Asian Plant Research Journal

8(3): 1-9, 2021; Article no.APRJ.73375
ISSN: 2581-9992

Effect of Selected Weed Management Practices on the Growth and Yield Components of Finger Millet (*Eleusine coracana*) in Western Region of Kenya

Mayaka Justus Mogaka[1,2*], Korir Kibet Nicholas[1], Wafula Wekha Nelson[1] and Joseph P. Onyango Gweyi[1]

[1]Department of Agricultural Science and Technology, Kenyatta University, P.O.Box 43844-00100 Nairobi, Kenya.
[2]Bukura Agricultural College, P.O.Box-23-50105, Bukura, Kenya.

Authors' contributions

This work was carried out in collaboration among all authors. Author MJM designed the study, wrote the protocol and wrote the first draft of the manuscript. Authors KKN and JPOG reviewed the study design and all drafts of the manuscript. Authors KKN and WWN managed the analyses of the study and performed the statistical analysis. Author JPOG managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/APRJ/2021/v8i330175
Editor(s):
(1) Dr. Langa Tembo, University of Zambia, Zambia.
Reviewers:
(1) C. Tamilselvan, Bioscience Research Foundation, India.
(2) Wossen Tarekegne, Bahir Dar University Peda Campus, Ethiopia.
Complete Peer review History: https://www.sdiarticle4.com/review-history/73375

Original Research Article

Received 26 June 2021
Accepted 06 September 2021
Published 16 September 2021

ABSTRACT

Finger millet (*Elusine coracana*) accounts for 8% of the total area and 11% of the millet production worldwide. It is grown on over 4 million ha globally, mainly for food purposes. Millions of people in the dry lands of Central and East Africa, and South of India depend on finger millet as an important source of food to them (CGIAR, 2001). Finger millet is one of the most neglected and underutilized crops. Additionally, the crop has received limited research attention compared to wheat, rice, and maize (FAO, 2011). Therefore, production challenges such as those caused by weeds like goose grass *Elusine indica* remain at large. Manual weeding is the commonly employed weed control method in finger millet production, but is expensive and labour intensive. The current study was set to evaluate the influence of weed management practices on finger millet growth and yield components. The experiment was laid out in a Randomized Complete Block Design (RCBD) with

**Corresponding author: E-mail: majormogaka@gmail.com;*

three replicates. The plots measured 2 by 2m with a border width of 1m. The treatments included Pendimethalin, Dimethyl amine, Metolachlor, Metribuzin, Atrazine (at three rates each 1.0, 1.5 and 2.0 l/ha), No weeding and Hand weeding. Data was collected on the number of weed species, weed biomass, number of basal tillers, herbicide phytotoxicity, weed and crop heights, number of panicles, weight of panicles, weight of un-threshed and threshed grains and 1000 grain weight. Data was analyzed using one-way ANOVA using GenStat version 15.1. Application of Pendimethalin at 1.5 and 2.0 L/ha Active Ingredient (AI), resulted in weed optimal control and least phytotoxicity. Results also indicated that the height of finger millet was significantly ($p<0.001$) higher where the herbicides were applied. Lower weed biomass was also positively correlated with higher crop height, more panicles, high unthreshed and threshed weights and a 1000 grain weight. Application of 2,4D at rates of 1.5L and 2.0L resulted in significantly taller plants 33.00 cm, than the other weed management methods. Finger millet under Pendimethalin 1.5 L gave the highest number of 86 panicles while Atrazine 2.0L and Pendimethalin1.5L methods of weed control, had significantly higher weight compared to all the other treatments. The 1000 seed mass across the treatments averaged 2.31 g while the on the untreated treatments had an average of 1.54 g. Weed control using pre emergence herbicides significantly ($p<0.001$) increased the yields of finger millet.

Keywords: Herbicide; weed; finger millet; labor; phytotoxicity.

