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Effect of Intercropping Maize with Bean at Different Planting Dates in Southern Region of Ethiopia

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Abstract
Establishment of the ideal time planting is an important factor for obtaining maximum benefits while growing two different species together. Experiments were carried out at Hawassa agricultural research experimental field in two successive growing seasons (2011/12 and 2012/13) to determine optimal planting time for common bean while intercropping and investigate the performances of the component crops. The varieties BH-543(Maize) and Hawassa-Dume (common bean) were used and grown under conventional tillage practice. The plot size of 35.7 square was used having 5.1 meter long and 7 meter wide been employed to conduct the experiment. Common bean was planted simultaneously with maize, 30 days after maize and 60 days after maize. Sole planting of maize, sole planting of common bean, sole planting of common bean after thirty and sixty days maize were used to determine relative and land productivity for maize-bean intercropping system. The results showed that average maize grain yield across different planting time in intercropping were almost the same to those obtained from sole cropping in each seasons. Bean seed 60 days after maize had no significant adverse effect on maize yield and an additional 1.3 tons per of bean seed yield was obtained in 2011 growing season. In 2012 growing season, all but simultaneous growing of bean with maize improved maize grain yield higher than the second and last dates of bean intercropping with maize. Relative yields of maize showed that maize yields were lower in mixture than mono cropping during 2011 and higher in 2012. The results of the study also showed that the total yield of maize-bean mixtures per unit area of land were considerably higher than those obtained from the two crops grown separately in both seasons. Overall Land Equivalent Ratio(LER) values for grain yields of maize and beans showed that intercropping compared to sole cropping is advantageous and best indices were obtained at bean planting dates of 60 days after maize in no moisture stress season of 2011 and same time planting under moisture stress growing season of 2012.
Keywords: intercropping, planting time, land equivalent ratio

1. Introduction

Maize is the most important cereals crops of Ethiopia, ranking next in area coverage and first in production (CSCA 2012). As a mixed crop, it is often grown with bean, soybean and cowpea. Cropping systems such as multiple cropping, mono cropping and crop rotations are among the majors one exercised in maize based cropping system of the Southern regions of Ethiopia. Intercropping, which is one type of multiple cropping system, has been practiced traditionally by small scale farmers in Ethiopia. In particular maize-bean intercropping is a common cropping system in Southern Ethiopia. According to Baldy and Stiger (1997) the main reason for using a multiple cropping system is the fact that it involves integrating crops using space, labor and other resources such as rainwater more efficiently. While integrating different crops resource allocations and management such as plant population, fertilizations and time of intercropping for the components crops that need to be addressed so as to increase the benefits from using multiple cropping or intercropping increased. Although intercropping is traditionally practiced in the regions, the crop management and agronomic practices farmers follow in the region are not consistent and studied very well. Establishment of the ideal time planting is an important factor for obtaining maximum benefits while growing two different species together. Hence the present experiment was conducted to determine a suitable planting dates for beans in maize-bean intercropping system.

2. Materials and methods

2.1 Study area

Trials studies were conducted at Hawassa agricultural research center, South Agricultural Research Institute (latitude longitude, altitude 1800m above sea level) during two summer growing season(2011/12 and 2012/13). A total of seven treatments comprised of sole maize and common bean and maize-common bean intercropping with three dates of common bean planting. The treatments arranged in RCBD with three replications. The varieties BH-543 and Hawassa-Dume was used and grown under conventional tillage practice. The plot size of 35.7 meter square was used having 5.1meter long and 7 meter wide been employed to conduct the experiment. Common bean was planted at three planting dates. These were Simultaneous with maize, 30 days and 60 days

after maize, sole planting of maize, sole planting of common bean, sole planting of common bean after thirty and sixty days maize was used to determine land equivalent ratio for maze- bean intercropping system. The seed rate of 25kg/ha was used for maize and beans planted with rate of 60kg/ha for sole and 30 kg/ha used for bean in the intercropped plot. Basal application of 100kg/ha DAP applied at planting and split application of 200kg/ha urea, two third at emergence and one third after 30 days was used. All crops were planted by hand and hand weeding was carried out throughout the growing season. Maize grain and seed yield of bean was taken from the whole plot. Land equivalent ratio was calculated according to *Mead and Willey* 1985 MYI+BYI. SAS was employed to run statistical analysis and mean separation

2.2 Treatments

SM = Sole Maize
MBIST=Maize Bean Intercropping same time
MBIBA30D = Maize Bean Inter cropping Bean after 30 days of maize planting
MBI BA60D = Maize Bean Inter cropping Bean after 60 days of maize planting
SB= Sole Bean
SBA30D= Sole Bean after 30 days of maize planting
SBA60D = Sole Bean after 60 days of maize planting

3. Result and Discussion

Yield of mixed crop and monocultures different due to seasonal variations and time of intercropping and the different seed rates of bean used under sole bean and intercropping.

