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Intercropping of short duration vegetables with hybrid maize

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ABSTRACT

The experiment was conducted at Multi Location Testing Site, Bangladesh Agricultural Research Institute, Phulpur, Mymensingh in two consecutive winter seasons of 2013-2014 and 2014-2015 to select the suitable vegetable for cultivation with hybrid maize. Four crop combinations were as sole maize, maize + red amaranth, maize + radish, and maize + spinach. The crop combinations were arranged in a randomized complete block design with four replications. The highest maize yield (8.54 tha^{-1}) was obtained from sole maize cropping and lowest yield (8.30 tha^{-1}) was recorded from maize + spinach combination. The highest maize equivalent yield (13.89 tha^{-1}), gross return (Tk. 2,08,350 ha^{-1}) and gross margin (Tk.1,47,975 ha^{-1}) were obtained from maize + red amaranth combination. Whilst the lowest maize equivalent yield (8.54 tha^{-1}), gross return (Tk. 1,28,100 ha^{-1}) and gross margin (Tk. 58,875 ha^{-1}) were obtained from sole maize cropping. Among the crop combinations, red amaranth with maize was found economically profitable and suitable crop arrangement for increasing productivity in the study area.

Introduction

Intercropping is a way of increasing crop production per unit land area by intensifying the use of land. It is a practice of growing two or more crops simultaneously in same piece of land, particularly in the tropics (Faruque et al., 2006). This has already been practiced in many countries such as Bangladesh, India, China, Taiwan, Srilanka, Vietnam, Africa and Latin America (Beets, 1977). It increases total productivity as well as farmer's income (Villare, 1976) through efficient utilization of land, labour and growth resources such as increasing utilization of solar radiation and different inputs including fertilizer and water (Ahmed et al., 2006). Higher productivity from intercropping depends on judicious choice of component crops, suitable planting system or proportion of crops (Islam et al., 2006). It is reported that the use of early maturing crop varieties, spacing and plant population are some of the important components that help in increasing the yield of intercrop (Craufard, 2000; Bashak et al., 2006). Intercropping offers more stability, less risk, better utilization of limited resources and wide diversity in the production of food (Hirota et al., 1995). Intercropping plays an important role in increasing vegetable production. So, suitable crop combination is needed to identify for better compatibility.

Maize *(Zea mays* L.) is one of the important cereal crops in the world. It is the world's most widely grown cereal and is the primary staple food in many developing countries (Morris et al., 1999). It is a third most important food grain for human after rice and wheat in Bangladesh and the condition of maize has been gaining popularity in recent years. It is the high yielding grain crop having multiple uses such as food, feed and fodder for human, poultry and livestock sector, respectively. However, maize is a highly spacious crop required 75 cm × 25 cm for grain production and the space between two rows of maize could be utilized by growing any short duration vegetable crops at the early stage of maize production. On the other hand, maize is a long duration crop which takes 140 to 150 days for maturity. So, there is a scope of cultivating any other crops simultaneously with maize as intercrop.

In Bangladesh, maize is generally grown as sole or sporadic and sometimes in pocket areas due to expansion of boro cultivation. On the other hand, vegetables are the main component of human food that supplies proteins, carbohydrates, fats, vitamins and minerals but the production is much less than requirement. There is a limited scope of bringing additional land for vegetable cultivation. In this context, the space between two rows of maize or the long time of maize maturation could be utilized as intercropping of any kind of vegetable crop combination. Hence, maize and vegetables as intercrop would be the profitable system of intercrop in the same piece of land to get quick return. Therefore, an experiment was designed to study the feasibility and agro-economic performance of maize intercropping with three short duration vegetable crops such as red amaranth, radish and spinach.

Materials and Methods

Experimental site

The experiment was conducted at the farmers' field of Phulpur, Mymensingh district of Bangladesh during winter seasons of 2013-14 and 2014-2015.

