

PERFORMANCE OF FIELD PEA WITH MUSTARD AS A MIXED CROP FOR YIELD AND PROFITABILITY

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Abstract

Mixed cropping practices can help farmers meet their different types of daily needs because mustard can be used as edible oil, whereas field peas may be consumed as legume food. The field experiments were carried out at a farmer's field in South Lemua, MLT site, Feni (AEZ 19a), during the Rabi seasons of 2015-16 and 2017-18 to find out the performance of field pea as a mixed crop with mustard. The treatment combinations were T₁ = Sole field pea (100%) @ seed rate 50 kg ha⁻¹, T₂ = Sole mustard (100%) @ seed rate 7 kg ha⁻¹, T₃ = field pea (90%) + mustard (10%), T₄ = Field pea (80%) + mustard (20%), and T₅ = Field pea (70%) + mustard (30%). A field pea var. BARI Motor-1 and a mustard var. BARI Sarisha-14 were used. The trial was conducted in a randomized complete block design with 6 dispersed replications. The seed yield of field pea decreased with the increase of mustard population and the yield of mustard decreased with the increase of field pea population in the mixed cropped situation. All the mixed cropping combinations showed superiority over sole cropping in terms of gross margin, benefit cost ratio (BCR), and field pea equivalent yield (FEY). The highest field pea equivalent yields were 1646 kg ha⁻¹ in 2015-16 and 1576 kg ha⁻¹ in 2017-18, respectively in the treatment combination of field pea (80%) and mustard (20%). The lowest FEYs were observed at 1326 kg ha⁻¹ in T₂ during 2015-16 and 1296 kg ha⁻¹ in T₁ during 2017-18. The highest gross margins (Tk. 49280 ha⁻¹ in 2015-16 and Tk. 44854 ha⁻¹ in 2017-18) as well as BCR (2.45 in 2015-16 and 2.32 in 2017-18) were obtained from T₄ treatment. In 2015-16, T₂ provided the lowest gross margin (Tk. 31980 ha⁻¹) and BCR (1.93), but in 2017-18, T₁ yielded the lowest gross margin (Tk. 32515 ha⁻¹) and BCR (2.00). More profitable mixed crops combinations should be explored in future research.

Keyword: Field Pea, Mustard, Mixed crop, Yield, Profitability.

Introduction

Practicing the mixed cropping technique always provides some benefits to the farmer. It decreases the chance of total crop failure and increases crop yield. Besides, this practice makes it possible to harvest multiple crops at the same time. Traditionally, farmers in char areas have liked to cultivate some crops as

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intercrops and others as mixed crops to minimize the input cost. Crop compatibility is the most important factor in determining the viability of a mixed cropping system. Only those crops that do not harm other crops by providing shade can be cultivated as a mixed crop. Mustard grows tall, whereas field pea grows short; as a result, mustard provides shade to field pea, which may escape the hot weather in coastal char areas of Bangladesh. Field peas as well as other legumes are known for their unpredictable yields and being unable to withstand changing weather circumstances, such as high temperatures during flowering (Watson *et al.*, 2017; Jiang *et al.*, 2019). Thus, the success of any mixed cropping system is dependent on the proper selection of crop species with the least amount of competition for light, space, moisture, and nutrients (Fukai and Trenbath, 1993). Competition in a mixed crop mixture can be significantly reduced by judicious crop selection as well as changing plant populations with the spatial orientation of either crop. A careful crop selection could significantly reduce competition (Ofori and Stern, 1986). On the other hand, choosing the right crop species for intercropping could increase the possibility of increasing overall production per unit of land and time (Midmore, 1993). Some farmers in the coastal charland areas of Bangladesh also practice mixed/ intercropping to fulfill their families' needs. The farmers of the said area do not maintain proper seeding ratios, planting times, and other management practices. Field pea is a dry-land winter pulse, and its cultivation area is increasing day by day in the coastal areas of Noakhali, Feni, and Laxmipur. On the other hand, mustard is the major oil seed crop and main source of edible oil in char areas of Bangladesh. Farmers usually use local varieties and obtained poor yields due to their low yield potential. The Bangladesh Agricultural Research Institute (BARI) has developed some high-yielding varieties of field pea and mustard, which need to be disseminated among the farmers. It is observed that some farmers in the char areas of Feni, Noakhali, and Laxmipur cultivate field pea as a mixed crop with mustard. Farmers obtained a higher yield and profit from field pea and mustard as mixed cropping than from sole cropping. Mixed cropping increases food production and income for small farmers by encouraging agricultural diversification, ensuring consistent returns throughout the season, and providing a safety net against climatic uncertainties. Mixed cropping has been shown to improve crop productivity and develop a more balanced, biodiverse, and richer ecosystem. The present study was, therefore, undertaken to find out the most profitable mixed crop combination for field pea with mustard.

