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# Optimum Ratio of Coriander Intercropping with Onion

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***Authors' contributions***

*This work was carried out in collaboration between all authors. Authors AHMMRT and JR contributed in designing, conducting, statistical analysis, and report writing. Author MMR contributed in monitoring the experiment. Author MB contributed in designing and justifying the experiment. Author MA contributed in report writing and literature searches. All authors read and approved the final manuscript.*

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## ABSTRACT

**Aims:** The main aim of this study was to find out the optimum plant density of onion for intercropping with coriander for higher productivity and economic return.
**Study Design:** The experiment was arranged following randomized complete block design with three replications.
**Place and Duration of Study:** Agronomy Experimental Field of Regional Agricultural Research Station, Jamalpur, Bangladesh during the cropping season *rabi* 2011-2012 and 2012-2013.

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**Methodology:** We broadcast coriander seeds in different ratio with onion. The seeding ratio includes sole onion i.e., 100% onion seed broadcasting, 100% onion + 50% coriander, 100% onion + 40% coriander, 100% onion + 30% coriander and 100% onion + 20% coriander. Onion var. BARI Peaj-1 and Coriander var. BARI Dhania-1 were used in the present experiment. Randomly five onion plants were recorded earlier to collect the yield and yield contributing characteristics. Yield attributes of coriander were also recorded from five plants selected randomly earlier and yield data was recorded considering the whole plot in case of both crops. Onion equivalent yield (OEY) was calculated considering the local market price during the harvesting time.
**Results:** During the both year's maximum onion equivalent yield 13.10 t $ha^{-1}$ and 12.83 t $ha^{-1}$ was obtained from the treatment of 100% onion + 20% coriander followed by 100% onion + 30% coriander intercropping system during the first and second year, respectively. Onion (100%) + 20% coriander gave the highest benefit cost ratio (BCR) of 5.01 and 4.92 in first and second year, respectively followed by sole onion 4.86 and 4.59, respectively while 100% onion + 50% coriander gave the lowest BCR of 3.50 and 3.37 during the first and second year, respectively.
**Conclusion:** From two years result it may be concluded that 100% onion + 20% coriander and 100% onion + 30% coriander seeding ration may be extended in the char land (river flood plain) areas of this region.

*Keywords: Mixed cropping; seeding ratio; benefit cost ratio; onion; coriander*

## 1. INTRODUCTION

Mixed cropping is the practice of growing two or more crops in close proximity. It is a common practice to the farmers of char areas of Bangladesh. Intercropping has been practiced most widely in developing countries [1]. Intercropping has been considered for increasing sustainability of crop production [2]. To increase the productivity, intercropping system should be considered as one of the important approaches of cropping systems. Moreover, it has emerged as an important tool for increasing crop production. Better intercrop production could be achieved through the choice of appropriate crops mixture [3], population density and planting geometry of component species/crops [4]. Among the intercropping practices onion + coriander intercropping practices is common and familiar practices to the farmers of char areas of Bangladesh. The land area covered by spice crops is about 3.38% of the total cultivated land of the country. On the other hand onion has preservative and medicine uses [5]. It has been compared cropping systems over three successive seasons (monsoon, winter, and summer) in India [6]. While investigation on intercropping pepper with onion, garlic (*Allium sativum*), or coriander (*Coriandrum sativum*) during the rainy season in India has also been compared [7]. The pepper–garlic intercrop receiving recommended fertilization rates produced the highest net return. Various pepper–onion intercrop spacing and sole plantings of each crop in Nigeria [8]. In another study, intercropping pearl millet with cowpea or groundnut showed their significant effects on soil and crop productivity after either sole or intercrop systems [9,10]. To optimize plant density, the seedling rate of each crop on the mixture has been suggested to adjust below the full rate to reduce competition from overcrowding. Thus, intercrops yield was found to be increased in the mixture stand compared to sole stand [11].

Plant architecture allows one intercrop to capture sunlight that would not otherwise be available to others. This phonological character is particularly important to growth and yield of cereal and legume crops [9,12]. Land Equivalent Ratio (LER) is another important physiological concept to be measured for evaluating the performance of intercrop components. It measures the advantages of using intercropping systems on combined yields of both crops [13]. It also provides a standardized basis for comparing systems under different situations and crop combinations [14]. Depending on the crops to be intercropped, competition for water, light and nutrients may result in lower yields. In this case changes in the spatial arrangement of the intercrops will reduce resource competition [9]. Fertilizers are more efficiently used in an intercropping system, due to different rooting systems of the crops as well as differences in the amount of nutrients taken up [15-20]. Earlier studies on intercropping of onion, garlic, coriander, green gram, black gram, soybean, chilli and cotton have been found to be remunerative [21,22].

