

INTERCROPPING OF CABBAGE WITH MAIZE

M.M. Khanum^{1*}, M.M. Bazzaz², B. Ahmed³, M.S. Huda⁴ and M.A. Hossain⁵

¹Scientific Officer, Agricultural Research Station, BARI, Rajbari, Dinajpur-5200

²Senior Scientific Officer, Bangladesh Wheat and Maize Research Institute, Nasipur, Dinajpur-5200

³Scientific Officer, Plant Physiology Division, Station, BARI, Gazipur-1701

^{4,5}Senior Scientific Officer, Agricultural Research Station, BARI, Rajbari, Dinajpur-5200
Corresponding E-mail: mahbuba.bari27@gmail.com

(Received: 19 September 2019, Accepted: 27 November 2019)

Keyword: Intercropping, maize, cabbage, cereal, yield, cost-benefit

Abstract

The experiment was carried out at the research field of Agricultural Research Station, Rajbari, Dinajpur (Latitude: 25.63544, Longitude: 88.65144) during rabi season of 2016-2017 and 2017-18 under AEZ-1 to find out the suitable crop combination for higher productivity and economic return. Five different treatments were employed in the study viz. T₁= Sole maize (60cm x 420cm), T₂= Maize planting (75cm x 25cm) + 1 row cabbage (50cm x 50cm) T₃= Maize paired row (150cm/37.5cm x 25cm) + 2 rows cabbage (50cm x 50cm) T₄=Maize planting (60cm x 420cm) + 1 row cabbage (60cm x 50cm), T₅= Maize paired row (120cm/30cm x 20cm) + 2 rows cabbage (60cm x 50cm) were evaluated. Maize grain yield in intercropped combination varied from 6.60-9.23 t ha⁻¹. But the highest maize yield was recorded in Maize planting (60cm x 20cm) + 1 row cabbage (60cm x 50cm) followed by that in maize paired row (150/37.5cm x 25cm) + 2 rows cabbage (50cm x 50cm), while the highest cabbage yield was recorded in maize planting (60cm x 20cm) + 1 row cabbage (60cm x 50cm) between maize. The highest maize equivalent yield was also obtained in maize planting (60cm x 20cm) + 1 row cabbage (60cm x 50cm) followed by that in maize paired row (150/37.5cm x 25cm) + 2 rows cabbage (50cm x 50cm). The highest gross return, gross margin and BCR were obtained in maize planting (60cm x 20cm) + 1 row cabbage (60cm x 50cm) followed by that in maize paired row (150/37.5cm x 25cm) + 2 rows cabbage (50cm x 50cm) and the lowest in sole sowing of maize. The overall results indicated that among the intercrop combinations maize planting (60cm x 20cm) + 1 row cabbage (60cm x 50cm) and maize paired row (150/37.5cm x 25cm) + 2 rows cabbage (50cm x 50cm) were found suitable for total productivity and economic return of the system.

Introduction

Intercropping may be defined as the cultivation of two or more crops at the same time in the same field (Ouma and Jeruto, 2010). Intercropping offers a possible solution to raise productivity through temporal intensification in a country like Bangladesh where the possibility of bringing more land under cultivation is limited. Yield advantages through intercropping have been reported by many workers (Willey, 1979). The advantages is often attributed to the fact that different crops complement each other and make better use of resources when grown together rather than separately (Ahmed *et al.*, 2018). Besides, intercropping also acts as insurance for resource poor farmers if one crop fails, they get some yield of another crop (Islam *et al.*, 2014). Maize (*Zea mays*) is a versatile photo insensitive crop which can give high yield relatively in a shorter period of time due to its unique photosynthetic mechanism as C₄ plant (Hatch

