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Effect of Growth and Yield Responses of Maize (*Zea Mays L.*) Intercropped with Cowpea (*Vinga Unguiculata L.*), Under Rain-fed Condition in Jigjiga Woreda of Fafen zone in Somali region, Ethiopia

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ABSTRACT

Maize (*Zea mays L.*), the queen of cereals, is planted with wide spacing and so it offers the scope of intercropping. As maize is a wide spaced crop, the inter row space allows to grow the short statured crops such as legumes. Maize - legume intercropping system is one of the most important intercropping systems followed worldwide. Considering the benefits of cereal-legume association, an experiment of maize-cowpea intercropping system was conducted during the season of 2017 G.C. in farmers field at Amadle Kebale in Jigjiga Woreda of Fafen zone in Somali region, Ethiopia, Jigjiga is under humid-hot sub-tropical climatic conditions. The treatments were comprised of five cropping systems namely, T1: sole maize, T2: sole cowpea, T3: Maize with cowpea (1:1), T4: Maize with cowpea (2:1), T5: Maize with cowpea (2:2), Paired row sowing of melkasa4 maize was done with a spacing of 75X30 cm in both sole and intercropped systems, whereas pure stand and intercropped systems of cowpea was sown with 50X30 cm spacing. As per the treatments, single and double row of intercrops were taken in between two pairs of maize. The observations recorded from the experiment clearly showed that the growth and productivity of maize was influenced by the intercropping systems used in this research study. Based on the present finding, intercropping of two rows maize and two rows cowpea more economic advantage than the other crop combination or grown alone. However, in additive series of intercropping treatments, cowpea produced considerable yield. The competition functions like land equivalent ratio (LER), relative crowding co-efficient (RCC), aggressivity (A) and competitive ration (CR) prominently indicated the benefits of maize-cowpea intercropping system under Jigjiga area conditions

Key Words: Maize, cowpea intercropping, growth, productivity, economic feasibility, competitive ability

1. Introduction

Maize (*Zea mays L.*) is a major cereal crop in the global agricultural economy, serving as both human food and animal feed. There are no other cereals on the planet with such enormous yield potential that is why it is known as the 'queen of cereals (Lithourgidis et al., 2011). Maize, being a member of the Poaceae family, is a prominent crop in the world, ranking third after rice and wheat in terms of cereals output. Cowpea (*Vigna unguiculata (L.) Walp.*) is an economically important indigenous African legume crop contributing to food security of millions of small-scale farmers in Africa and maintenance of the environment (Langyintuo et al., 2003; Tarawali et al., 2003). Cowpea is an important legume crop growing across the world mainly in tropical and subtropical regions including Ethiopia. Besides its noticeable production, little is known about its yield, productivity, importance, and distribution in Ethiopia. Its production is practiced under varying cropping systems including sole cropping, intercropping and mixed cropping system.

Intercropping agriculture, as defined by many researchers is growing of two or more crops simultaneously in the same land. It is popular in rain-fed agriculture, with limited resources, because one crop can exploit a resource that the other is not exploiting fully. Mixed or intercropping as a method of crop intensification is practiced in densely populated countries to produce more food per unit area. Intercropping appears to be one of the methods to enhance productivity and profitability with livelihood security (Vasilakoglou et al., 2005). Further, intercropping offers multifaceted advantages such as enhanced yield form unit area, higher resources (soil nutrients, soil moisture, atmospheric CO2, sunlight, land, nutrients, and soil moisture) use efficiency, conservation of resources and soil health management and enhancement of soil fertility (Sullivan, 1998). Because of widely spaced rows of maize, the crop

