

EVALUATION OF THE LEVEL OF AWARENESS ON SAFE USE OF HERBICIDES BY TEA GROWERS IN BOMET COUNTY, KENYA

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Abstract

Herbicides play a major role in crop protection and control of vector borne diseases in all agricultural sectors. This study was carried out to evaluate the level of awareness on safe use of herbicides by tea growers in the catchments of Kapkoros and Tirgaga tea factories in Bomet County, Kenya. A pre tested questionnaire was used with the adoption of purposive and stratified random sampling methods to collect primary data from 363 respondents in all the six tea growing zones. Secondary data was collected from health centres in the study area and data analyzed using descriptive and inferential statistics. Most of the tea growers (52%, n=363) preferred to use an herbicide with glyphosate formulation called round up in varying degrees. There was significant statistical difference between the preferred herbicide and the years of tea growing ($\chi^2 = 17.03$, $p < 0.05$, $n = 362$). The study show that 80.2% of the respondents in the area read the herbicide labels before use. Majority of the tea growers (90.4%) use Personal Protective Equipments (PPEs) when handling herbicides. Before or after the use of herbicides, most respondents stored them in stores (99.6%). On accidental contact with herbicides, 86.2% adopt to washing their bodies with water while 13.2 % visit a doctor and 0.06% just wipe the herbicides from their bodies. There was significant statistical difference between the frequency of herbicides use and the economic benefits of using herbicide ($\chi^2 = 64.869$, $p < 0.05$, $n = 362$).

The study found that 22.9% of the tea growers have not received any training. Of the trained, 44.9% were found not to have been trained on herbicide handling.

The study showed that most cases of intoxication were accidental (70%) and first aid was administered before one is taken to the hospital. It was also found that the level of intoxication were mostly mild (80%) which was mainly due to inhalation (80%) of the chemicals while those from ingestion and contact were 20% and 10% respectively.

In most of the reported case of intoxication, the study found that victims (50%) do not know the dangers associated with improper use, whereas 30% were completely ignorant and a paltry 20% had some knowledge of intoxication. It is therefore recommended that training of tea growers in Bomet County on proper use of herbicides be improved by Kenya Tea Development Agency (KTDA) and other relevant authorities so as to help minimise the negative impacts associated with improper use.

Key words: Herbicides, *Camellia sinensis*, glyphosate, training, safe use, awareness.

1.0 Introduction

Herbicides are pesticides used to kill weeds. Herbicides play a major role in crop protection and control of vector borne diseases in all agricultural sectors. They are chemically active compounds designed in the most part to kill targeted organisms, but unfortunately, herbicides are dangerous when they are not used properly or as recommended in crops and the environment, (www.edis.ifas.ufl.edu). Selective herbicides kill specific targets while leaving the desired crop relatively unharmed. Throughout the world herbicides are an effective, relatively simple and quick method weed control. In many cases without chemical control crops would be ravaged by diseases, insect pests and weeds hence severe loss of food production occurs. About 50% of global agricultural production is lost before or after harvest due to combined effects of disease, pest attacks and weeds. Use of herbicides in management of weeds is emphasized rather than their permanent removal (George, 1980).

In Indonesia herbicides have been used in producing fields since 1970 because they gave effective results. It was also used because in larger tea planting mechanical weed control is difficult because it is labour intensive. Chemical weed control has been widely used but further research was recommended that due to continual spraying changed the weed composition and enhanced growth of dominants weeds. Among the chemical used are Paraquat, Triazine, 2, 4-D, Diuron, Dalapon (2, 2 dichloro- propionic acid) and Glyphosate (Sasusi, 1977).

India has unique distinction of being the largest producer and consumer of tea in the world producing about 840 million kg annually (Rajkhowa et al, 2005). Being a perennial crop tea (*camellia sinensis*) needs to be fully protected from weed competition particularly in the young tea to allow tea bushes develop strong frame, obtain good harvest and long productivity. Weed control is the second most expensive input in tea production. This was predicted to increase because of acute shortage of labour and escalating wages of labour with tea plantation alone using about 20% of the total quantities of herbicides used in India. The pre and post-emergence herbicides that have been recommended for controlling weeds in tea are simazine, diuron, glyphosate, glufisate ammonium, oxyfluorfen and Dalapon. The selection of herbicides is very different due to variations of weeds species as well as their intensity of infestation (Rajkhowa et al, 2005).

