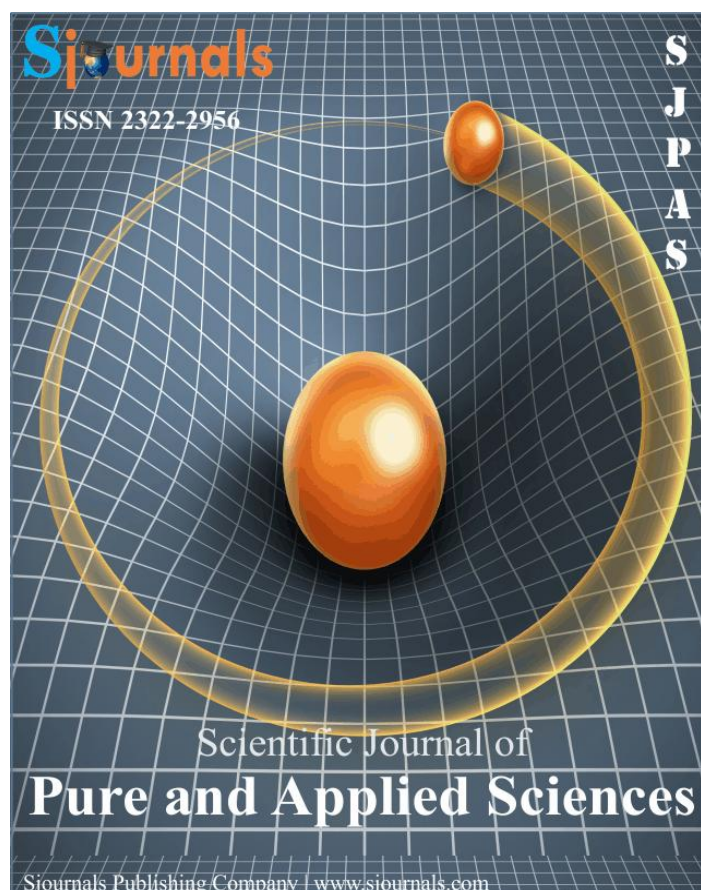


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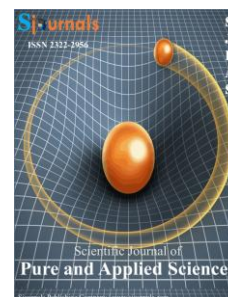
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Original article

Assessment of linseed (*Linum usitatissimum* L.) yield loss due to weed in Sinana, highland condition of Bale, South Eastern Ethiopia

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ARTICLE INFO

Article history,

Received 12 December 2017

Accepted 13 January 2018

Available online 20 January 2018

iThenticate screening 14 December 2017

English editing 12 January 2018

Quality control 19 January 2018

Keywords,

Linseed weeding

Disease

Grain yield

ABSTRACT

Weed plays an important role in important role in proper stand establishment of the growing crops, which finally hinder productivity and quality of the crop. Field experimental was conducted at Sinana Agricultural Research Center on station during 2013-2015 growing season to determine optimum weeding frequency for weed management in linseed (*Linum usitatissimum* L.). Weeding treatments consisted of five levels weedy check (no weeding), weeding at 30-35 days after emergency, weeding at 55-60 days after emergency, weeding at 30-35 and 55-60 days after emergency and total weed free. The results indicated that effects of weeding frequency observed on all yield parameter showed that the importance of weeding frequency for linseed growth, yield and yield component. However, significant ($P \leq 0.05$) effect of weeding frequency was not observed in the case of flowering date and plant height. The maximum seed yield was recorded from weed free plot (1808.35kg/ha) and weeding two times (30-35 and 55-60 days after crop emergence) (1621.58kg/ha) respectively. Weed significantly reduces the vegetative growth and productivity parameter of the crop. In this field trail 24.6% yield loss was observed in linseed when weeds are allowed to grow for the whole season. Weeding twice at 30-35 and 55-60 days after emergence was optimal for growth, yield and yield component of linseed. The major weed identified during the experimental

conducted in the experimental site were *Cyperus esculantus*, *Chenopodium album*, *Amaranthus* spp. *Guizotia scabra*, *Bromus pectinatus* and *Commelina benghlensis*.