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has a huge scope for adoption of intercropping system (Lithourgidis et al., 2006). Maize has traditionally been known as a typical component of intercropping system (Gebremichael et al., 2019). Maize has been considered as the leading cereal component of intercropping system and is frequently associated with different legumes (Yilmaz et al., 2008). The effect of maize-based intercropping system was not well researched in south Odisha conditions; hence, the current study was considered to assess the efficiency of rabi maize–legume intercropping system targeting higher net return and agricultural sustainability. Cereal-legume mixture is the common form of intercropping practiced by smallest scale farmers in the tropics and subtropics. Intercropping conserves soil water by means of reduction of the evaporation losses and increases the organic matter in the soil, which in turn improves soil structure, infiltration and water retention and helps prevent soil erosion. Intercropping generally produces more yield per unit of land than sole cropping and reduces the risk of crop failure due to pests and diseases (Osman et al., 2011; Yu et al., 2015). The beneficial interaction that is perhaps most widely applicable in intercropping systems is the better use of environmental resources. Cowpea is one the five widely cultivated oilseed crops in Ethiopia. Eastern Hararghe zone of Oromia region hold primary position in producing and supplying both domestic and export markets as compared to other parts of the nation.

Intercropping provides enough scope to include two or more crops simultaneously in same piece of land targeting higher productivity from unit area. Maize, a cereal crop of versatile use, as planted in wide rows offers the opportunity for adoption of intercropping. The intercropping system with maize and legume is beneficial in multifaceted aspect (Lithourgidis et al., 2011). The success of maize-legume intercropping system largely depends on choice of crops and their maturity, density, and time of planting. Advantage of maize-legume combination of intercropping system is pronounced in the form of higher yield and greater utilization of available resources, benefits in weeds, pests and disease management, fixation of biological nitrogen by legumes and transfer of to associated maize, insurance against crop failure to small holders, and control of erosion by covering a large extent of ground area (Boudreau, 2013). Though maize-legume intercropping system exhibits limitations like less scope of farm mechanization, dependence on more human workforce, and chance of achieving less productivity from maize, the system implies more advantages for small holders in developing countries where human workforce is not a constraint. Farmers practice different cropping systems to increase productivity and sustainability. Yields of intercropping are often higher than in sole cropping systems mainly due to resources such as water, light and nutrients that can be utilized more effectively than in sole cropping systems. Cereal-legume intercropping plays an important role in subsistence food production in both developed and developing countries, especially in situations of limited water resources.

Legumes fix atmospheric nitrogen, which may be utilized by the host plant or may be excreted from the nodules into the soil and be used by other plants growing nearby Legumes can also transfer fixed N to intercropped cereals during their joint growing period and this N is an important resource for the cereals. Declining crop yields in the smallholder farmers in dryland cropping systems in Region present the need to develop a more sustainable cropping system. Due to high costs of inorganic fertilizers, the majority of smallholder farmers in Somali region grow maize and sorghum in soils deficient in nitrogen, phosphorus and potassium. To maintain productivity in smallholder cropping systems in Somali, the use of inorganic fertilizers in combination with available organic fertilizers such as manure. Plant residues and compost is required (Li et al., 2001).

Intercropping legumes with non-legume in Somali Region can be a principal means of intensifying crop production both spatially and temporally to improve crop yields for smallholder farmers in remote and arid areas. Legume intercrops are a potential source of plant nutrients that compliment/supplement inorganic fertilizers. Legume intercrops have several socioeconomic and biological and ecological advantages compared to sole cropping for small-holder farmers In addition, certain legumes crops provide food to humans and livestock. The overall low yield potential of cowpea like other crops cultivated in Somali Region are mainly attributed to limited attention by research and development programmes, severe attacks of pest complexes, low soil fertility, drought, poor management practices, marketing problems, and poor technology dissemination and popularization. However, Ethiopia has a high potential for the production of various crops, especially cowpea, due to the diverse agroecology and suitability of the country. Therefore, since this agronomic practices are rarely used in the region due to limited knowledge and the lack of accessibility of the technology at the target areas and surroundings areas this project were help farmers of the region specially at the Jigjiga farmers to improve their agricultural practices to increase crop production and productivity and improve their livelihood with the objectives of To evaluate adopted improved crop technology of maize (melkasa4) intercropped with cowpea(Babile1) variety and evaluate the economic benefits and cost of production

2. Materials and Methods

This study was conducted in two locations or Jigjiga namely: Amadle Kebale of Jigjiga Woreda of Fafen zones in Somli region. Amadle kebale locates 30 km south-east of Jigjiga city alongside the main road from Jigjiga to Degahbour approximately between 9013' to 490 E, latitude and 430 33.2' e longitudes N. The research site is generally characterized sandy and some silty loamy type of soils. The textures are fairly course with both sands loamy travel present sheet flood alluvium consists of deposits of silt and associated thin sands occur in some plains and ranges from silt loamy to sandy loam with pH of 6.1-8.1.

