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# Productivity of chickpea (*Cicer arietinum* L.) + mustard (*Brassica juncea* L.) intercropping under various row combinations

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**Abstract**
A field experiment entitled "Productivity of chickpea (*Cicer arietinum* L.) + mustard (*Brassica juncea* L.) intercropping under various row combinations" was conducted during *rabi* 2019-20 at Research Farm, Guru Kashi University, Talwandi Sabo, Bathinda (Punjab). The experiment was laid in randomized complete block design. The treatments consisted of sole chickpea, sole mustard, chickpea + mustard (2:1), chickpea + mustard (2:2), chickpea + mustard (4:1) and chickpea + mustard (4:2).
Chickpea can be successfully grown in mustard. Chickpea + mustard intercropping system sown at 2:2 row ratio gave higher plant height of chickpea, whereas, sole chickpea resulted in higher dry matter accumulation, number of branches/plant, number of pods/plant, number of seeds/pod, 1000-seed weight and seed and haulm yields and harvest index of chickpea than other treatments. Chickpea + mustard (4:2) recorded the highest plant height, dry matter accumulation, number of branches/plant, number of siliquae/plant, number of seeds/siliqua, 1000-seed weight of mustard than sole mustard and other row combinations of chickpea + mustard. Chickpea + mustard (4:2) gave 6.87 q/ha seed yield of mustard with additional yield of 9.90 q/ha of chickpea.

**Keywords:** chickpea, intercropping, mustard, row ratio, seed yield and siliquae

## Introduction

Chickpea (*Cicer arietinum* L.), the most important pulse crop of *Rabi* season, is cultivated mainly in semi-arid and warm temperate regions of the world. It is, probably, the highest protein yielding grain legume except groundnut and soybean. The high nutritional value makes chickpea an important food particularly in famine prone areas of the world. Grain legumes (pulses) such as chickpea contain quality protein and are suited both for animal feed as well as for human diet. Chickpea seeds contain 21 per cent protein, 61 per cent carbohydrates and 2.2 per cent oil (Gupta 1988) [9]. The crop, being a legume, can be used to restore fertility in crop rotations (Baldav 1988) [5]. India is the largest producer as well as the consumer of chickpea in the world. In India, it was grown on an area of 10.5 million hectares with a production of 11.2 million tonnes during 2018-2019 (Anonymous 2020a) [3, 4]. In Punjab, it was grown on 2.1 thousand hectares with a production of 2.8 thousand tonnes during 2018-2019 (Anonymous 2020b) [3, 4].

India is fourth largest contributor of oilseeds and rapeseed and mustard (*Brassica juncea* L.) contributes about 28.6% in total oilseeds production. It is third important oilseed in world. Rapeseed mustard were grown on 30.5 thousand ha with a production of 46.5 thousand tonnes, while its productivity was 15.2 q/ha during 2016-17 in Punjab.

The shortage of pulses has aggravated the problem of malnutrition in humans and thus, there is an urgent need for meeting their increasing demand by manipulating the production technologies appropriately. This could be achieved by increasing the area under these crops or by increasing their per unit productivity. The area under pulses does not seem likely to expand, as the land has become limiting factor due to rapid industrialization and urbanization. The solution therefore lies in the second option i.e. in boosting up the productivity of the existing area, which can be achieved, through many ways, of which intercropping is the most important one (Kumar 2008). Intercropping offers an opportunity for efficient utilization of light, water, land and other inputs. As compared to sequential cropping and relay cropping, the practice of intercropping is known to increase the total productivity, because, the crops are able to utilize different resources at a time (Willey 1979) [13, 14]. Intercropping with specific crop species is more productive, profitable and secured than sole cropping. Intercropping of pulses with wheat, mustard, cotton and sugarcane etc. is commonly practised in some parts of India (Sharma *et al.* 1993) [11]. But due to lack of systematic research and adequate technologies in this area the considerable advantages cannot be achieved from intercropping systems.

