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Effect of Weed Management Methods on the Growth and yield of Turmeric in Metu, Illubabor, Ethiopia

Tadesee Eshetu Melaku Adissu Fantahun Asfaw
Ethiopian Institute of Agricultural Research, Jimma Agricultural Research Center
P.O.Box 192, Jimma , Ethiopia

Abstract
A field experiment was carried out at Metu Research Sub Center to determine the best weeding practice for turmeric under Metu condition. The experiment was carried out between 2010 and 2012 cropping seasons. Turmeric was subjected to nine weeding regimes using randomized complete block design with three replications The result showed that the major weeds recorded were: Gyzotia scabra., Nicandra physaloidesspp./ Commelina spp., Bidens Polynchyma, Caylusia abyssininca and Ageratum conyzoides. The result also reveled that turmeric rhizome yield was highly significantly ($p<0.1$) affected by weeding regimes . As hand weeding frequency increased turmeric yield also increased. The result reveled that one early hand weeding applied between 30 and 45 days after planting was critical for high yield of turmeric When the first hand weeding was delayed up to 60 days from planting yield of turmeric was reduced tremendously. However, the result showed that by mulching turmeric at planting the first hand weeding can be delayed up to 60 days without yield affected. Mulching turmeric at planting followed by two hand weeding at 60 and 90 days gave high yield compared with the with the treatment where the first hand weeding was applied at 60 days. Similarly, hand weeding at 30 and 60 days followed by mulching once also gave comparable yield with the weed free treatment. In addition, the result also revealed that mulching at planting enhanced the fast germination and emergence of turmeric compared with none mulched turmeric. On the other hand, the result also showed that turmeric was poor competitor of weed competition that it required to be free of weeds throughout the season.. The highest weed biomass was recorded from the control treatment and when weeding was totally ignored yield reduction as a result of uncontrolled weed growth amounted 98.7 % under Metu condition
Keywords: Weed management, Turmeric

Introduction

Turmeric (Curucumis longa (linn) belongesto the family Zingiberaceac Turmeric internationally and locally is used as a natural coloring agent for food, cosmetic or dye and medically for treating various kinds of diseases (Njoku et al, 2012) Turmeric is important spice crop which have been under cultivation since antiquity in Ethiopia. Turmeric can be cultivated up to 2000 masl but the crop grows well in the hot humid and lowland areas of the southwest part of the country. Weeds cause reduction in crop yield and takes extra cost in the total labor use in crop production. Akobunda (1987) reported that weeds result in 65 % reduction in yield of root and tuber crops and takes 25% 0f total labor use in production. Weed competition has also been identified as a constraint to root and tuber production (Unamma,1984)

As the crop is slow germinating and growing yield loss as a result of weed competition is expected to be tremendous. The environmental condition of southwest Ethiopia is characterized by high temperature and high rainfall which is highly conducive for year round emergence and growth of highly competitive perennial and annual weed species such as *Cynodon spp., Cyprus spp., Digitaria spp./ Commelina spp., Bidens pilosa, Gyzotia scabra, and Ageratum conyzoides* (Tadesse et al,1998). In spit of the divers and highly competitive weed flora existing in the turmeric growing areas, research information on weed management is not available for Metu area so far.

The objective of the present study was therefore, to identify appropriate weed management method for optimum growth and yield of turmeric under Metu condition.

Materials and Methods

The study was conducted on naturally weed infested field at Metu Agricultural Research Sub Center between 2010 to 2012. . Metu has an altitude of 1680 m.a.s.l with a mean annual rainfall of 1840 mm. The mean maximum and minimum temperatures of the center are 28.5 ^{0} c and 10.3 ^{0} c, respectively.