The study area characterized a semi-arid and arid type of climate, receiving bi-modal rain fall annually the long rains of Gu usually occurs in the months of mid-April to mid-July, while the short rains usually come in July to August which is called Karen according to the meteorological agency in 2003. Its altitude range from 1500 to 1700 m a.s.l and it receive from 500 to 700 mm annual rain fall according central statistical agency (CSA, 1998) The minimum mean monthly temperature varies from 5C0 in November to 14C0 from July to September and the maximum mean monthly temperature varies from 25C0 July to 29C0 from march to April forest hazard exist. In addition, high run off rates coupled with high evaporation rates make the available rainfall insufficient especially for moisture sources of crop production.

2.1. Field Experiment Design Procedure

This experiment was carried out at Amadle Kebals in Jigjiga Woreda of Fafen zone in Somali Region, Ethiopia. Five experimental plots were arranged in a randomized complete block (RCB) design with three replicates. Plots size of 5X4 m in plot each were used and prepared and separated by 0.5cm. Blocking was done against the direction of soil gradient to prevent any possible run offand increase water holding capacity of the soil. The five used treatment were T1= sole maize (75X30 cm), T2= sole cowpea (50X30 cm), T3= maize +cowpea (1:1), T4=maize +cowpea (2:1), T3= maize +cowpea (2:2), Seed of cowpea (Bole variety) and maize (var. Melkasa4) were used in this research.

Data pertaining for growth parameters, yield attributes and yield were recorded during the respective growth stages and finally at harvest. Data of each parameter were collected on plot basis and plant basis from the central five rows for all traits. For data recorded on single plant basis (pods per plant and seeds per pod), five plants were randomly taken and tagged from the ret harvestable plots and the mean values of these five plants were calculated using Microsoft Excel Economics of intercropping system was also calculated. Data recorded were analyzed statistically by using analysis of variance (ANOVA) and the standard error of means (S.Em.±) and critical difference at 5% probability level of least differences significance (LSD 0.05) (Gomez and Gomez, 1984).

3. Results and Discussion

3.1. Analysis of variance

Analysis of variance computed for each maize component revealed that variation among intercropping system were significant (P<0.05) affected for all traits except number of ear/plant and thousand grain weight (g) whereas for cowpea were significant (P<0.05) affected for all traits except shelling percent (%) (Table1). The presence of variations among different intercropping of maize and cowpea under experiment for agronomic traits studied indicated the presence of sufficient variability among maize and cowpea intercropping.

3.2. Effect of phenological and growth parameters

The results of this research study indicated that days to maturity were differently influenced by maize intercropped with c.owpea For maize maximum days to maturity was taken by sole crop than different cropping systems with cowpea. Among the intercropped systems maximum day to maturity (143.7days) were recorded from maize cowpea combination of (2:2) which is statistically par with all other treatments combinations and sole crop as well. This is indicated that maize preferred with the intercrop of cowpea of two by two lines combinations. For cowpea sole crop stand was taken longer days to achieve maximum days of crop maturity than other cowpea intercropped combinations. This might be due to less competition effect and favorable condition of growth factors such as solar, radiation, nutrients, water, space, etc. Among intercrop combinations cowpea delayed days to maturity in maize cowpea (2:2) intercrop when the crop planted under the maize+cowpea (2:1) The growth parameters like the height of the plant (cm), ear length and number of primary branches/plant were presented in table (2), which clearly indicated that there was significant difference among the treatments in expression of said characters of maize and cowpea. Sole maize produced the maximum height of the plant (189 cm) and it was significantly more than the treatments maize+ cowpea combinations irrespective of the row proportion of cowpea. However, the values of the height of the plant were statistically at par with sole crop of maize when it is intercropped with cowpea either with single or double rows of the crop. There was also significant difference among the treatments in maximization of the height of the plant of cowpea. The maximum height of the plant (43.4 cm) was noted with sole cowpea which was statistically at par with intercropped cowpea with single and double row proportions.

