academicresearchJournals

Vol. 5(2), pp. 107-115, March 2017
DOI: 10.14662/ARJASR2016.057

ISSN: 2360-7874
http://www.academicresearchjournals.org/ARJASR/Index.htm

Academic Research Journal of Agricultural Science and Research

Full Length Research

Intercropping of Onion with Rosemary as Supplementary Income Generation at Wondo Genet Sidama zone, Southern Ethiopia

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Accepted 14 February 2017

A field experiment was conducted at wondo genet Agriculture research center under irrigated condition to diversify onion based farming system by inclusion of rosemary for additional cash generation and to determine optimum percentage of rosemary in onion-rosemary based farming system during the two successive seasons of 2014 and 2015. The experiment comprised of six treatments in additive series: sole onion (250000 plants ha-[1]), sole rosemary (83333 plants ha-[1]) and 4 onion-rosemary intercropping mix- proportion: 100 onion:80 rosemary, 100 onion:60 rosemary, 100 onion:40 rosemary and 100 onion:20 rosemary, using randomized complete block design with four replications. Analysis of variance revealed that; intercropping of onion with different population densities of rosemary might affect fresh and dry bulb yield; highest bulb fresh yield and dry bulb yield were recorded at solitary cropping than that of intercropped. Regardless of mix proportion, highest (10973 kg/ha) and lowest (7839kg/ha) value of dry bulb yield were recorded at 20% and 80% rosemary intercropped with onion, respectively. Likewise; essential oil yield of rosemary was significantly influenced by cropping system; highest essential oil yield was obtained in sole planted than intercropped. In the same way, essential oil yield of rosemary was affected by different level of intercropped treatments; highest and lowest Essential oil yield were obtained at 80% and 20% rosemary intercropped with onion. The highest value of Land Equivalent Ratio (1.68) and Monitory Advantage (3956.5) were obtained when onion intercropped with 80 % rosemary population density. Therefore, the inclusion of onion with 80% a rosemary intercropping scheme raised yield advantage over the single crop per unit area and year as revealed by the highest total LER, and monetary advantage.

Key words: Bulb yield, Income, Intercropping, Oil yield, and Supplementary

Cite this article as: Nigussie A, Lulie B, Chala M (2017). Intercropping of Onion with Rosemary as Supplementary Income Generation at Wondo Genet Sidama zone, Southern Ethiopia. Acad. Res. J. Agri. Sci. Res. 5(2): 107-115

INTRODUCTION

Onion, *Allium cepa* L. (Amaryllidaceae (Alliaceae)) and the widely grown herbaceous biennial vegetable crop with cross-pollinated and monocotyledonous behavior having diploid chromosomes number 2n. Consumption of onions has been increasing significantly in the world partly because of the health benefits they possess (Wang, B 2006). In Ethiopia, it is an important vegetable produced across a wide range of latitudes. It is the most indispensable vegetable crops used as condiments in most Ethiopian cuisine. It is one of the oldest known and

an important bulbous vegetable crop grown in Ethiopia. It is used in preparation of different foods and in therapeutic medicine in the country. It has a great potential to produce every year for both local consumption and export with an average yield of 10.77 tons per hectare (CSA, 2012).

Rosemary (*Rosmarinus officinalis*) belongs to Labiatae family. Native to the Mediterranean, Portugal, and northwestern Spain, and is cultivated worldwide. Rosemary is a hardy, temperate plant that can tolerate frost. It grows well at day temperatures of 20 to 25° C. It is used in food products and non alcoholic beverages. Fresh and dried rosemary leaves, whole or ground, are used as seasonings for soups, stews, sausages, meat, fish, and poultry .In Ethiopia it is used in preparation of Berebere and Shero. It's essential oil is used as an ingredient in soaps, creams, candles, deodorants, hair tonics, shampoos, fresheners and organic pesticides.