Materials and Methods

The experiments were carried out at the MLT site in South Lemua, Feni, during the Rabi seasons of 2015–16 and 2017–18. The experiments were conducted at

latitude 22° 56' 49" N and longitude 91° 26' 36" E. The experimental site's climate was hot, humid, and tropical monsoon-like.

Table 1. The average climatic condition of the site during the experimental periods of 2015-16 and 2017-18

| Month | Temperature (°C) | | Total Rainfall (mm) |
|----------------|------------------|------|---------------------|
| | Low | High | |
| December, 2015 | 17 | 25 | 11 |
| January, 2016 | 14 | 24 | 2 |
| February, 2016 | 19 | 29 | 14 |
| March, 2016 | 22 | 33 | 106 |
| December, 2017 | 11 | 29 | 77 |
| January, 2018 | 7 | 27 | 0 |
| February, 2018 | 13 | 34 | 2 |
| March, 2018 | 15 | 34 | 4 |

The soils of the experimental areas belong to the Old Young Meghna River Estuarine Flood Plain (AEZ 19a). The soils of the experimental plots were clay loam in texture. The experiment was laid out in a randomized complete block design with six dispersed replications. The treatments were T₁ = sole field pea (100%) @ seed rate 50 kg ha⁻¹, T₂ = sole mustard (100%) @ seed rate 7 kg ha⁻¹, T₃ = field pea (90%) + mustard (10%), T₄ = field pea (80%) + mustard (20%), and T₅ = field pea (70%) + mustard (30%). The unit plot size was 40 m² (10 m x 4 m). The fertilizer doses for sole mustard (60-20-25-7-2-1 kg N-P-K-S-Zn-B ha⁻¹) and sole field pea (18-17-20-7-2-1 kg N-P-K-S-Zn-B ha⁻¹) were given according to FRG-2012 in sole crop fields. The other mixed crop plots were fertilized with 21-17-25-7-2-1 kg N-P-K-S-Zn-B ha⁻¹, respectively. The entire amount of all fertilizers was applied during final land preparation in all treatment combinations. A field pea (var. BARI Motor-1) and a mustard (var. BARI Sarisha-14) were used. Seeds of both crops were treated with Provax 200 WP at the rate of 3 g/kg to protect the seeds from seed-borne and soil-borne diseases. Field pea and mustard seeds were mixed based on the treatments and sown by the broadcast method on December 7–11, 2015, and December 11–14, 2017. The crops were grown under a rain-fed condition because the soil moisture level was adequate for crop growth due to rainfall that occurred during the crop-growing period. Plant protection measures and all other management practices were done as and when necessary. Aphid infestation was observed in some parts of the plot, which was relatively low. Tafgor 40 EC was sprayed at the rate of 2 mL/L water to control this pest. Disease infestation was not observed during the experiment period. Mustard was harvested on February 22–28, 2016 and February 27–March 3, 2018, whereas field pea was harvested on March 20–25, 2016 and March 7–12, 2018. Data on the different crop

parameters were analyzed by the computer program Crop Stat. Field pea equivalent yield (FEY) and economic analysis were calculated to ascertain the efficiency of intercropping. Field pea equivalent yield was calculated by converting the yield of mixed crops to the yield of field pea on the basis of prevailing market prices for individual crops. Based on the mustard crop's local market price, the yield of the crop was converted into field pea equivalent yield (Prasad and Srivastava, 1991).