Moreover, it was also noted that cowpea when intercropped with maize did not show any difference with in the same species. Among the treatments sole maize recorded the minimum plant height (182.2 cm) than intercropped maize and it is probably due to the benefitted of cowpea intercrop faced by sole maize, whereas intercropped maize treatments were in association with cowpea and competed for resources favorable for growth (ABOU-KERISHA et al., 2010). The results in contrary the findings of (Mandal et al., 2014) and (Ghanbari et al., 2010), noted variation in growth parameters of maize and legumes in intercropping system. Ear length (cm) of maize and cowpea was influenced by intercropping systems. Sole maize was statistically at par with maize intercropped with all cowpea intercrops and it registered significantly more ear length (32cm) than any other combinations. Among different cowpea treatments sole or in combination with maize recorded sole crop the maximum number of primary branch accumulation. For other cowpea treatments also, it was noted that there was no significant difference within the cowpea between pure stand and in association with maize irrespective of row ratio. Earlier (Mandal et al., 2014) noted variation in growth parameters of maize and cowpea in intercropping system

Table 1: List and description of genotypes tested in the experiment

Sources of variance	DF	DTM	PH	EPP	EL	TKW	GY (Qtls/ha)	BY (Qtls/ha)	HI
Replication	2	32	17	0.012	13.3	2112	11.7	6.14	21
Intercrop	3	12.1*	3.5*	0.002NS	22*	1033NS	16.6*	25.6*	22.2*
ERROR	6	27.4	6.0	0.006	10.3	1135	10.8	8.0	15.3
SED (+)		3.4	3.2	0.2	3.4	27	2.3	2.4	4.3
LDS (0.05)		7	4.3	0.3	5.8	67.2	6.7	5.6	16.1
CV (%)		6	7.5	6.2	1.7	10	13.2	4.8	7.4
Sources of variance	**DF**	**DTM**	**PH**	**NPB**	**NPPP**	**TGW**	**GY (qtls/ha)**	**GY BY (qtls/ha)**	**SP (%)**
Replication	2	67	15	0.6	1.4	7.0	2.5	22.5	51
Intercrop	3	28.6*	32.6*	3.3*	1.33*	12*	7.4*	1.7*	20.7NS
ERROR	6	8.2	18	2.7	2.3	12.5	12	2.2	38.4
SED (+)		3.7	3.6	1.2	1.3	3.5	3.2	1.5	6.1
LDS (0.05)		7.4	8	3.7	3.31	7.3	7.3	4.0	13
CV (%)		2.4	9.7	5.1	10	6.4	8	2.8	9.1

NS, *, non-significant, significant, significant at ($p<0.05$) DF= degrees of freedom,, DTM= days to maturity, PH=Plant Height (cm), NPB= number of primary branch, NPPP= pods per plant, TGW= thousand grain weight (g) SP (%) =Shelling Percentage, GY (Qtls/ha) = Grain yield in Quintals per hectare and harvest index (%)

The results of this study indicated that the mean maximum number ear/plant and number of pod/plant (1.14and 29) for maize intercropped (2:2) and cowpea sole crop respectively, and it was closely followed by maize + cowpea (2:1) and maize + cowpea (1:1) the values of 1.2 and 1.13, respectively. There was no significant difference among the intercropping treatments in influencing the number of ear/ plant. The number ear/plant and number of pod/plant of maize and cowpea were influenced by cropping system. Maize intercropped produced the maximum number ear/plant than sole maize and sole cowpea crop produced maximum number of pod/plant than the intercropped system (Table 2). Sole crop of maize resulted in significantly less number of ear/plant than the intercropped maize with the cowpea. It was noted that all intercrop combinations produced more number of ear/plant than sole cropping of maize. Earlier studies also showed non-significant difference in production of number of ear/plant of maize among sole and mixed stands (Maitra et al., 2001; Khan et al., 2018) reported that in intercrops usually the maize has a competitive advantage over legumes for light and water since they are tall and with larger root system and hence experience limited competition.

