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Research article

Evaluation of Sequential Intercropping of Maize with Common bean followed by Chickpea

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Food insecurity is increased by adverse weather condition. Intercropping has been practiced traditionally by small-scale farmers in the tropics. The key to sustainable agriculture probably lies in increased output per unit area. Hence, this research aimed to improve the productivity through sequential intercropping of maize with common bean followed by chickpea. A field experiment was conducted in Cheha district of Guraghe zone in 2017 and 2018 cropping seasons. Six treatments (sole maize, sole common bean, sole chickpea, intercropping of maize with common bean, maize with chickpea and sequential intercropping of maize with common followed by chickpea) in RCBD with three replications. The grain yield of maize was not significantly affected due to intercropping. All the intercropping involved in this study were advantageous over sole cropping. The highest yield advantage was recorded due to the sequential intercropping of maize with common bean followed by chickpea. Hence, in the area where intensive agriculture is the odd option for improving food security, this practice is recommended where there is no labor shortage.

Key words: grain yield, land equivalent ratio, relative total yield, relative total value

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INTRODUCTION

Agriculture in the next decade will have to produce more food from less area of land through more efficient use of natural resources with minimal impact on the environment in order to meet the growing population demands (Hobbs *et al*., 2008).Multiple cropping offers one of the best ways of increasing production per unit area by growing two crops of dissimilar growth habit in the same field with little intercrop competition. Traditionally, intercropping is being used by small farmers to increase the density of their products and stability of their output. Cereal-legume mixtures have been judged the most productive form of intercropping since the cereals may benefit from the nitrogen fixed in the root nodules of the legumes in the current cropping year (Undie *et al*., 2012).

The advantages of intercropping will be more apparent when the crops have different requirements for the available resources, in quantity, quality, and time of demand. Farmers experienced sowing chickpea after harvesting maize. Late sowing, resulted in moisture shortage during growth stage and finally low yield. Maize and common bean intercropping is common practices in most small scale farming system to improve productivity. In the study area farmers experienced relay intercropping of maize and chickpea. But this is remained as traditional farmers practice. The improvement of crop productivity is the common aim of farmers. The key to sustainable agriculture probably lies in increased output per unit area.

Hence, this research aimed to improve the productivity through sequential intercropping of maize with common bean followed by chickpea.

MATERIALS AND METHODS

Treatments, design and data collection

A field experiment was conducted in Cheha district of Guraghe zone in 2017 and 2018 cropping seasons. The experimental site is located altitude 08°10’18”N, longitude 037°50’15”E and altitude of 1945 m.a.s.l. The six study factors were sole cropping of maize, sole common bean, sole chickpea, intercropping of maize with common bean, intercropping maize with chickpea, and sequential intercropping of maize with common bean followed by chickpea. Maize was sown at spacing of 80 cm and 40 cm inter and intra row spacing, respectively both in sole and intercrop. The variety used was BH-546 for maize. Common bean and chickpea were sown at inter and intra row spacing of 40 cm and 15 cm, respectively. ‘Hawassa dume’ common bean and ‘Habru’ chickpea varieties were used. The design was randomized complete block with three replications.

Experimental plots of pure maize and intercrops received the recommended rate of 100 kg/ha NPS and 150 kg/ha urea. Sole common bean and chickpea plots received 100 kg/ha NPS all applied at planting. Maize to both common bean and chickpea were sown at the ratio of 1:2 for respective plots. Chickpea was sown after harvesting common bean and removing all maize leaves of blow the ear.

The component crops were harvested separately from the whole plot. Seeds were weighed and adjusted to moisture levels of 12% for maize and 10% for both common bean and chickpea. Maize was considered as the main crop and common bean and chickpea as an intercrop components**.** The relative advantage of intercropping compared to sole crop was calculated for each intercropping system using total land equivalent ratio (LER) as:

LER= $Yij/ Yii+ Yji/Yjj$

Where *Yii* and *Yjj* denote yields of crops *i* and *j* in sole crop and *Yij* and *Yji* are the corresponding yields in intercrop.

Also, relative total yield (RTY), which is used to examine resource demand status of component crops was determined by:

$$RTY = p_1/m_1 + p_2/m_2$$

where, p_1 and p_2 are the yields of two crops in intercropping, and m_1 and m_2 are the yields of each crop in a monoculture system. Values of RTY> 1 indicate that the species make different demands on resources or avoid competition in some way, while values of RTY< 1 imply mutual antagonism, RTY values of 1 indicate that the components fully share the same limiting resources.

