Weeding Frequency to Increase Productivity of Sorghum in Gumara -Maksegnit Watershed

Yimer Abeje, Tsedalu Jemberu*, Tesfay Jorgi

Gondar Agricultural Research Center, **ETHIOPIA**

*Corresponding Contact:
Email: tsedalu2009@gmail.com

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ABSTRACT

In Amhara region, Ethiopia, sorghum production took 655,671 hectare of land, of which North Gondar zone accounts one third of it, 204, 686 ha. But its productivity is low, around 1.9 tons per hectare. Sorghum production has so many constraints, insect pest, disease and weed infestation are the most known among of them. Farmers in the North western Ethiopia, Gumara-maksegnit watershed have no weeding habit of their sorghum at the right time and frequency, because they believe that weed free crops at the early stage of the crop will be infested with stalk borer damage and after at the beginning of September they start to weed their land and used the weed as a feed for their animal. Therefore the objective of this study was to determine weeding frequency of sorghum in Gumara-maksegnit watershed, North Western Ethiopia in order to increase its productivity. The experiment was conduct in the Gumara- maksegnit watershed for two cropping seasons (2014-2015) in the main season at three sites. The experimental design was arranged in randomized complete block design with three replications. Treatments like weed free, unweeded, and farmers practice treatments, hand weeding once, two times hand weeding, three times hand weeding and Shelshalo were studied. According to the combined analysis of variance of the two-year data showed that weed free treatments gave the highest yield (3314 kg/ha) followed by two times and three times hand weeding. However, here was no significance difference between weed free and two times hand weeding. Therefore, two times hand weeding is recommended for Gondar Zuria and similar agro ecological areas.

Keywords: Sorghum, weed, productivity, North Western Ethiopia

INTRODUCTION

Cereal crop production in the country accounts 80.78 percent of the total grain production. Of which Sorghum production took up to 14.58% (1.83 million ha) from the total grain production. In Amhara region, Ethiopia, sorghum produced 655,671ha of land, North **Gondar zone, took** 204, 686 ha (CSA, 2007). But its productivity is low, around 1.9 tons per hectare.

Sorghum production has so many constraints, insect pest, disease and weed infestation are the most known among of them. Farmers in Ethiopia commonly lose up to 40% of their crops due to weed infestations (Kebede Desta, 2000). Although Maize (*Zea mays*) is susceptible to competition from weeds, with commonly reported yield losses greater than 30% (Chikoy & Ekeleme, 2003; Hassan et al., 2010). Because it is not normally planted in rows, weeding is a time-consuming task, taking up to 140 hr/ha. Most farmers in Ethiopia as well as in Amhara Region do not weed their fields at the right time because of labor bottlenecks. Weeds are therefore one of the most important crop production constraints in the country and the region.

Weeds growing among crop plants adversely affect yield and quality of the harvest and increase production costs, resulting in high economic losses. Some species of weed plants might be a serious threat to crop plants diversity, sharing nutrients, moisture, sun light and space (Ozturk et al, 2012). Meanwhile, to consolidate the expansion of the cultivated area with sweet sorghum, and to achieve satisfactory yield potential, it is necessary to properly conduct the treatments in the crop. The integrated weed management stands out as one of the main bottlenecks in the production system, because the weed control in inappropriate time may adversely affect the production cost and/or result in qualitative and quantitative losses in crop yield (Ciuberkis et al., 2007).

The most troublesome weeds in sorghum include Striga (*Striga hermonthica),* Nut-grass (*Cyperus rotundus*), and other common narrow and broad leaved weeds. Farmers in the North western Ethiopia, Gumara-maksegnit watershed have no a weeding habit of their sorghum at the right time and frequency, because they believe that weed free crops at the early stage of the crop will got stalk borer damage (farmers suggestion during interview). And after at the beginning of September they start to weed their land and used the weed as a feed for their animal (Personal observation). Identifying factors that could affect crop competitive ability independently or synergistically with known factors over a wide range of situations is therefore important to enhance crop competitive ability (Tomar et al., 2003).Therefore the objective of this study was to determining better weeding frequency of sorghum in Gumara-Maksegnit watershed, North western Amhara.

MATERIALS AND METHODS

Site Description

The experiment was conduct in the Gumara- maksegnit watershed, North Western Ethiopia, for two cropping seasons (2014-2015) at three sites. Annual rainfall in the year 2014 and 2015 was 1418 and 1108mm respectively (Figure 1). The mean maximum temperature of the area is about 28.5 °C and while the mean minimum temperature is about 13.3 °C.

