Reprint **ISSN 1923-7766 (Web Version)**

International Journal of Experimental Agriculture

(Int. J. Expt. Agric.)

Volume: 3	Issue: 1	March 2013

Int. J. Expt. Agric. 3(1):38-45(March 2013)

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ijea** issn 1923-7766, HQ:19-10 cantral place, saskatoon, saskatchewan, s7n 2s2, Canada

ISSN-1923-7766 (Online)
Int. J. Expt. Agric. 3(1):38-45(March 2013)

EFFECT OF PLANTING CONFIGURATIONS ON YIELD AND YIELD COMPONENTS IN MAIZE + SOYBEAN AND MAIZE + BUSHBEAN INTERCROPPING SYSTEM

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Accepted for publication on 20 January 2013

ABSTRACT

Das AK, Khaliq QA, Haider ML (2013) Effect of planting configurations on yield and yield components in maize + soybean and maize + bushbean intercropping system. *Int. J. Expt. Agric.* 3(1), 38-45.

This intercropping experiment was planned under the concept of cereal + legume intercropping system to find out the effect of intercropping on the yields and yield parameters of the component crops under maize + soybean and maize + bushbean intercropping system at different planting configurations. During the experiment the data on yield parameters of the component crops were recorded under sole cropping and intercropped conditions. Yield and yield components were significantly influenced by the crop combination and planting configurations. Intercropping reduced the yield in component crops. The highest yields were obtained in sole crops compared to those in intercrops. In maize the highest plant height (210.66cm), longest cob (21.15 cm) and highest grain yield (7.03 t ha^{-1}) was recorded in sole cropping maize. Variation in grains cob^{-1} and 1000- seed was found insignificant. Maize equivalent yield was the highest (8.26 t ha^{-1}) in maize-bushbean intercropping at single row arrangement of maize. Plant height in soybean and bushbean was increased by intercropping with maize. Pods plant^{-1}, seeds pod^{-1}, pod length in soybean and bushbean were significantly reduced under intercropping condition. But intercropping increased the seed size in soybean and bushbean. The 100- seeds weight in soybean was the highest (14.50 g) in maize + soybean intercropping at paired row arrangement of maize. In bushbean it was the highest (19.13 g) in maize + bushbean intercropping at single row arrangement.

Key words: *intercropping, sole cropping, planting configuration, yield, equivalent yield*

INTRODUCTION

Intercropping system becomes productive and economical when it is done properly by selecting compatible crops (Santalla *et al.* 2001), planting configuration and population density of component crops (Myake 1995). The way in which the crop plants are arranged in the field is usually referred to as planting configuration. Planting configuration can be changed by manipulating the plant to plant and row to row distance. In intercropping system competition for growth resources can be optimized by manipulating the plant configuration. Reddy (2000) reported that plants arranged in square should make more efficient use of resources than those in rectangle. In the tropical and sub-tropical region, cereal - legumes intercropping is the most popular practice because of its many additional advantages (Willey 1979; Papendic *et al.* 1976; Okigbo and Greenland, 1976). Maize based intercropping is a popular practice under subsistence farming system. Growing period of maize coincides with a number of winter crops. Intercropping of maize with contemporary grain legume may be an alternate way of accommodating maize in existing cropping system. Among the cereals maize is considered as one of the most important and high yield potential crops for intercropping. Intercropping of maize with legumes is more advantageous than non legumes (Ptra *et al.* 2000 and Santalla *et al*. 2001). The winter maize cultivation period coincides with a number of legumes in Bangladesh. Among those bushbean and soybean were considered as potential for intercropping with maize and an experiment was designed with soybean and bushbean with a view- to find out the planting configurations effect on the growth and yield of component crops under maize-soybean and maize-bushbean intercropping system.

MATERIALS AND METHODS

The experiment was conducted in the experimental field of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Salna, Gazipur, Bangladesh. The treatment combinations were T_1 = Sole maize, T_2 = Sole soybean, T_3 = Sole bushbean, T_4 = Maize - soybean single row, T_5 = Maize - bushbean single row, T_6 = Maize - soybean paired row, T_7 = Maize - bushbean paired row. In this experiment the maize cv. BARI hybrid maize-5, bushben cv. BARI jharshim-1 and soybean cv. Sohag were used. Plants from 0.5 linear meters in each plot were collected at 15 days interval starting from 10 DAE to 100 DAE for growth analysis. Then the plant materials were oven dried at 70^0C for 72 hours and final dry weights were recorded. Data on other yield parameters were recorded from 10 randomly selected plants from each plot. Yield of crop was calculated from 4m^2 demarcated areas from the experimental plots. The plot size was 5.0 m x 4.0 m and the experiment was laid out in RCBD with 4 replications.

