Prime Scholars Library

Advances in Agronomy, Plant Breeding and Horticulture

Research Article

Vol. 11 (1), pp.01-06, April, 2023

Available online at
https://primescholarslibrary.org/

Evaluation of common bean varieties for simultaneous and relay intercropping with maize in Siltie zone, Ethiopia

Bezabih Woldekiros*
Department of Agricultural Research, South Agricultural Research Institute, Worabe, Ethiopia

Received: 17-Feb-2023, Manuscript No. AAPBH-23-89614; **Editor assigned:** 20-Feb-2023, PreQC No. AAPBH-23-89614 (PQ); **Reviewed:** 06-Mar-2022, QC No. AAPBH-23-89614; **Revised:** 17-Apr-2023, Manuscript No. AAPBH-23-89614 (R); **Published:** 24-Apr-2023, DOI: 10.51268/2736-1802.23.11.098.

ABSTRACT

In places with significant climate variability and resource poor agricultural conditions, intercropping can be an effective approach for sustainable and efficient crop production to improve food security. The field experiments was conducted in 2017 and 2018 cropping seasons under rain fed condition in Hulbareg district of Siltie zone to evaluate common bean varieties for simultaneous and relay intercropping. The experiment was laid out in randomized complete block design with three replications. Hawassa dume, Remeda, Lalo and Wajo common bean varieties were grown in sole and intercropping with BH-546 maize variety during Belg and Meher cropping seasons. The grain yield of common bean varieties were significantly varied in sole and intercrop in both cropping seasons. Higher grain yield was recorded when common bean varieties were grown during Belg season both in sole and intercrop. Maize grain yield was not significantly affected as intercropped with common bean varieties. All common bean varieties simultaneous and relay intercropped with maize showed yield advantage over sole cropping. Hence, simultaneous and relay intercropping of maize with common bean is recommended in areas where there is land shortage with no labor shortage.

Keywords: Relay intercropping, Simultaneous intercropping, Yield advantage, Yield reduction.

INTRODUCTION

Crop production and food security are the two major concerns as climatic variations and increasing food demand are expected to affect the global community (Abera T, 2005). About 770 million people or closes to 10% of the world population were exposed to severe food insecurity in 2017 (Alexandratos N, Bruinsma J, 2015). The ability of agriculture to feed a growing population is a major concern due to a shortage of new cropland, falling soil fertility and declining yields of major food crops (Bodirsky, et al., 2012).

Cereal crops make up 67.51% of the cropland in Ethiopia (Brooker RW, et al., 2015). Next to teff, maize is the second largest crop in the country, sharing around 24% of all the land used for cereal crops. In the other hand pulse crops occupy 1,674,950 hectares of the total cropland of the country. Of that common bean shares the largest amount (18.60%) dedicated to followed by the faba bean, which occupies about 504,570 hectares (CSA, 2021).

Despite the study area is with ideal climate for common bean growth, few farmers actually grow and use this crop. Cereal crops including tef, maize and sorghum are major crop in the area. The area experiences recurrent crop loss due to drought, poor soil fertility, insect pests and disease (Gebeyehu S, et al., 2006). It is frequently stated that intercropping systems provide greater yield stability than sole cropping

systems. In places with significant climate variability and resource poor agricultural conditions, intercropping can be an effective approach for sustainable and efficient crop production to increase food security. Additionally, intercropping improves the utilization of resources like land, light, soil, water and nutrients (Mead R and Willey RW, 1980).

In different parts of Ethiopia, farmers are getting better yields by intercropping maize with pulses and other crops. Also, in some places, there is a practice of planting common bean together with maize more than once, although it has not been confirmed by scientific research. Therefore, the main objective of this research work was to identify the most suitable common bean varieties for simultaneous and relay intercropping to ensure productivity and food security (Rediet A, et al., 2017).

MATERIALS AND METHODS

Description of the study area

The field trial was conducted in Hulbareg district of Siltie zone in 2017 and 2018 under rain fed condition. The experimental site is located at 07°48'17"N and 038°09'46"E with altitude of 2092 meters above sea level (Sinclair TR and Gardner FP, 1998).

The rainfall in 2017 and 2018 was 1008 mm and 1379 mm, respectively, but this varies depending on the agricultural seasons. The maximum and minimum temperatures were also recorded as 26°C and 12°C, respectively. The vegetation period of the experimental site extends from late February to early October with dry May. While, from July to late September is classified as a humid period. Besides, the dry period is experienced from mid November to March (Ten Berge H, et al., 2019).