Treatments and Experimental Design

1. Hand weeding at 30,60,90, days after planting
2. Hand weeding at 45,75,105,135 &165 days after planting
3. Hand weeding at 60,90,120,& 150 days after planting
4. Mulching at planting followed by hand weeding at 45 and 75 days after planting
5. Mulching at planting followed by hand weeding at 60 and 90 days after planting
6. Hand weeding at 30 and60 days after planting followed by mulching followed by one hand weeding as needed

7. Hand weeding at 45 and 75 followed by mulching followed by one hand weeding as needed
8. Clean weeding
9. Weedy control

The study was laid out in randomized complete block design with three replications.
Weed species were visually observed and recorded throughout the study period. Weed biomass was determined by harvesting all weeds on the plots shortly before harvest. For final measurement the weed biomass was sundried until the weeds were well dried. Stand count, rhizome weight, rhizome length, number of tillers per plant and yield was recorded at harvest.
Yield loss (YL) was calculated using the following formula developed by Panda 2010

$$YL = \frac{Y1 - Y2}{Y1} X100$$

Where YL= Yield Loss, Y1 and Y2 represent yield of clean weeding and the respective treatments
Weed Control Efficiency (WCE) was calculated using the following formula (Devasenapathy et al 2008)

$$WCE = \frac{WDC - WDT}{WDC} X100$$

Where WDC= weed dry weight from untreated control plot WDT= weed dry weight from treated plot
Growth parameters such as rhizome length, rhizome weight and number of fingers per rhizome were determined by considering ten rhizomes per plot at the time of harvest.

Data Analysis

All data were subjected to the analysis of variance (ANOVA) with the appropriate design as per Gomez and Gomez (1984) using SAS version 9.0 computer software program (SAS, 2002). Mean separation was performed when means were significant using Least Significant Difference (LSD) at 5 % and 1% level of probability

Results and Discussion

Weed species

The major naturally occurring weed species recorded growing in association with Turmeric during the study period is presented in (Table 1). All noxious perennial and annual weeds were abundantly growing in the experimental field. The classification as noxious and important weeds was based on the species competitive ability and time and many spent for their control. The noxious species are highly competitive for essential growth requirements and are too difficult to control once they are established in the field. The noxious weed species such as *Gyzotia abysinica, Nicandra physaloides* and *Bidens ploncyma* flush and grow vigorously all year round inflicting their impact on turmeric development and growth.
Table1. List of Noxious and important weed species at Metu.

Botanical name	Family	Growth nature	Ecophysiology definition	Economic importance
Cynodon spp	Poacea	Perennial	C4	Noxious
Cyperus spp	Poacea	Perennial	C4	Noxious
Digitaria spp	Poacea	Perennial	C4	Noxious
Gyzotia scabra	Asteracea	Annual	C3	Noxious
Nicandra physaloides	Solanaceae	Annual	C3	Noxious
Bidens polynchyma	Compositea	Annual	C3	Noxious
Commelina benghalensis	Commelinacea	Annual	C3	Noxious
Ageratum conyzoides	Compositea	Annual	C3	Importanat
Plantago lanceolata	plantaginaceae	Annual	C3	Importanat

Rhizome weight, Rhizome length and number of fingers per rhizome

The result reveled that there was a highly significant ($p<0.1$) differences between treatments in terms of rhizome weight, rhizome length and number of rhizomes per rhizome (Table 2). The shortest rhizome length and the lowest rhizome weight was recorded from the control treatment where weeds were allowed to compete throughout the growing period and the highest rhizome weight and the longest rhizome length was recorded from the clean weeding treatment where plots were kept free of weeds. The result clearly showed that as hand weeding frequency was increased rhizome weight and rhizome length also increased. On the contrary, as weeding was delayed rhizome weight and rhizome length also decreased indicating serious weed competition. Mulching at planting followed by two hand weeding at 60 and 90 days or mulching at planting followed by hand weeding at 45 and 75 days resulted in comparable rhizome weight and rhizome length compared with the clean weeding treatment.