There was also variation in number of pod/plant of cowpea sole and maize intercropped treatments. Pure stands of cowpea produced more number of pod/plant than when these intercropped with maize and this variation is due to the less competition effects. When the cowpea was intercropped in maize with single row after a pair of maize rows, the cowpea got only a for more population than pure stand of their respective combinations. Similarly, when the cowpea was taken in combination with maize with 2:2 ratios, these got half of the population than the sole legumes. The yield difference of cowpea is due to variation in population in maize-cowpea intercropping, this was also noted earlier by scientists (Kheroar and Patra, 2014; Mandal et al., 2014)

3.3. Effect on yield of maize and cowpea

The results of this study showed that Maize + cowpea intercropping systems had a substantial impact on maize thousand grain weight. Maximum thousand grain weight (331 and 76.2 g) for maize and cowpea respectively were registered in maize+cowpea (2:2) combinations for maize and sole cowpea and is statistically superior to maize + cowpea (1:1), maize + cowpea (2:1), maize+ cowpea (2:2), maize + cowpea and maize sole crop (Table 3). This is indicated that maize positively impacted with the cowpea intercrop while cowpea was negatively impacted with maize intercropping systems. This due to that maize is nutrient depleting crop from the soil while the cowpea and legumes in general are nutrient contributing to the soil.

The results of this study indicated that yield of maize and cowpea were differently influenced by cropping system. The maximum yield (26.5) of maize was recorded from maize+cowpea (2:2) combination while sole crop maize produced the minimum grain yield (24 Qtls/ha) and the treatment was statistically at par with all intercrop combinations with cowpea (Table 3). But, sole maize resulted insignificantly less grain yield than the intercropped maize with cowpea irrespective of row proportion. It was noted that all intercrop combinations produced more grain yield than sole crop of maize. Sole maize also produced minimum biomass yield and the treatment was statistically at par with the biomass produced in maize+cowpea (2:1) intercrop combination. Moreover, maize+cowpea (2:2) recorded more biomass yield than remaining treatments of intercrop combinations and sole crop. In case of biological yield, sole maize being statistically at par with maize + cowpea (2:2) registered significantly higher values than other intercrop combinations (Table 3¬). Earlier researchers also noted similar type of observations in productivity of maize (Bhatnagar et al., 2012; Mandal et al., 2014). This is consistent with the findings of Ofori and Stern (Ofori and Stern, 1987) and (Alhaji, 2008) who observed reduction in cowpea yield due to high maize density in the intercropping system. Studies conducted by Agricultural Research Division also reported that intercropping reduced the yield of cowpea. grain yield of cowpea and grain yield of maize were significantly differed by different treatments. Cowpea yield was

Table 2: Effect of intercropping of phenocogical, growth parameters for cowpea

Treatments	DTM		PH (cm)		EL, NPB		EPP, NPPP	
	Maize	**Cowpea**	**Maize**	**Cowpea**	**Maize**	**Cowpea**	**Maize**	**Cowpea**
Sole maize	135.6^{a}	-	189^{a}	-	33^{a}	-	1.2^{a}	-
Sole cowpea	-	67^{a}	-	43.4^{a}	-	33.3^{a}	-	50^{a}
Maize+cowpea (1:1)	140^{a}	63^{ab}	182.2^{a}	40.5^{a}	34^{a}	31.7^{a}	1.21^{a}	47.7^{a}
Maize+cowpea(2:1)	142.5^{a}	62^{c}	186^{a}	41.6^{a}	35.5^{a}	32.7^{a}	1.14^{a}	49.2^{a}
Maize+cowpea(2:2)	143.4^{a}	61^{ab}	188.3^{a}	42.8^{a}	36^{a}	31,6	1.15^{a}	48.4^{a}
Mean	**141**	**127**	**184**	**42**	**34**	**32.4**	**1.18**	**48.4**

DTM=days to maturity, PH=plant height(cm), earl length (cm), NPB=number of primary branches, EPP=ear/plant, number pod/plant