Planting materials and crop combinations

The crop varieties were used in this intercropping study was maize (*Zea mays* var. BARI Maize 9), Red amaranth (*Amaranthus Gangeticus* Linn. var. BARI Red amaranth 1), Radish (*Raphanus sativus* var. BARI Radish 4) and local spinach. There were four crop combinations such as sole maize, maize + red amaranth, maize + radish and maize + spinach.

Cultivation procedures

A randomized complete block design with four dispersed replications was followed in the study. The unit plot size was 8 m × 5 m. The spacing of sole maize was 75 cm × 25 cm. Seeds of red amaranth, radish, spinach were broadcasted between two (75 cm apart) rows of maize. The crop was raised with 250-60-100-30-5-1 kg of N-P-K-S-Zn-B ha^{-1}, respectively in the form of urea, triple super phosphate (TSP), muriate of potash (MOP), gypsum, zinc sulphate and boric acid along with 5 tha^{-1} cowdung. One third of urea and all other fertilizers were applied as basal at final land preparation. The rest of urea was applied in two equal splits at 30 and 60 days after emergence (DAE). The seeds of BARI Hybrid Maize 9 were sown on 20 November in both of the years (2013 and 2014). Vegetable seeds were sown on the same time also. The intercrops red amaranth, radish and spinach were harvested at 35-40 DAS. The maize crop was harvested on 23 April, 2014 and 25 April, 2015.

Data collection and statistical analysis

Data on yield and yield contributing characters were collected from 10 randomly selected plants of maize. Pooled analysis was done as because there was no significant variation in yield and yield parameters in between two years. Finally**,** data were analyzed statistically and mean comparison was done by LSD test. Maize equivalent yield were calculated by converting the yield of red amaranth and radish into the yield sown at the same time. The crop was irrigated at 20, 40, 70 DAS and grain filling stage. Weeding and other intercultural operations of maize were done on the basis of prevailing market price using the following formula (Anjaneyulu et al., 1982).

$$\textbf{Maize Equivalent Yield (MEY)} = Y_m + \frac{Y_{int} \times P_{int}}{P_m}$$

Y_m= Yield of Maize, P_m= Selling price of maize, Y_{int}= Yield of intercrop (red amaranth, radish and spinach) and P_{int}= Selling price of intercrop

Results and Discussion

Effect of intercropping vegetables on yield and yield components of maize

Different intercrop combinations had no significant effect on yield and yield contributing characters (**Table 1**). However, sole maize showed better performance comparing than those of other treatments. Individual cob weight (298.5 g) was found maximum in sole maize which was statistically identical to all other treatments except maize + spinach (272.7 g) combination. The highest number of grains (525.6) per cob was found from sole maize which was statistically at par with maize + red amaranth combination (519.4), while the lowest values were recorded in maize + radish and maize + spinach combinations (498.8 and 481.3, respectively). Thousand grain weights recorded in different crop combinations were ranged from 330.7-344.6 g. The highest maize grain yield (8.54 tha^{-1}) was recorded from sole maize that could be due to higher yield attributes and it was statistically identical to the yields obtained from maize + red amaranth and maize + radish crop combinations. The lowest yield was found from maize + spinach combination (8.30 tha^{-1}). Straw yield in different treatments were ranged from 8.12-8.32 tha^{-1}. It also showed that maize yield was reduced due to intercropping vegetables but it was not significant.

Effect of intercropping on the yield of intercrops

Individual yield of red amaranth, radish and spinach as intercrop with maize ranged from 6.1 to 8.1 tha^{-1} (**Table 1**). Maximum intercrop yield (8.1 tha^{-1}) was obtained from red amaranth and maize intercropping system. Among the intercrops red amaranth, radish and spinach reduced grain yield of maize. Though considerable grain yield of maize was reduced by intercrops but it was compensated by intercrops yield.

Maize equivalent yield under intercropping with short duration vegetables

All the crop combinations produced higher maize equivalent yield over sole maize (**Fig. 1**). Results revealed that maize equivalent yield obtained from different crop combinations was ranged from 11.55 to 13.89 tha^{-1} and it was 35-62% higher over the sole maize (8.54 tha^{-1}). The results corroborated with the findings of Uddin et al. (2009) and Sarker et al. (2013). The findings also agreed with the results of BARI, where higher maize equivalent yield was obtained from maize + red amaranth intercropping system at Kushtia and Manikganj, maize + spinach at Jessore, Mymensingh and Rangpur (OFRD, 2006), maize + potato at Kishoreganj, maize + radish at Tangail (OFRD, 2014).