Table2. Effect of weed control methods on rhizome weight, and rhizome length at Metu

Treatment	Rhizome weight (gm)				Rhizome length (cm)			
	2010	2011	2012	Mean	2010	2011	2012	Mean
T1	6.5	5.6	6.1	6.1	4.7	3.7	4.7	4.4
T2	8.2	8.9	8.6	8.6	4.6	3.7	4.6	4.3
T3	5.3	5.9	5.6	5.6	3.8	3.3	3.8	3.7
T4	5.3	6.1	5.7	5.7	3.7	4.1	3.7	3.9
T5	5.4	6.5	6.0	5.9	4.0	4.1	4.0	4.1
T6	6.0	7.4	6.7	6.7	4.0	4.1	4.0	4.1
T7	6.3	8.3	7.3	7.3	4.3	3.8	4.3	4.2
T8	7.7	8.0	7.9	7.9	4.8	4.5	4.8	4.7
T9	2.1	3.1	2.6	2.6	1.0	2.7	1.4	1.7
CV%	11.4	24.5	18.3		14.6	10.4	12.2	
LSD 5%	1.2	2.8	2.5		0.9	0.7	1.0	
LSD !%	1.6	3.9	3.6		1.4	1.0	1.4	

Yield

The result reveled that there was a highly significant yield difference ($P<0.01$) between treatments (Table 3). Turmeric responded well for weeding that as weeding frequency increased yield also increased tremendously. The result clearly demonstrated that the first hand weeding cannot be delayed up to 60 days after planting under Metu condition. This was evident by comparing T3 with mean yield of 21.9 quintal/ha with T4 with 41.3 quintal /ha which is 46% yield increase over T3. This was because in T4 the dense growth of weeds was removed at 45 days whereas in T3 the dense growth of weeds stayed in association with the crop up to 60 days resulting in tremendous yield loss in about fifteen days time.

The result showed that three hand weeding applied at 30,60 and 90 days was not adequate to avoid weed competition under Metu condition resulting in 63.3 % yield loss compared with the clean weeding. This can be attributed to the fact that weed germination and growth is continuous throughout growing season specially with the noxious robust growing weed species such as *Gyzotia scabra, Bidens ploynchyma, Nicandra physaloides* and *Caylusia abyssinica* resulting in serious competition for the necessary growth requirements after the third hand weeding was applied at 90 days. This finding suggests that weed removal has to be continued until towards harvest under Metu condition for high yield of turmeric.

On the other hand, in T3 where the first hand weeding was started at 60 days after planting followed by three hand weeding thereafter, at 90,120 and 150 days had secured the removal of weeds growing during the mid and late seasons of the growing period. However, this treatment had 63.5 % yield loss compared with the weed free treatment. This result clearly demonstrates that serious weed competition had taken place associated with high yield loss during the early establishment period of the crop. Hence it is essential to apply one hand weeding during the early establishment period between 30 and 45 days after planting under Metu condition.

On the other hand however, the result also clearly showed that the first hand weeding in turmeric can be delayed up to 60 days by mulching turmeric at planting followed by hand weeding at 60 and 90 days without any yield loss (Table 3). This is because the mulch has suppressed early dense establishment of weeds which can seriously compete with slow germinating and growing turmeric. This has far reaching implication that farmers can do other farm activities particularly at busy times at the expense of weeding turmeric at early establishment period. Similarly, mulching at planting followed by hand weeding at 45 and 75 days also gave similar yield with the treatment where turmeric was mulched at planting followed by hand weeding at 60 and 90 days after planting. The present result also reveled that mulching at planting has reduced the frequency of hand weeding. This is evident by comparing T4 and T5 with T2,T3, and T1 with 5,4 and 3 hand wedding frequencies.respectively.This can be explained by the fact that mulching has sufficiently covered the plots inhibiting the necessary growth requirements such as light that the frequent germination and growth of the noxious weeds was inhibited.

The present finding also showed that mulching turmeric after two hand weeding at 30 and 60 days after planting and also mulching after hand weeding at 45 and 75 days gave comparable yield with those treatments where the mulch was applied at planting followed by hand weeding at 60 and 90 days and also hand weeding at 45 and 75 days after planting. This finding has indicated that mulching was found to be good agronomic practice in terms of suppressing weed growth and increasing turmeric yield under Metu condition.