In Bangladesh, investments in the large scale production of spices powder and paste in factories for local and foreign markets are increasing. In spite of high demand of these spices in the local and foreign market farmers could not increase the total productivity either through sole or intercropping practices due to the lacking of proper combination of planting geometry. As a result farmers are depriving of from good yield and as well as higher economic returns. Therefore, the present study was undertaken to find out the optimum plant density of coriander for intercropping with onion for higher productivity and return.

## 2. MATERIALS AND METHODS

### 2.1 Experimental Site, Design and Treatments

The experiment was conducted at the Regional Agricultural Research Station, Jamalpur, Bangladesh during *rabi* 2011-2012 and 2012-2013 to find out the optimum seeding ratio of onion and coriander under mixed cropping. The seed rates were calculated from recommended dose for onion and coriander. Seeds of both onion and coriander were broadcasted according to the tested seeding ratio. In this study, the treatments were included as sole onion i.e., 100% onion seed broadcasting, 100% onion + 50% coriander, 100% onion + 40% coriander, 100% onion + 30% coriander and 100% onion + 20% coriander. The experiment was arranged following randomized complete block design with three replications.

### 2.2 Planting Material and Cultural Practices

Onion var. BARI Peaj-1 and coriander var. BARI Dhania-1 were used as test varieties in this experiment. Seed were sown on 16 November, 2011 in the first year while in the second year seeds were sown on 4 November, 2012. The experimental unit plot size was 3 m $\times$ 2 m. For sole onion and mixed cropping fertilizers were used at the rate of 90-45-120-30-3-1.4 kg ha$^{-1}$ of NPKSZn and B, in the form of urea, triple super phosphate, muriate of potash, gypsum, zinc sulphate and boric acid, respectively. Half of urea, muriate of potash and full amount of other fertilizers were applied as basal during the final land preparation. Irrigation was applied twice at 25 and 50 days after sowing (DAS) and after each irrigation remaining urea and muriate of potash was top dressed in two equal splits. One weeding was done 30-35 days after sowing. During the first year coriander was harvested at 124 days after sowing on 19 March, 2012 while in the second year harvesting was done at 135 days after sowing on 18 March, 2013. On the other hand during the first year onion was harvested at 127 days after sowing on 22 March, 2012 while in the second year harvesting was done at 142 days after sowing on 25 March, 2013.

### 2.3 Data Collection

Randomly five onion plants were recorded earlier to collect the yield and yield contributing such as bulb length, bulb diameter, 10-bulb weight, and bulb yield. Yield attributes of coriander such as branch plant$^{-1}$, seed umble$^{-1}$, umble plant$^{-1}$, 100-seed weight, and seed yield were also recorded from five plants selected randomly earlier. Yield data was recorded considering the whole plot in case of both crops. OEY was calculated considering the local market price during the harvesting time following the formula as stated by Aujeneyulu et at. [23].

$$\text{Onion Equivalent Yield (OEY) (t ha}^{-1}\text{)} = \frac{\text{Yield of Coriander (t ha}^{-1}\text{)} \times \text{Price of Coriander (Tk kg}^{-1}\text{)}}{\text{Price of Onion (Tk kg}^{-1}\text{)}}$$

Economic analysis was done in terms of total cost of cultivation, net return and BCR.

$$\text{Benefit Cost Ratio (BCR)} = \frac{\text{Gross Return (Tk ha}^{-1}\text{)}}{\text{Cost of Cultivation (Tk ha}^{-1}\text{)}}$$

### 2.4 Statistical Analysis

Data recorded on yield and yield attributes of onion and coriander were subjected to analysis of variance using MSTAT-C Program. Means were separated using LSD test at 5% level of probability.

## 3. RESULTS AND DISCUSSION

### 3.1 Yield and Yield Attributes of Onion under Coriander Intercropping

Two years of trial of coriander intercropping showed significant influence on the growth and yield characters of onion (Table 1). Results indicated that plant height of onion differed

significantly due to different ratios of coriander seeding and the tallest plant was found in sole onion. Similar result was obtained by Kadali et al. [24]. It also found that during the both years plant height of onion reduced significantly due to higher plant density of coriander in the intercropped stand with onion. Bulb length of onion also differed significantly among the different seeding ratios and during the both years sole onion gave the significantly higher bulb length compared to other mixture stands, which was statistically at par with 100% onion + 20% coriander intercropping. During the first year the 100% onion broadcasting gave the highest bulb diameter which was statistically similar to the seeding of 100% onion + 20% coriander while in the second year sole onion produced the significantly highest bulb diameter. During the both years among the intercropping ratios bulb diameter was increased with the decrease of coriander density. Ten bulb weight differed significantly among the different seeding ratio of coriander. The sole onion seeding gave the highest 10-bulb weight that was statistically similar to the seeding of 100% onion + 20% coriander. The 100% onion + 30% coriander seeding gave the second highest 10-bulb weight while the 100% onion + 50% coriander and 100% onion + 40% coriander seeding ratio produced the lowest 10-bulb weight than the other ratios. It might be due to the heavy shading effect of coriander population on onion plant canopy that limit the photosynthesis. The highest bulb yield was obtained from the sole onion, which was statistically similar to 100% onion + 20% coriander intercropping. The possible reason is the higher light interception, spacing and nutrients availability to the onion plants broadcasting with 20% coriander seed. The second highest bulb yield was obtained from the 100% onion + 30% coriander seeding ratio. The 100% onion + 50% coriander and 100% onion + 40% coriander gave the lowest bulb yield. This result was the results of light and nutrient resource competing among the denser plant population. In addition during the both years bulb yield was mainly influenced by the 10-bulb weight.