In North East India where tea growing is done annually, up to two hundred million rupees is spent annually on weed control. In general weed manifestation is severe in young tea in the years following light pruning, medium pruning and deep skipping. Grassy weeds reduce the productivity of tea by 21% while broad-leaved weeds accounts for 9% to 12% percent.

In Kenya, weed control in tea bushes is unique in many ways such that pests and diseases management practices have focused on Integrated Pest and Disease Management (IPDM) for the last 3 decades. The pests, weeds and diseases

constraints to tea production are managed through cultural practices, biological control and chemical control. No clear best practice have been adopted by the government or the farmers thus leaving the farmers to try any mode of weed control which ever suits them (Anon, 2002).

Herbicides when used as recommended are safe for use in the environment improve crop production and protect human and plants life from disease, illness and annoyance. Chemical crop protection in most cases is effective and profitable in controlling weeds and diseases. But herbicides expose operators and consumers to risks for example small amounts of herbicides and their degradation products (residues) can turn up in food supplies. Reports from experiments using rats, rabbits, guinea pigs or from observation on personnel exposed to pesticides in manufacturing firms shows that exposure to pesticides can lead to health problems which can range from mild skin irritation to birth defects, tumours, genetic changes, blood and nerve disorders, endocrine disruption and even coma or death (Green, 1976; Lorenz, 2009).

There are always risks with agricultural chemicals and care is needed to avoid accidental poisoning, irritation of eyes, nose and skin, allergies, chemical residues on food, environmental damage and pollution, build up of resistance, fire, corrosion and problems with disposal (Kamotho, 2004). Exposure routes other than consuming food that contains residues, in particular pesticide drift are potential hazards significant to the general public. Therefore safety measures have become of big concern worldwide when handling pesticide. Safety must be ensured for users of herbicides when handling, for consumers on treated crops from herbicides residues and the environment during application and disposal of left-over of spray mixtures, obsolete or unwanted chemicals and empty the containers (Matthews, 1985).

2.0 Materials and Methods

Study Area

Bomet County was chosen for the study because it produced a total of 45,023,957 million kilograms of green leaf out of the total 480 million produced in the country by small scale tea growers (KTDA, 2010). The study was conducted in both catchments of Tirgaga and Kapkoros tea factories within Bomet county and managed by KTDA. The area lie between 35° E and 0.75° S, with an altitude of 1745-2,200 Masl surrounded by Mau forest to the East and Maasai Mara to the South. It situated South East of Nairobi and is about 280 Km from Nairobi.

A total of 24868 growers are involved in tea production with a total of 5119 hectares under tea plant.

2.1 Sample Selection

A total of 24868 growers from the catchment of Kapkoros/Tirgaga are involved in tea growing. Simple random sampling was employed where growers were allocated into six strata called zones. The six zones were Sibaiyan, Ndaraweta, Singoruwet, Chesoen, Tegat/Chemaner and Kiromwok/Mugango. The sample size was

proportional to the relative size of the strata as described by Mugenda and Mugenda (1999). All growers belong to certain buying centres hence all buying centres were represented in the zone depending on their numbers. All the government run health facilities in the area were also sampled.

2.2 Data Collection

The data was obtained from the respondents through face-to-face interviews using a semi-structured and pre-tested questionnaire. Both qualitative and quantitative data were obtained. Secondary data was obtained from the health centres in the area of study.

2.3 Target Population and Sample Size Determination

Due to the huge population (24868), a 3% (746) of the population was used for the study. This was supported by Mugenda and Mugenda (1999) findings stating that in a huge population a minimum of 1% population size that is randomly distributed can be taken as a representative sample and must constitute all the characteristic of a population in the study area. Using a population of 746 the sample size was determined as guided by Bartlett et al (2001) table for categorical data giving a sample size of 363. The margin of error were set at 0.05.

2.4 Data Analysis

Data collected was analyzed by use of descriptive statistics as well as inferential statistic. Qualitative analysis was done on some unstructured questions. Presentation was done in form of chi square, tables, graphs.

3.0 Results and Discussion

The study found that majority of the respondents who participated in the study was males (82.6%). In all the areas fewer females participated in tea growing with Sibaiyan, Kironwok, Chesoen, Singoruwet, Chemaner, and Ndaraweta having 27.4%, 19.1%, 17.5%, 17.4%, 13.7% and 10.1% respectively an indication of gender parity.