Intercropping is the growing of two or more cultivars simultaneously in the same land by utilizing resources such as soil, water, nutrients and solar radiation more efficiently [Rana et al., 2013]. Resources such as water, light and nutrients are utilized more effectively than in the respective mono-cropping systems (Wang, D., Marschner, P., Solaiman, Z. and Rengel, Z. 2007). This cropping system increased total productivity per unit land, per unit time and improves the judicious utilization of the land and other resources on farm (Anitha, S., Geethakumari, V. L. and Raghavan Filial, G. 2001). Intercropping has been practiced most widely in developing countries (Francis R, Decoteau DR., 1993). Diversification of cropping systems, for instance, by increasing the number of crop species grown, has been proposed as a solution to some problems of modern agriculture Poggio, S. L. 2005. It is a wide spread agronomic practice in the tropics because it reduces the losses caused by pests, diseases and weeds, as well as also guarantee better yield.

Intercropping onion with the vegetables reduced both the total and marketable bulb yield. This is in agreement with findings by Talukder *et al* (2015), who reported that intercropping onion with coriander reduce bulb yield. Similar investigation also reported by Trdan *et al*. (2006), Kabura *et al*. (2008) and Kucharczyk and Legutowska (2003), who reported that intercropping leek with carrot reduced yields. The reduction in yield could have been caused by the reduction in onion population and intercrop competition for nutrients, water and light (Ofosu-Anim and Limbani, 2007). With increasing pressures on agricultural land arisen out of population growth, farmers have to explore new ways to intensify production per unit area of land. Mixed cropping is one of the methods of this crops intensification. Spatial arrangement in the intercropping is one of the most important factors for better yield advantages [Usmanikhail et al., 2012]. Therefore the present study was carried out to diversify onion based farming system by inclusion of rosemary for additional cash generation and to determine optimum percentage of rosemary in onion-rosemary based farming system.

MATERIAL AND METHOD

During 2014 and 2015, field experiments were conducted under irrigated condition at Wondo Genet Agricultural Research center. Wondo Genet Agricultural Research Center is geographically located at 07° 19.1' North latitude, 38° 30' East longitude and an altitude of 1780m.a.s.l. The texture of the top soil (0-20cm) was sandy clay loam with soil pH 5.91 (1:2.5 soil water suspensions) which was slightly acidic.

The experimental design was randomized complete block design (RCBD) in additive series with six (6) treatments and four (4) replications. Plot size was $3*4m^2$. Onion was the principal crop and spaced at a distance $(10*40)cm^2$ and the plant population was 250000 ha^{-1}.The sole rosemary population was taken as 83333plant ha^{-1} and was spaced at a distance(30*40) cm^2 and also four rosemary populations 80%, 60%, 40% and 20% as a companion crop. In every alternate row of onion with a plant to plant distance of 37.5, 50, 75, and 150cm for 80, 60, 40 and 20% rosemary population were used, respectively.

Rosemary seedlings were raised at nursery and transplanted to the actual field after three months for both cropping seasons. Onion seed variety "Adama Red" was raised at nursery and transplanted to the actual field after forty five days for both seasons. The land was fertilized with 50 kg Urea/ha and 100kg DAP/ha as source of nitrogen and phosphorous. Nitrogen containing Urea fertilizer was applied in split form two times, for each application time one half of the recommended N was applied during planting and the remaining before flowering of the main crop, respectively. Basal (rows) P dressing was applied to all plots at a uniform rate in accordance with the local recommendation.

All required manage mental operations were done as and when required. Five plants were selected randomly from each plot by excluding the borders to collect yield and yield contributing characters such as plant height(cm), number of leaf per plant, Bulb diameter, fresh bulb yield and dry bulb yield for onion; Number of primary branch/plant, above ground biomass(gm), Leaf fresh weight, stem fresh weight(gm), leaf dry weight(gm), essential oil yield(gm), and essential oil content(w/w, wet/dry based%) of the plant rosemary were collected. After recording leaf fresh weight at harvest, Essential oil yields analysis was done using gas chromatography-mass spectrophotometer or modified Clevenger collector apparatus.