Experimental design

Four recently released common bean varieties (*i.e*. Hawassa dume, Remeda, Lalo and Wajo) were grown in sole and intercropped with BH-540 maize variety in randomized complete block design with three replications (Workayehu T, and Wortmann CS, 2011).

Experimental procedures

The experimental field was carried out in Shamameda farmers training center of Hulbareg district, Siltie zone. Maize, tef and sorghum are the major crops grown in this area. The field was made ready for planting maize after ploghing four times by oxen driven plough. Then maize seeds were sown at 80 cm inter row and 30 cm intra row spacing under intercropping and sole cropping in Belg cropping season. As well, four common bean varieties were planted at 40 and 10 cm inter row and intra row spacing, respectively at the same cropping season. Both intercropped and sole maize crop plots received 121 kg/ha NPS and 150 kg/ha urea fertilizers. While, 121 kg/ha NPS and 50 kg/ha urea fertilizers applied for sole common bean plots only. Common bean grown in Belg cropping season was harvested in June and then, the field was managed for sowing the next common bean in Meher season (Worku W, 2008).

During this season sole common bean received 121 kg/ha NPS and 50 kg/ha urea while no additional fertilizer is applied for plots sown under maize as relay cropping. Maize was harvest as it reached harvest maturity and the field management for common bean varieties continued until harvested at harvest maturity. The spatial arrangement was in the ratio of one row maize to two rows common bean, where two rows of common bean were sown between the successive rows of maize.

RESULTS AND DISCUSSION

Grain yield of common bean

The grain yield of common bean varieties was significantly varied. In sole cropping, substantially higher yield was obtained both seasons. When common bean was grown during the Belg cropping season in both sole and intercropping, a higher yield was obtained. Accordingly, sole cropping of Wajo produced the highest grain yield (1.99t/ha) during the Belg season but the yield decreased by 23.62% during Meher season cropping.

The maize/Tato intercropping had the highest grain yield among the associations of maize and common bean varieties during Belg cropping season. In comparison to the Meher cropping season, the yield advantage for the different common bean varieties ranged from 5 to 23.87% in Beleg (Table 1). According to these results, the Belg season is to grow common bean in the study area.

Table 1: Grain yield of common bean varieties under sole and intercropped with maize in Meher and Belg cropping of common bean varieties.

Cropping system	Common bean varieties	Belg season (Simultaneous)	Meher season (Relay cropping)
Sole	Hawassa dume	1.55	1.18
	Remeda	1.80	1.71
	Wajo	1.99	1.52
	Tato	1.89	1.43
Intercropping	Hawassa dume	1.37	1.15
	Remeda	1.45	1.08
	Wajo	1.27	0.52
	Tato	1.95	0.90
LSD (5%)		0.07	0.32
CV		14.31	15.61

Even though there was relative yield reduction ranging from 3.08% to 65.79% for overall performance of the practice shows advantage over sole cropping of the component crops and also from that of simultaneous intercropping (Table 2).

Table 2: Grain yield (tha^{-1}) of common bean varieties in belg and meher season under sole and intercropping with maize.

Cropping system	Cropping seasons							
	Belg				Meher			
	HD	R	W	T	HD	R	W	T
Sole	1.55	1.8	1.99	1.95	1.18	1.71	1.52	1.43
Intercrop	1.37	1.45	1.27	1.89	1.15	1.08	0.52	0.9
Yield reduction (%)	11.61	19.44	36.18	3.08	2.54	36.84	65.79	37.06
Note: HD: Hawassa dume; R: Remeda; W: Wajo; T: Tato								

Maize grain yield

Intercropping common bean varieties did not significantly affected maize grain yield (Table 3). Similar to this result, (Gebeyehu, et al. 2006) reported that intercropping beans with maize had no negative effect on maize grain yield. In contradiction, the study by (Rediet, et al. 2017) reported that maize yield reduced by 11.34 % when intercropped with common bean.

Table 3: Yield and yield components of maize under sole and intercropped with common bean varieties.

