015) [27].

**Land equivalent ratio (LER)**

The data on land equivalent ratio of chickpea as influenced by different chickpea based intercropping system during both the years and on mean basis are presented in Table 2. Among different chickpea based intercropping system, all the intercropping treatments, recorded land equivalent ratio value more than one whereas, the maximum value of land equivalent ratio was noted under chickpea + linseed (6:2) intercropping system and least value was recorded under chickpea + wheat (6:2) intercropping system during both the years and on mean basis. Sharma *et al.* (2008) [29] also reported the maximum land equivalent ratio under maize + legume intercropping system.

**Cost of cultivation**

The data presented in Table 3 pertains to cost of cultivation as influenced by different chickpea based intercropping systems during both the years and on mean basis. Among the different chickpea based intercropping system, the maximum cost of cultivation was noted under sole.

**Table 1:** Seed yield, Stover yield and harvest index of chickpea as influenced by different chickpea based intercropping system

| Treatment | Seed yield (kg ha$^{-1}$) | | | Stover yield (kg ha$^{-1}$) | | | Harvest index (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2020-21 | 2021-22 | Mean | 2020-21 | 2021-22 | Mean | 2020-21 | 2021-22 | Mean |
| Sole chickpea | 1637.50 | 1673.00 | 1655.25 | 2693.50 | 2570.00 | 2631.75 | 37.82 | 39.42 | 38.62 |
| Sole linseed | - | - | - | - | - | - | - | - | - |
| Sole safflower | - | - | - | - | - | - | - | - | - |
| Sole wheat | - | - | - | - | - | - | - | - | - |
| Sole mustard | - | - | - | - | - | - | - | - | - |
| Chickpea + linseed (6:2) | 1389.00 | 1400.75 | 1394.88 | 2335.00 | 2325.00 | 2330.00 | 37.32 | 37.61 | 37.47 |
| Chickpea + safflower (6:2) | 1331.50 | 1360.25 | 1345.88 | 2220.50 | 2251.25 | 2235.88 | 37.50 | 37.66 | 37.58 |
| Chickpea + wheat (6:2) | 1333.50 | 1358.75 | 1346.13 | 2259.25 | 2217.75 | 2238.50 | 37.11 | 38.02 | 37.57 |
| Chickpea + mustard (6:2) | 1325.50 | 1361.50 | 1343.50 | 2243.50 | 2243.50 | 2243.50 | 37.13 | 37.78 | 37.46 |
| SEm ± | 25.83 | 26.64 | 17.76 | 44.20 | 42.83 | 32.31 | 0.44 | 0.56 | 0.26 |
| CD (P=0.05) | 75.75 | 78.13 | 52.09 | 129.65 | 125.63 | 94.77 | NS | NS | 0.76 |

**Table 2:** Chickpea equivalent yield and LER of chickpea as influenced by different chickpea based intercropping system

| Treatment | Chickpea equivalent yield (kg ha$^{-1}$) | | | LER | | |
|---|---|---|---|---|---|---|
| | 2020-21 | 2021-22 | Mean | 2020-21 | 2021-22 | Mean |
| Sole chickpea | 1637.50 | 1673.00 | 1655.25 | - | - | - |
| Sole linseed | 967.38 | 996.18 | 981.78 | - | - | - |
| Sole safflower | 1456.19 | 1421.84 | 1439.01 | - | - | - |
| Sole wheat | 730.02 | 715.94 | 722.98 | - | - | - |
| Sole mustard | 978.49 | 982.88 | 980.69 | - | - | - |
| Chickpea + linseed (6:2) | 1717.00 | 1741.72 | 1729.36 | 1.21 | 1.19 | 1.20 |
| Chickpea + safflower (6:2) | 1763.14 | 1752.96 | 1758.05 | 1.11 | 1.12 | 1.12 |
| Chickpea + wheat (6:2) | 1544.36 | 1540.29 | 1542.33 | 1.10 | 1.09 | 1.10 |
| Chickpea + mustard (6:2) | 1649.32 | 1649.02 | 1649.17 | 1.14 | 1.17 | 1.16 |
| SEm ± | 37.25 | 32.52 | 33.39 | - | - | - |
| CD (P=0.05) | 109.24 | 95.39 | 97.93 | - | - | - |