Land equivalent ratio (LER) which verifies the

effectiveness of intercropping for using the resources of the environment compared to sole cropping. The LER values were computed using the following formula described by Abdul et.al (2009), Takim (2012**),** Sullivan (2003), Willey et al (1983) : LER = (LERO + LERRo), where LERO = YIO/YO and LERRo= YIRo/YRo, where Yo and YRo are the yields of onion and rosemary as sole while YIO and YIRo are the yields of onion and rosemary as intercrops, respectively;

Gross monetary value and monetary advantage are calculated from the yield of onion and rosemary in order to measure the productivity and profitability of intercropping as compared to sole cropping of the component crops. The local market price of onion and essential oil yield of rosemary were 8 birr/kg and 20 birr/kg, respectively during the two consecutive harvesting seasons.

GMV= Yield of component crops X respective market price. While monetary advantage (MA) is calculated as, Yield of combined inter crop yield * (LER−1) (Mahapatra, 2011).

The collected data were statistically analyzed using SAS computer soft ware version 9.0 English and the significance difference between any two treatments means were tested by least significant difference (LSD) at 5% probability level. It must be noted that data for each trait measured for the two years were pooled and analyzed to determine the year effect.

RESULT AND DISCUSSION

The two component crops in the intercrop are treated separately in the discussion due to the fact that, they have distinct biological and agronomic characteristics.

Onion plant

Plant height

In both cropping seasons and pooled mean analysis result depicted that, plant height not significantly influenced by cropping system; however, pooled mean analysis result revealed that numerically highest plant height (57.53cm) was recorded in 80% rosemary intercropped with onion this probably due to high competition between onion and rosemary plants for light. Brintha and Thayamini H. Seran (2012) reported onion plant height was higher in intercropping and lower in mono-cropping. This might due to more capture light by intercropping resulted grown taller plant than mono-cropping. However, dissimilar result was obtained by (Kadali *et al*., 1989). It was found that plant height of onion reduced significantly due to higher plant density of coriander in the intercropped stand with onion.

Number of leaves per plant and Bulb diameter

In 2014 cropping season, significant ($p<0.05$) number of leaves per plant was recorded at sole planted compared to intercropped treatments. While, the population density of the companion crop decreased from 80% to 40% number of leaves per plant increased from 10.05 to 11.85. Similarly, second cropping season number of leaves per plant significantly ($p<0.05$) influenced by cropping system but the highest was recorded at 40% rosemary intercropped with onion; though it was at par with sole planted onion. Over years analysis result showed that highest number of leaves per plant was recorded in sole planted onion; however statistically similar with treatments number at 40% and 20% onion rosemary intercropping.

Over years analysis of variance depicted that; bulb diameter of onion significantly affected by cropping system. Sole onion gave significantly higher bulb diameter compared to other mixture stands, which was statistically at par with 100% onion + 60%, 40%, and 20% rosemary intercropping. In this particular study bulb diameter decreases while number of companion crop increases. Similar result was reported by Brintha and Thayamini H. Seran (2012). (Table 1)

Fresh and dry Bulb yield

Fresh Bulb yield of onion significantly ($p<0.05$) influenced by cropping system, highest fresh bulb yield was recorded at sole onion followed by 20% rosemary intercropped with onion. Regarding to intercropping treatments, highest and lowest bulb fresh yield were recorded at 20% and 80% rosemary intercropped with onion, respectively. This study show that while population densities of companion crop increase, productivity of main crop decreased; lowest fresh bulb yield was recorded at 80% rosemary intercropped with onion. However, the significant ($p<0.05$) variation was inconsistent to the coming year (2015) which showed no significant variation among treatments (Table 2).

Similar with first cropping season, pooled mean analysis result showed there was significant ($p<0.05$) variation on fresh bulb yield, highest fresh bulb yield was obtained from the sole onion which was statistically equivalent with 100% onion + 60%, 40%, and 20% rosemary intercropping. The possible reason is the higher light interception, spacing and nutrients availability to the onion plants. The lowest fresh bulb yield was obtained from 100% onion intercropped with 80% rosemary. The reduction in yield could also be caused high competition for nutrients, water and light (Ofosu-Anim and Limbani, 2007).