$$\text{Field pea Equivalent Yield} = Y_{\text{mFp}} + \frac{\text{Yield of Mustard (kg ha}^{-1}) \times \text{Price of Mustard (Tk. kg}^{-1})}{\text{Price of Field pea (Tk. kg}^{-1})}$$

Here, Y_{mFp} = Yield of the Field pea in the mixed crop combination

Results and Discussions

Yield and yield attributes of field pea

The result indicated that most of the yield attributes of field pea were influenced by mixed cropping with mustard (Tables 2 and 3). The results showed that plant populations of field pea varied depending on the percentage of seeds used in each treatment. Plant population increased when only field pea was used and decreased when mustard plants in the mixed cropping in the same plot. The treatment T_1 had the highest number of plants m^{-2} (106 in 2015-16 and 89.40 in 2017-18), while the T_5 plot had the lowest (59.00 in 2017-18 and 72 in 2015-16). The highest plant height was found in T_5 , which were 84.5 cm in 2015-16 and 88.34 cm in 2017-18. However, the lowest plant height resulted from the T_1 plot 69.6 cm in 2015-16 and 73.86 cm in 2017-18. This result has a similarity to Chongtham *et al.* (2018). Some researchers observed a similar result, suggesting that this type of result may happen because heat stress was higher in field peas than in mixed cropping with mustard, which provided some shade to reduce the heat stress of pea plants (Jiang *et al.* 2019). The maximum number of pods per plant were 14 and 13.20, which were recorded in 2015-16 and 2017-18, respectively, from the T_1 (sole field pea), followed by T_3 and T_4 . The lowest number of pods per plant (10 and 10.20) obtained from the T_5 combination in 2015-16 and 2017-18, respectively. The maximum numbers of seeds pod^{-1} (6.0 and 5.60 in 2015-16 and 2017-18, respectively) were obtained from T_1 but at par to T_2 treatment. Moreover, in 2015-16, t maximum numbers of seeds pod^{-1} showed a non-significant difference. The lowest seeds per pod were found in T_5 , which was identical to T_4 . This result has a similarity to Ahmed *et al.*, 2020. The treatment T_1 had the maximum 1,000 - seed weight (80 and 89.32 g in 2015-16 and 2017-18, respectively), followed by T_3 . The lowest 1,000 seed weight was found in T_5 (76 and 87.26 g) during 2015-16 and 2017-18, where field pea (70%) and mustard (30%) as broadcast. This is possible because nutrient availability is greater in sole cropping than in mixed cropping. The highest seed yield was recorded in the sole field pea, i.e., T_1 (1343 and 1295.80

kg ha⁻¹) while the lowest seed yield in the treatment T₅ (986 and 921.40 kg ha⁻¹) in 2015-16 and 2017-18, respectively. In a mixed crop situation, seed yield decreased as the mustard population increased. It could be due to nutrient competition and reduced light interception between the main and intercrops. Below-ground competition for water and nutrients may increase as crop species share similar areas of the soil profile (a similar resource pool), resulting in greater niche overlap (Bramley et al., 2007), limiting some intercropping benefits. It was observed that for mustard, the low (10%), medium (25%), and high (50%) seeding rates significantly reduced field pea yield compared with the field pea monoculture (Elkin et al., 2021).

Table 2. Seed yield and yield attributes of field pea as a mixed crop with mustard at Feni MLT site during 2015–16

| Treatments | Plant population m ⁻² (no.) | Plant height (cm) | Pods plant ⁻¹ (no.) | Seeds pod ⁻¹ (no.) | 1000-seeds weight (g) | Seed yield (kg ha ⁻¹) |
|--|--|-------------------|--------------------------------|-------------------------------|-----------------------|-----------------------------------|
| T ₁ = Sole field pea (100%) | 106 | 69.6 | 14 | 6.0 | 80 | 1343 |
| T ₃ = Field pea (90%) + mustard (10%) | 94 | 79.2 | 13 | 6.0 | 78 | 1202 |
| T ₄ = Field pea (80%) + mustard (20%) | 84 | 79.8 | 12 | 5.0 | 78 | 1134 |
| T ₅ = Field pea (70%) + mustard (30%) | 72 | 84.5 | 10 | 5.0 | 76 | 986 |
| LSD (0.05) | 8.63 | 5.19 | 3.63 | NS | 0.10 | 59.01 |
| CV (%) | 6.72 | 4.25 | 4.50 | 3.78 | 2.54 | 9.63 |