Another indicator used in assessment of intercropping is relative total value (RTV), which evaluates intercropping in terms of economic value. This index was determined as:

$$RTV= (ap_1+ bp_2+cp_3) / am1$$

Where, a is the price of the main crop, b the price of the secondary crop, c the price of third crop, p1 the yield of the main crop in intercropping, p2 the yield of the secondary crop and p3 is the product of third crop in intercropping, m1 the yield of the sole cropping of the main species. By placing the numbers associated with each parameter in the formula of this index, the economic value of each treatments of intercropping was calculated and interpreted. In calculations during this study, the average price of component crops for grain in two consecutive years (2017 and 2018) was used. So, the price of a kilogram of maize, common bean and chickpea seed were estimated about 10, 14 and 20 ETB.

RESULT AND DISCUSSION

Effects of intercropping on grain yield of component crops

Analysis of variance of grain yield reveled that there was no significant differences ($p<0.05$) among different cropping systems involved in this experiment. This means that intercrops did not adversely affect the grain yield of maize (Table 1). This is due to the fact that maize deep root system and vigorous plant growth offered more competition both below and above ground for growth resources (Patel and Rajagopal 2001).

In 2017 due to intercropping, the yield of intercrops was significantly affected. Sole stand of common bean and chickpea showed higher values for their respective grain yield (Table 1). This is due to lesser competition for nutrients, light and space (Padhi 2001). Accordingly, common bean yield reduced by 16% and 20% being in maize with common bean intercropping and maize with common bean followed by chickpea respectively. While, the yield of chickpea reduced by 15% and 28% due to intercropping of maize with chick pea and maize with common bean followed by chickpea respectively. Adaniyan *et al*. (2007) also confirmed that yield reductions in intercropping are associated to inter-specific competition for nutrients, moisture or space.

Table 1. Mean Grain yield (kg/ha) of maize, common bean and chickpea under different cropping systems

Treatment	2017			2018		
	M	Cb	Cp	M	Cb	Cp
Sole maize	7266	-	-	6633	-	-
Sole common bean	-	2312a	-	-	2433	-
Sole chickpea	-	-	1700a	-	-	1866
Maize +common bean	6800	1925b	-	6942	2466	-
Maize + chickpea	7230	-	1433b	6700	-	1206
Maize + common bean + chickpea	7173	1833b	1216c	7100	2000	1500
LSD (0.05)	ns	268	185	ns	ns	ns
CV	7.46	5.85	5.63	8.21	12.54	14.64

M =maize, Cb=common bean, Cp= chickpea

Land equivalent ratio (LER)

Land equivalent ratio (LER) was calculated for intercropping treatments to determine any advantage to be realized from the intercropping. All inter cropping systems gave LER greater than 1.0 (Table 2). Such results were also reported by Saban *et al.* (2007) and Dahmardeh *et al.* (2010).The largest LER was obtained due to sequential intercropping of maize with common bean followed by chickpea in both 2017 and 2018 cropping seasons. Hence, all the intercropping systems involved in this study are advantageous over the sole cropping of component crops. For the highest land productivity sequential intercropping of maize with common bean and followed by chickpea can be introduced. This practice is practical in areas where intensive agriculture is the peculiar option to improve crop production where there is no labor shortage.

Table 2. Land equivalent ratio (LER), Relative yield totals (RYT) and Relative value total (RVT)

Cropping system	LER		RYT		RVT	
	2017	2018	2017	2018	2017	2018
Sole maize	-	-	-	-	1.04	1.00
Sole common bean	-	-	-	-	0.55	0.56
Sole chickpea	-	-	-	-	0.65	0.52
Maize with common bean	1.75	1.95	1.88	1.97	1.50	1.57
Maize with chickpea	1.84	1.67	1.94	1.58	1.65	1.40
Maize with common bean followed by chickpea	2.52	2.77	2.52	2.53	1.94	1.93

Relative total yield (RTY)

For all the intercrops the value of relative yield total, which is used to examine resource demand status of component crops is greater than 1 in both 2017 and 2018 cropping seasons. This indicates that the component crops are not competing for the same limiting resource. The highest relative yield total was recorded due to maize with common and followed by chickpea sequential intercropping.

Relative total value (RTV)

The economic term of intercropping was evaluated by relative value of total using the prices of the respective crops in each of the practices involved. The monetary value of maize monoculture was lower compared to the intercropping. The highest value of relative value total was recorded due the sequential intercropping of maize with common bean and followed by chickpea. This is due to the additive effect of the yield of the component crops. Hence, in small scale farming system, sequential intercropping of maize with common bean and followed by chickpea is advisable for intensive agricultural production.

CONCLUSION

Sequential intercropping of maize with common bean and followed by chickpea could be economically and environmentally promising in small farm size and low farm income. In this study, the sequential intercropping as a whole exhibited higher total productivity as measured by total grain yield, relative total value and total land equivalent ration of the component crops. Hence, the sequential intercropping of maize with common and followed by chickpea is recommended in area where intensive agriculture is the odd option for improving food security given that there is no labor shortage.

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