Cost and return analysis of maize intercropping with short duration vegetables

Cost and return analysis showed significant variation among the short duration vegetables with maize (**Table 2**). The highest gross return and gross margin were Tk. 2,083,50 ha^{-1} and Tk. 1,47,975 ha^{-1}, respectively. Sole maize gave the lowest gross return and gross margin Tk. 1,28,100 ha^{-1} and Tk. 69,225 ha^{-1}, respectively.

Table 1. Yield and yield contributing characters of maize in intercropping system (Pooled data).

Crop combination	Individual cob wt. (g)	No. of grains cob^{-1}	Grains wt. cob^{-1} (g)	1000-grain weight (g)	Grain yield (tha^{-1})	Stover yield (tha^{-1})	Intercrop yield (tha^{-1})
Sole maize	298.5	525.6	245.0	344.6	8.54	8.32	-
Maize + red amaranth	294.8	519.4	215.8	340.6	8.49	8.12	8.1
Maize + raddish	290.6	498.8	210.1	335.0	8.40	8.20	6.8
Maize + spinach	272.7	481.3	205.4	330.0	8.30	8.17	6.1
CV (%)	3.65	3.81	6.8	5.55	6.16	3.17	12.6
LSD (0.05)	15.90	29.06	22.59	28.35	0.783	0.393	1.377

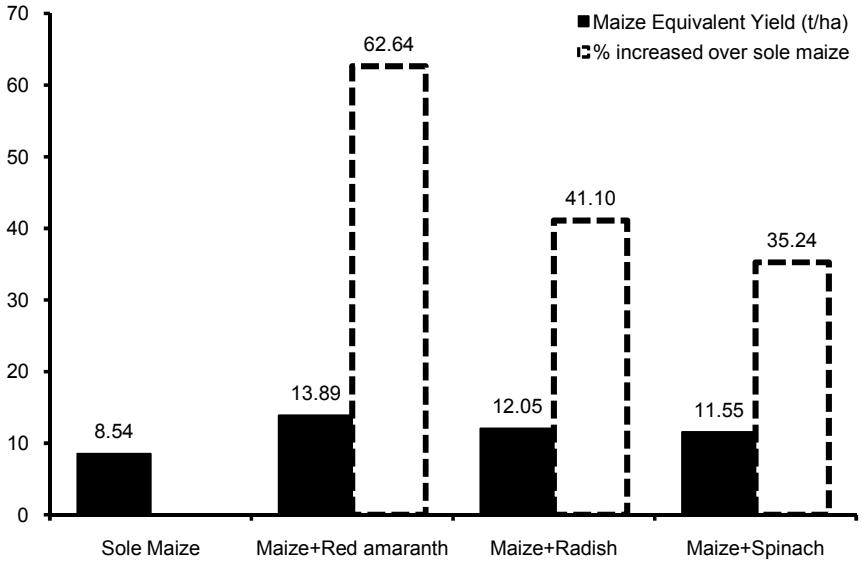

Fig. 1. Maize equivalent yield and % increase over sole maize in different intercropping system

Table 2. Cost and return analysis of maize intercropping with vegetables (average of two years).

Crop combination	Gross return (Tk. ha^{-1})	*TVC (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})
Sole maize	1,28,100	58,875	69,225
Maize + red amaranth	2,083,50	60,875	1,47,975
Maize + radish	1,80,750	60,375	1,20,375
Maize + spinach	1,73,250	60,375	1,12,875

*Total value of cost includes cost of seed, fertilizer, irrigation, labour and tillage cost. Price: Urea Tk. 20 kg^{-1}, TSP Tk. 22 kg^{-1}, MOP Tk. 15 kg^{-1}, Gypsum Tk. 10 kg^{-1}, Zinc sulphate Tk. 130 kg^{-1}, Boric acid Tk. 130 kg^{-1}, Maize seed Tk. 50 kg^{-1}, Maize non-seed Tk. 15 kg^{-1}, Maize Stover Tk. 0.50 kg^{-1}, Red amaranth Tk. 10 kg^{-1}, Radish Tk. 8 kg^{-1}, Spinach Tk. 10 kg^{-1}.