RESULTS AND DISCUSSION

Plant height in maize

Plant height is an important morphological character that acts as a potential indicator of availability of growth resources in its vicinity. It also indicates the competitive ability of component crops (Berkowitz 1988). Generally taller plants are more competitive than inferior ones. Plant height of maize was influenced by the different row arrangements when intercropped with soybean and bushbean. The superior plants (210.66 cm) were recorded in sole cropping of maize (T_1) and it maize was statistically similar to that of T_6 (Table 1). There were variations in plant height of maize in single row and paired row arrangement with soybean and bushbean. Under intercropped condition, the superior plant height was 204.89 cm when intercropped with soybean at paired row arrangement (T_6), which was statistically similar to the plant height of maize recorded in T_4 and T_5 treatments. The inferior plant height in maize was at paired row arrangement (T_7) but it was statistically similar to that of T_4 and T_5 treatments. These results indicated that plant height in maize at paired row and single row arrangement with soybean and bushbean decreased significantly than that of maize sole cropping. Similar result was reported by Shivay and Shingh (2000) who found that height in maize was affected by the intercropping when maize was intercropped with soybean at different row arrangements.

Cob length in maize

Grain yield was found significantly and positively associated with cob yield in sole cropping and intercropping systems, whilst kernel yield significantly and positively associated with cob length (Mahajan and Singh, 1998). Associations between morphological and physiological characters were stronger when intercropped than in monoculture. Evaluation of ear length in intercropping may be effective for determining the suitability for intercropping with legumes. The length of cob in maize significantly varied with the variation in intercropping systems when maize was intercropped with soybean and bushbean at different row arrangements (Table 1). The longest cob (21.15 cm) was recorded in sole cropping (T_1) and it was statistically similar to that of maize + bushbean at single row (T_5) arrangement (19.84 cm). The shortest cob in maize was found in maize + bushbean at paired row arrangements (T_5) which was statistically similar to those of the other treatments except the sole cropping maize (T_1). From these results it was revealed that intercropping systems had significant effects on the length of cob in maize. Maize - bushbean at single row arrangement provided the best cob length which was close to that of the sole cropping maize (T_1).

Grains cob^{-1} in maize

Grains cob^{-1} is one of the most important yield components. It was found unaffected in maize under different planting configuration when intercropped with soybean and bushbean (Table 1). Similar result was documented by Islam *et al.* (2002) who found insignificant relation with the intercropping systems in the grain cob^{-1} when maize was intercropped with bushbean at different planting configuration. There was little difference between cropping systems for grains cob^{-1} as it was a genetic variance (Amankwa and Michaels, 1997).

Seed size in maize

The seed size of maize expressed in term of 1000 seed weight. The effect of planting configuration on the 1000 seed weight in maize was found insignificant when intercropped with soybean and bushbean (Table 1.) Seed size is one of the important yield contributing characters and yield attributes in maize were not significantly different between intercropping and sole cropping (Neupane *et al*. 1997; Sharma *et al*. 1998; and Jana and Saren, 1998). Similarly Islam *et al.* (2002) also found insignificant effect of intercropping on seed size in maize when intercropped with bushbean.

Table 1. Plant height, length of cob, grains cob^{-1} and 1000 seed weight in maize as influenced by intercropping with soybean and bushbean at single row and paired row arrangements

Treatment	Plant height (cm)	Length of cob (cm)	Grains cob^{-1} (no.)	1000 Seed weight (g)
T_1	210.66	21.15	513.77	325.18
T_4	199.56	18.80	509.30	325.13
T_5	200.06	19.84	511.15	329.08
T_6	204.89	19.00	508.30	286.98
T_7	196.19	18.63	507.20	325.10
$LSD_{(0.05)}$	6.87	1.39	NS	NS
CV %	2.20	4.61	3.33	10.21