Interestingly, mulching turmeric at 30 and 60 days after planting or mulching turmeric at 45 and 75 days has effectively suppressed the noxious weed species such as *Gyzotia scabra* and *Bidens polyncyma, Nicandra physaloides* and *Caylusia abyssinica* with the ability of germinating and growing all year round and which are responsible for turmeric yield loss during the mid and late growing season of the crop. This is evident by comparing T1 with mean yield of 31.8 quintal /ha compared with T5 and T6 with mean yields of 46.3

quintal/ha and 52.1 quintal /ha, respectively (Table 3). The present finding has clearly reveled that mulching either at planting or mulching after two hand weeding can effectively suppress noxious weeds which seriously reduce turmeric yield under Metu condition. Experience and research results elsewhere have proved that mulching apart from suppressing weed growth also conserve moisture and also significantly improve the soil structure.

In the present study we have clearly observed that in plots where no mulch was applied the soil was frequently eroded during heavy rains and as a result the underground rhizome was exposed to direct sun light which is believed to seriously affect the quality of the crop (data not shown). Under Metu growing condition characterized with high rain fall and well distributed throughout the growing period where weed germination and growth is very frequent and continuous the advantage of mulching can conserve the limited moisture specially at planting time to enhance fast and vigorous establishment of turmeric to effectively compete with weeds. In addition it is also vital in terms of reducing the frequency of hand weeding and saving time of the farmer who is involved with many commodities and farm activities.

When weeding was totally ignored yield loss amounted 98.2% suggesting that turmeric is very poor competitor of weed competition that timely and adequate weed control in turmeric under Metu condition is critical to secure high yield.

Conclusion and recommendation

Since Metu area is characterized with high rain fall and since the rain fall is well distributed throughout the crop growing period weed flush and growth is continuous necessitating season long weed removal to secure high yield of turmeric under Metu condition. Since turmeric is slow germinating and growing crop repeated hand weeding is required to save the crop from noxious robust growing tall weed species such as *Gyzotia scabra, Bidens ploynchyma, Nicandra physaloides* and *Caylusia abyssinica.* The result has confirmed that early hand weeding between 30 and 45 days was critical for vigorous growth of turmeric. In addition, three hand weeding applied at30, 60 and 90 days was not adequate resulting in serious weed competition leading to tremendous yield loss thereafter. The present finding has proved that mulching at planting was found to be good agronomic practice in suppressing weed growth and reducing the frequency of hand weeding in turmeric under Metu condition. Hence, based on the present finding, turmeric can be mulched at planting and supplemented by two hand weeding at 60 and 90 days or at 45 and 75 days after planting for high yield of turmeric under Metu condition.

Table 3.Yield of turmeric as affected by weed management methods at Metu

Treatment	Weed dry weight Q/ha.	Yield Q/ha.			Mean yield Q/ha	% yield loss compared with clean weeding	% weed control efficiency
		2010	2011	2012			
Hand weeding at 30,60,90, days after planting	38.0	38.9	31.4	25.1	31.8	47.0	53.7
Hand weeding at 45,75,105,135 &165 days after planting	7.5	43.2	48.0	32.7	41.3	31.1	90.9
Hand weeding at 60,90,120,& 150 days after planting	35.0	28.1	19.3	18.4	21.9	63.4	57.3
Mulching at planting followed by hand weeding at 45 and 75 days after planting	36.5	94.7	33.7	21.1	49.8	17.0	55.5
Mulching at planting followed by hand weeding at 60 and 90 days after planting	26.5	88.9	38.6	22.4	50.0	16.7	67.7
Hand weeding at 30 and60 days after planting followed by mulching followed by one hand weeding as needed	6.0	72.8	43.1	23.1	46.4	22.7	92.7
Hand weeding at 45 and 75 followed by mulching followed by one hand weeding as needed	4.5	69.1	58.4	28.7	52.1	13.2	94.5
Clean weeding	0.0	82.6	65.5	31.9	60.0	-	100.0
Weedy control	82.0	0.0	0.0	2.3	0.8	96.2	0.0
CV %	40.0	21.0	30.6	23.5			
LSD 5%	3.4	15.6	19.4	16.3			
LSD 1%	4.7	23.8	26.5	24.2			

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