Dry bulb yield of onion significantly ($p<0.05$) influenced by cropping system in both cropping seasons and pooled

Table 1: Mean Yield of Onion in Onion-Rosemary Intercropping as Supplementary Income generation

Treatments	Plant height (cm)			Number of leaves per plant			Bulb diameters (cm)		
	Year 1	Year 2	Pooled	Year 1	Year 2	Pooled	Year 1	Year 2	Pooled
Sole onion	67.7	44.95	56.31	12.80^{a}	5.45^{ab}	9.13^{a}	6.10	4.42	5.11^{a}
80% rosemary	68.95	46.10	57.53	10.05^{c}	5.20^{ab}	7.62^{c}	5.78	3.55	4.66^{b}
60% rosemary	68.00	44.05	56.03	10.7^{bc}	4.75^{b}	7.73^{bc}	5.99	3.49	4.74^{ab}
40% rosemary	68.25	45.95	57.1	11.85^{ab}	5.85^{a}	8.85^{a}	6.15	4.11	5.13^{a}
20% rosemary	68.15	46.85	57.5	11.80^{ab}	5.05^{ab}	8.43^{ab}	6.07	4.01	5.04^{ab}
LSD@0.05	ns	ns	ns	1.52*	0.86*	0.79*	ns	ns	0.39*
CV	5.25	4.69	6.75	8.62	10.64	9.31	5.12	11.22	5.72

Means followed by similar letter under in each column are not significantly different at 5% level, Year 1= 2014 and Year 2= 2015

Table 2: Mean Yield of Onion in Onion-Rosemary Intercropping as Supplementary Income generation

Treatments	Fresh bulb yield (Kg/ha)			Dry bulb yield (Kg/ha)		
	Year 1	Year 2	Pooled	Year 1	Year 2	Pooled
Sole onion	13805^{a}	9317	10078^{a}	12682^{a}	8275^{a}	11561^{a}
80% rosemary	8053^{b}	7625	7105^{b}	7127^{b}	7083.3^{ab}	7839^{b}
60% rosemary	11293^{ab}	6849	8178^{ab}	10269^{ab}	6087.5^{b}	9071^{ab}
40% rosemary	12093^{ab}	9207	9286^{ab}	10297^{ab}	7472.9^{ab}	10650^{a}
20% rosemary	13244^{a}	8703	9563^{a}	11504^{a}	7622.9^{ab}	10973^{a}
LSD@0.05	4524.8*	ns	2413*	4088.7*	2036.9*	2742.3*
CV	25.11	21.06	26.6	25.57	18.09	26.68

Means followed by similar letter in each column are not significantly different at 5% level, Year 1= 2014 and Year 2= 2015

mean. The highest dry bulb yield was recorded in sole planted onion; which was statistically parallel with 100% onion + 60%, 40%, and 20% rosemary intercropped. These increment in dry bulb yield might be due to less inter and intra-competition among plants in natural resource (moisture, light, plant nutrient and so on). Similar finding showed that maximum onion equivalent yield was recorded in 100% onion intercropped with 20% coriander (Talukder et al.; 2015). However, lower dry bulb yield was recorded at 100% onion + 80% rosemary intercropped. The reduction in yield could also be caused high competition for nutrients, water and light (Ofosu-Anim and Limbani, 2007). Abdel Motagally and A.K. Metwally, (2014) Reported that Onion bulb yield reduction was observed by intercropping Sugar Beet with onion, compared with pure stand onion. Also this result is in agreement with findings by Kabura *et al*. (2008), Trdan *et al*. (2006), and Kucharczyk and Legutowska (2003), who reported that intercropping leek with carrot reduced yields.

Related outcome was reported by Marey (2003) who reported that the intercropping resulted in a significant decrease in bulb yield. Concerning dry bulb yield in intercropped treatments the result indicated that, significant increment was observed while population densities of companion crop decreased from 80% to 20% rosemary intercropped. The highest and lowest value of dry bulb yield were recorded 10973 kg/ha and 7839kg/ha at 20% and 80% rosemary intercropped with onion, respectively. The reduction in dry bulb yield might be compensated by the yield from the rosemary intercropped.