The way in which crop plants are arranged in the field is usually referred to as planting configuration. Unjustified plant configuration leads to unevenness in competition for resource utilization. The productivity of intercropping system depends, to a large extent, on the nature and extent of plant competition (Harper 1977) [10]. At community level, plant competition can be modified and yield density relationships can be altered by manipulating plant configuration or spatial arrangement (Frappel 1979, Mayers and Foale 1980) [7].
The ability of leguminous crops to use atmospheric nitrogen through biological nitrogen fixation (BNF) is economically more sound and environmentally acceptable. Nitrogen fixation by legumes is further enhanced when associated with cereals as the excessive nitrate in the root zone is utilized by cereals (Fujita *et al.* 1992) [8]. On the other hand, legume mono-cropping accumulates excessive nitrate in the root zone and ultimately decrease N fixation (Anil *et al.* 1998) [2].
Intercropping utilizes the inter space of widely space crop like mustard and chickpea. Chickpea cultivation with mustard crop augments the production and profitability. Chickpea being legume augment the nitrogen nutrition through nitrogen fixation and consequently improve the soil fertility. Further the production and profitability of mustard chickpea intercropping may be increased through the use of optimum dose of fertilizers. Cereal with legume intercropping is common but the work done so far on oilseed and legume intercropping with a suitable nutrient management and proper crop ratio in merge. In association with mustard + chickpea as inter crop with optimum dose of fertilizers improved the yield of both crops. Tanwar *et al.* (2011) [12] replied that mustard + chickpea intercropping with ratio of (1:6) and fertilizer with 100% RFN + full P and K recorded highest yield and net profit. Hence, an experiment was planned to study the production potential of chickpea + mustard intercropping at various row combination.

## Material and Methods

The present investigation entitled **"**Productivity of chickpea (*Cicer arietinum* L.) **+** mustard (*Brassica juncea* L.) intercropping under various row combinations" was conducted at the Students' Research Farm**,** Guru Kashi University, Talwandi Sabo during *Rabi* 2019-20. Talwandi Sabo is located at 29 57'N latitude and 75 7'E longitude and altitude of 213 meters above the sea level. This tract is characterized by semi-arid climate, where both winters and summers are extreme. The meteorological data recorded at the meteorological observatory of the Punjab Agricultural University, regional station, Bathinda during the crop growing season (November to April).
The no. of siliquae/plant were counted from five different selected plant of each plot. The siliquae from each of the five plants were selected and the numbers of seeds were counted and mean value was calculated. The samples of 1000-seed were drawn from each plot after cleaning and weighted with the help of electric balance and mean value was calculated. The seed yield from each plot was recorded after threshing and cleaning and weighted with the help of electric balance, the weight of the seed per plot was recorded in kg, later on it was converted into q/ha. The seed weight per plot was deducted from the total weight of crop biomass from each plot and stover yield in kg/plot was calculated and converted it into q/ha. HI was calculated by dividing economic (grain) yield by the total biological (grain + straw) yield and expressed as percentage.

$$\text{HI (\%)} = \frac{\text{Economic yield}}{\text{Biological yield (Grain + Straw)}} \times 100$$

Five pods were selected at random from each plot. The number of pods were counted and averaged for number of pods plant$^{-1}$. Randomly selected twenty pods were taken from each plot and threshed manually. The number of seeds were counted and averaged for number of seeds pod$^{-1}$. One thousand grains from produce of each plot were taken and their weight was recorded. The thousand grain weight was expressed in grams. The total produce was weighed in bundles after harvesting and threshed thereafter. The weight of grains was recorded. The haulm weight was obtained after deducting the weight of grains from total bundle weight. Grain and haulm yield was computed and expressed as quintal ha$^{-1}$. HI was calculated by dividing economic (seed) yield by the total biological (seed + stover) yield and expressed as percentage.

$$\text{HI (\%)} = \frac{\text{Economic yield}}{\text{Biological yield (Seed + stover)}} \times 100$$

## Results and Discussion

### Yield attributing characters of chickpea

Number of pods/plant of chickpea could significantly influence by chickpea + mustard row ratios (Table 1). The maximum number of pods/plant was recorded in sole chickpea and was significantly higher than all the chickpea + mustard row combinations. This might be due to the highest area under chickpea in sole crop and having no benefit to chickpea from the intercropped mustard. Moreover mustard might have competed with chickpea for nutrients and moisture. The lowest Number of pods/plant of was recorded in chickpea + mustard (2:1) row ratio. The lowest dry matter accumulation in chickpea + mustard (2:1) might be due to more number of rows.

**Table 1:** Yield attributes of chickpea as influenced by chickpea + mustard row combinations

| Treatments | No. of pods/plant | Number of seeds/pod | 1000-seed weight (g) |
|---|---|---|---|
| Sole chickpea | 28.7 | 1.90 | 170.4 |
| Chickpea + mustard (2:1) | 24.5 | 1.80 | 165.1 |
| Chickpea + mustard (2:2) | 25.1 | 1.83 | 163.7 |
| Chickpea + mustard (4:1) | 26.4 | 1.81 | 166.7 |
| Chickpea + mustard (4:2) | 26.7 | 1.80 | 164.5 |
| LSD ($P$=0.05) | 0.9 | NS | NS |

Of mustard giving severe competition to chickpea for nutrients and moisture and proportionally less area under chickpea in this row ratio. These results confirm the findings of Tripathi *et al.*, (2005) and Kumar and Singh (2006) [12].
The data regarding number of seeds/pod of chickpea have been presented in Table 1. The number of seeds/pod of chickpea was not significantly influenced by different chickpea + mustard row combinations. However, numerically highest values of number of seeds/pod were observed in sole chickpea.
The 1000-seed weight of chickpea was not significantly influenced by different chickpea + mustard row combinations (Table 1). However, numerically highest values of 1000- seed weight were observed in sole chickpea.