1. INTRODUCTION

Finger millet (*Eleusine coracana* L.) is an annual and tufted crop that grows to a height of 30–170 cm and maturing in 75–160 days. It is a robust C4 crop, that has narrow leaves (grass-like) and capable of producing many tillers and nodal branches. Finger millet can be considered to have a well-balanced protein for a cereal grain [1]. Of the four essential amino acids, the proportion of lysine is 2.86 %, tryptophane 1.39 %, methionine 2.86% and threonine 3.06 %. This is especially good for diabetic patients [2]. According to [3] demand for small millets like finger millet need to be enhanced to act as a catalyst for increasing productivity.

Finger millet require nutrients, water, light and carbon dioxide for growth. Since weeds are among plant species, when found in the cultivated land, they compete with crop plants for these growth factors. The critical period of weed competition starts with the beginning of interference from weeds and ends when the crop covers 80 per cent of the soil. The length of critical period of weed competition depends on the nature of crop, its competitive ability, variety, and growing conditions. Nature of the crop Certain crops like sorghum, maize, and sunflower grow faster and cover the field quickly hence the length of critical period of weed growth is short. In other crops like sugarcane, potato and cotton whose initial growth is slow and as they are widely spaced, they take longer time to cover the soil. Critical period of weed competition is therefore longer, this is a similar case for finger millet which normally displays a slower field establishment [4]. At early stages of crop and weeds development, leaf area index and root density are low, and each plant is able to get its requirements as though every one of them is growing in isolation. In majority of crops, the period of non-interference between crop and weed is short. Even at low population of weeds, competition is set in at three leaf stage of weeds. The close proximity of weeds and their numbers cause sub-optimal absorption of growth factors resulting in reduction in growth and yield of crops. Among the growth factors, light and nutrients are particularly important in reducing growth [5].

Apart from cultural and mechanical means, weeds can be effectively controlled by use of herbicides. Ashton and Monaco [6] reported that work done in the communal areas, showed that the use of herbicides, combined with fine tillage, is a better and cheaper option for controlling weeds by these farmers. The most common weeds which were under the experiment could easily be controlled by the cheap pre-emergence herbicides, such as alachlor and atrazine.

In Western Kenya weed control in finger millet is usually done manually by several rounds of hand weeding which is not only hindered by lack of labour due to competition with other crops like maize but also the bad weather conditions such as heavy rainfall which makes the exercise difficult. Weeds are a serious problem in finger millet and the first two weeks after germination are critical. Several rounds of manual weeding are common, requiring much labour during this time. Weeding is labor intensive, and is further

complicated by wild relatives of the crop. Due to these constraints, the critical period of weed free competition is not achieved for the crop which is between 25 to 45 days thus leading to heavy losses. The 25 to 45 days is a window in the crop growth cycle during which weeds must be controlled to prevent unacceptable yield losses. It is therefore imperative that pre emergence herbicides should be used as an alternative for improved yields. The advantage of these herbicides is that they control weeds early and well and minimize competition. Most of the herbicides are usually applied 2-3 days after sowing when there is enough moisture in the soil for effective activity on the weeds. Most studies have not shown decreases in yields with the use of reduced rates of herbicides but none has been in the Western Kenya region on Finger millet. The objective of the study was to determine the weed management practices on the growth and yield components of finger millet (*Eleusine coracana*) in Western Region of Kenya.

2. MATERIALS AND METHODS

2.1 Study Sites

The study was carried out at Bukura Agricultural College (BAC) at the teaching and demonstration farm, which is situated at Butsotso South sub-location, Butsotso location, Lulambi Sub County, Kakamega County. The average rainfall in BAC is 1800 mm per annum, annual temperature of about 23^0c and lies at an altitude of about 1400 m above sea level (BAC Meteorological station, 2015).

2.2 Experimental Design and Layout

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replicates and each replicate had seventeen treatments. The plots measured 2 by 2m with a border width of 1m. The chemicals which were applied included Pendimethalin, Dimethyl amine, Metolachlor, Metribuzin and Atrazine. The treatment comprised; No weeding, Hand weeding and the five herbicides. The five herbicides; Pendimethalin, Dimethyl amine, Metolachlor, Metribuzin and Atrazine were applied at three rates each 1.0, 1.5 and 2.0 l/ha in each replication as described in the treatments.