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1. Introduction

Ethiopia is now considered the secondary center of diversity and the 5th major producer of linseed in the world next to Canada, China, United States and India (Adugna, 2007). Linseed is an annual field crop that is largely grown in temperate climates (Mansby et al., 2000). Linseed requires cool temperatures during its growing period to provide better yields. The mean temperature required for this crop was from 10-30°C and the crop was growing well within 21 and 22°C. Linseed has wide importance: It is a source of food, feed, fiber, oil, medicine and industrial raw material and export commodity.

In Ethiopia linseed was the second oil crops grown next to Niger seed in highlands of the country. In Bale zone it is becoming one of dominant cash earning crops next to bread wheat and barley and it is the first oil crop in area coverage. In 2015/2016, Ethiopia allocated 85415.67 hectares of land for linseed and production 885511.44 in quintals, which was 10.37 yields per hectares (CSA, 2016). Likewise, Bale zones about 18972.10 hectares of land was covered by linseed and about 211681.32 quintals of yield was obtained. In Ethiopia linseed production is characterized by low yield and poor quality, mainly due to poor management practices such as lack of proper weed management system and field hygiene, poor seed bed preparation, inadequate plant nutrition, inappropriate seeding rate and improper cleaning.

Weed causes great yield losses to crop, especially where a monoculture cropping systems is practiced. At early stage linseed cannot compete effectively with weeds, especially up to two months after sowing. Early removal of weeds is important before flowering because a yield reduction of up to 56% can be caused depending on the infestation level (Rezene, 1992). In general all weed species do not equally contribute to this loss, so, it is based on weed distribution and abundance of weed species. Weed growth, population and distributions vary from place to places depending up on soil and climate factors. The difference in the effect of weeds on crops production is mainly due to differences in characteristics and competitive status of the weeds and the crop, i.e. the ability of plants to obtain and use the growth determining and limiting resources, namely, light, water and nutrients. The salient objective of the study was aimed to assess the effect of weeding frequency towards yield loss in the commercially grown linseed in the areas of Sinana and similar agro-ecology.

2. Materials and methods

2.1. Description of experimental site

The experiment was conducted at Sinana, on-station for three years (2013-2015) under rain-fed conditions during the “bona” season August-December, which is the main cropping season. Bale highland is characterized by *bimodal* rainfall patterns or two separate crop growing seasons namely, “bona” extends from August to December and “ganna” from March to July. Sinana is located at 7°7’N longitude and 40°10’E latitude at an elevation of 2400 m.a.s.l. It is found at a distance of 463km southeast of Addis Ababa and 33km east of Robe town (capital city of the Zone) on the road to Goro and Sofumar cave. The soil of the area is dominated by cambisol.

2.2. Experimental treatments and design

The experimental fields were ploughed once and disked twice prior to planting using mold-board and disc ploughs, respectively. The experiment was laid out in randomized complete block design (RCBD) in four replications. The treatment was consisted five weeding frequency no weeding, once weeding at 30 to 35 days after crop emergence, once weeding at 55 to 60 days after crop emergency, twice weeding at (30-35 and 55-60 days after crop emergency) and weed free plot. Linseed variety 'Dibanne' was used and sown at a seed rate of 25kg/ha. National fertilizer recommendation for linseed production is 23/23kg/ha N/P₂O₅ was used. Each treatment was planted in a plot consisting of six rows of 5m long with spacing of 20cm between rows. The distance between

replications was 2 meters. Disease or insect control chemicals were not applied during the growth of linseed. On the other hand, all other recommended cultural practices were properly followed in order to successfully grow the crop.

2.3. Data collection

All agronomic parameters collected included 50% date of flowering, plant height, number of primary branch, number of bole per plant and number of seeds per bole, stand percentage, seed yield per hectare, thousand seed weight and disease severity of linseed was taken. Finally, seed price and labor person-day were collected to investigate the economic profitability of the treatments. To estimate seed yield of linseed, sample size of 4m² was harvested from each plot. After threshing seeds were cleaned, weighed and adjusted to 7% moisture content. Total seed yield recorded on plot basis was converted to kg/ha for statistical analysis. Amount and present of yield loss was determined by:

$$\text{Yield loss} = \text{Yield from weed free plot (Attainable yield)} - \text{Yield from weedy plot (Actual yield)}$$

$$\% \text{ Yield loss} = 100 \left(1 - \frac{\text{Yield of unweeded plot}}{\text{Yield of weeded plot (Weed free)}} \right) \text{ Milberga and Hallgren (2004)}$$

2.4. Statistical analysis

The crop data were subjected to analysis of variance using the General Linear Model Procedure of SAS statistical package version 9.1 (SAS Institute, 2002). The least significant difference (LSD) test at 5% level of significance was used to compare the means.