**Table 2:** Seed yield, haulm yield and harvest index of chickpea as influenced by chickpea + mustard row combinations

| Treatments | Seed yield q/ha) | Haulm yield (q/ha) | Harvest index (%) |
|---|---|---|---|
| Sole chickpea | 13.50 | 21.03 | 39.1 |
| Chickpea + mustard (2:1) | 8.40 | 17.45 | 32.5 |
| Chickpea + mustard (2:2) | 7.83 | 16.41 | 32.3 |
| Chickpea + mustard (4:1) | 10.23 | 18.83 | 35.2 |
| Chickpea + mustard (4:2) | 9.90 | 18.31 | 35.1 |
| LSD (*P*=0.05) | 0.52 | 0.63 | 0.4 |

### Productivity of chickpea

Seed yield of chickpea was significantly influenced by different row ratios of chickpea + mustard intercropping. Data pertaining to the seed yield have been presented in Table 2.

Sole chickpea gave significantly higher seed yield (13.50 q ha$^{-1}$) than all chickpea + mustard row combinations. Among the chickpea + mustard row ratios, chickpea + mustard (4:1) gave significantly higher seed yield than all the chickpea + mustard row ratios except chickpea + mustard (4:2) where it was statistically at par. Seed yield in chickpea + mustard (2:1) and chickpea + mustard (2:2) row ratios (8.40 and 7.83 q ha$^{-1}$, respectively) were statistically at par with each other. The significantly lowest seed yield was obtained in chickpea + mustard (2:2). The highest seed yield in sole chickpea might be due to least competition to the chickpea plants by mustard and also due to proportionally higher area under chickpea. The lowest seed yield in chickpea + mustard (2:2) might be due to proportionally less area under chickpea in this row ratio. These results confirm the findings of Tripathi *et al.*, (2005) and Kumar and Singh (2006) [12].

Haulm yield of chickpea was significantly affected by different chickpea + mustard row ratios (Table 4.8). The highest haulm yield (21.3 q ha$^{-1}$) was obtained in sole chickpea which was significantly higher than all the chickpea + mustard row combinations. It was associated with the higher plant population per unit area in sole stand of both crops. Among the different chickpea + mustard row ratios, the highest haulm yield was obtained in chickpea + mustard (4:1) which was statistically at par with chickpea + mustard (4:2). Haulm yield in chickpea in chickpea + mustard (2:1) and chickpea + mustard (2:2) was statistically at par among each other. These results confirm the findings of Tripathi *et al.*, (2005) and Kumar and Singh (2006) [12].

Harvest index (HI) of chickpea was significantly affected by chickpea + mustard intercropping system. Data pertaining to the harvest index are presented in Table 2. The highest harvest index of chickpea (39.1%) was observed in sole chickpea which was significantly higher than chickpea + mustard (2:1), chickpea + mustard (2:2), chickpea + mustard (4:1) and chickpea + mustard (4:2). Harvest index of chickpea in chickpea + mustard (2:1) and chickpea + mustard (2:2) was statistically at par among each other. Similarly, harvest index of chickpea in chickpea + mustard (4:1) and chickpea + mustard (4:2) was statistically at par among each other.

### Yield attributes of mustard

Number of siliquae/plant of mustard could significantly influenced by chickpea + mustard row ratios (Table 3). The maximum number of siliquae/plant was recorded in chickpea + mustard (4:2) and was significantly higher than all the chickpea + mustard row combinations and it was statistically at par with chickpea + mustard (4:1). Moreover mustard might have competed with chickpea for nutrients and moisture. The lowest number of siliquae/plant of mustard was recorded in sole mustard. These results confirm the findings of Tripathi *et al.*, (2005) and Kumar and Singh (2006) [12].

The number of seeds/siliqua of mustard was significantly influenced by chickpea + mustard row ratios (Table 3). The highest values of number of seeds/siliqua was recorded in chickpea + mustard (4:2) and significantly higher than other row combinations of sole mustard and chickpea + mustard. Sole mustard resulted in the lowest number of seeds/siliqua of mustard. The 1000-seed weight of mustard was significantly influenced by chickpea + mustard row ratios (Table 3). The highest values of 1000- seed weight was recorded in chickpea + mustard (4:2) which was statistically at par with chickpea + mustard (4:1) and significantly higher than other row combinations of sole mustard and chickpea + mustard. Sole mustard resulted in the lowest 1000-seed weight of mustard.