Rosemary plant

Above ground biomass, Leaf fresh weight and Steam fresh weight

In this investigation above ground biomass significantly ($p<0.05$) influenced by cropping system in both harvesting seasons and pooled mean. The highest above ground biomass per hectare was obtained at sole planted rosemary followed by 80%, 60%, 40% and 20% rosemary intercropped with onion, respectively. This could be due to the occurrence of higher number of branch and leaves

contributed from greater number of plants per unit area; resulted in higher use of light in that experiment. This finding was in line with previous similar findings in maize intercropped with spearmint [Belsity *et at*., 2014]. Related result was also reported by [Rajesh, 2011] who reported that highest above ground biomass of Rose-scented geranium was obtained in sole planted than intercropped with vegetables.

Similar to above ground biomass, leaf fresh weight and stem fresh weight at each harvesting season, were significantly influenced by cropping system. Sole planted rosemary showed very highly significant variation ($p<0.001$) than the intercropped at different inter row spacing in both harvesting seasons(Table 3).The significant variation was consistent in 2015 harvesting season. Concerning to different level of intercropped rosemary also revealed that leaf fresh weight and stem fresh weight significantly depressed while its population densities decreased. The highest and lowest leaf fresh weight and stem fresh weight were observed at 80% and 20% rosemary intercropped with onion, respectively. This could be due to more number of plants per unit area, more efficient utilization of applied inputs such as irrigation water, fertilizers by the crop plants which otherwise over utilized by the two intercropped plants. This finding was in line with previous similar findings in rose-scented geranium intercropped with vegetables [Rajesh, 2011] and in medicinal and aromatic plants intercropped with teak (Karnataka, 2007).

Essential oil yield and Essential oil content

In both cropping seasons, essential oil yield of rosemary was significantly ($p<0.05$) influenced by cropping system. Highest essential oil yield was obtained in sole planted followed by 80% rosemary intercropped with onion and lowest essential oil yield was recorded in 20% rosemary intercropped with onion. Similarly, essential oil yield of rosemary was affected by different level of intercropped treatments. During first harvest, essential oil yield reductions were 36.2, 61.9, 86.5 and 137.8 in 80%, 60%, 40% and 20% rosemary intercropped with onion compared to sole planting of rosemary, respectively. This reduced oil yield of rosemary might possibly be due to the reduction of biomass yields in the intercropped treatments. Comparable results were observed on Rose-scented geranium intercropped with vegetables (Rajesh et al., 2011) and Rose-scented geranium intercropping with corn mint (Rajeswara Rao, 2002).

Essential oil content of the two consecutive harvesting seasons were not significantly influenced by cropping system and different level of intercropped treatments. However, pooled mean analysis showed significant variation among the treatments; highest essential oil content was recorded at 60% followed by 40% rosemary intercropped with onion. (Table 4)

Land Equivalent Ratio

First year and pooled mean analysis result depicted that, Partial Land Equivalent Ratio of onion was revealed significant ($P<0.05$) difference among different intercropped level; highest Partial Land Equivalent Ratio was recorded at 20% followed by 40% rosemary intercropped with onion. Likewise, Partial Land Equivalent Ratio of Essential oil yield of rosemary was significantly ($P<0.05$) influenced by the component onion and different level of rosemary intercropping in both seasons and pooled mean (Table 5). In all case, highest Partial Land Equivalent Ratio of Essential oil yield of rosemary was recorded at 80% followed by 60% rosemary intercropped with onion. As population densities of companion crop decrease from 80% to 20%; similar trained was showed by partial land equivalent ration of EOY from 0.89 to 0.29, respectively. (Table 5)

Agronomic productivity of intercropping was also evaluated using total LER, in which, the total LER values for all intercropped treatments were greater than one, indicating that all the treatments had advantage in land use. Especially, the highest total LER of 1.68 was obtained when Onion intercropped with 80% rosemary. This implies that the association of onion and rosemary is complementary to each other on growth resource utilization. Higher LER in intercropping compared to mono-cropping of maize, sorghum, rice, corn mint, faba bean were also reported by Takim (2012), Egbe (2010), Abdul *et al.* (2009), Rajesware Rao(2002), (Tolera and Daba, 2009) and (Belstie *et at*., 2014).

The total LER results revealed that it would require the 0.68 more units of land to have the same yields as intercropping system when onion is solely planted. This might be because of efficient utilization of growth resources in time and space by intercropping system (Willey, 1991).