2.3 Cultural Practices

Land was prepared by doing primary, secondary, and tertiary cultivation with the aim of getting a fine tilth since finger millet seeds are small. Finger millet variety (P224) which is commonly grown in Western Kenya was sourced from Kenya Seed. Sowing was done at the onset of rains end of March 2015 during the first season and end of August 2015 during the second season, by drilling 30cm apart and a depth of 3-4 cm. The seeds were mixed with Di Ammonium Phosphate (DAP) fertilizer at a rate of 125 Kg/ha and then planted along the drills which were then followed by covering of the drills. This was followed by application of the selected pre emergence herbicides after three days. The herbicides were sourced from Kakamega farmers agrovet and Kenya Farmers Association (KFA), and applied using a well calibrated knap sack sprayer with a flat fan nozzle. Ten days DAS, the thinning was done to maintain an intercrop distance of 10 cm. Ten days after sowing, crop emergence count was recorded.

2.4 Data Collection

Data was collected on the number of weeds, plant height, height of weeds, weight of wet weeds, weight of dry weeds, number of panicles weight of panicles, weight of threshed panicles and a thousand grain weight. The numbers of weeds per plot were determined using 1m by 1m quadrants. Plant height and weed height were measured using a tape measure from the stem base to the tip of top most leaf. Six plants were tagged from each plot and data was recorded after 20, 30 and 45 days after sowing.

The number of tillers was determined using twenty randomly selected plants at 20, 30 and 45 days after sowing**.** The crop was harvested at physiological maturity at the end of July 2015 for first season, end of December during second season and the number and weight of panicles from the net plot were recorded. The panicles from each net plot after weighing were dried, threshed separately, winnowed and all the dirt removed. One thousand grains for each plot were counted physically and their weights recorded. The grain yield from the net plot of every experimental unit was weighed and recorded at 13.5% moisture content.

2.5 Statistical Analysis

Data collected were compiled, cleaned and tabulated for statistical analysis. The data was then subjected to one-way ANOVA using GenStat version 15.1 to determine treatment effect. Tukeys Test was used to separate means at 5% probability level.

3. RESULTS AND DISCUSSION

3.1 Plant Height

There was an exponential increase in height between 20 and 30 days after sowing in all the treatments. In season one, at 20 days after sowing (DAS), use of all the herbicides in weed control resulted significantly ($p < 0.001$) higher plant height compared to no weeding and hand weeding. Although the performance of Atrazine at 1.0L in season two was significantly better than no weeding it was similar to that of hand weeding ($p \leq 0.001$), with majority of herbicides at different rates giving significantly taller plants than both hand weeding and no weeding (Table 1). At 45 DAS of season two, the height of finger millet plants grown in plots treated with Metribuzin2.0L, Metribuzin1.5L, Pendimethalin 1.0L, Atrazine2.0L, Atrazine1.5L, 2,4D2.0L, 2,4D1.5L and Pendimethalin1.5L was significant ($p<0.001$) than finger millet plants grown in plots where Atrazine1.0L, Metolachlor1.0L, Pendimethalin2.0L, 2,4D1.0L, Metolachlor1.5L, Metolachlor2.0L, hand weeding and no weeding (Table 3).

The increased finger millet heights in herbicide treated plots could be due reduction in crop weed competition [7]. Crops could have got enough space for air, light interception, root growth and nutrient acquisition which led to maximum growth as reported by [8]. Early growth stages of finger millet if subjected to a lot of weed infestation leads to decline in the growth and productivity of the crop, hence it is important to control the weeds during the critical period [9].