T_1= Sole maize, T_4 = Maize - soybean (Single row), T_5 = Maize - bushbean (Single row), T_6 = Maize - soybean (Paired row), T_7 = Maize - bushbean (Paired row)

Grain yield in maize

Grain yield in maize varied significantly when intercropped either with bushbean or soybean at different planting configurations. The highest yield was recorded 7.03 t ha^{-1} in the sole cropping of maize (Table 2). Under intercropped condition the highest yield was obtained (6.50 t ha^{-1}) in maize - bushbean at single row arrangement (T_5) which was statistically similar to that in the maize - soybean at paired row arrangement (T_5) and maize - bushbean at paired row (T_7) planting configuration. On other hand, the sole crop yield in maize (7.03 t ha^{-1}) was also statistically similar to the yield of maize in maize + soybean at single row (T_4) and maize + bushbean single row planting configuration (T_5). This indicated that intercropping of maize either with soybean or with bushbean under different planting configuration significantly reduced the maize yield. These results agreed with the findings of Upasani *et al.* (2000) who found the grain yield in intercropped maize was reduced compared to that in sole cropping. Shivay *et al.* (2001), Kus and Jonezyk (1999) and Halikatti and Banarasilal (1998) also found reduced yield in maize when intercropped with legumes.

Table 2. Grain yield, harvest index and equivalent yield in maize as influenced by planting configurations and intercropping with soybean and bushbean

Treatment	Yield t ha^{-1}	Maize equivalent yield (t ha^{-1})	Harvest index (%)
T_1	7.03	7.03	52.04
T_4	6.67	7.91	50.39
T_5	6.50	8.26	54.20
T_6	5.47	6.64	49.43
T_7	5.75	7.60	48.18
$LSD_{(0.05)}$	2.13	0.38	3.77
CV %	11.31	5.14	44.81

T_1= Sole maize, T_4 = Maize - soybean (Single row), T_5 = Maize - bushbean (Single row), T_6 = Maize - soybean (Paired row), T_7 = Maize - bushbean (Paired row)

Maize equivalent yield

The efficiency of maize + soybean and maize + bushbean intercropping systems was evaluated on the basis of maize equivalent yield. All maize based intercropping system provides higher maize equivalent yield (Pandey *et al.* 2003). The equivalent yield of maize was significantly influenced by the planting configuration (Table 2). Maize equivalent yield in both planting configuration was higher than that in the maize under sole cropping. Among the intercropping treatments, the highest maize equivalent yield (8.26 ton ha^{-1}) was obtained in maize + bushbean at single row arrangement (T_5) which was statistically similar to that in maize + soybean single row treatment (T_4) but dissimilar to those in all other treatments. The lowest maize equivalent yield was recorded in maize + soybean at single row arrangements (T_6) which was statistically similar to that in the maize under sole cropping (T_1). Shivay *et al.* (1999) conducted an intercropping experiment on maize with soybean and recorded higher maize equivalent yield in all planting configurations. Similar result was found in maize + cowpea and maize - blackgram intercropping (Khola *et al.* 1999). Sharma *et al.* (1998) conducted a field experiment in combination of maize, cowpea, soybean and blackgram and concluded that the maize equivalent yield was higher in all intercropping systems than from maize under sole cropping.

Harvest index in maize

Harvest index is one of the most important indicators for biological efficiency of a crop. The harvest index in maize significantly varied with the variation in maize + soybean and maize + bushbean intercropping systems under different planting configuration (Table 2). The maximum harvest index (54.20%) was found in maize + bushbean at single row arrangement (T_5) which was statistically similar to that in maize (52.30%) under sole cropping (T_1). The harvest index was the lowest (48.18%) in maize + bushbean at paired row intercropping system (T_7), and it was statistically dissimilar to those in other treatments. In maize + soybean at single row arrangement (T_4) the harvest index was 50.39% which was statistically similar to that in the maize + soybean paired row (T_6) intercropping system. In an experiment on maize + bushbean intercropping system the harvest index in maize increased (Oljaca *et al.* 2000). On the other hand, the harvest index was found unaffected by maize + soybean intercropping system (Carruthers *et al.* 2000).

