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Potato based sorghum intercropping in the lowlands of Shewarobit

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Abstract

Intensifying crop production is becoming a necessity in the face of the ever shrinking per capita agricultural land. Experiences elsewhere suggest that intercropping potato with sorghum could be a feasible alternative so as to intensify production, and give cash and food source alternatives for subsistence farmers. Three intercrop proportions (intercropping full density of potato with 75%, 50% and 25% of sole crop density of sorghum) were compared with sole crops of potato and sorghum in a RCB design of four replications for two years on sites representing sandy clay loam and silt clay black soil. The objective was to determine compatible proportions of sorghum for intercropping with full plant density of potato. Marketable tuber yield of potato on sandy clay loam soil was not significantly affected by intercropping but it was significantly ($P<0.01$) reduced on silt clay black soil. Land equivalent ratios that are significantly ($P<0.05$) higher than one on both soil types ranged from 1.32-2.04, indicating that sole crops of potato and sorghum require 32-104% more land so as to achieve the yield levels obtained from intercrops. As compared to silt clay black soil, higher monetary advantage was recorded on sandy clay loam soil because of the marketable tuber yield depression caused by fungal disease (*Helmintosporium solani*) probably associated with high soil temperature on sole cropped potato at maturity. Intercropping full density of potato with 50 to 75% of sole crop density of sorghum could be advantageous in raising productivity and income on sandy clay loam and silt clay black soils in the lowlands of Shewarobit and similar areas.

Introduction

Potato production in the lowlands of Shewarobit has been limited (unpublished survey report of SHARC, 2001). This may be due to the hot to warm temperature that is not conducive for the growth and productivity of the temperate crops like potato. However, introduction of a technology that would provide shade from scorching sun hit might help expansion of potato production so as to give cash and food source alternative for subsistence farmers. It is also becoming a necessity to intensify crop production in the face of the ever shrinking per capita agricultural land. To these effects, *intercropping* potato with sorghum has been suggested as a feasible alternative. Intercropping often gives more yield than sole cropping, because crops grown in association with each other may use resources more efficiently than sole crops (Andrews and Kassam, 1976; Willey, 1979). Batugal *et al* (1990) showed that intercropping potato with maize could be beneficial in providing partial shade to potato and reduce both air and soil temperatures and thus favor tuber production. The experience in our country also tells us that farmers are traditionally growing potato as an intercrop with maize occupying about 11% of the arable land in Yilmana Densa wereda of the Amhara Region (Tesfaye Abebe, 1998). Intercropping of potato with sorghum is also believed to raise productivity and reduce risk through stability of income and yield in the existing unreliable marketing system faced by Shewarobit farmers in onion production. However, to harvest such advantages, it is necessary to determine compatible proportions of sorghum for intercropping with full planting density of potato.

Materials and methods

The experiment on intercropping of potato with sorghum had been conducted on sandy clay loam soil (56% sand, 20% clay and 24% silt) and on silt clay black soil (8% sand, 50% clay and 42% silt) in Shewarobit areas for two years. In 2005 this experiment was conducted only on one site (Ataye) representing sandy clay loam soil because of shortage of potato tubers for seed. In 2006 it was conducted on the two sites representing two soil types while in 2007 only on one site representing silty clay black soil in areas surrounding Shewarobit. The treatments were sole potato, sole sorghum and three intercrop proportion of potato and sorghum (i.e., intercropping of full density of potato with 75%, 50% and 25% of sole crop density of sorghum). These treatments were laid out in a RCB of four replications at each site. Crop varieties used in the experiment were *Gera*, a potato variety released in 2003 for the highlands of North Shewa, and the local variety *Serina* (in 2005) and the improved (early and striga resistant) variety *Birhan* (in 2006 and 2007) released in 2002 for sorghum. *Serina* was replaced because of its lateness in maturity and absence of resistance to striga infested poor lands which were more common on sandy clay loam soils. Sowing is done from 11-16 July while the soil was moist at all sites. An inter- and intra-row spacing of 75cm x 40cm, respectively, was used for potato as sole and intercrop. Similarly a 75cm x 20cm inter- and intra-row spacing ,respectively, is used for sole sorghum. Recommended rate of 165/195 kg ha^{-1} of Urea/DAP fertilizers was used to fertilize sole and intercropped potato. All DAP and half of Urea is applied at sowing while the other half of Urea was applied after full emergence of potato at the time of first weeding and hilling. Also the recommended rate of 50/100 kg ha^{-1} of Urea/DAP fertilizer is used for sole cropped sorghum in such a way that half of Urea and all DAP was applied at sowing while the other half is applied at the time of first weeding. First and second weeding were done for all plots at 20-25 and 45-50 days after sowing, respectively. Thinning of sorghum plants to the required level of plant population per hectare for sole and intercropped sorghum was done when sorghum reached 3-4 leaf stage. Each plot had six rows each with 4m length. Yields of potato and sorghum were estimated from the harvest of 10 hills free from bird and porcupine damage in the central rows. At harvesting the potato tubers were separated into marketable and unmarketable sizes by experienced women in potato marketing at Debre Birhan. Diseased tubers were also unmarketable. The major tuber disease identified was silver scurf caused by *Helmintosporium solani*. As treatment by soil type interaction was significant final analyses of variances were done separately for each soil type using General Linear Model in which year and treatments were considered as random and fixed factors, respectively. Mean separation was done by Duncan's multiple range test while one sample t-test was used to test whether land equivalent ratio was different from unity at 5% probability level. Net income and monetary advantages were calculated using input and output farm gate prices of areas around Shewarobit town in July 2008 (Table 1). July 2008 was specified due to the difficulty of getting an average price caused by increasing price at every month.

Table 1: Farm gate price of inputs and outputs of potato and sorghum at Shewarobit as of July 2008.