### 3.2 Yield and Yield Attributes of Coriander Under Intercropped with Onion

The two years independent field experiment it was found that, all the growth and yield variables of coriander except the number of umble plant$^{-1}$ and seed yield did not differed significantly among the different seeding ratios (Table 2). During the both years the maximum number of umble plant$^{-1}$ was produced in the 100% onion + 20% coriander seeding while the minimum number was in 100% onion + 50% coriander seeding. The number of umble plant$^{-1}$ was decreased with the increasing of coriander density. It might be due to the higher intra plant compotation of coriander. During the both years the seed yield also differed significantly among the different seeding ratios. The 100% onion + 50% coriander gave the highest coriander seed yield that was statistically similar to the 100% onion + 40% coriander and 100% onion + 30% coriander. During the both years lowest seed yield of coriander was obtained from the 100% onion + 20% coriander seeding. The seed yield of coriander significantly influenced by the different seeding ratio of coriander. Bulb yield of onion and seed yield of coriander was comparatively lower in the second year than first year it might be due to the heavy rainfall just after sowing at 5 November, 2013.

### 3.3 Onion Equivalent Yield (OEY) Under Coriander Intercropping with Onion

During the both years among the intercropping systems, maximum OEY was found maximum in broadcasting of 100% onion + 20% coriander followed by the 100% onion + 30% coriander (Table 1). The lowest OEY was obtained from the 100% onion + 50% coriander seeding.

### 3.4 Economic Performances of Coriander Intercropping with Onion

During the both years maximum cost of cultivation was found in the 100% onion + 50% coriander while minimum in sole onion (Table 3). The seeding ratio of 100% onion + 20% coriander gave the highest gross return (Tk. 2,87,500 ha$^{-1}$ and Tk. 2,82,300 ha$^{-1}$) gross margin (Tk. 2,30,147 ha$^{-1}$ and Tk. 2,24,947 ha$^{-1}$) and BCR (5.01 and 4.92) during the first and second year, respectively. During the both years minimum gross return (Tk. 2,11,200 ha$^{-1}$ and Tk. 2,04,080 ha$^{-1}$) gross margin (Tk. 1,50,715 ha$^{-1}$ and Tk. 1,43,595 ha$^{-1}$) and BCR (3.50 and 3.37) was obtained from the seeding ratio of 100% onion + 50% coriander.

**Table 1. Yield and yield components of onion in onion-coriander intercropping system during *rabi* 2012 and 2013**

| Seeding ratio | Plant height (cm) | | Bulb length (cm) | | Bulb diameter (cm) | | 10- bulb wt. (g) | | Bulb yield (t ha$^{-1}$) | | OEY (t ha$^{-1}$) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ |
| $T_1$ | 47.3 | 45.5 | 3.60 | 3.30 | 4.01 | 4.20 | 229.6 | 238.3 | 12.0 | 11.31 | 12.00 | 11.31 |
| $T_2$ | 43.5 | 40.5 | 2.79 | 2.70 | 2.71 | 2.83 | 122.7 | 122.0 | 7.35 | 7.04 | 9.60 | 9.28 |
| $T_3$ | 46.9 | 41.7 | 2.86 | 2.77 | 2.95 | 2.91 | 149.6 | 145.0 | 8.07 | 7.72 | 10.30 | 9.93 |
| $T_4$ | 45.9 | 43.0 | 3.03 | 2.71 | 3.04 | 3.20 | 202.7 | 198.3 | 10.12 | 9.89 | 12.35 | 12.02 |
| $T_5$ | 47.1 | 44.8 | 3.07 | 2.95 | 3.41 | 3.20 | 219.6 | 225.0 | 11.50 | 11.25 | 13.10 | 12.83 |
| CV (%) | 2.03 | 3.44 | 6.3 | 7.39 | 12.3 | 6.76 | 3.35 | 5.17 | 5.19 | 8.73 | - | - |
| $LSD_{0.05}$ | 1.76 | 2.79 | 0.36 | 0.39 | 0.75 | 0.42 | 11.65 | 18.07 | 0.95 | 0.94 | - | - |
| F- test | ** | * | ** | * | * | ** | ** | ** | ** | ** | - | - |