3.2 Tiller Development in Finger Millet

There was significant difference between the weedy check and other control methods ($p< 0.05$). The tillering of finger millet plants under no weeding was very poor. In addition, both Pendimethalin and 2, 4-D at 1.0L, 1.5L, and 2.0L and Metribuzin at 1.5L resulted in the highest number of tillers per plant (Fig. 1). Similar results were reported by Pradhan et al. (2010) who reported that there as more tillering in finger millet where chemical control and hand weeding was applied that the weedy check. Also Shanmugapriya, (2019) reported that there were enhanced growth attributes like plant height and tillers in finger millet where pre emergence herbicides like bensulfuron methyl 60 g/ha + pretilachlor 600 g/ha fb EPOE bispyribac sodium 25 g/ha were applied and were comparable to hand weeding during the critical weed free period (Fig. 1).

Table 1. Effects of different weed control practices on growth of finger millet in height (cm) season one

Treatments	20 DAS	30 DAS	45 DAS
No weed	15.33f	31.57e	35.57a
Hand weed	15.93ef	31.63de	36.27a
Atrazine1.0L	16.00de	31.50e	36.00a
Metolachlor1.0L	16.07cde	30.57g	35.50a
Pendimethalin2.0L	16.13bcde	31.93cd	36.53a
2,4D1.0L	16.50abcde	32.97b	36.00a
Metolachlor1.5L	16.53abcde	31.00f	36.07a
Metolachlor2.0L	16.57abcde	31.00f	36.43a
Pendimethalin1.5L	16.63abcd	31.67cde	36.03a
Metribuzin1.0L	16.70abc	31.50e	36.07a
Metribuzin2.0L	16.77ab	31.97cd	36.50a
Metribuzin1.5L	16.77ab	31.53e	36.53a
Pendimethalin1.0L	16.80a	31.47e	36.03a
Atrazine2.0L	16.83a	32.00c	36.73a
Atrazine1.5L	17.00a	31.50e	36.53a
2,4D2.0L	17.03a	33.50a	36.03a
2,4D1.5L	17.03a	33.00b	35.70a
SED	0.1706	0.0905	0.3377
LSD	0.34	0.18	0.68
P values	< 0.001	0.008	0.573

Treatments with different letters in the same column are significantly different at 5%

Table 2. Effects of different weed control practices on growth of finger millet in height (cm) season two

Treatment	20 DAS	30 DAS	45 DAS
No weed	15.03g	30.03ghi	33.73g
Hand weed	15.87ef	31.67cd	35.37de
Atrazine1.0L	15.93ef	30.30ghi	35.03e
Metolachlor1.0L	16.03de	29.93hi	34.50f
Pendimethalin2.0L	16.23cd	31.00ef	35.57cd
2,4D1.0L	16.03de	32.43b	35.03e
Metolachlor1.5L	16.47bc	30.03ghi	35.07e
Metolachlor2.0L	16.00de	29.50i	35.00e
Pendimethalin1.5L	16.53b	30.57fg	36.00bc
Metribuzin1.0L	16.23cd	30.00hi	34.97e
Metribuzin2.0L	16.53b	31.07ef	36.37ab
Metribuzin1.5L	16.50b	31.07ef	36.00bc
Pendimethalin1.0L	16.47bc	31.47de	36.00bc
Atrazine2.0L	16.83a	31.00ef	36.53a
Atrazine1.5L	17.03a	30.10gh	36.00bc
2,4D2.0L	16.47bc	32.03bc	35.60cd
2,4D1.5L	15.70f	33.03a	35.70cd
SED	0.0642	0.1482	0.1185
LSD	0.13	0.3	0.24
P values	<0.001	<0.001	<0.001

Treatments with different letters in the same column are significantly different at 5%