Table 3. Seed yield and yield attributes of field pea as a mixed crop with mustard at Feni MLT site during 2017–18

| Treatments | Plants m ⁻² (no.) | Plant height (cm) | Pods plant ⁻¹ (no.) | Seeds pod ⁻¹ (no.) | 1000 - seeds weight (g) | Seed yield (kg ha ⁻¹) |
|--|------------------------------|-------------------|--------------------------------|-------------------------------|-------------------------|-----------------------------------|
| T ₁ = Sole field pea (100%) | 89.40 | 73.86 | 13.20 | 5.60 | 89.32 | 1295.80 |
| T ₃ = Field pea (90%) + mustard (10%) | 77.80 | 84.40 | 11.60 | 5.20 | 88.24 | 1151.20 |
| T ₄ = Field pea (80%) + mustard (20%) | 68.40 | 85.82 | 11.50 | 4.60 | 87.83 | 1106.20 |
| T ₅ = Field pea (70%) + mustard (30%) | 59.00 | 88.34 | 10.20 | 4.60 | 87.26 | 921.40 |
| LSD (0.05) | 3.53 | 2.17 | 0.94 | 0.84 | 0.58 | 61.25 |
| CV (%) | 2.00 | 3.60 | 6.10 | 12.60 | 0.50 | 4.00 |

Yield and yield attributes of mustard

The findings show that field pea mixed cropping had a significant effect on the most of the yield parameters of mustard (Tables 4 and 5). The results showed that mustard plant populations varied depending on the percentage of seeds used in each treatment. The sole mustard plot had the highest number of plants per square meter (185.60 in 2017–18 and 168.2 in 2015–16, respectively). Plant populations increased as the amount of mustard seeds increased. The maximum plant height was observed in the mixed crop in T₄ (89.57 and 87.82 cm) during 2015-16 and 2017-18, whereas the shortest plant in sole mustard (79.62 cm in 2015-16 and 70.16 cm in 2017-18). The nitrogen-fixing ability of field peas could increase the amount of nitrogen in a mixed crop plot, which may increase plant height. Moreover, T₄ combination generated the highest number of pods on plant⁻¹ (33 in 2015–16 and 37.20 in 2017–18). As compared to the other treatments, the sole mustard plot produced the lower plant⁻¹ pods (27 and 29) of 2015–16 and 2017–18. The number of seeds in each pod was not significantly different in 2015-16 but during 2017-18, it showed a significant variation, and the maximum number of seeds pod⁻¹ (21.40) was recorded in the T₃ treatment, which was similar to the T₄ combination, and the lowest number of seeds pod⁻¹ (18.40) in the treatment T₂. Nitrogen accumulation by the pea nodule might provide more nutrients to the mustard plant, which promoted pod and seed production. This might also be due to the high plant density and the fact that competition for light and nutrients was higher in sole mustard than in mixed pea. Similar results were reported by Kumar *et al.* (2006). The treatment T₄ and T₃ combinations produced the highest (2.80 g) and lowest (2.75 g) seed weights in 2015–16. Besides, the lowest 1,000- seed weight was achieved in T₄ (2.97 g), while T₅ (3.05 g) recorded the highest 1,000 - seed weight during 2017–18. This result was in conformity with the result found from the chickpea and mustard mixed crop (Hasan *et al.*, 2018). The highest seed yields (1105 and 1215 kg ha⁻¹) were recorded in T₂ (sole mustard) during 2015–16 and 2017–18, respectively. However, the minimum seed yields (212 and 200.60 kg ha⁻¹) were found from T₃ treatment, which was 70% field pea with 10% mustard. Because the population of mustard increased, the seed yield increased. The result of sole mustard is in conformity with Rahman *et al.* (2009). Similar findings were also reported by Maniruzzaman *et al.*, 2020, where lentil and mustard were cultivated in mixed cropping.