3. Results and discussion

3.1. Weed flora

The most common weed species identified in the study area were including broadleaved and grassy weeds (Table 1). The most important linseed yield limiting weed species in these areas those need to be controlled by integrated weed management options were listed in following Table.

Table 1

Major weeds recorded in linseed crops in Sinana on station from experimental site.

Botanical name	Family name	Duration
<i>Chenopodium album</i>	Chenopodiaceae	Annual
<i>Amaranthus</i> spp.	Amaranthaceae	Annual
<i>Guizotia scabra</i>	Compositae	Annual
<i>Bromus pectinatus</i>	Poaceae	Annual
<i>Avena fatua</i>	Graminea	Annual
<i>Plantago lanceolata</i>	Plantignaceae	Annual
<i>Commelina benghlensis</i>	Commelinaceae	Annual/Perennial
<i>Cyperus esculantus</i>	Cyperaceae	Annual
<i>Commelina latifolia</i>	Commelinaceae	Annual/Perennial

3.2. Effects of weeding time on growth and disease reaction of linseed at Sinana

Results of statically analysis (Table 2) showed that weeding frequency had no significant effect on flowering date and plant height, However effects of weed frequency were observed on several yield parameters such as number of tillers per plant, number of pods per plant and final seed yield as compared to un weedy plot. The growth and yield parameters increased as the weed frequency increased and vice versa as the weed-infested period increased. Similarly effective weeding time decrease the incidence of powdery mildew and pasmo disease on linseed (Table 2). On the other hand, there is no significant difference for flowering date, plant height and number of seed per bole for individual as well as combined years. The impact of the presence of weeds on crop

production is very considerable since weed has impact on growth and development of the crops. The extent to which weed yield is depressed by weed competition varies greatly depending on the resources available and the competitive ability of the crops with weeds (Roberts, 1982).

3.3. Effects of weed competition on linseed yield and yield components

Weeds are considered as a major problem in linseed crops causing great losses in seed yield and oil quality due to direct nutrient and resource competition. The present results revealed that weed free plot provide maximum seed yield advantage over the control plot. The combined results of the three cropping seasons have shown that twice hand weeding resulted in better increment in number of pods per plant and seed yield as compared to weed control (Table 3). Increasing weeding times increased tillers per plant, number of pods per plant and final seed yield as compared to unweeded plot, due to effective weed management at early stage. This finding was similar with El-Naim et al. (2010) who reported that weeds significantly reduced the vegetative growth attributes measured. Similarly Meseret et al. (2008) reported that number of pods per plant, seed yield and 1000-seed weight were significantly ($P \leq 0.05$) influenced by time and weeding frequencies. According to this finding linseed late weeding (weeding at 50-60 days after crop emergency) cause more than 18% seed yield reduction over the control (Table 3). This finding was similar with Anon 1997 who reported on sesame crops in the Humera area due to late weeded because of lobar shortage and losses due to weed range from 30-40%. Similarly kassahun et al. (1988) reported that 92% yield loss was observed in ground nut in the unweeded plot and late weeded plot at Melka Werer. In this paper maximum seed yield increment of linseed was achieved by weeding two times (30-35 and 55-60 days after emergence) as compared to unweeded plot.

Table 2
Effects of weeding frequency on growth and disease reaction of linseed at Sinana.

Treatments	Days to		Disease score		Number of tiller per plant
	Flower day	Plant height	Powdery mildew	Pasmo	
Weedy check (Control)	71.50	95.75	1.38	0.48	2.28
Weed free	72.50	93.53	1.20	0.24	3.61
Weeding at 30-35 DAE	72.58	93.85	1.36	0.42	2.31
Weeding at 55-60 DAE	72.75	90.77	1.40	0.44	2.56
Weeding at 30-35 and 55-60 DAE	73.08	92.48	1.33	0.39	2.75
Mean	72.48	93.28	1.33	0.39	2.70
LSD (5%)	1.51	6.24	0.06	0.03	0.26
CV	2.54	8.16	5.65	3.12	11.51

Table 3
Effects of weeding frequency on yield component of linseed at Sinana on station.