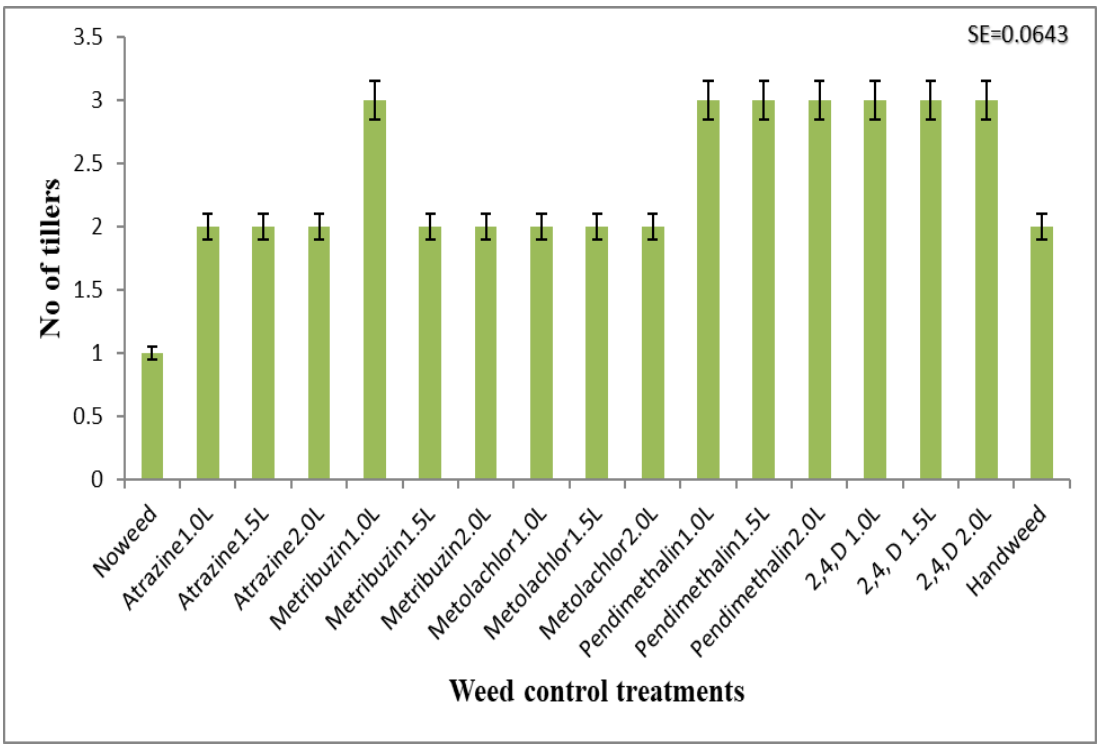

Fig. 1. Number of tillers across weed control treatments

Usually finger millet crop is free tillering especially when there is less competition of nutrients and other growth factors with weed. The good tillering under herbicide use was due to lower weed density and weed biomass caused low crop-weed competition and thus the crop plant fully utilized nutrients, moisture, space and light hence leading to production of more tillers.

[10]. Also, the increase in the number of tillers could be attributed to increased photosynthetic efficiency of finger millet as reported by [11] in kodo millet. The least tillering was observed at weedy check and this could be attributed to weeds competed for nutrients with the crop thus reducing its potential and eventually low yields [12, 13 and 14].

3.3 Yield of Finger Millet

The number of panicles averaged 84 in number except in the control under which produced significantly lower number of 63 compared to the 84-85 in other weed management methods ($p<0.05$) during the first season. Finger millet under Pendimethalin1.5L gave the highest number of 86 panicles which was significant ($p< 0.05$) than other weed control methods. In terms of unthreshed weight yield, Atrazine2.0L and Pendimethalin1.5L methods of weed control, had significantly higher weight compared to all the other treatments ($p< 0.05$) (Table 3).

The high yields achieved using pendimethalin could be attributed to the high number of tillers. Prashanth Kumar [15] and Prithvi [16]. Also increase of the yields in weeded plots was due to increased production and translocation of photosynthates to grains, due to adequate availability of growth resources which resulted of less competition offered by weeds. Rawat [17]. Increase in yield parameters in weeded plots is associated with better nutrition and increased nutrient uptake which result in better and healthy plant growth and development, leading to greater dry matter production and its translocation to the sink.