Table 3. Plant height, pods plant^{-1}, seeds pod^{-1} and pod length in soybean as influenced by planting configurations and intercropping with maize

Treatment	Plant height (cm)	Pods plant^{-1} (no.)	Seeds pod^{-1} (no.)	Pod length (cm)
T_2	41.63	35.62	3.37	3.69
T_4	50.43	25.60	2.20	3.56
T_6	46.23	28.65	2.27	3.67
$LSD_{(0.05)}$	2.936	3.90	0.43	0.134
CV %	3.72	7.53	9.34	2.53

T_2 = Sole soybean, T_4 = Maize - soybean (Single row), T_6 = Maize - soybean (Paired row)

Plant height in soybean

Plant height in soybean under intercropped condition varied significantly with the variation in planting configurations (Table 3). The superior plants of soybean were (50.43 cm) observed when intercropped with maize at single row arrangement (T_4) which was statistically different from that of soybean under sole cropping (T_2) and at the paired row arrangement (T_6). The inferior plant height (41.63 cm) was recorded in soybean under sole cropping (T_2) and also statistically different from those in other treatments. Sood and Sood (2001) found variations in plant height due to intercropping. Higher plant height of soybean was recorded when intercropped with maize. Difference in the height of cowpea genotypes was reported by Robertson *et al*. (2000) when intercropped with maize. The increase in plant height in soybean was attributed to the decrease in red to far- red light ratio as result of preferential absorption of red light by the plants (Morgan and Smith, 1981). Such change in spectral balance increased internodes elongation process (Kretchmer *et al.* 1977) and increased the plant height in soybean under intercropping system.

Pods plant^{-1} in soybean

Number of pods plant^{-1} is an important attribute to yield in grain legumes. Number of pods plant^{-1} varied significantly in soybean when intercropped with maize at different planting configurations (Table 3). The highest number of pods plant^{-1}(35.62) was found in the soybean under sole cropping (T_2) and it was statistically different from that of maize + soybean at single row (T_4) and maize + soybean at double row arrangement (T_6). Number of pods plant^{-1} was the lowest (25.60) in maize + soybean at single row arrangement (T_4) but it was statistically similar to maize + soybean at double row arrangement (T_6). In Turkey when bean was intercropped with maize the bean in sole cropping had higher number of pods plant^{-1} (Cifteci *et al.* 2006). Similarly pods plant^{-1} in *Phaseolus vulgaris* was found to be decreased by intercropping with maize (Amankwa and Michaels, 1977 and Atuahene *et al.* 2004). In maize + cowpea intercropping pods plant^{-1} and seeds pod^{-1} decreased significantly (Ndakidemi and Dakora, 2007). Osumi *et al*. (1998) reported that shading by the taller component resulted in flower and pod dropping, which ultimately decreased number of pods plant^{-1} in legumes.

Seeds pod^{-1} in soybean

Seed pod^{-1} varied significantly with the variation in cropping system (Table 3). Soybean when intercropped with maize, seeds pod^{-1} was the superior (3.37) in soybean under sole cropping and it was statistically different from the seeds pod^{-1} in soybean at single row arrangement (T_4) and at paired row (T_6) arrangement. At single row arrangement (T_4) and at paired row arrangement (T_6) the seeds pod^{-1} was 2.20 and 2.27, respectively but these were statistically similar. Similar result was found in maize - bean intercropping where the cropping system significantly decreased the number of seeds pod^{-1} in bean (Atuahene *et al.* 2004). Number of seeds pod^{-1} in grain legumes is assumed as a genetic trait but it may be modified under changed growing environment. Reduction in production of photo- assimilates under prolonged shading by maize might have resulted in the lowest number of seeds pod^{-1} in soybean (Egli and Yu, 1991).

Pod length in soybean

Cropping systems significantly affected the pod length in soybean. The superior length of pod (3.69 cm) was recorded in soybean under sole cropping but it was statistically similar to the pod length in soybean recorded (3.56 cm) at single row (T_4) and (3.68 cm) at paired row (T_6) arrangement, respectively (Table 3). Similarly in sorghum + soybean intercropping the pod length in soybean was found statistically similar (Raji 2002).