Gross monetary value of sole onion (TMVa, ETB ha $^{-1}$) was significantly ($P<0.05$) higher than intercropping (Table 6). The highest and lowest gross monetary values were recorded at sole onion and onion intercropped with 80% rosemary 91831 and 67466 ETB ha $^{-}$1, respectively. Gross monetary value of sole rosemary (TMVb, ETB ha $^{-1}$) was significantly ($P<0.05$) higher over intercropping.

Second cropping season, MAI was significantly ($p<0.05$) higher at onion intercropped with 80% rosemary population density; which might be due to higher LER. The result is in line to the previous study in grass-legume intercropping systems (Mahapatra, 2011). However, during first cropping season and pooled mean analysis showed, non significant ($p<0.05$) variation among treatments. Still, numerically the highest monitory

Table 3: Mean of Number of primary branch, above ground biomass and Leaf fresh weight t of Rosemary in Onion-Rosemary Intercropping

Treatments	AGB (kg/ha)			LFW (Kg/ha)			SFW(Kg/ha)		
	Year1	Year 2	Pooled	Year1	Year 2	Pooled	Year1	Year 2	Pooled
Sole rosemary	34763^{a}	30430^{a}	32902^{a}	23008.9^{a}	21499.2^{a}	22427^{a}	11754.4^{b}	8930.6^{a}	10474.3^{a}
80% rosemary	23200^{b}	27067b	28259^{b}	18574.7^{c}	18893.4^{b}	19115^{a}	9645.6^{c}	8173.3^{a}	9143.9^{b}
60% rosemary	22967^{c}	17987^{c}	21015^{c}	15432.7^{c}	11884.7^{c}	14012^{b}	2534.0^{c}	6101.9^{b}	7003.9^{c}
40% rosemary	18416^{d}	14100^{d}	16715^{d}	12419.6^{d}	9307.2^{d}	11164^{b}	5996.4^{d}	4792.8^{b}	5550.8^{d}
20% rosemary	8896^{e}	7909^{e}	8729^{e}	6137.8^{e}	5617.9^{e}	6104^{c}	2757.8^{e}	2291.1^{c}	2625.7^{e}
LSD@0.05	***	3273.9	3872.7	***	2179.1	3386.8	***	1444.1	1175.7
CV	**10.78**	10.49	17.53	**9.93**	10.13	22.67	**13.96**	14.9	16.46

Means followed by similar letter in each column are not significantly different at 5% level, Year 1= 2014 and Year 2= 2015

Table 4: Mean of Essential oil yield and Essential oil content of Rosemary in Onion in Onion-Rosemary Intercropping as Supplementary Income generation

Treatments	EOY (Kg/ha)			EOC %		
	Year1	Year 2	Pooled	Year1	Year 2	Pooled
Sole rosemary	187.906^{a}	139.12^{a}	164.93^{a}	0.65	0.66	0.65^{ab}
80% rosemary	151.692^{b}	121.92^{a}	139.92^{b}	0.55	0.64	0.58^{b}
60% rosemary	126.034^{c}	94.96^{b}	113.38^{c}	0.76	0.80	0.74^{a}
40% rosemary	101.428^{d}	67.68^{c}	87.01^{d}	0.68	0.72	0.71^{ab}
20% rosemary	50.124^{e}	39.96^{d}	46.89^{e}	0.62	0.71	0.66^{ab}
LSD@0.05	***	23.45	20.79	ns	0.14	0.14
CV	**9.93**	15.82	18.36	**27.2**	12.23	21.04

Means followed by similar letter in each column are not significantly different at 5% level, Year 1= 2014 and Year 2= 2015

Table 5: Partial and Total Land Equivalent Ratio of Onion intercropped with rosemary