Table 4. Seed yield and yield attributes of mustard as a mixed crop with field pea at Feni MLT site during 2015–16

| Treatments | Plants m ⁻² (no.) | Plant height (cm) | Pods plant ⁻¹ (no.) | Seeds pod ⁻¹ (no.) | 1000-seeds weight (g) | Seed yield (kg ha ⁻¹) |
|--|---------------------------------|----------------------|-----------------------------------|----------------------------------|--------------------------|--------------------------------------|
| T ₂ = Sole mustard (100%) | 168.2 | 79.62 | 27 | 19 | 2.77 | 1105 |
| T ₃ = Field pea (90%) + mustard (10%) | 25.3 | 84.48 | 31 | 22 | 2.75 | 212 |
| T ₄ = Field pea (80%) + mustard (20%) | 49.6 | 89.57 | 33 | 21 | 2.80 | 442 |
| T ₅ = Field pea (70%) + mustard (30%) | 71.10 | 82.87 | 30 | 18 | 2.78 | 525 |
| LSD (0.05) | 9.39 | 1.79 | 0.54 | NS | 0.042 | 53.6 |
| CV (%) | 10.47 | 3.81 | 6.25 | 3.06 | 2.40 | 7.95 |

Table 5. Seed yield and yield attributes of mustard as a mixed crop with field pea at Feni MLT site during 2017–18

| Treatments | Plants m ⁻² (no.) | Plant height (cm) | Pods plant ⁻¹ (no.) | Seeds pod ⁻¹ (no.) | 1000-seeds weight (g) | Seed yield (kg ha ⁻¹) |
|--|---------------------------------|----------------------|-----------------------------------|----------------------------------|--------------------------|--------------------------------------|
| T ₂ = Sole mustard (100%) | 185.60 | 70.16 | 29.00 | 18.40 | 3.03 | 1205.00 |
| T ₃ = Field pea (90%) + Mustard (10%) | 20.80 | 85.88 | 34.40 | 21.40 | 3.04 | 200.60 |
| T ₄ = Field pea (80%) + mustard (20%) | 43.20 | 87.82 | 37.20 | 21.20 | 2.97 | 391.40 |
| T ₅ = Field pea (70%) + mustard (30%) | 66.60 | 87.34 | 32.40 | 19.20 | 3.05 | 509.60 |
| LSD (0.05) | 7.61 | 1.86 | 3.09 | 1.70 | 0.20 | 37.75 |
| CV (%) | 7.20 | 1.70 | 6.90 | 6.40 | 4.90 | 4.90 |

Field pea equivalent yield (FEY)

All the mixed crop treatments produced a higher field pea equivalent yield than their respective sole crops (Tables 6 and 7). The results showed that the field pea equivalent yield increased with increasing mustard seed percentage for mixed cultivation up to 20% with 80% field pea and then decreased with increasing mustard seed percentage. It might be due to excessive interplant competition for nutrients, light, water, and space. The field pea (80%) and mustard (20%) combination (T₄) produced the highest field pea equivalent yield of 1646.4 and 1576 kg ha⁻¹ during 2015–16 and 2017–18, respectively. The FEYs in T₄ were

higher than the sole crops of field pea and mustard, respectively. The findings suggested that field pea-mustard mixed cropping could benefit farmers more than either field pea or mustard alone. Lauk and Lauk (2008) found similar result when growing peas and oats in mixed cropping systems, the higher yield of the mixed cropping system was more productive than that of monoculture crops. The increment in total production by intercropping rather than sole cropping was also reported by several authors (Rao and Willey, 1980; Umrani *et al.*, 1984; Bandhyopadhyay, 1984; and Basak *et al.*, 2006).