Table 4. Hundred seed weight, grain yield, harvest index and equivalent yield in soybean as influenced by planting configurations and intercropping with maize

Treatment	100-seed weight (g)	Grain yield (t ha^{-1})	Harvest index (%)	Soybean equivalent yield (kg ha^{-1})
T_2	12.66	1.23	53.77	1217.50
T_4	13.95	0.93	37.52	4648.70
T_6	14.50	0.72	35.53	3893.60
$LSD_{(0.05)}$	1.283	0.08	5.88	366.00
CV %	5.41	4.25	8.04	6.50

T_2 = Sole soybean, T_4 = Maize - soybean (Single row), T_6 = Maize - soybean (Paired row)

Seed weight in soybean

Seed weight is another yield component, which is also a stable trait. But changed environment may modify the seed weight. Maize + soybean intercropping system significantly affected the 100-seed weight in soybean (Table 4). The 100-seed weight was the lowest (12.66 g) in soybean under sole cropping (T_2) and it was statistically different from those in maize + soybean at single row (T_4) and maize + soybean at paired row arrangement (T_6). In maize + soybean at single row arrangement the 100-seed weight was 13.95 g and at paired row arrangement it was 14.50 g and these were statistically similar. In intercropping of rice associated with greengram, blackgram and pigeonpea the 100-seed weight of legumes increased (Mandal *et al*. 2000) in different intercropping systems. Comparatively less number of seeds received more assimilates which might increased the seed size in legume under intercropping system.

Grain yield in soybean

Grain yield in soybean was significantly influenced by the cropping systems and the planting configurations (Table 4). The highest grain yield (1.23 ton ha^{-1}) was obtained in soybean under sole cropping (T_2) which was statistically different from those in maize - soybean at single row (T_4) and maize - soybean at paired row arrangement (T_6). In maize - soybean at single row arrangement (T_4) the soybean yield was 0.93 t ha^{-1} which was higher than yield in soybean (0.72 t ha^{-1}) in maize - soybean at paired row arrangement (T_6) and these were statistically different. Similarly in maize - soybean intercropping system the grain yield in soybean found to be decreased significantly by intercropping treatments (Halikatti and Banarasilal, 1998 and Carruthers *et al*. 2000). Maize when intercropped with blackgram the grain yield in blackgram decreased significantly (Upasani *et al.* 2000). The grain yield in common bean was also decreased when intercropped with maize (Maingi *et al.* 2000).

Harvest index in soybean

Harvest index is one of best indicator of the biological efficiency of a crop under the specific cropping system. In maize - soybean intercropping system it was significantly influenced by the planting configurations and the cropping system (Table 4). The highest harvest index (53.77%) was recorded in soybean under sole cropping (T_2), which was statistically different from those in maize + soybean at single and at paired row (T_6), arrangement. Harvest index in single row (37.52) and paired row (35.53) were identical. Harvest index in soybean decreased under intercropping system compared to that in sole cropping of soybean. In the results of the experiments in maize research institute Yugoslavia, revealed that the harvest index in soybean decreased under intercropping system (Olijaca *et al.* 2000). This result was found at par with the present study.

Soybean equivalent yield

In evaluation of intercropping system equivalent yield is an important intercropping index. Soybean equivalent yield was significantly influenced by planting configurations (Table 4). In the sole cropping the soybean yield was 1217.50 kg ha^{-1} which was statistically different from the soybean equivalent yield at single row (T_4) and at the paired row (T_6) treatment. The highest soybean equivalent yield was 4648.70 kg ha^{-1} recorded in T_4 treatment. In $T_{6,}$ it was 3893.60 kg ha^{-1} and statistically different from those of other treatments.

Table 5. Plant height, branches $plant^{-1}$, pods $plant^{-1}$, seeds pod^{-1} and pod length in bushbean as influenced by planting configurations and intercropping with maize

Treatment	Plant height (cm)	Branches $plant^{-1}$ (no.)	Pods $plant^{-1}$ (no.)	Seeds pod^{-1} (no.)	Pod length (cm)
T_3	17.18	2.53	9.13	5.40	13.85
T_5	22.20	2.00	7.14	4.58	13.82
T_7	18.99	1.68	6.06	4.05	13.67
$LSD_{(0.05)}$	1.76	0.29	0.94	0.70	2.00
CV %	5.17	8.19	7.26	8.77	8.41

T_3 = Sole bushbean, T_5 = Maize - bushbean (Single row), T_7 = Maize - bushbean (Paired row)