and Slack, 1998). Maize is the third important cereal crop in Bangladesh (BBS, 2015). The area coverage under maize in Dinajpur is expanding rapidly instead of wheat. Due to development of some potential hybrid maize and its availability in this region, farmers tend to shift their cultivation with maize crop in *Rabi* season (Shaheenuzzaman *et al.*, 2015). In addition to that, favorable agro-climatic conditions have made this crop suitable for greater adoption in winter season in Dinajpur region as well as in the country. Being row and spaced crop, some short duration vegetables may have access to grow with maize as intercrop for extra quick cash generation without hampering maize yield. Innovations in Maize-Legume intercropping allow farmers to grow a wide range of food legumes as understory intercrops with Maize. Maize can be planted at its recommended population, but every other row is shifted to provide a wider alternate inter row to the legume or strip-cropped by lowering Maize population but maintaining similar yields (Ahmed *et al.*, 2008). Growing of short duration vegetables specially cabbage as intercrop with maize in between row may offer considerable yield advantage over sole cropping due to efficient utilization of growth resources (Talukder *et al.*, 2016). Cabbage (*Brassica oleracea* L.var. *capitata* f.), is an important cole crop, belonging to family cruciferae, is rich in phyto nutrients and antioxidants. Mixed or intercropping can increase total productivity of land through maximum utilization of natural resources (Thayamini *et al.*, 2010). Higher total productivity per unit area in intercropping is achieved over sole cropping (Boras *et al.*, 2006). Intercropping practices lead to more monetary return and better utilization of land and inputs (Quayyum *et al.*, 1985). Regarding this views, an attempt was undertaken to get maximum benefit from intercropping by optimizing plant population of maize and cabbage.

Materials and Methods

The experiment was conducted in the research field of Agricultural Research Station, Rajbari, Dinajpur (Latitude: 25.63544, Longitude: 88.65144) during *rabi* season of 2016-2017 and 2017-18. The experiment was laid out in randomized complete block (RCB) design with three replications. The unit plot size was 6m x 4m. Five different treatments were employed in the study viz. T₁= Sole maize (60cm x 420cm), T₂= Maize planting (75cm x 25cm) + 1 row cabbage (50cm x 50cm), T₃= Maize paired row (150cm/37.5cm x 25cm) +2 rows cabbage (50cm x 50cm), T₄=Maize planting (60cm x 420cm) +1 row cabbage (60cm x 50cm), T₅=Maize paired row (120cm/30cm x 20cm) +2 rows cabbage (60cm x 50cm). The land of the experimental plot was prepared with a power tiller by ploughing and cross ploughing followed by laddering and the soil was brought into good tilth. Fertilizers were applied @ 260-72-148-48-4-2 kg ha⁻¹N-P-K-S-Zn-B in the form of Urea-TSP-MOP-Gypsum-ZnSo₄-Boric acid for both the sole maize and intercrop combinations. One third of urea and full amount of other fertilizers were applied at final land preparation. Remaining urea was applied at 30 and 60 DAS in two equal splits. Maize (BARI hybrid bhutta-9) was sown on November 02-04 during the conducting years and cabbage (BARI Badhacopy-1) was sown on November 12-14 during the consecutive years. Two irrigations were provided after top dressing of urea. Earthing up and other intercultural operations were done when required. Other plant protection measures were taken when required. Cabbage was harvested on January 10-12 and the maize on April 10-13 respectively during the consecutive years. Yield contributing characters of cabbage and maize were measured from ten randomly selected plants of the sampling area of each treatment avoiding border plants. Maize grain yield and cabbage yield were measured from the whole plot and then calculated per hectare basis maintaining standard moisture content. The relative yield was

obtained by dividing the intercrop yield of a crop with the respective sole crop yield of that crop using the formula (Dewit and Vander Bergh, 1965).

The relative yield of a crop = Yield of component crops / Yield of sole crop
Maize equivalent yield was computed by converting yield of intercrops on the basis of prevailing market price of individual crop following the formula of Bandyopadhyay (1984) as given below:

$$\text{Maize equivalent yield} = Y_{im} + (Y_{ic} \times P_c) / P_m$$

Where, Y_{im} = Yield of intercrop maize, Y_{ic} = Yield of intercrop cabbage, P_m = Market price of maize and P_c = Market price of cabbage.