The result (Table 1) indicated that large differences were observed between seasonal average maize grain yields. This is due long and severe drought occurred in 2012 growing season (data not shown). The results showed that average maize grain yield across different planting time in intercropping were almost the same to those obtained from sole cropping in each seasons indicating that maize grain yield did not be affected due to bean intercropping.

In 2011 maize grain yield were lower in mixture when bean planted at the same date and 30 days after maize than monoculture. Differences in yield between mixed crop and monoculture indicated the effects of competition in the mixture. In contrast maize under intercropping with bean after 60 days showed better grain yield than sole cropping. Different trends of variation in maize yield were observed in 2012 drought season. The maize yield in intercropping produced highest yield 3.1 t/ha and 2.9 t/ha respectively than sole cropping (2.6 t/ha). The increase in maize yield under intercropping might be due to the beneficial effect of bean on maize as a cover crop for reducing evaporation demand under drought. Alemseged *et.al* (1990) explained the contribution of mixed cropping for increasing water use efficiency and its role in reducing evapo-transipiration demand of the microclimate.

Table 1 Effect of Mixed cropping on grain yield of maize

Treatments	Grain yield t/ha	
	Year1 (2011)	Year 2 (2012)
SM	10.7	2.7
MBIST	10.4	3.1
MBIBA30D	10.1	2.9
MBI BA60D	11.3	2.4
SB	----	----
SBA30D	-----	-----
SBA60D	----	----

Yield differences between bean were observed mainly due to different of seed rates used in mixed and sole cropping. The seed rates of bean in intercropping were half of sole bean consequently large differences in seed yield of beans were observed between intercropping and sole cropping in both seasons. In mixed cropping the yield of bean was different significantly mainly due to different time of planting with maize in 2012. Early bean intercropping with bean (i.e. same time of planting) produced the highest seed yield (1.4 t/ha) than late intercropping during moisture stress. Seed yield of bean were statistically identical to different time of intercropping with maize in 2011 (Table 2).

Table 2 Effect of mixed cropping on seed yield of bean

Treatments	Year1 (2011)	Year 2 (2012)
SM	---	---
MBIST	1.3[b]	1.4[a]
MBIBA30D	1.4[a]	0.6[b]
MBI BA60D	1.3[b]	0.3[c]
SB	3.4	3.7
SBA30D	2.8	2.1
SBA60D	2.5	1.4

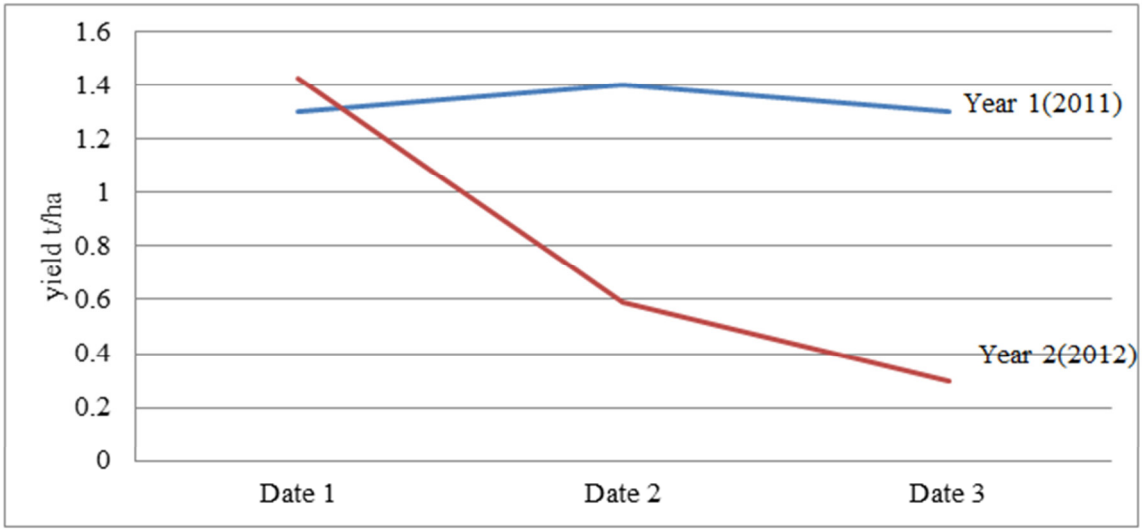
Contrasting trends between on seed yield of bean across different time of intercropping with maize were observed between the two seasons (figure 1). The trend between seed yield across different dates in intercropping was consistence in 2011 growing season whereas a sharp decline of bean seed yield from early to late planting date were observed in 2012 experimental season. This might be due to variations in moisture requirements of the component crops for growth and developments that common bean is more water efficient than maize.