Plant height in bushbean

Plant height in bushbean under intercropped condition varied significantly with the variation in planting configurations (Table 5). The tallest plants in bushbean were (22.20 cm) observed when intercropped with maize at single row arrangement (T_5) which was statistically superior to that in bushbean under sole cropping (T_3) and at the paired row arrangement (T_7). The inferior plant height (17.18 cm) was recorded in bushbean under sole cropping (T_3) and it was also statistically similar to that in maize + bushbean paired row arrangement (T_7). Sood and Sood (2001) found the variations in plant height of soybean when intercropped with maize. Difference in the height of cowpea genotypes was reported by Robertson *et al*. (2000) when intercropped with maize. The increase in plant height in bushbean was attributed to the decrease in red to far- red light ratio as result of preferential absorption of red light by the plants (Morgan and Smith, 1981). Such change in spectral balance increased internodes elongation process (Kretchmer *et al*. 1977) and increased the plant height in bushbean bean under intercropping system.

Branches $plant^{-1}$ in bushbean

Cropping system and planting configuration significantly influenced the number of branches $plant^{-1}$ in bushbean when intercropped with maize (Table 5). Number of branches $plant^{-1}$ was the highest (2.53) in bushbean under sole cropping (T_3) and it was statistically different from that in maize + bushbean at single row (T_5) and paired row (T_7) treatments. The inferior number of branches $plant^{-1}$ (1.68) was found in bushbean at paired row treatment (T_7) which was statistically different from that in maize + bushbean at single row arrangement (T_5) and bushbean under sole cropping (T_3). Sood and Sood (2001) reported that number of branches $plant^{-1}$ in soybean being a genotypic trait variation was higher under the intercropping system.

Pods $plant^{-1}$ in bushbean

Number of pods $plant^{-1}$ is an important attributes to yield of grain legumes. Number of pods $plant^{-1}$ varied significantly in bushbean with the variation in cropping system and planting configuration when intercropped with maize (Table 5). The highest number of pods $plant^{-1}$(9.13) was found in bushbean under sole cropping (T_3) and it was statistically different from that of maize - bushbean single row (T_5) and maize - bushbean paired row

(T_7) treatment. Number of pods plant^{-1} was the lowest (6.06) in maize - bushbean at paired row arrangement (T_7) and it was statistically dissimilar to that in bushbean under maize - bushbean at single row arrangement (T_5). Under intercropped condition the maize - bushbean at single row (T_5) treatment gave the highest number of pod plant^{-1} in bushbean and it was statistically different from those in other treatments. In Turkey when bean was intercropped with maize the bean had higher number of pods plant^{-1} under sole cropping (Cifteci *et al.* 2006). Similarly pods plant^{-1} in *Phaseolus vulgaris* was found to be decreased by intercropping with maize (Amankwa and Michaels, 1977 and Atuahene *et al.* 2004). In maize - cowpea intercropping pods plant^{-1} in cowpea decreased significantly (Ndakidemi and Dakora, 2007). Shading by the taller component caused flower and pod dropping in legumes which ultimately resulted in lower number of pods plant^{-1} (Osumi *et al*. 1998).

Seeds pod^{-1} in bushbean

Seeds pod^{-1} varied significantly with the variation in cropping systems and planting configurations (Table 5). Bushbean when intercropped with maize seeds pod^{-1} was the highest (5.40) in bushbean under sole cropping and it was statistically different from the seed pod^{-1} in bushbean at single row (T_5) and paired row (T_7) treatment. In single row arrangement (T_5) and paired row arrangement (T_7) the seeds pod^{-1} were 4.58 and 4.05, respectively and these were statistically similar. Similar result was found in maize + bushbean intercropping system where the intercropping significantly affected the number of seeds pod^{-1}(Atuahene *et al.* 2004). Number of seeds pod^{-1} in grain legumes is assumed as a genetic trait but it may be modified under changed growing environment. It was reported by Egli and Yu (1991) that reduction in production of photo - assimilates under prolonged shading by maize caused the lowest number of seeds pod^{-1} in soybean.