The panicle yield in the plots which were not weeded was small and this could be attributed to weeds compete with the crop for nutrients, water and space leading to the significant reduction in the number of panicles. Weeds compete with crop plants for water, nutrients, space, and solar radiation [18].

3.4 Weight of Threshed Grains and a Thousand Grain Weight

There was significance between the weights of un threshed panicles among the treatments ($p<0.05$). The weight of threshed grains ranged from 3.2 t ha^{-1} to 5.5 t ha^{-1} where by the unweeded plot and pendimethalin treated plots gave the least and highest yields respectively. (Table 5). Pendimethalin at 2.0,1.5 and 1.0 l/ha gave the yields of 5.4, 5.5 and 5.5 t ha^{-1} respectively, this was followed by Atrazine which

Table 3. Effects of different weed control practices on number of panicles and unthreshed weight

	Number of panicles	Unthreshed Weight (Kg)
Treatment	**Season 1**	**Season 1**
No weed	63.00c	0.84d
2,4D1.0L	84.00b	1.61c
Metribuzin1.0L	84.00b	1.66c
Metolachlor1.0L	84.00b	1.6c
Hand weed	84.00b	1.60c
Atrazine1.5L	84.00b	1.77ab
2,4D2.0L	84.33ab	1.60c
2,4D1.5L	84.33ab	1.59c
Pendimethalin1.0L	84.33ab	1.80a
Atrazine1.0L	84.33ab	1.78a
Pendimethalin2.0L	84.67ab	1.84a
Metribuzin2.0L	84.67ab	1.64c
Metribuzin1.5L	84.67ab	1.67bc
Metolachlor2.0L	84.67ab	1.78a
Metolachlor1.5L	84.67ab	1.68bc
Atrazine2.0L	84.67ab	1.78a
Pendimethalin1.5L	86.33a	1.82a
SED	0.5557	0.0249
LSD	1.13	0.05
P values	0.004	0.004

Treatments with different letters in the same column are significantly different at 5%

Table 4. Effects of different weed control practices on number of panicles and unthreshed weight

	Number of panicles	Unthreshed Weight (Kg)
Treatment	**Season 2**	**Season 2**
No weed	60.33c	0.79i
2,4D1.0L	81.33a	1.68defg
Metribuzin1.0L	81.00a	1.69cdef
Metolachlor1.0L	81.33a	1.70cde
Hand weed	81.00a	1.57h
Atrazine1.5L	81.67a	1.77ab
2,4D2.0L	80.67ab	1.63gh
2,4D1.5L	82.33a	1.64fg
Pendimethalin1.0L	80.67ab	1.72bcd
Atrazine1.0L	80.67ab	1.79a
Pendimethalin2.0L	78.33b	1.77a
Metribuzin2.0L	80.67ab	1.65efg
Metribuzin1.5L	81.67a	1.67defg
Metolachlor2.0L	82.00a	1.73abc
Metolachlor1.5L	80.33ab	1.68cdef
Atrazine2.0L	80.00ab	1.77ab
Pendimethalin1.5L	80.67ab	1.78a
SED	0.695	0.0144
LSD	1.41	0.02
P values	<0.001	<0.001

Treatments with different letters in the same column are significantly different at 5%

Table 5. Effects of different weed control practices on threshed and a thousand grain weight

	Threshed grain weight(Kg)	Thousand grain weight(Kg)
Treatment	**Season 1**	**Season 1**
No weed	0.51f	1.54c
Metribuzin1.0L	0.76e	2.26ab
2,4D1.5L	0.77de	2.24ab
Metribuzin1.5L	0.77de	2.19ab
2,4D2.0L	0.78de	2.24ab
2,4D1.0L	0.78de	2.26ab
Metribuzin2.0L	0.78de	2.22ab
Metolachlor1.0L	0.81cd	2.27ab
Hand weed	0.81cd	2.03b
Metolachlor1.5L	0.83bc	2.24ab
Atrazine1.5L	0.84bc	2.15ab
Atrazine1.0L	0.84bc	2.12ab
Atrazine2.0L	0.85abc	2.25ab
Metolachlor2.0L	0.86ab	2.27ab
Pendimethalin2.0L	0.87ab	2.30a
Pendimethalin1.5L	0.88ab	2.24ab
Pendimethalin1.0L	0.89a	2.11ab
SED	0.0122	0.0643
LSD	0.02	0.13
P values	0.031	0.166

