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Performance of Rabi Crops Intercropping with Wheat at Different Planting Geometry

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Abstract: An experiment on intercropping of potato, bushbean and edible poded pea with wheat at different row ratios was conducted in the irrigated upland ecosystem to study the agronomic and economic productivity and advantages of intercropping as compared to sole cropping. Intercropping of potato with wheat at 2:5 row ratio gave significantly higher wheat equivalent yield (WEY), higher land equivalent ratio (LER), higher gross return and benefit cost ratio followed by the same intercropping at 3:8 row ratio. On the other hand, competitive ratio was lower when potato was intercropped with wheat at the 3:8 row ratio followed by the same intercropping at 2:5 ratio. On an average intercropping of potato with wheat at 2:5 row ratio indicated the advantage of intercropping than those of other tested crops at different row ratios and sole cropping.

Key words: Rabi crops intercropping, wheat, planting geometry, performance

Introduction

The cropping intensity of upland ecosystem is very low due to low crop productivity and declining soil fertility. But stability of crop yields on upland condition can be achieved through crop substitution and intercropping (Rao and Willey, 1980). To improve the upland productivity as well as soil fertility, it is important to grow two or three crops either as inter or mixed cropping. Due to increased productivity and reliability ri production, farmers have to practice intercropping and explore new ways to intensity production per unit area of land. In intercropping systems, the important determinants are the judicious selections of crops, which are compatible, have minimum competition and give maximum total yield. Intercropping offered considerable yield advantages and higher economic return over sole cropping because of its efficient utilization of growth resources (Faruque *et al.*, 1996; Hashem and Muniruzzaman, 1986; Pathic and Malla, 1979). It also increases land equivalent ratio (LER) to a varying degrees (Mehta and Dey, 1980; Hashem *et al.*, 1990).

The farmers mostly grow wheat as a sole crop in upland, under rainfed condition. As a result they get poor yield. Now a day, increasing irrigation facilities provides an opportunity to increase the productivity of this ecosystem. Vegetables are very important group of crops and they constitute a major part of the diet contributing nutrients, especially vitamins, minerals and protein. They also make our diet more palatable and variable (Tsou, 1992). Vegetable production may be the answer to the potential problems of hunger and malnutrition in Bangladesh. Intercropping short duration high value Rabi vegetables with wheat might be an option for increasing the productivity of the said ecosystem. Potato, edible poded pea and bushbean are the short duration crops grown in early Rabi season. These crops could be grown with wheat as intercrops and may be suited to the system. As legume crop edible poded pea and bushbean could improve the fertility of the soil. Generally, legumes in association with non-legumes not only helps in utilization of the nitrogen being fixed in the current growing season, but also helps in residual nutrient build up of the soil (Sharma *et al.*, 1991). Potato intercropping with different vegetables produced 4 to 38% higher total yield over monoculture potato at the cost of 4 to 16% reduction in the yield of monoculture potato (Hashem *et al.*, 1990). Moreover, studies on the productivity and profitability of intercropping potato, edible poded pea and bushbean with wheat have not been reported. Therefore, this study was undertaken to determine agro-economic productivity and advantages of intercropping of potato, edible poded pea and bushbean with wheat at different row ratios as compared to sole crops.

Materials and Methods

A field experiment was conducted at the experimental farm of the Bangladesh Rice Research Institute (BRRI), Gazipur during the Rabi season (December-March) of 1997-98 and 1998-1999. The soil was clay having pH of 6.5. Six crop combinations were compared to the corresponding sole crops, which were given in Table 1.

Table 1. Comparison of six crop combinations

Sole and intercrops	Wheat intercrops ratio
Potato intercropping with wheat	5:2
Potato intercropping with wheat	8:3
Edible poded pea intercropping with wheat	3:2
Edible poded pea intercropping with wheat	5:3
Bushbean intercropping with wheat	3:2
Bushbean intercropping with wheat	5:3
Wheat sole	-
Potato sole	-
Edible poded pea sole	-
Bushbean sole	-

The experiment was laid out in a randomized complete block design. The unit plot size was 7 x 6 m^2. The variety Kanchan, Heera, Barimotor-2 and Jharsheem-1 for wheat, potato, edible poded pea and bushbean respectively were used in the experiment. The seed rates for wheat, potato, edible poded pea and bushbean were 120, 1500, 90 and 60 kg ha^{-1}, respectively. For intercrops, amounts of seed were measured based on row ratios.