The soil status of the experimental area showed that the PH value of both sites laied on neutral soil conditions. The available Phosphrus content of the experimental site-1 indicated that, it has very low Available soil phosphorus content when compared to site 2, which have relatively high soil phosphorus. But both experimental sites have low available phosphorus content when compared to the critical P content for crop growth which is characterized as low < 23, medium 23-56 and high > 56ppm (Tandon, 2004).

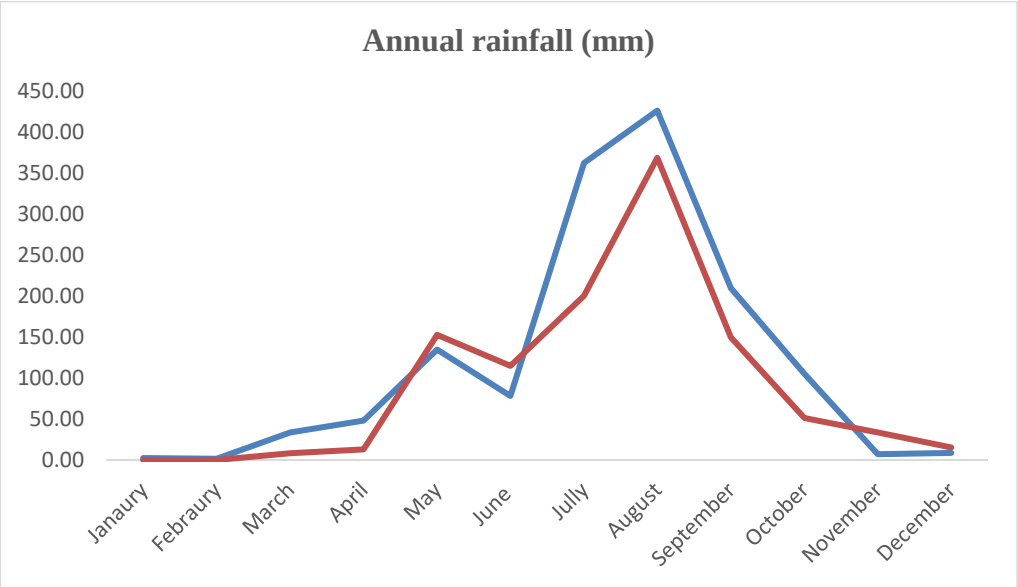

Figure 1: Annual rainfall distribution

Experimental Design and Analysis

The experimental design was arranged in randomized complete block design with three replications. The plot size was 4.5m ×5m (22.5m^2) with six rows, Ridge and furrow planting method was used on black soil. Local sorghum variety was used at a seed rate of 10 kg/ha and planted in rows. The spacing between replications, plots, rows and plants was 1.5m, 1m, 75cm and 15cm, respectively. The planting date of the experiment was on the second week of June for both years. Application of urea was applied at a rate of 41kg N/ha in two splits (1/2 at planting and the rest was applied at knee height stage) whereas, 46kg $P_2 0_5$/ha at was applied at planting.

Treatments of the experiment

1. HW1 -Hand weeding once (25 days after sorghum crop emergence/DAE/)
2. HW2-Two times hand weeding (25 and 55 days after sorghum crop emergence/DAE/)
3. HW3- Three times hand weeding (25, 55 and 90 days after sorghum crop emergence/DAE/)
4. HW4- Farmers practice (weeding once at 80 days after sorghum crop emergence/DAE/)
5. HW5- Weed free plot
6. HW6- Control (Un weeded plot)
7. Shelshalo (Interrow cultivation with hand or animal drawn implements)

Statistical analysis: analysis of variance (ANOVA) was carried out to determine the presence of significant difference among the treatments using SAS 9.2 software mean separation was done using least significant difference.

RESULT AND DISCUSSION

The experiment was conducted on the vertisol of gumara maksegnit watershed, North gondar zone, ethiopia. The result revealed that, there were significance difference on heading days, plant height, thousand seed weight, grain yield and fresh biomass in 2014. Farmers practice and unweeded treatment took longest days to heading which was 104 and 102 days respectively. It is probably because of the fact that, there is high competetion between sorghum crop and weeds for nuitrent especially and haveing slow growth. In this expeiment the highest grain yield was recorded on two times hand weeding (2916kg/ha) and weed free treatments (2666 kg/ha).