Treatments with different letters in the same column are significantly different at 5%

Table 6. Effects of different weed control practices on threshed and a thousand grain weight

	Threshed grain weight(Kg)	Thousand grain weight(Kg)
Treatment	**Season 2**	**Season 2**
No weed	0.50h	1.40f
Metribuzin1.0L	0.75fg	2.13abc
2,4D1.5L	0.76fg	2.12abcd
Metribuzin1.5L	0.74g	2.16ab
2,4D2.0L	0.77efg	2.14abc
2,4D1.0L	0.76fg	2.09abcde
Metribuzin2.0L	0.78def	2.17a
Metolachlor1.0L	0.79cdef	2.15ab
Hand weed	0.80bcde	2.00de
Metolachlor1.5L	0.82abc	2.15ab
Atrazine1.5L	0.81abcde	2.04bcde
Atrazine1.0L	0.80bcde	1.98e
Atrazine2.0L	0.82abcd	2.16ab
Metolachlor2.0L	0.83ab	2.18a
Pendimethalin2.0L	0.83ab	2.12abcd
Pendimethalin1.5L	0.83ab	2.02cde
Pendimethalin1.0L	0.84a	2.11ab
SED	0.0100	0.0346
LSD	0.02	0.07
P values	<0.001	<0.001

Treatments with different letters in the same column are significantly different at 5%

ranged between 5.2 to 5.2 t ha^{-1} , Metolachlor between 5.0 to 5.3 t ha^{-1} , Hand weeding 5.0 t ha^{-1} , Metribuzin 4.8 to 4.9 t ha^{-1} and 2,4 D 4.8 to 4.8 to 4.9 t ha^{-1} (Table 5). A similar trend was observed in both seasons even though in the second season, the yields were slightly lower than the first season. The results are in conformity whit the findings of [19] who reported that application of pre emergence application of herbicides over weedy check even though a thousand grain weight was not affected by weed management practices.

The unweeded plots gave the least weight of the threshed grains due to weed infestation critically reduced grain yield of finger millet due to competition for growth factors like light, nutrients, and moisture. According to [20] obtained negative correlation of weed dry weight and grain yield in finger millet.

The weights of a thousand grains across the treatments ranged from 1.54 grams being that of unweeded crop to 2.307 grams being that of the crop where pendimethalin 2.0l/ha was applied (Table 5). This indicates that weeds indeed decrease both the quality and quantity of the produce because of competition for nutrients with the crop. In the other treatments the weights averaged at about 2 grams indicating that the control of weeds was good across all the herbicides which were applied including hand weeding. Pendimethalin was most effective in control of weeds thus giving higher yields and heavier a thousand grain yields confirming [4] that use of herbicides like Pendimethalin controls a wide spectrum of weeds which in turn gave higher grain weight because since the weeds had been controlled effectively, It was observed that the lowest grain weight was recorded from the unweeed plot and these results are in conformity with the findings of [21 and 22].

4. CONCLUSION

Pendimethalin and Atrazine pre- emergence herbicides at the rates of 1.5 and 2.0 l/ha respectively were the most effective in terms of weed control since they lead to enhanced crop growth and high yields among the treatments.