Land was ploughed with a disc harrow and leveled by laddering. Seeds of intercrops and sole crop were sown at the first week of December. The fertilizer rate for intercrop and sole wheat, potato, edible poded pea and bushbean were 100-60-40-10 N-P_2O_5-K_2O-S, 140-105-150-20 N-P_2O_5-K_2O-S, 60-60-30-20 N-P_2O_5-K_2O-S and 60-60-30-20 N-P_2O_5-K_2O-S kg ha^{-1}, respectively in the form urea, triple super phosphate (TSP), muriate of potash (MP) and gypsum. Whole of TSP, MP and Gypsum were applied at the time of final land preparation. Two-third urea for wheat and a half of urea for potato, edible

poded pea and bushbean were applied at basal and remaining urea were topdressed at 30 days after sowing (DAS). Top dressing was done followed by a hand weeding. All vegetables were harvested in the second and third week of February and wheat was harvested at the maturity in the second week of March.

Grain and crop residue yields of all crops were measured at harvest and expressed in t ha^{-1}. The data were analyzed statistically and means were compared by the Duncan's New Multiple Range Test (DMRT). The land equivalent ratio (LER) and the competitive ratio (CR) were calculated in accordance with Willey (1979) and Willey and Rao (1980) as follows:

$$LER = \frac{YA}{SA} + \frac{YB}{SB}$$

Where, YA and YB are the intercrop grain yields of crop A, and crop B, and SA and SB are the corresponding sole crop grain yields.

$$CRa = \frac{La}{Lb} \times \frac{Zb}{Za}$$

Where, CRa is the competitive ratio for crop a in mixture with crop b. La and Lb are the relative yields of crop a and crop b respectively in the mixture and Za and Zb are their proportion.

The wheat equivalent yields (WEY) were computed by converting yields of potato, edible poded pea and bushbean into the yield of wheat in accordance with Singh *et al.* (1993) as follows:

$$\text{WEY of the crop} = \frac{\text{Yield of the crop (kg/ha)} \times \text{Market price of the crop (Tk/kg)}}{\text{Market price of wheat (Tk/ha)}}$$

Economic analysis of both sole and intercrops were done based on local market price of all inputs and outputs.

Results and Discussion

The grain yield of wheat significantly differed due to intercropping of potato, edible poded pea and bushbean during 1997-98 and 1998-99 (Table 2). In 1997-98, the highest wheat yield (2.92 t ha^{-1}) was obtained from sole wheat and the lowest (1.74 t ha^{-1}) from the intercropped wheat when potato was intercropped with wheat at 3:8 row ratio. In 1998-99, similar trend was also observed. Although there was no significant straw yield difference in both the years. Sole wheat produced higher straw yield. The results are similar with the findings of Ghosh *et al.* (2000) where they found that grain yield of individual crop decreased significantly in intercropping system when compared to the yields of their respective sole crops. Yields of companion crops were more or less similar in both the years (Table 2).

Significantly higher wheat equivalent yield (WEY) was produced when potato was intercropped with wheat at 2:5 row ratio than other intercrops and sole crops which was followed by same crop combination at 3:8 row ratio (Table 2). Wheat + potato (5:2 row ratio) gave 81% higher WEY than sole wheat averaged over two years. In the case of intercropping Pigeonpea with rice, Mollah *et al.* (1997) also found that rice equivalent yield (REY) produced by intercrops at 10:1 row ratio was significantly higher than Intercrops at other tested row ratios and sole crops.

The competitive ratio (CR) for all crops in all intercropping systems were less than one indicating the compatibility of the crops in the intercropping systems except when edible poded pea and bushbean were intercropped with wheat at 2:3 row ratio (Table 3). The apparent absence of competition could probably be due to different rooting depth of the crops (Angus

Table 2: Yield and wheat equivalent yield of sole and intercrops

Treatment	Wheat yield (t ha^{-1})				Companion crops yield (t ha^{-1})		Wheat equivalent yield (WEY) (t ha^{-1})		
	1997-98		1998-99		1997-98	1998-99	1997-98	1998-99	Average
	Grain	Straw	Grain	Straw					
Wheat + Potato (5:2)	2.13b	2.76	2.00c	2.82	5.60	5.47	6.36a	6.19a	6.28
Wheat + Potato (8:3)	1.74c	2.37	1.69d	2.65	5.49	6.06	5.87b	5.91b	5.89
Wheat + EPP (3:2)	2.16b	3.24	2.27b	3.40	2.46	2.43	4.42d	4.52d	4.47
Wheat + EPP (5:3)	1.80c	2.74	1.78d	2.75	2.60	2.68	4.09de	4.13e	4.11
Wheat + BB (3:2)	2.22b	3.21	2.35b	3.50	2.24	2.35	4.30d	4.55d	4.43
Wheat + BB (5:3)	2.11b	3.17	2.27b	3.20	2.38	2.39	4.30d	4.46d	4.38
Wheat (Sole)	2.92a	4.55	2.84a	4.69	-	-	3.49f	3.43g	3.46
Potato (Sole)	-	-			8.07	8.37	5.04c	5.23c	5.14
EPP (Sole)	-	-	-	-	5.10	5.03	3.83e	3.77f	3.80
BB (Sole)	-	-	-	-	5.46	5.27	4.10de	3.95e	4.03
CV (%)	3.7		3.5	-	-	-	4.2	2.3	-

In a column means followed by a common letter (s) do not differ significantly at the 5% level by DMRT.
EPP = Edible poded pea; BB = Bushbean.