**Table 3:** Yield attributes of mustard as influenced by chickpea + mustard row combinations

| Treatments | No. of siliquae/plant | No. of seeds/siliquae | 1000-Seed weight (g) |
|---|---|---|---|
| Sole mustard | 290.1 | 11.8 | 4.18 |
| Chickpea + mustard (2:1) | 322.4 | 12.5 | 4.29 |
| Chickpea + mustard (2:2) | 330.5 | 13.8 | 4.38 |
| Chickpea + mustard (4:1) | 332.9 | 14.3 | 4.46 |
| Chickpea + mustard (4:2) | 335.9 | 14.9 | 4.49 |
| LSD (*P*=0.05) | 4.2 | 0.4 | 0.07 |

### Productivity of mustard

Seed yield of mustard was significantly influenced by different row ratios of chickpea + mustard intercropping. Data pertaining to the seed yield have been presented in Table 4. Sole mustard gave significantly higher seed yield (11.30 q ha$^{-1}$) than all chickpea + mustard row combinations. Among the chickpea + mustard row ratios, chickpea + mustard (4:2) gave significantly higher seed yield than all the chickpea + mustard row ratios. Seed yield in chickpea + mustard (2:1) and chickpea + mustard (2:2) row ratios (5.42 and 5.92 q ha$^{-1}$, respectively) were statistically at par with each other. The lowest seed yield was obtained in chickpea + mustard (2:1). The highest seed yield in sole mustard might be due to least competition to the mustard plants by chickpea and also due to proportionally higher area under chickpea. The lowest seed yield in chickpea + mustard (2:1) might be due to proportionally less area under mustard in this row ratio. These results confirm the findings of Tripathi *et al.*, (2005) and Kumar and Singh (2006) [12]. Cochran and Schlenter (1995) [6] and Willey and Osiru (1972) [13, 14] reported that intercropped legume fixes N that benefits the system and cereal component that depends heavily on nitrogen for maximum yield. Andrews (1979) [1] also reported that intercropping of legumes with cereals/oilseeds improved the grain yield of the cereals/oilseeds.

Stover yield of mustard was significantly affected by different chickpea + mustard row ratios (Table 4). The highest stover yield (40.5 q ha$^{-1}$) was obtained in sole mustard which was significantly higher than all the chickpea + mustard row combinations. It was associated with the higher plant population per unit area in sole stand of both crops. Among the different chickpea + mustard row ratios, the highest stover yield was obtained in chickpea + mustard (4:2) which was significantly higher than other row combinations of chickpea + mustard. These results confirm the findings of Tripathi *et al.*, (2005) and Kumar and Singh (2006) [12].

**Table 4:** Seed yield, stover yield and harvest index of mustard as influenced by chickpea + mustard row combinations

| Treatments | Seed yield (q/ha) | Stover yield (q/ha) | Harvest index (%) |
|---|---|---|---|
| Sole mustard | 11.30 | 40.5 | 21.8 |
| Chickpea + mustard (2:1) | 5.42 | 17.6 | 23.5 |
| Chickpea + mustard (2:2) | 5.92 | 20.9 | 22.1 |
| Chickpea + mustard (4:1) | 6.29 | 21.7 | 22.5 |
| Chickpea + mustard (4:2) | 6.87 | 23.1 | 22.9 |
| LSD (*P*=0.05) | 0.51 | 0.6 | NS |

Harvest index (HI) of Indian mustard was not significantly influenced by chickpea + mustard row combinations. Data pertaining to the harvest index have been presented in Table 4. Numerically the highest harvest index of mustard (21.8%) was observed in chickpea + mustard (2:1).

## Conclusion

The findings of this study indicate that chickpea can successfully grown in mustard. Chickpea + mustard intercropping system sown at 2:2 row ratio gave higher plant height of chickpea, whereas, sole chickpea resulted in higher number of pods/plant, number of seeds/pod, 1000-seed weight and seed and haulm yields and harvest index of chickpea than other treatments. Chickpea + mustard (4:2) recorded the higher number of siliquae/plant, number of seeds/siliqua, 1000-seed weight of mustard than sole mustard and other row combinations of chickpea + mustard. Chickpea + mustard (4:2) gave 6.87 q/ha seed yield of mustard with additional yield of 9.90 q/ha of chickpea.

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