Cost and Return Analysis

The cost and return analysis is displayed in Tables 6 and 7. Gross returns as well as gross margins were found higher in mixed crop cultivation in comparison to sole cropping. From cost and return analysis, the combination of field pea (80%) and mustard (20%) (T₄) had the highest gross margin (Tk. 49280 ha⁻¹ in 2015-16 and Tk. 44854 ha⁻¹ in 2017-18), followed by T₅. In 2015–16, the sole mustard plot provided the lowest gross margin (Tk. 31980 ha⁻¹), but in 2017–18, the sole field pea plot yielded the lowest gross margin (Tk. 32515 ha⁻¹). In terms of benefit-cost ratio (BCR), the most profitable treatment combination was T₄ (2.45 and 2.32) during 2015-16 and 2017-18, respectively, followed by T₅. In 2015–16, the lowest BCR (1.93) was observed in sole mustard cultivation, whereas in 2017–18, the lowest BCR (2.00) was found in the sole field pea plot. Farhad *et al.* (2018) reported a similar type of outcome.

Table 6. Field pea equivalent yield (FEY) with cost benefit analysis at the MLT site, Feni during 2015-16

| Treatment | Yield (kg ha ⁻¹) | | FEY (kg ha ⁻¹) | Gross return (Tk. ha ⁻¹) | Total cultivation cost (Tk. ha ⁻¹) | Gross margin (Tk. ha ⁻¹) | Benefit cost ratio (BCR) |
|--|------------------------------|---------|----------------------------|--------------------------------------|--|--------------------------------------|--------------------------|
| | Field Pea | Mustard | | | | | |
| T ₁ = Sole field pea (100%) | 1343 | - | 1343 | 67150 | 32275 | 34875 | 2.08 |
| T ₂ = Sole mustard(100%) | - | 1105 | 1326 | 66300 | 34320 | 31980 | 1.93 |
| T ₃ = Field pea (90%) + Mustard(10%) | 1202 | 212 | 1456.4 | 72820 | 34030 | 38790 | 2.13 |
| T ₄ = Field pea (80%) + mustard (20%) | 1134 | 442 | 1646.4 | 83220 | 33940 | 49280 | 2.45 |
| T ₅ = Field pea (70%) + mustard(30%) | 986 | 525 | 1616 | 80800 | 33750 | 47050 | 2.39 |

Table 7. Field pea equivalent yield (FEY) with cost benefit analysis at the MLT site, Feni during 2017–18.

| Treatment | Yield (kg ha ⁻¹) | | FEY (kg ha ⁻¹) | Gross return (Tk. ha ⁻¹) | Total cultivation cost (Tk. ha ⁻¹) | Gross margin (Tk. ha ⁻¹) | Benefit cost ratio (BCR) |
|---|------------------------------|---------|----------------------------|--------------------------------------|--|--------------------------------------|--------------------------|
| | Field pea | Mustard | | | | | |
| T ₁ = Sole field pea (100%) | 1295.80 | - | 1295.80 | 64790 | 32275 | 32515 | 2.00 |
| T ₂ = Sole mustard (100%) | - | 1205.00 | 1446.00 | 72300 | 34320 | 37980 | 2.10 |
| T ₃ = Field pea (90%) + mustard (10) | 1151.20 | 200.60 | 1391.92 | 69596 | 34030 | 35566 | 2.04 |
| T ₄ = Field pea (80%) + mustard (20) | 1106.20 | 391.40 | 1575.88 | 78794 | 33940 | 44854 | 2.32 |
| T ₅ = Field pea (70%) + mustard (30) | 921.40 | 509.60 | 1532.92 | 76646 | 33750 | 42896 | 2.27 |

FEY= Field pea Equivalent Yield,

Price of Field pea per kg =Tk. 50.00 and Mustard per kg = Tk. 60.00,

Price of Urea =Tk.16.00 kg⁻¹, TSP = Tk.22.00 kg⁻¹, and MoP = Tk.15.00 kg⁻¹

Conclusion

Considering the yield and return, it can be concluded that the combination of 80% (40 kg/ha) field pea and 20% (1.4 kg/ha) mustard is the most profitable as compared to other treatment combinations when grown as a mixed crop. From the result of this study, it is evident that mixed cropping is more profitable than sole cropping, and the risk of cultivation of one crop can be reduced by mixed cropping. Further study should be done to identify more relevant combinations for growing mixed crops.

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