Treatments	Number of bole per plant	Number of seed per bole	Thousand seed weight	Grain yield kg/ha	Biomass
Weedy check (Control)	57.14	10.64	6.22	1363.67	3908.33
Weed free	77.97	11.12	6.18	1808.35	5604.17
Weeding at 30-35 DAE	68.54	10.66	6.25	1405.02	4058.96
Weeding at 55-60 DAE	66.59	10.66	6.10	1483.85	4645.83
Weeding at 30-35 and 55-60 DAE	70.68	10.38	6.02	1621.58	4838.75
Mean	68.18	10.69	6.15	1536.49	4611.21
LSD (5%)	8.5	0.76	0.14	120.35	732.06
CV	15.19	8.60	2.84	9.54	19.34

3.4. Partial budget analysis for linseed weeding frequency

Partial budget analysis was done to identify the profitability of treatments. Therefore, partial budget analysis was performed in order to evaluate the economic feasibility of the treatments the minimum rate of return i.e. 50

to 100% (CIMMYT, 1988). Yields of linseed from experimental plots were adjusted down ward by 10% (i.e. for management and plot size differences to reflect the difference between the experimental yield and the yield that farmers could expect from the same treatment). Farm-gate prices of linseed Ethiopian birr (23.0kg⁻¹) of the average of one month from the time of crop harvesting and labor valued at Ethiopian birr 35 per person per day were used for variable cost determination. This enables us to identify the optimum weeding frequency for linseed production.

Table 4
Economic analysis for linseed weeding frequency at Sinana.

Treatments	Grain yield kg/ha	Adjusted grain yield kg/ha	Gross benefit	Total cost	Net benefit
Weedy check (Control)	1363.67	1227.303	28227.97	0	28227.3
Weed free	1808.35	1627.515	37432.85	875	36557.85
Weeding at 30-35 DAE	1483.85	1335.465	30715.7	350	30365.7
Weeding at 55-60 DAE	1405.02	1264.518	29083.91	525	28558.91
Weeding at 30-35 and 55-60 DAE	1621.58	1459.422	33566.71	525	33041.71

Linseed seed price 100 kg=2300 birr; Labor price for hand weeding=35 birr/day.

4. Conclusion

Weeding frequency has significant (<0.05) difference on plant height, number of branches per plant and grain yield of linseed. Maximum grain yield and number of branch per plant, pod per plant was observed on weed free treatment. The minimum grain yield was observed in no weeding and weeding only one time at flowering stage. The critical time weed have to removed, to obtain maximum yield is during the early growth stage after crop emergence. Late weeding led to yield reduction due to linseed was sensitive to weed at early stage. Based on the result of the current study, two times weeding one at early stage and one before flower stage was recommended for linseed. According to this activity over 24.6% yield loss was observed among treatment when weeds are allowed to grow for the whole season i.e. growing of linseed without weeding.

Generally, linseed weeding frequency has no significant difference on plant height, number of branches per plant, thousand seed weight. But the significant difference on number of bolls per plant and grain yield was observed. There was significant yield difference between repeated weeding treatment and once and two time weeding. The best yield was obtained when the crop was kept weed free, weeding twice after crop emergence was found to be economically optimum treatment (Table 4). Result from this trial indicated that weeding linseed not later than four weeks after emergence, supplemented with another hand weeding at the seventh week after crop emergence were economical. So, the critical weeding period of linseed is within 30-35 and 55-60 days after crop emergence was optimal and provide better yield for linseed production.

Acknowledgments

The authors are grateful to all staff members of Sinana Agricultural Research Center Pulse and Oil crops technology generating team for their help me in trials management and data collection. This research was funded by Oromia Agricultural Research Institute (OARI).

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How to cite this article: Meleta, T., Dargie, R., Wakweya, K., 2018. Assessment of linseed (*Linum usitatissimum* L.) yield loss due to weed in Sinana, highland condition of Bale, South Eastern Ethiopia. *Scientific Journal of Pure and Applied Sciences*, 7(1), 729-734.

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