Majority of the tea growers (54%) in the area were aged 25-40 years, 31.9% were above 40 years and 14.1% were below 25 years.

Tea growers who attained secondary level of education were 61.2%, while those with primary qualification were 26.9% and 11.9% were college and university graduates. From the study there was significant statistical difference between the age and the level of education.

Growers with 6-10 years experience (48%) in tea growing were the most while those with above 10 years were 30.3%. There was no significant statistical difference between the level of education and experience in tea growing.

3.1 Herbicides used by Tea Growers in Bomet County

Herbicides in use were found to be glyphosate in different formulations sold under different trade names like Twigasate, Eraiser, Glyweed, Glycel, Touchdown, Wound out, Mamba and Round up. Glyphosate is a broad-spectrum, non-selective systemic

herbicide. The study found that Round up (53.7%) was the most preferred formulation herbicide used, followed by Wound out and Mamba (Figure1). The use of round up was 45.1%, 46.8%, 56.5%, 68.4%, 53.2% and 52.9% for Chemaner, Sibaiyan, Singoruwet, Chesoan, Ndaraweta and Kiromwok zones respectively. Its significant use is attributed to its trade name which has become synonymous herbicide that is sold in most agro vet stores and distributed by Monsanto.

Some growers indicated that they mix two herbicides when controlling weeds like Round up/Mamba (5.2%) and Round up/Wound out (5.0%). Most of these herbicides are manufactured by different companies like Monsanto, Highchem, Twiga chemicals, Agriscope, Farmchem e.t.c

All the herbicides use were found registered by Pest Control and Produce Board (PCPB) 2010 and hence they comply with standard requirements (Anon, 2010). Herbicides like Mamba that constituted 15% of total usage and showed good results were not necessarily meant for weeds control in tea. Agarwala (1971) reported that the choice of herbicide mainly depends on weed flora present, type of herbicide, its availability, age of plantation and economic considerations.

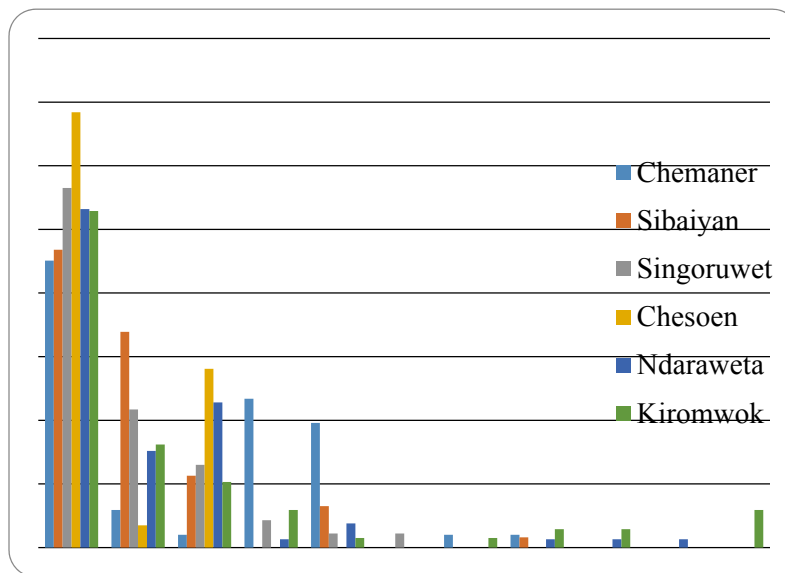


Figure 1: Herbicides usage in Kapkoros/Tirgaga catchment

The study found that growers who have been in the business for long have adapted to using certain herbicides. There was significant statistical difference between the preferred method of weed control and the years of experience in tea growing. ($\chi^2 = 17.03$, $p < 0.05$, $df = 362$). The choice of herbicide was seen to be influenced by marital status of the grower in that it was properly discussed and was agreed upon as a family. There was significant statistical difference between the preferred herbicide used and ones marital status ($\chi^2 = 16.37$, $p < 0.05$, $df = 362$).