Table 3: Yield of crops maize-cowpea intercropping system

Treatments	TGW		Gy(qtls/ha)		BY(Qtls/ha)		HI, SP (%)	
	Maize	**Cowpea**	**Maize**	**Cowpea**	**Maize**	**Cowpea**	**Maize**	**Cowpea**
Sole maize	308^{a}	-	24^{a}	-	55.6	-	44.8^{a}	-
Sole cowpea	-	176.2^{a}	-	12.4^{a}	-	43.7^{a}	-	76.6^{a}
Maize+cowpea(1:1)	311^{a}	174.85^{a}	26.2^{a}	11.5^{a}	57.1^{a}	42.7^{a}	46.2^{a}	73.8^{a}
Maize+cowpea(2:1)	322^{a}	174.1^{a}	25.5^{a}	11.73^{a}	56.7^{a}	42.2^{a}	40^{a}	72.73^{a}
Maize+cowpea(2:2)	331^{a}	173.8^{a}	26.5^{a}	11.4^{a}	58.7^{a}	41.8^{a}	41.3^{a}	74.2^{a}
Mean	**323**	**174.7**	**24.2**	**28/14**	**56**	42.64	**43.1**	**73**

TGW=thousand grain weight (g), Grain yield (Qtls/ha),BY=biomass yield (Qtls/ha), HI=harvest index (%), SP=shelling percent (%)

significantly highest from sole crop due to more number of rows and higher yield attributes. The yield of cowpea reduced in intercropping situation in case of cowpea sole cowpea recorded maximum grain/ pod yields because of their plant stand compared to 1 or 2 rows of legumes in maize paired rows. Pure stands of cowpea produced more grain yield (30 and 39.7 Qtls/ha) in both shelled and unshelled yield respectively than when intercropped with maize and this variation is due to the difference in population (Table 4). Similarly, when the cowpea was taken in combination with maize with 2:2 ratios, these got half of the population than the sole cowpea. The yield difference in cowpea in both shelled and unshelled yield due to variation in population in maize-cowpea intercropping was also noted earlier by scientists (Kheroar and Patra, 2014; Mandal et al., 2014)

Shelling percentage is the sign of pod filling effectiveness and high shelling percentage values showed effective pod filling. Therefore, shelling % was positive and significantly associated with maize+cowpea (2:2). The association of maize+cowpea (2:1) and maize+cowpea (1:1) shelling % while the association of maize+cowpea (2:1) was positive and highly significant. In line with the obtained results the association between HI and BY was not significant while positive association between grain yield and biomass yield were reported in cowpea (Gutu, 2015). These findings suggest that the characters showing positive correlation could effectively be utilized in crop improvement program and develop new cowpea genotypes.

3.4. Effect on competitive ability of crops

Different competition-functions like land equivalent ratio (LER), relative crowding co-efficient (RCC), aggressivity (A) and competitive ration (CR) were calculated and presented in table 4. LER is the relative land area required for sole crops to produce the yield achieved in intercropping system. LER of maize and cowpea were calculated and they were added to get combined LER. Maize + cowpea (2:1) registered the highest combined LER among all intercrop combinations. In case of some other combinations LER value was close to the highest value. Maize is a wide spaced crop with slower growth during early stage. Besides, paired row planting of maize provided enough scope to the cowpea to grow. These ultimately helped the crops to express the higher LER and advantage of maize+cowpea intercropping system. The results showed that the combined RCC was more than 1, indicating a clear yield advantage in the study. This might be due to complementarity effect of the intercrop. This result is similar to the study of (F. Yilmaz, M. Atak and M. Erayman, 2007) who reported that intercropping sorghum cowpea increases the land productivity (LER>1) indicating the benefits of intercropping. The highest combined RCC was obtained with maize + cowpea (2:2) indicated greater yield advantage.