Collected data were statistically analyzed by using MSTAT software packages and mean differences for each character were compared by Least Significant Difference (LSD) test (Gomez and Gomez, 1984).

Results and Discussion

Effect on yield and yield components of maize

Yield and yield contributing characters of intercropped maize were statistically significant (Table 1). The highest plant height (273.13 cm) was recorded from sole maize and the lowest plant height (244.28cm) was obtained from Maize paired row (120cm/30cm×20cm) + 2 rows cabbage (60cm×50cm) intercropping combination. The highest number of grains cob⁻¹ (579.06) was recorded from sole maize plot and the lowest number of grains cob⁻¹ (453.27) was found in Maize paired row (120cm/30cm×20cm) +2 rows cabbage (60cm×50cm) intercropping combination. The same trend was observed in case of 1000- grain weight and it was ranged from 236.73- 285.53 g in different treatments. The highest 1000-grain weight (285.53 g) was recorded from sole maize and the lowest 1000-grain weight (236.73) was obtained from Maize paired row (120cm/30cm×20cm) + 2 rows cabbage (60cm×50cm) intercropping combination. The highest grain yield (9.11 t ha⁻¹) was recorded from sole maize, which could be due to higher no. of grains cob⁻¹ and 1000- grain weight. The grain yield of maize in intercropped combination varied from 6.60-9.23 t ha⁻¹. The yield data indicated that due crop competition in intercropping yield loss of maize was observed.

Effect of intercrops

The intercrop yield of cabbage was influenced significantly by different intercropping combinations (Table 2). The highest cabbage yield (50.04 t ha⁻¹) was recorded from Maize planting (60cm×20cm) + 1 row cabbage (60cm×50cm) intercropping combination followed by Maize paired row (150cm/37.5cm × 25cm) + 2 rows cabbage (50cm × 50cm) combination (46.97 t ha⁻¹). The lowest yield was obtained from Maize planting (75cm×25cm) +1 row cabbage (50cm×50cm) intercropping combination (41.41t ha⁻¹).

Maize equivalent yield

Maize as wider spaced plant offers some component crops to grow together without economic loss sacrificing small maize yield with greater total production in respect of land and time. This practice offered considerable yield advantages and higher economic return over sole cropping because of its efficient utilization of growth resources (Faruque *et al.*, 1996). All the intercropped combinations showed higher maize equivalent yield than sole maize in all cases. Among the treatments, the highest maize equivalent yield (25.50 t ha⁻¹) was obtained from Maize planting (60cm x 20cm)+ 1 row cabbage (60cm x 50cm) followed by that of maize paired row (150/37.5cm x 25cm) +2 rows cabbage (50cm×50cm) intercrop combination in the both years (Table 2). The lowest maize equivalent

yield (20.40 t ha⁻¹) was obtained from Maize paired row (120cm/30cm x 20cm) + 2 rows cabbage (60cm x 50cm) intercrop combination.

Cost and return analysis

The cost and return analysis of sole and intercropping of maize and cabbage are presented in Table 3. Higher gross return was obtained from all intercrop combinations than sole crop. The result revealed that the highest gross return (Tk. 382500 ha⁻¹) and gross margin (Tk. 298270 ha⁻¹) were obtained in maize planting (60cm x 20cm) + 1 row cabbage (60cm x 50cm), followed by maize paired row (150/37.5cm x 25cm) + 2 rows cabbage (50cm x 50cm). The lowest gross return and gross margin were obtained from sole maize. The highest benefit cost ratio (4.54) was also obtained from maize planting (60cm x 20cm) + 1 row cabbage (60cm x 50cm) followed by that of maize paired row (150/30cm x 25cm) + 2 rows cabbage (50cm x 50cm) and the lowest in sole maize (2.55).