Farmers' opinion

Farmers showed interest in cultivating short duration vegetables with maize in their field for its quick and high economic return.

Conclusion

Intercropping of short duration vegetables with maize could be an agro-economically profitable crop production technique. Maize in combination with red amaranth showed 62.64% increase over sole maize. Thus, intercropping maize with red amaranth was found to be suitable crop combination in the studied area. So, short duration vegetables can be grown in space between maize rows without hampering the maize yield.

References

Ahmed, F., Rahman, M. A., Jahan, M. A. H. S., Ahmed, M., & Khayr, M. A. (2006). Effect of different planting system in maize/spinach-red amaranth intercropping. *Bangladesh J. Agric. Environ.* 2, 2, 69-76.

Anjaneyulu, V. R., Singh, S. P., & Pal, M. (1982). Effect of competition free period and technique and pattern of pearlmillet planting on growth and yield of mungbean,

and total productivity in solid pearlmillet and pearlmillet/ mungbean intercropping system. *Indian J. Agron.* 27, 3, 219-226.

Basak, N. C, Altaf Hossain, S. M., Islam, N., & Bhuiyan, N. I. (2006). Intercropping wheat with ground nut with variable plant population. *Bangladesh J. Agril. Res.* 31, 2, 207-215.

Beets, W. C. (1977). Multiple cropping of maize and soybean under high level of crop management. *Netherlands J. Agric. Sci.* 25, 2, 95-102.

Craufrad, P. Q. (2000). Effect of plant density on the yield of sorghum-cowpea and pearl millet- cowpea intercrops in northern Nigeria. *Expt. Agric.* 36, 379-395.

Faruque, A., Rahman, M. A., Jahan, M. A. H.S., Ahmed, M., & Khyer, M. A. (2006). Effect of different planting system in maize/ spinach-red amaranth intercropping. *Bangladesh J. Agric. Environ.* 2, 2, 69-76.

Hirota, O. A., & Hamid, A. (1995). Yield photosynthesis and canopy structure of maize mungbean intercropping system. *Jpn. J. Trop. Agr.* 39, 168-176.

Islam, M. N., Haque, M. M., & Hamid, A. (2006). Planting arrangement and population density effects on the physiologically attributes and productivity of maize + bushbean intercropping system. *Bangladesh J. Agril. Res.* 31, 3, 353-364.

Morris, M. L., Risopoulos, J., & Beck, D. (1999). Genetic change in farmer-recycled maize (*Zea mays* L.) seed; a review of the evidence. *CIMMYT Economic Working paper No. 99-07. Mexico, D.F., CMMYT.* p. 1.

OFRD (2006). Annual research report on On-Farm Research Division, 2005-2006. On-Farm Res. Div. BARI, Gazipur, Bangladesh. pp. 291-297.

OFRD (2014). Annual research report on On-Farm Research Division, 2013-2014. On-Farm Res. Div. BARI, Gazipur, Bangladesh. pp. 59-70.

Sarker, U. K., Dey, S., Kundu, S., & Awal, M. A. (2013). On-farm study on intercropping of hybrid maize with short duration vegetables. *J. Bangladesh Agril. Univ.* 11, 1, 1-4.

Uddin, M. J., Quayyum, M. A., & Salahuddin, K. M. (2009). Intercropping of hybrid maize with short duration vegetables at hill valleys of Bandarban. *Bangladesh J. Agril. Res.* 34, 1, 51-57.

Villarel, R. L. (1976). Observation on the multiple cropping in Taiwan. *Philippines J. Crop Sci.* 3, 2-8.