Relative yields of maize showed that maize yields were lower in mixture than mono cropping during 2011. That is mixed when planted with cropping of maize yield beans at the same and 30 days after maize produced 0.03% and 0.06% lower yield of maize sole cropping (Table 3). The trend was different during the season of moisture stress that relative yield of maize with beans at the same time and beans after 30 days of maize produced 0.19% and 0.11% higher yield than maize sole cropping respectively.

Table 3 Relative yields and LER (land equivalent ratio) for different maize-bean cropping systems

	Year1 (2011)			Year 2 (2012)		
	Relative Yield			Relative Yield		
Treatments	Maize	Bean	LER	Maize	Bean	LER
SM	1	---	1	1	---	---
MBIST	0.97	0.38	1.35	1.19	0.38	1.57
MBIBA30D	0.94	0.5	1.44	1.11	0.29	1.4
MBI BA60D	1.06	0.52	1.58	0.92	0.22	1.14
SB	----	1	1	-----	1	1
SBA30D	----	1	1	-----	1	1
SBA60D	----	1	1	-----	1	1

The results of the study also showed that the total yield of maize-bean mixtures per unit area of land were considerably higher than those obtained from the two crops grown separately in both seasons (Table 3). The highest land equivalent ratio of 1.58 was obtained when bean planted 60 days after maize in moisture stress free season of 2011 while simultaneous cropping of the two crops gave the highest LER followed by the second and last dates of bean planting with maize during moisture stress season of 2012. From the above results, it may be observed that the practice of maize-bean intercropping time is highly influenced by seasonal rainfall. Many papers have pointed out the beneficial advantages of mixed cropping than mono cropping in various crop combinations in terms of yield (Islam et al 1991, Owner, Luis and Robert 2008) and insect infestation (El-Fakharany et. al. 2012).



Total dry matter yield of maize-bean intercropping were significantly different from sole cropping of the two crops (Table 4). Variation on patterns of dry matter accumulation in intercropping of maize with bean across different dates was significantly different which showed a consistent tendency. Dry matter accumulation decreased from early to late time of intercropping.

Table 4 Dry matter (tones/ha) and rain water productivity (Kg ha mm^{-1}) at Hawassa in 2012

Treatments	DM (t/ha)	RWE (kg ha mm^{-1})	Rank
SM	17.04bc	18.bc	3
SB	10.12d	11.16d	5
MBIST	21.4a	23.62a	1
MBIBA30D	19.6ab	21.61ab	2
MBIBA60D	15.16c	16.73c	4
SBA30D	4.59e	6.57e	6
SBA60D	2.13e	5.94e	7
Mean	12.86	14.92	
CV (%)	14.17	13.86	

Conclusion

From the above results it may be observed that time the practice of maize-bean intercropping time is highly affected by seasonal rainfall. Late bean intercropped on maize did not affect maize grain yield producing highest LER of 1.58 in moisture stress free season of 2011. In contrast, planting the two crops at the same time produced better yield with highest LER of 1.57 during moisture stress season. Overall LER values for grain yields of maize and beans showed that intercropping compared to sole cropping is advantageous and best indices were obtained at bean planting dates of 60 days after maize in no moisture stress season of 2011 and same time planting under moisture stress growing season of 2012. Similarly, highest dry matter accumulation and water use efficiency was obtained from growing maize and bean crops at the same time during moisture stress.

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