Table 1: Soil properties of the experimental site

No.	Site	PH (H_2O)	E.C	Available P/PPM	O.C%	Texture (Hydrom.)
1	Tilahun-Site 1	7.1	0.03	7.68	071	Clay loam ---2014
2	Mande-Site 2	6.94	0.1	14.54	0.88	Clay ---2015

Whereas the lowest grain yield were recorded on unweeded treatments, farmers practice and one times weeding which was 1778, 1836 and 2003 kg/ha respectively (Table 1). this reveald that, weeding in sorghum production at gondar zurria woreda ha significance effect on grain yield.

Table 2: List of weeds observed in the experimental area

N0.	Weed Type in heavy clay soil (Amharic)	Weed Type in heavy clay soil (Scientific Name)	Weed type in light soil (Amharic)	Weed type in light soil (Scientific Name)
1	Gicha	Cyperus rotundus L.	Lolia	Commelina benghalensis
2	Enat kurit	Chenopodium murale	Gicha	Cyperus rotundus L.
3	Chilika	Cynodon nlefuensis	Enat kurit	Chenopodium murale
4	Yewusha milas	Scorpiurus muricatus	Mech	Guizotia scabra
5	Nech abeba	Tagetes minuta	Akakma	Oxygonum sinuatum
			Maget	Medicago polymorpha L.
			Meskel ferche	Galinsoga parviflora
			Nech abeba	Tagetes minuta

Almost all treatments gave the highest fresh biomass yield except farmers practice which gave the lowest biomass yield of sorghum, 8.04 t/ha. The highest were recorded from weed free experimental plots and followed by three times hand weeding (Table 3).

Table 3: Mean Value of HD, MD, PH, TSW, Yield and Fresh Biomass of sites sorghum in G/Maksegnit watershed on 2014

Treatment	HD	MD	PH	TSW	Yield kg/ha	Fresh biomass
HW1	99.0b-d	184.0	172.8b	35.2ab	2003b	9.6cde
HW2	96.0b	180.6	180.0ab	35.5a	2916a	12.1ab
HW3	98.0cd	185.6	176.6b	36.0a	2663ab	12.0abc
FP	104.0a	185.3	175.0ab	34.2a-c	1836b	9.2de
WF	97.6cd	182.0	183.2a	33.2bc	2666ab	13.4a
Control	102.3ab	183.3	171.6b	35.2ab	1778b	8.3e
Shelshalo	101.3a-c	181.6	176.0ab	32.3c	2256ab	11.0bcd
LSD%	4.21	9.33	9.37	1.97	888	2.43
CV%	2.37	2.86	2.98	3.21	21.6	12.6

The interaction effect of treatment with year, only sorghum thousand seed weight and fresh biomass showed significance difference (Table 3). However, the other important parameters like maturity days, plant height and grain yield of sorghum didn't show significance difference on the combined interaction effect of treatment with year.

In 2015 different weeding frequency has shown difference in thousand seed weight, grain yield and fresh biomass, however, maturity days and plant height didn't showed significance difference over the treatments. In the year 2015, the highest grain yield was observed on weed free treatments (3638kg/ha), followed by two times and three times hand weeding respectively. The lowest grain yield were observed on un weeded and farmer practice treatments which was 2433kg/ha and 2820kg/ha respectively. In contrast, the highest biomass was recorded on un weeded treatment (Table 4).

Table 4: Mean Value of HD, MD, PH, TSW, yield and Fresh Biomass of sites sorghum in G/Maksegnit watershed on 2015

Treatment	MD	PH	TSW	Yield kg/ha	Fresh biomass t/ha
HW1	146.3	179.8	31.9b	2729c	7.97ab
HW2	145.3	188.2	32.5ab	3254ab	7.51b
HW3	147	185.3	32.0b	3250ab	7.76b
FP	146	183.4	34.3a	2820bc	7.42b
WF	146.7	189.3	33.7a	3638a	7.23b
Control	145.7	182.2	32.9ab	2433c	9a
Shelshalo	146.2	178.8	32.1b	2812bc	7.56b
LSD%	3.75	13.8	2.02	505	1.2
LS	ns	ns	ns	**	ns
Trt* Site	ns	ns	ns	ns	ns
CV%	2.16	6.3	5.2	14.2	13.1

The two years combined analysis of variance showed that, thousand seed weight, grain yield and fresh biomass showed significance difference, whereas, maturity days and plant height didn't showed significance difference. The effect of weed in crop depends greatly on crop species, type and level of weed infestation and environmental conditions (Hussein et al., 2007).