Table 3: Competitive ratio (CR) and land equivalent ratio (LER) of sole and intercrops

Treatments	CR			LER		
	1997-98	1998-99	Average	1997-98	1998-99	Average
Wheat + Potato (5:2)	0.42	0.43	0.43	1.50	1.43	1.47
Wheat + Potato (8:3)	0.33	0.31	0.32	1.44	1.34	1.39
Wheat + EPP (3:2)	0.97	1.11	1.04	1.22	1.28	1.25
Wheat + EPP (5:3)	0.73	0.74	0.74	1.13	1.16	1.15
Wheat + BB (3:2)	1.24	1.23	1.24	1.17	1.28	1.23
Wheat + BB (5:3)	0.98	0.67	0.83	1.16	1.25	1.21
Wheat (Sole)	1.00	1.00	1.00	1.00	1.00	1.00
Potato (Sole)	1.00	1.00	1.00	1.00	1.00	1.00
EPP (Sole)	1.00	1.00	1.00	1.00	1.00	1.00
BB (Sole)	1.00	1.00	1.00	1.00	1.00	1.00

Table 4. Economic return of sole and Intercrops

Treatments	Gross return (Tk. ha^{-1})			Total variable cost (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})	Benefit cost ratio
	1997-98	1998-99	Average	Average	Average	Average
Wheat + Potato (5:2)	50,800	49,520	50,160	19,600	30,560	2.56
Wheat + Potato (8:3)	46,960	47,280	47,120	19,920	27,200	2.37
Wheat + EPP (3:2)	35,360	36,160	35,760	15,600	20,160	2.29
Wheat + EPP (5:3)	32,720	33,040	32,880	15,720	17,160	2.09
Wheat + BB (3:2)	34,400	36,400	35,400	15,820	19,580	2.24
Wheat + BB (5:3)	34,400	35,680	35,040	15,500	19,540	2.26
Wheat (Sole)	27,920	27,440	27,680	14350	13,330	2.07
Potato (Sole)	40,320	41,840	41,080	20,700	20,380	1.93
EPP (Sole)	30,640	30,160	30,400	14,400	16,000	2.11
BB (Sole)	32,800	31,600	32,200	14,930	17,270	2.16

et al., 1983) and transfer of fixed N by legume to the associated cereals (Bhagat *et al.*, 1986). Therefore, the crops studied were considered mutually compatible and could be grown in association. But particularly CR does not indicate the profitability of intercropping systems. To show the real land productivity, land equivalent ratio (LER) is the best method for evaluating land productivity of the intercropping system.

Land equivalent ratio (LER) was used to evaluate the advantages of intercropping. The LER was computed based on land area only and the duration of the component crops was not taken into consideration. However, crop production is a function of both crop duration (time) and land area (Hiebsch and McCollum, 1987). In all row ratio combinations in both the year, LER was higher in the intercrops than that of the sole crops (Table 3). Among them, intercropping of potato with wheat at 2:5 row ratio gave the highest LER followed by the same crop combination at 3:8 row ratio (Table 3) indicating the advantage of intercrop over sole crop. An increase in LER, due to intercropping of cereals with legumes has also been reported by many workers (Singh and Patil, 1984; Tariah and Wahua, 1985; Ofori and Stern, 1987).

Economic analysis of the sole and intercrop association indicated that the intercrop systems gave higher economic returns than sole crops (Table 4). Among the crop combinations, intercropping potato with wheat in both tested ratios gave higher gross margin (Tk. 30,560 at 5:2 row ratio and Tk. 27,200 at 8:3 row ratio, respectively) than all other combinations (Table 4) which resulted higher benefit cost ratio (2.56 and 2.37, respectively). Intercropping potato with wheat at different row ratios gave higher return, which resulted higher benefit cost ratio than all other intercropping and sole cropping systems.

From the results, it was revealed that potato could successfully be intercropped with wheat in coarse textured upland soil. Intercropping of potato with wheat was found more profitable than other intercrops at different row ratios and sole cropping. Considering higher wheat equivalent yield, gross margin, benefit-cost ratio and farmers diversified need for food, intercropping of potato with wheat in irrigated upland ecosystem might be an ideal and productive option.

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