Pod length in bushbean

Cropping systems and planting configurations significantly affected the pod length in bushbean (Table 5). The highest length of pod (13.85 cm) was recorded in bushbean under sole cropping (T_3), however, the pod length in bushbean was statistically similar to the pod length 13.82 cm and 13.67 cm recorded in single row (T_5) and paired row (T_7) arrangement, respectively. Similarly in sorghum - soybean intercropping the pod length of soybean was different when intercropped with sorghum (Raji 2002).

Table 6. Hundred seed weight, grain yield, harvest index and equivalent yield in bushbean as influenced by planting configurations and intercropping with maize

Treatment	100-seed weight (g)	Yield (ton ha^{-1})	Harvest index (%)	Equivalent yield (kg ha^{-1})
T_3	17.88	1.40	89.10	1402
T_5	19.13	1.05	82.87	4636
T_7	19.08	0.99	79.49	4335
$LSD_{(0.05)}$	1.02	0.09	3.48	1.63
CV %	3.15	5.01	2.40	8.62

T_3 = Sole bushbean, T_5 = Maize - bushbean (Single row), T_7 = Maize - bushbean (Paired row)

Seed weight in bushbean

Seed weight is another yield component, which is also a stable trait. But changed environment may modify the seed weight. Maize + bushbean intercropping system significantly affected the 100-seed weight in bushbean (Table 6). The 100-seed weight was the lowest (17.88 g) in bushbean under sole cropping (T_3) and it was statistically different from the seed weight in bushbean under maize + bushbean at single row (T_5) and maize + bushbean paired row (T_7). In maize + bushbean single row arrangement the 100-seed weight was 19.13 g and in paired row arrangement it was 19.08 g, which were statistically similar. Similar trend was found in legumes under intercropping of rice with greengram, blackgram and pigeonpea. The 100-seed weight of legumes increased in different intercropping systems (Mandal *et al*. 2000).

Grain yield in bushbean

Grain yield in bushbean was influenced by planting configurations under intercropping condition with maize (Table 6). The highest grain yield (1.40 t ha^{-1}) was recorded in sole cropping bushbean and it was statistically different from those of T_5 and T_7 treatments. Under intercropping condition the higher grain yield (1.05 t ha^{-1}) was obtained from T_5 treatment. It was statistically different from that of T_3 and similar to that of T_7 treatment. Intercropping decreased the grain yield in bushbean and this finding was found in conformity with the observation of Dwivedi *et al*. (1998) in another intercropping experiment of wheat and mustard.

Harvest index in bushbean

Harvest index is one of best indicator of the biological efficiency of a crop under the specific cropping system. In maize - bushbean intercropping system harvest index in bushbean significantly varied by the planting configurations and the cropping systems (Table 6). The highest harvest index (89.10%) was recorded in bushbean under sole cropping (T_3), which was statistically different from those in maize - bushbean at single

(T_5) and paired row (T_7) arrangement. In the single row arrangement (T_5) the harvest index in bushbean was 82.87% and at paired row arrangement (T_7) it was recorded 79.49%. These were statistically similar. Harvest index in bushbean decreased under intercropping than that of bushbean under sole cropping. The results were found in conformity with the experiments of maize the research institute Yugoslavia, where the harvest index in bean under intercropping reduced compared to the bean under sole cropping (Olijaca *et al.* 2000).

Bushbean equivalent yield

In the evaluation of intercropping systems equivalent yield is an important index of efficiency. The performance of maize - bushbean intercropping system was evaluated on the basis of equivalent yield (Bandyopadhyay 1984). Bushbean equivalent yield was found to be significantly influenced by planting configurations and cropping systems (Table 6). Under the sole cropping the bushbean yield was 1402 kg ha^{-1} which was significantly different from the equivalent yield in bushbean at single row (T_5) and paired row (T_7) arrangements. The highest bushbean equivalent yield was 4636 kg ha^{-1} recorded in T_5 treatment. In T_7 it was 4335 kg ha^{-1} and statistically different from those in other treatments. Similarly Islam *et al*. (2002) reported that the bushbean equivalent yield was significantly higher when intercropped with maize.

CONCLUSION

Intercropping reduced the yield in component crops. The highest yields were obtained in sole crops compared to those in intercropping condition. Maize equivalent yield recorded the highest in maize- bush bean intercropping at single row arrangement of maize. The plant height and seed size increased in the lower story crops bushbean and soybean irrespective of the planting configurations.

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