Table 1. Yield and yield contributing characters of maize and yield of cabbage under intercropping situation at ARS, Rajbari, Dinajpur (Pooled data of 2 years)

Treatments	Plant height (cm)	Grains cob ⁻¹ (no.)	1000-grain wt.(g)	Yield (t ha ⁻¹)	
				Maize	Cabbage
T ₁	273.15	558.13	285.53	9.23	-
T ₂	269.40	579.06	266.80	6.69	46.32
T ₃	251.04	532.33	265.60	7.82	46.97
T ₄	270.43	570.06	270.80	8.82	50.04
T ₅	244.28	453.27	236.73	6.60	41.41
CV (%)	3.24	5.13	3.25	3.56	5.44
LSD _(0.05)	13.59	52.04	13.79	13.17	5.04

T₁= Sole maize (60cm x 20cm), T₂= Maize planting (75cm x 25cm) + 1 row cabbage (50cm x 50cm), T₃= Maize paired row (150cm/37.5cm x 25cm) + 2 rows cabbage (50cm x 50cm), T₄= Maize planting (60cm x 20cm) + 1 row cabbage (60cm x 50cm), T₅= Maize paired row (120cm/30cm x 20cm) + 2 rows cabbage (60cm x 50cm).

Table 2. Maize grain yield, Cabbage yield, maize relative and equivalent yield influenced by intercropping with cabbage at ARS, Rajbari, Dinajpur

Treatments	Maize grain yield (t ha ⁻¹)	Cabbage yield (t ha ⁻¹)	Relative yield of maize (t ha ⁻¹)	Maize equivalent yield (t ha ⁻¹)
T ₁	9.23	-	-	9.23
T ₂	6.69	46.32	0.72	22.13
T ₃	7.82	46.97	0.85	23.48
T ₄	8.82	50.04	0.95	25.5
T ₅	6.60	41.41	0.71	20.40

T₁= Sole maize (60cm x 20cm), T₂= Maize planting (75cm x 25cm) + 1 row cabbage (50cm x 50cm), T₃= Maize paired row (150cm/37.5cm x 25cm) + 2 rows cabbage (50cm x 50cm), T₄= Maize planting (60cm x 20cm) + 1 row cabbage (60cm x 50cm), T₅= Maize paired row (120cm/30cm x 20cm) + 2 rows cabbage (60cm x 50cm).

Table 3. Cost and return analysis of maize and cabbage under sole and intercropping situations (Average of two years)

Intercropping of Cabbage With Maize

119

Treatments	Gross return (Tk. ha ⁻¹)	Total Variable Cost (Tk. ha ⁻¹)	Gross margin (Tk. ha ⁻¹)	BCR
T ₁	138450	54230	84220	2.55
T ₂	331950	84230	247720	3.94
T ₃	352150	85457	266693	4.12
T ₄	382500	84230	298270	4.54
T ₅	306050	87251	218799	3.50

Market price: Maize 15 Tk. kg⁻¹, Cabbage 5 Tk. kg⁻¹

Conclusion

The results revealed that the highest yield of maize was obtained in sole cropping of component crops. Under intercropping, the highest maize yield was recorded in Maize planting (60cm x 20cm) + 1 row cabbage (60cm x 50cm) followed by that of maize paired row (150/37.5cm x 25cm) +2 rows cabbage (50cm x 50cm), while the highest cabbage yield was recorded in maize planting (60cm x 20cm) + 1 row cabbage (60cm x 50cm) between maize. The highest maize equivalent yield was also obtained in maize planting (60cm x 20cm) + 1 row cabbage (60cm x 50cm) followed by that of maize paired row (150/37.5cm x 25cm) +2 rows cabbage (50cm x 50cm). The highest gross return, gross margin and BCR were obtained in maize planting (60cm x 20cm) + 1 row cabbage (60cm x 50cm) followed by that of maize paired row (150/37.5cm x 25cm) +2 rows cabbage (50cm x 50cm) and the lowest in sole sowing of maize. The overall results indicated that among the intercrop combinations maize planting (60cm x 20cm) + 1 row cabbage (60cm x 50cm) and maize paired row (150/37.5cm x 25cm) +2 rows cabbage (50cm x 50cm) were found suitable for total productivity and economic return of the system.