Treatments	NEP	NRPP	NSPR	HSW (g)	Gy (t/ha)
Sole maize	1.66	15.93	39.31	38.12	9.67
Maize/Hawaasa dume	1.26	15.93	35.13	37.13	7.68
Maize/Remeda	1.13	16.73	35.81	37.99	7.54
Maize/Wajo	1.2	16.6	33.4	36.43	7.14
Maize/Tato	1.33	15.73	37.21	40.33	8.04
LSD (5%)	NS	NS	NS	NS	NS
CV	16.48	2.84	8.8	6.28	19.5
Note: NEP: Number of Ears Per Plant; NRPP: Number of Rows Per Plant; NSPR: Number of Seeds Per Row; HSW: Hundred Seed Weight; Gy: Grain yield					

Efficiency of intercropping

The land equivalent ratio due to intercropping of common bean varieties varied depending on associated varieties and cropping seasons. Accordingly, the total land equivalent ration was varied as associated common bean variety and cropping season. For instance, Hawassa dume variety had the highest partial LER (0.92), while Wajo had the lowest values (0.51) (Table 4).

All common bean varieties intercropped with maize showed yield advantage over sole cropping of component crops (Table 4). Accordingly, the yield advantages of the intercrop over sole crop ranged from 25% to 71% showing simultaneous and relay intercropping of maize with these varieties is advantageous. Similarly, previous researches indicated that associations between maize and beans increased yield.

Table 4: Partial and total Land Equivalent Ratio (LER).

Common bean varieties	Partial LER		Total LER
	Maize	Common bean	
Maize/Hawaasa dume	0.79	0.92	1.71
Maize/Remeda	0.78	0.72	1.5
Maize/Wajo	0.74	0.51	1.25
Maize/Tato	0.83	0.83	1.66

CONCLUSION

In this study, simultaneous and relay intercropping exhibited higher total productivity as measured by total land equivalent ratio. Not only yield advantage, also food diversity can be addressed by this cropping system. Therefore, simultaneous and relay intercropping of maize with common bean can be recommended in the study area and areas where there is land shortage with no labor shortage.

ACKNOWLEDGMENT

The author would like to acknowledge all organizations and individuals who contributed to this study.

CONFLICT OF INTEREST

The author declares that he has no conflict of interest.

REFERENCES

1. Abera T, Tanaand T, Pant LM (2005). Grain yield and LER of maize climbing bean intercropping as affected by inorganic, organic fertilisers and population density in western Oromiya, Ethiopia. Asian J Plant Sci. 4:458–465.
2. Alexandratos N, Bruinsma J (2015). World Agriculture Xtowards 2030/2050: The 2012 Revision. ESA Working Paper. FAO, Rome.
3. Bodirsky BL, Rolinski S, Biewald A, Weindl I, Popp A, Lotze-Campen H (2012). Global food demand scenarios for the 21st century. PloS one. 10(11):0139201.
4. Brooker RW, Bennett AE, Cong WF, Daniell TJ, George TS, Hallett PD, Hawes C, Iannetta PPM, Jones HG, Karley AJ (2015). Improving intercropping: A synthesis of research in agronomy, plant physiology and ecology. New Phytol. 206:107–117.
5. CSA (Central Statistics Authority) (2021). The Federal Democratic Republic of Ethiopia central Statistical report on area and production of major crops (private peasant holding, Meher season), Statistical Bulletin, Addis Ababa, Ethiopia. 4.
6. Gebeyehu S, Simane B, Kirkby R (2006). Genotype × cropping system interaction in climbing bean (*Phaseolus vulgaris* L.) grown as sole crop and in association with maize (*Zea mays* L). Eur J Agron. 24:396-403.
7. Mead R, Willey RW (1980). The concept of a 'land equivalent ratio' and advantages in yield from intercropping. Exp Agric. 16:217-218.
8. Rediet A, Walelign W, Sheleme B (2017). Performance variation among improved common bean (*Phaseolus vulgaris L.*) varieties under sole and intercropping with maize (*Zea mays L.*). Afr J Agric Res. 12:397–405.
9. Sinclair TR, Gardner FP (1998). Principles of ecology in plant production. 2nd ed, Wallingford, CAB International, Wallingford, UK. 1-186.
10. Ten Berge HF, Hijbeek R, vanLoon MP,

Rurinda J, Tesfaye K, Zingore S, Craufurd P, Van Heerwaarden J, Brentrup F, Schroder JJ, Boogaard HL, de Groot HLE, Van Ittersum MK (2019). Maize crop nutrient input requirements for food security in sub-Saharan Africa. Global Food Secur. 23:9–21.

11. Workayehu T, Wortmann CS (2011). Maize–bean intercrop weed suppression and profitability in Southern Ethiopia. Agron J. 103:1058–1063.
12. Worku W (2008). Evaluation of common bean (*Phaseolus vulgaris* L.) genotype of diverse growth habit under sole and intercropping with maize (*Zea mays* L.) in southern Ethiopia. J Agron. 7(4):306-313.