**Table 3:** Cost of cultivation, grass return, net return and B: C ratio of chickpea as influenced by different chickpea based intercropping system

| Treatment | Cost of cultivation (Rs. ha$^{-1}$) | | | Grass return (Rs. ha$^{-1}$) | | | Net return (Rs. ha$^{-1}$) | | | B:C ratio | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2020-21 | 2021-22 | Mean | 2020-21 | 2021-22 | Mean | 2020-21 | 2021-22 | Mean | 2020-21 | 2021-22 | Mean |
| Sole chickpea | 25395 | 26886 | 26141 | 85215 | 90463 | 87839 | 59820 | 63577 | 61699 | 3.36 | 3.36 | 3.36 |
| Sole linseed | 20747 | 22787 | 21767 | 47507 | 55791 | 51649 | 26760 | 33754 | 30257 | 2.29 | 2.53 | 2.41 |
| Sole safflower | 22634 | 23924 | 23279 | 74398 | 76061 | 75229 | 51764 | 52137 | 51951 | 3.29 | 3.18 | 3.23 |
| Sole wheat | 26483 | 27773 | 27128 | 47380 | 62627 | 55004 | 20898 | 34854 | 27876 | 1.79 | 2.25 | 2.02 |
| Sole mustard | 23366 | 24657 | 24012 | 50815 | 53589 | 52202 | 27450 | 28932 | 28191 | 2.17 | 2.17 | 2.17 |
| Chickpea + linseed (6:2) | 25382 | 26672 | 26027 | 92641 | 95387 | 94014 | 67260 | 68716 | 67988 | 3.65 | 3.58 | 3.61 |
| Chickpea + safflower (6:2) | 25576 | 26866 | 26221 | 91337 | 96888 | 94112 | 65761 | 70022 | 67892 | 3.57 | 3.61 | 3.59 |
| Chickpea + wheat (6:2) | 26314 | 27605 | 26960 | 83299 | 90183 | 86741 | 56985 | 62578 | 59782 | 3.17 | 3.27 | 3.22 |
| Chickpea + mustard (6:2) | 26040 | 27331 | 26686 | 85902 | 91051 | 88476 | 59863 | 63720 | 61791 | 3.30 | 3.33 | 3.32 |
| SEm ± | - | - | - | 1644 | 2057 | 1590 | 1633 | 2048 | 1576 | 0.07 | 0.08 | 0.07 |
| CD (P=0.05) | - | - | - | 4822 | 6034 | 4663 | 4790 | 6007 | 4623 | 0.20 | 0.25 | 0.20 |

Wheat followed by chickpea + wheat (6:2) and chickpea + mustard (6:2) intercropping system and the lowest was recorded under sole linseed during both the years and on mean basis.

**Gross return, net return and B: C ratio**

The data on gross return, net return and benefit cost ratio of chickpea as influenced by different chickpea based intercropping systems during both the years and on mean basis are presented in Table 3. Significantly highest gross return and net return was obtained in chickpea + linseed (6:2) intercropping system, which was at par with chickpea + safflower (6:2) intercropping system but significantly superior over rest of the treatments during both the years and on mean basis. The lowest gross return (Rs. $ha^{-1}$) was recorded under sole wheat during 2020-21 as well as sole mustard during 2021-22 and sole linseed on mean basis.

Significantly higher benefit cost ratio was recorded under chickpea + linseed (6:2) intercropping system during 2020-21 and chickpea + safflower (6:2) intercropping system during 2021-22. Both chickpea + linseed (6:2) and chickpea + safflower (6:2) intercropping systems were statistically similar but superior over rest of the treatments. The lowest benefit cost ratio was recorded under sole wheat during 2020-21 and on mean basis as well as sole mustard during 2021-22. These results were supported by the findings of Singh *et al.* (2017) [20], Meena and Kumar (2017) [13] and Singh *et al.* (2019) [21] who also reported higher gross and net returns under different intercropping systems over sole cropping.

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