References

- Ahmed, B., D. Shabnam, S. Shabnam, M.A. Hossain and M.M. Islam. 2018. Intercropping grasspea with chilli at varying plant population. *Int. J. App. Res.* 4 (1): 58-61.
- Ahmed, H., H. Herren, Z. R. Khan, J. A. Pickett and C. M. Woodcock. 2008. Integrated Pest Management: the push-pull approach for controlling insect pests and Weeds of cereals and its potential for other agricultural systems including animal husbandry. *Philos Trans R Soc Lond B Biol Sci.* 363(1491): 611-621.
- BBS (Bangladesh Bureau of Statistics). 2015. Statistical Pocket Book of Bangladesh. Statistics and Informatics Division, Ministry of Planning, Government of the People's Republic of Bangladesh. pp.91-93.
- Boras, M., N. Roukia and R. Babilie. 2006. The effect of Corn Intercropping on Autumn Potato in Terms of Productivity and Land Equivalent Ratio. *Tishreen Univ. J. Studies & Scientific Research- Biol. Sci. Series.*28(1).
- Bandyopadhyay, S.N. 1984. Nitrogen and water relations in grain sorghum-legume intercropping systems. Ph.D. Dissertation, Indian Agril. Res. Inst., New Delhi.
- Baidoo, P.K., M.B. Mochiah and K. Apusiga. 2012. Onion as a Pest Control Intercrop in Organic Cabbage (*Brassica oleracea*) Production System in Ghana. *Sus. Agric. Res.* 1(1): 36-41.

- Dewit, C. T. and J. P. Vander Bergh. 1965. Competition between herbage plants. *Neth. J. Agri. Sci.* 13: 212-221.
- Faruque, A., A. Hashem and A. Jahan. 1996. Productivity and profitability of potato intercropped with wheat. *Bangladesh J. Bot.* 25(1): 1-4.
- Gomez, K.A. and A.A. Gomez. 1984. *Statistical procedures for agricultural research.* John Wiley and Sons, New York. pp.97-129.
- Hatch, M.D. and C.R. Slack. 1998. C_4 photosynthesis: discovery, resolution, recognition and significance. *Discoveries in Plant Biology*, World Scientific Publishing, Singapore. 1: 175-196.
- Islam, H.M.S., R.U. Choudhury, B. Ahmed, S. Shabnam and M.M. Rahman. 2014. Adoption of Mixed Cropping in Rabi Season by the Farmers of Madaripur Sadarthana under Madaripur District. *Intl. J. Buss. Soc. Sci. Res.* 1(3): 168-171.
- Ouma, G. and P. Jerito. 2010. Sustainable horticultural crop production through intercropping: The case of fruits and vegetable crops: A review. *Agric. bio. J. North America.* 1(5): 1098-1105.
- Quayyum, M.A., M.E. Akanda and T. Islam. 1985. Effect of intercropping maize with groundnut at varying levels of plant population and nitrogen levels, *Bangladesh J. Agric.* 10(3): 1-6.
- Shahenuzzaman, M., R.R. Saha, B. Ahmed, J. Rahman and M. Salim. 2015. Green cob and fodder yield of sweet corn as influenced by sowing time in the hilly region. *Bangladesh J. Agril. Res.* 40(1): 61-69.
- Talukder, A.H.M.M.R., B. Ahmed, L. Nahar, K.M.F. Hossain, J. Rahman and S.K. Paul. 2016. Enhancement of Farm productivity through intercropping of vegetables, pulse and oilseed crops with wheat at Jamuna Char area of Islampur in Jamalpur District. *Int. J. Appl. Res.* 2(2): 71-76.
- Thayamini, H., Seran and I. Brintha. 2010. Review on Maize Based Intercropping. *J. Agron.* 9(3): 135-145.
- Willey, R.W. 1979. Intercropping its importance and research needs. Part. 1. Competition and yield advantages. *Field Crops Abst.* 32(1): 1-10.