Products	Price (ETB kg^{-1})
DAP fertilizer	8.20
Urea fertilizer	6.05
Marketable potato tuber yield	3.00
Sorghum grain yield	5.00
Sorghum Stover yield	0.25

Results and discussion

Yields of potato and sorghum as affected by intercropping and soil types are presented in Table 2. Marketable tuber yield of potato on sandy clay loam soil was not significantly affected by intercropping but it was significantly ($P<0.01$) reduced on silty clay black soil. However, all land equivalent ratios, except that of intercropping full density of potato with 25% of sorghum sole crop density on silty clay black soil, were significantly ($P<0.01$) higher than 1 indicating the higher advantage of intercropping on both soil types. The significant land equivalent ratios on both soil types ranged from 1.32-2.04, indicating that sole crops of potato and sorghum require 32-104% more land so as to achieve the yield levels obtained from intercropping. Similar results from potato/corn intercropping in the semi-arid areas of Jordan were also reported giving a land equivalent ratios ranging from 1.34 to 2.15 (Sharaiha and Battikhi, 2002).

As compared to silty clay black soil, higher monetary advantage was recorded on sandy clay loam soil because of the lower marketable tuber yield on sole cropped potato (Table 3). Unmarketable diseased tubers (caused by *Helmintosporium solani*) yield was higher and as the result of which the marketable tuber yield was lower in sole cropped potato on sandy clay loam soil. For example, on sandy clay loam soil, diseased tuber yield of 7.987 tone ha^{-1} of sole potato was significantly ($P<0.01$) higher than 4.537-4.840 tone ha^{-1} of intercrops in 2006. Unmarketable diseased tuber yield was negligible on the silty clay black soil, the highest being 0.483 tone ha^{-1} from sole cropped potato. Tuber disease caused by *Helmintosporium solani* is reported to be favored by high soil temperature at maturity (Martin et al, 1994), especially when harvesting is delayed. On silty clay black soil, soil cracks were high on sole cropped potato than on intercrops and hence these soil cracks exposed more number of tubers to direct sunlight that caused tubers greening due to high alkaloid content. Tuber disease infestation in sandy clay loam soil, and number of green tubers due to soil cracks on silty clay black soil can be reduced by early harvesting as soon as potato attained full maturity. Intercropping is proved to be very important in reducing the number of green tubers on silty clay black soil and number of diseased tubers on sandy clay loam soil when compared to sole cropping of potato.

Table 2: Yield of potato & sorghum as affected by intercropping & soil types; averaged over two years.

Treatments	Marketable tuber (tone ha^{-1})		Grain yield (kg ha^{-1})	
	Silty clay black soil	Sandy clay loam soil	Silty clay black soil	Sandy clay loam soil
Sole potato (100% P)	21.089A	13.340A		
Sole sorghum (100% S)			5986.6A	2416.9A
100%P+75%S	12.780B	15.746A	5169.2B	2077.4A
100%P+50%S	14.111B	16.548A	3910.4C	1599.2B
100%P+25%S	14.123B	15.503A	2071.3D	946.0C
Std. Error of the means	0.921	1.681A	182.806	132.1

Table 3. Net income and monetary advantage of potato based intercropping; averaged over two years.

Cropping systems	Net income (Birr ha-1)*		Monetary advantage (Birr ha-1) *	
	Silty clay black	Sandy clay	Silty clay black	Sandy clay loam soil
Sole potato (100%P)	60671A	37422B		
Sole sorghum (100%S)	28811C	10962C		
100%P+75%S	60165A	53904A	20503	29377
100%P+50%S	58166A	53919A	15081	27303
100%P+25%S	49028B	47518AB	836	18181
Std. Error of the means	2586	4496		

**Based on marketable potato tuber yield and sorghum grain yield*

Total net income from marketable tuber yield of sole cropped potato on both soil types ranged from 111-240% over that of grain yield from sole cropped sorghum, indicating that introduction of potato in the sorghum dominated production systems of the lowlands of Shewarobit would be by far advantageous for subsistence farmers as cash and food source alternatives. If potato is introduced as an intercropping system with sorghum, the monetary advantage could be synergetic. The same is true when stover yield of sorghum is included in the estimation of total net income even though using stover yield as cash source is a very rare practice in the area. For example, when stover yield is included for estimation of net income on sandy clay loam soil, sole cropped sorghum produced about 33% of the net income of sole cropped potato. All intercropping treatments produced about 28 to 47% more net income over sole cropped potato; and about 293 to 350% more net income over sole cropped sorghum.

On silty clay black soil, when stover yield is included, sole cropped sorghum produced about 51% of the net income of sole cropped potato. Intercropping full density of potato with 75% sorghum was the only intercropping treatment that produced about 3% more net income as opposed to others that produced less than sole cropped potato. As compared to sole cropped sorghum, all intercropping treatments produced about 60 to 100% more net income.

Conclusion and recommendations

All intercropping ratios produced LER of significantly (P<0.01) higher than one on sandy clay loam soil while only LER of 100%P + 75%S & 100%P + 50%S were significantly (P<0.01) higher than one on silty clay black soil. The significant land equivalent ratios on both soil types ranged from 1.32-2.04, indicating that sole crops of potato and sorghum require 32-104% more land so as to achieve the yield levels obtained from intercrops. Early harvesting is important to reduce fungal disease attack on matured tubers probably initiated by excessive soil heat. Early harvesting is also important on silty clay black soil so as to minimize tuber exposition to direct sun light due to soil cracks. The results suggest that intercropping of full density of potato with 50 to 75% of sole crop density of sorghum could be advantageous in raising productivity and income on sandy clay loam and silty clay black soils in the lowlands of Shewarobit and similar areas like Jemma and Wonchit valleys in *meher* season.

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