ACKNOWLEDGEMENTS

We express our profound gratitude to the Department of Agricultural Science Department of Kenyatta University for the opportunity to carry out this research project and the Bukura Agricultural College for allowing us to conduct the trials within their study fields.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Wekha NW, Korir K. Nicholas, Ojulong FH, Moses S, Joseph PG. Finger millet (*Eleusine coracana* L.) grain yield and yield components as influenced by phosphorus application and variety in Western Kenya. Tropical Plant Research Journal;2016.
2. Reddy SR. *Agronomy of Field Crops*. Kalyani Printings, New Delhi;2004.
3. Seetharam A. Coarse grains-food for farmers of rainfed, tribal and hilly areas. Indian Farming 2001;36-39.
4. Reddi GH, Reddy TY. *Principles of Agronomy*. Kalyani Puplishers, New Delhi;2010.
5. Gupta OP. *Fundamentals of Weed Science*. Agrobios (India) Jodhpur. 2007;379.
6. Ashton FM, Monaco TJ. Weed Science: *Principles and Practices* (3rd Ed.). New York: John Wiley and Sons;2003.
7. Pradhan A, Rajput AS, Thakur A. Effect of weed management on growth and yield of finger millet. Indian Journal of Weed Science. 2010;42(1&2):53-56.
8. Tippanagoudar PG, Roodgi MB, Jnanesha AC. Effect of sowing and weed management practices on nutrient uptake by crops and weeds on prosomillet. Adv. Res. J. Crop Improv. 2012;3:40-43.
9. Sahid IB, Md. Hossain S. The effects of flooding and sowing depth on the survival and growth of five rice-weed species. Plant Protection Quarterly;1995.
10. Pradhan A, Singh V. Integrated weed management in finger millet under rain-fed region. Indian Journal of Weed Science. 2009;41(3&4):188-192.
11. Laxminarayan P, Mishra BM. Effect of nutrient and weed management practices on weeds and yield of transplanted rice. (*Oryza sativa* L.). Ann. Agri. Res., 2001;22:258-261.
12. Oerke EC. Crop losses to pests. J Agric Sci. 2006;144(01):31–43. DOI:10.1017/S0021859605005708
13. Adikant P, Rajput AS, Thakur A. Effect of weed management on growth and yield of finger millet. Indian journal of weed science. 2010;10:2-4.
14. Bahar FA, Singh KN. Modification of crop ecology in maize (Zea mays) through fertility levels and weed control measures under temperature condition of Kashmir. Ind. J. Agron. 2013;58(3): 349-353.
15. Prashanth Kumar MK, Shekara BG, Yamuna BG, Sunil CM. Crop Weed Competition for Nutrients by Weed and Drill Sown Finger millet (*Eleusine coracana* L. Gaertn.). National Academy of Agriculture Science. 2015;33(3):2049-2054.
16. Prithvi KB, Rao AS, Srinivasulu K. Weed management in transplanted ragi. Indian Journal of Weed Science. 2015;47(2):214–215.
17. Rawat A, Chaudhary CS, Upadhyaya VB, Vikas Jain. Efficacy of bispyribac-sodium on weed flora and yield of drilled rice. Ind. J. Weed Sci. 2012;44(3):183-185.
18. Patil B, Reddy VC, Ramachandra Prasad TV, Shankaralingappa BC, Divendra R, Kalyanamurthy KN. Weed management in irrigated organic finger millet. Ind. J. Weed. Sci., 2013;45(2):143-145.
19. Kumara O, Basavaraj Naik T, Palaiah P. Effect of weed management practices and fertility levels on growth and yield parameters in finger millet. J. Agric. Sci. 2007;2:230-233.
20. Bulus TA. Performance of Finger milliet (*Eleusine coracana* L. Geartn) as influenced by nitrogen and phosphorus levels, intra-row spacing and weed interference. Weed Sci. 2002;22:364-373.
21. Khalil MF, Hussan G, Ahmad G, Anwar S, Khan S. Comparative efficacy of herbicides on yield and yield components of wheat (*Triticum aestivum*). APRN Journal of Agriculture Biological Science. 2013;8(1):76-80
22. Hussain Z, Marwat KH, Munsif F, Samad A, Ali K. Evaluation of various herbicides and their combinations for weed control in wheat crop. Pakistan Journal of Botany. 2013;45(1):55-59.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle4.com/review-history/73375