*OEY = Onion Equivalent Yield; $Y_1$= 2011-2012, $Y_2$= 2012-2013; $T_1$ = Sole onion (100%), $T_2$ = onion (100%) + 50% coriander, $T_3$ = onion (100%) + 40% coriander, $T_4$ = onion (100%) + 30% coriander, $T_5$ = onion (100%) + 20% coriander*

**Table 2. Yield and yield components of coriander in onion-coriander intercropping system during *rabi* 2012 and 2013**

| Seeding ratio | Plant height (cm) | | Branch plant$^{-1}$ (no.) | | Seed umble$^{-1}$ (no.) | | Umble plant$^{-1}$ (no.) | | 100-seed wt. (g) | | Seed yield ( t ha$^{-1}$) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ |
| $T_1$ | - | - | - | - | - | - | - | - | - | | - | - |
| $T_2$ | 97.7 | 94.2 | 6.90 | 5.30 | 32.4 | 34.3 | 56.8 | 97.6 | 0.96 | 1.37 | 0.99 | 0.82 |
| $T_3$ | 102.7 | 92.7 | 7.60 | 7.00 | 34.5 | 39.0 | 84.2 | 97.9 | 1.03 | 1.37 | 0.98 | 0.81 |
| $T_4$ | 103.2 | 89.9 | 8.30 | 7.40 | 36.8 | 30.6 | 90.2 | 125.7 | 1.02 | 1.33 | 0.98 | 0.78 |
| $T_5$ | 98.6 | 92.6 | 7.10 | 6.13 | 32.0 | 31.5 | 98.5 | 127.7 | 1.05 | 1.31 | 0.69 | 0.58 |
| CV (%) | 3.75 | 4.05 | 7.87 | 7.49 | 7.23 | 10.08 | 4.20 | 9.87 | 7.30 | 2.21 | 4.80 | 7.72 |
| $LSD_{0.05}$ | - | - | - | - | - | - | 6.89 | 22.13 | - | - | 51.7 | 0.109 |
| F- test | NS | NS | NS | NS | NS | NS | ** | * | NS | NS | ** | ** |

*$Y_1$= 2011-2012, $Y_2$= 2012-2013; $T_1$ = Sole onion (100%), $T_2$ = 100% onion + 50% coriander, $T_3$ = 100% onion + 40% coriander, $T_4$ = 100% onion + 30% coriander, $T_5$ = 100% onion + 20% coriander*

**Table 3. Economic performances of onion-coriander intercropping system during *rabi* 2012 and 2013**

| Seeding ratio | Yield (t ha$^{-1}$) | | | | Total cost of cultivation (Tk ha$^{-1}$) | | Gross return (thousands Tk . ha$^{-1}$) | | Gross margin (thousands Tk. ha$^{-1}$) | | BCR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Onion (bulb) | | Coriander (seed) | | | | | | | | | |
| | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ |
| $T_1$ | 12.00 | 11.31 | - | - | 54,245 | 54,245 | 264.0 | 248.82 | 209.76 | 194.58 | 4.86 | 4.59 |
| $T_2$ | 7.35 | 7.04 | 0.99 | 0.82 | 60,485 | 60,485 | 211.2 | 204.08 | 150.72 | 143.60 | 3.50 | 3.37 |
| $T_3$ | 8.07 | 7.72 | 0.98 | 0.81 | 58,855 | 58,855 | 226.5 | 218.44 | 167.69 | 159.59 | 3.85 | 3.71 |
| $T_4$ | 10.12 | 9.89 | 0.98 | 0.78 | 57,989 | 57,989 | 271.64 | 264.38 | 213.66 | 206.40 | 4.70 | 4.56 |
| $T_5$ | 11.50 | 11.25 | 0.69 | 0.58 | 57,353 | 57,353 | 287.50 | 282.30 | 230.15 | 224.95 | 5.01 | 4.92 |

*Price in $Y_1$= 2011-2012, onion (bulb)- Tk. 22 kg$^{-1}$, coriander (seed)- Tk. 50 kg$^{-1}$; and price in $Y_2$ = 2012-2013, onion (bulb) - Tk. 22 kg$^{-1}$, coriander (seed)- Tk. 60 kg$^{-1}$*

## 4. CONCLUSION

The aforesaid results indicated that during the both years the broadcasting of onion (100%) + 20% coriander gave the maximum BCR of 5.01 and 4.92 followed by sole onion. Farmers can follow the seeding combinations of 100% onion + 20% coriander and 100% onion + 30% coriander to obtain the maximum gross margin. Therefore, from two years result it may be concluded that broadcasting of 100% onion + 20% coriander seed and 100% onion + 30% coriander may be recommended for the char land areas in study region of Bangladesh.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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