Aggressivity with negative value indicated that the species is dominated and where the value is positive indicates the species as dominant. In the present study, maize showed positive value except when intercropped with cowpea (2:1). The competitive ratio (CR) of cowpea were greater than unity indicating cowpea was more competitive than maize. Such results might be due to variation in growth of component species and/or abilities to overcome bad effects of competition from either of component species grown in association. Among the cowpea intercrop treatments, the lower values were noted with maize when intercropped with cowpea with 2:2 ratios and it clearly indicated that (2:2) proportions created a balanced competition in maize-cowpea intercropping system. In the additive series of intercropping, maize got its desired population; thus produced yield higher to its pure stand and paired row geometry of planting provided enough scope to cowpea to express satisfactory

Table 4: Competition functions of summer maize+cowpea intercropping system

Treatment combinations	LER		RCC				A		PC	
	Maize	Cowpea	Combined	Maize	Cowpea	Combined	Maize	Cowpea	Maize	Cowpea
Maize+ cowpea(1:1)	0.974	0.864	1.798	7.821	1.212	8.6	0.1	-0.05	0	3.37
Maize+ cowpea(2:1)	0.961	0.923	1.874	24.6	1.237	24.5	0.1	-0.06	0	3.75
Maize+ cowpea(2:2)	0.97	0.962	1.892	13.34	1.25	13.8	-0	0.02	0	3.94

LER=land equivalent ration, RCC=relative crowding co-efficient, A=aggressivity, CR=competitive ratio

Table 5: Benefit, cost of production and marginal rate of return analysis for effects of maize cowpea intercropped at Jigjiga districts during the 2017 in main cropping season.

Treatment	Cost Culti-vation (Birr/ha)	Gross return (Birr/t)	Net return (Birr/t)	Benefit cost (B:C)
T1 Sole maize	52,760	108,000	55,240	1.05
T2 Sole cowpea	43,560	124,000	80,440	1.85
T3 maize+cowpea(1 1)	44,540	244,000	198,740	4.4
T4 maize+cowpea(21)	45,260	246,000	200,460	4.45
T5 maize+cowpea(2 2)	46,248	246,800	200,852	4.34

growth and productivity probably due to temporal and spatial complementary effect.

3.5. Cost benefit analysis

The economics of both pure stand and their respective intercropped were analyzed and represented in (table 5). Analyzed data revealed that maize + cowpea (2:2) intercropping system yielded the highest net returns of ETB 200,552/ha The treatment maize + cowpea (2:1) intercropping system came in second with net returns of ETB 200,460/ha The treatment maize + cowpea (2:2) had the maximum cost of cultivation of 46,248/ha and it was closely followed by maize + cowpea (2:1) and maize + cowpea(1:1) with respective cost of cultivation of ETB 45,260 and ETB 44,540/ha. Similarly, in case of gross return maize + cowpea (2:2) attended the greater value of ETB4678 /ha and it was nearly followed by maize + cowpea (2:1) and maize + cowpea (1:1). The benefit-cost ratio revealed that sole maize and maize + cowpea (2:2) resulted in maximum value of 3.3 for both, and sole cropping of cowpea gave the lower values. Further, the above two treatments were followed by maize+cowpea (2:1) and maize + cowpea 1:1). Sole maize gave less B:C ratio because the cost of cultivation was less than maize + cowpea intercropping systems also. The results are similar to the previous finding of J. Sarkodie-Addo and Abdul-Rahaman (2012).

4. Conclusion and Recommendations

The present study revealed that cultivation of maize in association with cowpea increased grain yield production per unit area. The increased yield with the intercropping was largely due to improved interspecies interaction and facilitation. Intercropping in order to improve land use efficiency, take advantage of intercropping facilitation and improve economic benefits. Also the current study result indicated that in terms of yield of maize and cowpea intercropping of maize with cowpea gave the highest grain yield/ha. However, in terms of LER of yield and soil moisture improvement intercropping of maize with cowpea was the best advantageous. Also in terms of farmers preference intercropping of maize with cowpea was chosen by farmers due to escape any crop failure. On the other hand, the net returns and benefit cost ratios were also satisfactory in maize cowpea intercropping system with 2:2 proportion. As maize is a soil exhaustive crop, intercropping cowpea in maize can be suggested considering agricultural sustainability. From the research findings, it may be concluded that intercropping maize and cowpea with 2:2 can be grown for better profitability under Jigjiga (Amadle kebale) conditions

Conflict of Interest

" Authors declare that there is no conflict of interests involve in publishing this research paper"

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