Table 5: Combined Mean Value of HD, MD, PH, TSW, yield and Fresh Biomass of sites sorghum in G/Maksegnit watershed on 2014 and 2015

Treatment	MD	PH	TSW	Yield kg/ha	Fresh biomass
HW1	158.9	177.5b	33.0ab	2487c	8.5ab
HW2	157.1	185.4ab	33.6ab	3141a	9.06ab
HW3	159.9	182.4ab	33.3ab	3054ab	9.19a
FP	159.7	180.6ab	34.3a	2492c	8.04b
WF	158.4	187.3a	33.6ab	3314a	9.3a
Control	158.2	178.6ab	33.7ab	2215c	8.78ab
Shelshalo	158.0	177.8b	32.2b	2627bc	8.71ab
LSD %		9.14	1.5	439	1.12
LS	ns	ns	ns	**	**
Tr*y	ns	ns	*	ns	*
CV%	2.36	8.2	5.2	17.6	14.9

In the combined analysis the highest grain yield were recorded from weed free, two times hand weeding and three times hand weeding treatments, 3314 kg/ha, 3141kg/ha and 3054 kg/ha respectively. Whereas, the lowest yield was recorded from the un weeded experimental plots which was 2215kg/ha, followed by farmers practice (2492 kg/ha). Two times hand weeding has yield advantage of 649 and 822kg/ha over farmers weeding practice and weed free experimental plots.

The economic analysis was carried out for weeding frequency sorghum crop at Gumara maksegnit watershed. The variable cost components such as seed, fertilizer, bags (sacks), land preparation, planting, harvesting and threshing have similar costs across treatments and locations, so were considered in the analysis. The difference in the total variable cost of production between the treatments, timing and hand weeding frequency, was attributable to the differences in costs of labour cost of weeding in the treatments and across the locations.

Table 6: Economic analysis

Treatment	Control	Shelshalo	HW1	HW2	FP	HW3	WF
Mean GY (kg/ha)	2215	2627	2487	3141	2492	3054	3314
Strover yield kg/ha	6565	6083	6013	5919	5548	6136	5986
Adj. yield (kg/ha)	1993.5	2364.3	2238.3	2826.9	2242.8	2748.6	2982.6
Adj. Stover yield(kg/ha)	5908.5	5474.7	5411.7	5327.1	4993.2	5522.4	5387.4
Adj. Stover yield(shekim/ha)*	295.425	273.735	270.585	266.355	249.66	276.12	269.37
GFB (ETB/ha)	21340.1	23393.48	22432.7	26447.2	21941.1	26143.2	27612.5
Labor cost (ETB/ha)	0	991.67	1118.06	2287.96	2300.93	2443.52	2565.50
TCV (ETB/ha)	0	991.67	1118.06	2287.96	2300.93	2443.52	2565.50
TFC	1500	1500	1500	1500	1500	1500	1500
Total Cost	1500	2491.667	2618.06	3787.96	3800.93	3943.52	4065.5
NB (ETB/ha)	19840.1	20901.81	19814.7	22659.2	18140.2	22199.7	23547
Dominance analysis			D		D	D	
MC (ETB/ha)		991.67		1296.3			277.54
MNB (ETB/ha)		1061.68		1757.4			887.74
MRR (%)		107.06		135.57			319.86

As shown on table below use of hand weeding at 20, 35 and 50 days after emergency were found profitable timing and frequency for upland rice production at current market condition as well as sensitivity analysis (table 6). The figure obtained is greater than the generally accepted minimum rate of return i.e. 100%. This implies that for one birr additional cost on the use of hand weeding at 20, 35 and 50 days after emergency have a return of birr 23.30. Similarly the sensitivity analysis showed hand weeding at 20, 35 and 50 days after emergency were found profitable timing and frequency for upland rice production if there is an increase in factor cost.

CONCLUSION AND RECOMMENDATION

Sorghum production in the region as well as in the study area is considered as vital especially for home consumption and Stover used as animal feed. However, different biotic and abiotic factors play major role on the reduction of sorghum productivity and weed is one of it in the study area. This experiment was conducted at Gumara maksegnit watershed with the objective of improving its productivity through utilization of appropriate weed management options. The results of the experiment showed that the

grain yield of sorghum crop is highly affected by weed. There is a yield loss from 822kg/ha in the un weeded field. Hence, weeds are found now a serious threat in sorghum production in the area, but relatively little attention has so far been paid to research on weed management.

The combined results of the two year data showed that weed free treatments gave the highest yield (3314 kg/ha) followed by two times and three times hand weeding. The economic analysis gave that, weed free (Three times weeding) gave 319% MRR followed by two times hand weeding (135% MRR) In general there was no significance difference between weed free and two times hand weeding. Therefore, two times hand weeding is recommended for Gondar Zuria and similar areas.

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