Treatments	PLER onion dry yield			PLER rosemary EOY			TLER		
	Year 1	Year 2	Pooled	Year 1	Year 2	pooled	Year 1	Year 2	pooled
Sole onion	-	-	-	-	-	-	-	-	-
Sole rosemary	-	-	-	-	-	-	-	-	-
80% rosemary	0.61^{b}	0.98	0.79^{b}	0.84^{a}	0.93^{a}	0.89^{a}	1.45^{ab}	1.91^{a}	1.68^{a}
60% rosemary	0.82^{ab}	0.83	0.83^{ab}	0.69^{b}	0.73^{a}	0.71^{b}	1.51^{a}	1.55^{ab}	1.53^{a}
40% rosemary	0.88^{ab}	1.1	0.98^{ab}	0.56^{c}	0.51^{b}	0.53^{c}	1.43^{ab}	1.61^{ab}	1.52^{a}
20% rosemary	0.95^{a}	1.01	0.99^{a}	0.29^{d}	0.31^{c}	0.29^{d}	1.23^{b}	1.33^{b}	1.29^{b}
LSD	0.31	ns	0.19	0.12	0.2	0.11	0.25	0.42	0.22
CV%	23.43	19.1	20.89	12.64	20.43	16.27	11.18	16.25	14.4

Means followed by similar letter in each column are not significantly different at 5% level, Year 1= 2014 and Year 2= 2015

Table 6: Gross Monetary Value (GMV) and Monetary Advantage (MA) of onion intercropped with rosemary

Treatments	GMV of onion dry yield			GMV of rosemary EOY			MAI		
	Year 1	Year 2	Pooled	Year 1	Year 2	Pooled	Year 1	Year 2	Pooled
Sole onion	101459[a]	82202[a b]	91831[a]	-	-	-	-	-	-
Sole rosemary	-	-	-	3814.7[a]	2782.4[a]	3298.5[a]	-	-	-
80% rosemary	57015[b]	77917[a b]	67466[b]	3158.3[b]	2438.3[ab]	2798.3[b]	3414	4499[a]	3956.5
60% rosemary	82155[a b]	66963[b]	74559[ab]	2635.9[c]	1899.1[bc]	2267.5[c]	4211	2791.5[ab]	3501.1
40% rosemary	82379[a b]	91025[a]	86702[ab]	2126.9[d]	1353.5[c d]	1740.2[d]	4124	3657.7[ab]	3891.1
20% rosemary	95031[a]	83852[a b]	87942[ab]	1076.2[e]	799.3[d]	937.7[e]	3086	2113.1[b]	2599.6
LSD	32710	22406	21502	421.34	718.41	410.84	ns	2188.5*	ns

Means followed by similar letter in each column are not significantly different at 5% level, Year 1= 2014 and Year 2= 2015

advantage was recorded at onion intercropped with 80% rosemary population density.

CONCLUSION AND RECOMMENDATION

The abovementioned result concluded that; intercropping of onion with different population densities of rosemary may affect fresh and dry bulb yield of onion; highest fresh and dry bulb yield were recorded at solitary cropping than that of intercropped. Regardless of mix proportion, highest (10973 kg/ha) and lowest (7839kg/ha) value of dry bulb yield were recorded at 20% and 80% rosemary intercropped with onion, respectively. Likewise; essential oil yield of rosemary was significantly influenced by cropping system; highest essential oil yield was obtained in sole planted than intercropped. In the same way, essential oil yield of rosemary was affected by different level of intercropped treatments; highest and lowest essential oil yield were recorded at 80% and 20% rosemary intercropped with onion. The highest value of Land Equivalent Ratio (1.68) and Monitory Advantage (3956.5) were obtained when onion intercropped with 80 % rosemary population density.

Since intercropping adds extra income and warrants insurance against a risk to the farmers, intercropping of onion component was found to be advantageous than single cropping of onion as there is a scarcity of land, a need to diversify production and optimum exploitation of the environmental resources. Generally, these finding suggest that intercropping of onion and rosemary increase total productivity per unit area and time by improve land equivalent ratio and generate additional income. Therefore, the inclusion of onion with 80% a rosemary intercropping scheme raised yield advantage over the single crop per unit area and time as revealed by the highest total LER, and monetary advantage.

ACKNOWLEDGEMENTS

We would like to acknowledge Land and Water Resource Research Directorate and Wondo Genet Agricultural Research Center for providing all the necessary facilities and supports during the entire experimentation. Our heartfelt thanks also go to Midekesa Chala, Muleta Gadisa, Misker Eshetu, Seferu Taddese, Begna Bekele, Abush Yosefe, Yesaq Wolebo and Bereket Tukisa, for their help in field and laboratory works.

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