Results from the study indicated that male respondents (79%) preferred using herbicides. This can be due to high number of males in tea farming, spraying is labour intensive and mainly done by men or the women are committed elsewhere like in taking care of the family. The study found that one's gender is not significant to the frequency of herbicide usage.

Respondents aged between 25-40 years (52.03%) were using herbicides the most while those of below 25 years (20.9%) applying the least. Respondents aged between 25-40 years are in their prime and doing farming as their business. Prolonged use of glyphosate can lead to chronic illness especially to persons aged between 28-40 years who use it regularly and these are the most reproductive age group. Previous studies done by Institute of biology and environmental sciences (German 2004) established that glyphosate exposure has been linked to increased risks of miscarriages. From the study, there was significant statistical difference between the ages of the tea growers and the frequency of herbicide usage ($\chi^2 = 18.97, p < 0.05, df = 362$).

Ones' experience in tea growing did not have a direct impact on preferred herbicide used. The new growers of 1-5 years (27.02%) use the herbicide quite often because they have young bushes and application is mainly restricted. Those of between 6-10 years (48%) use herbicide the most because they are at the peak of their production hence prefer to maximize their production while reducing their cost of production. Those whose have been growers for over 11 years (24.98%) have reduced uptake of herbicides. It is most likely that these groups have subdivided their land to their siblings or they are using the family labour to weed. The study concluded that one experience as a tea grower is not significant with frequency of herbicide usage.

Research by Agarwala (1971) supports the fact that the number of herbicide application depends on the efficiency of that particular herbicide in use and the type of weeds appearing after initial application. The researcher noted that the herbicide programs vary with weed situation hence a particular herbicide can be used as long as the weed spectrum does not change. It was also noted that the frequency of herbicide usage depends on the extent of and rate of new weed growth following initial application, the regenerative capacity of weeds, the persistency of weed following initial application and efficiency of initial spraying.

3.2. Awareness on safe use of herbicides

3.2.1 Training

The study found that 77.1% of farmers had received general training with 55.1% of them being trained on the safe use of herbicides. Sixty three percent (63%) of the growers had been trained in the last five years on use of herbicides. Tea Extension service Assistants (TESA) trained 43% of the growers. Rain Forest Alliance trained 31% while Government Extension Officers trained 3%. The results showed that TESAs were the most active in training farmers. The training by the TESA was high

though they were not equipped with pesticides safety skills and health hazards thus making the training incomplete.

The low level of training by government was attributed to the fact the ministry of Agriculture had implemented "Mkulima-Driven Programme or Demand-Driven Programme" which requires the farmer to seek the assistance of their officers when need arises. Most of these trainers are not specialist in health and safety field making the contents of their training lack the technical aspects.

The study established that of the total respondents trained, 61.2% attained secondary level of education, 26.9% primary level, 10.6% college level and 1.3% had attained university level. The high percentage of educated people meant that their overall understanding on proper use of herbicide will be high. The ones with college and university level education were the least because they were professionals pursuing different careers. There was no statistical significance between the training of growers and the level of education.

The study found out that 90.4% of the people trained were married. The high percentage of those married confirms that tea growing is mainly done by households. There was no significant statistical difference between training and the marital status of a grower.

Most of the trained growers were aged between 25-40 years (54%), above 40 yrs constituted 30% while those upto 25 years being the least at 15%. The high percentage of the trained growers who are older means that training was done routinely. There was no significant statistical difference between training and the ages of the growers.

From the data 83.2% of the trained were male an indication that there is still gender parity in tea farming. There is a likelihood that the females were source of labour not necessarily the growers themselves. There was significant statistical difference between training and gender of the growers ($\chi^2 = 0.277$, $p < 0.005$, $df = 362$).

It was established that training was not biased to one's experience as a tea grower. Twenty one point four percent (21.4%) of the trained had tea growing experience of between 1-5 years, 47.9% between 6-10 years while 30.7% were above 11 years an indication that training was well received by all the growers. There was no significant statistical difference between training and one's experience in tea growing. FAO (2002) supports the findings that Sprayers should also be trained on proper use, selection, maintenance that is where appropriate and when to discard the disposable.

3.2.2 Type and Use of PPE by Tea growers

The study found out that 90.4% of the farmers put on protective clothing when applying herbicides. This means that farmers in the area were aware on how to protect themselves from the harmful effects of chemicals.

Table 1. Use of PPE in different level of education

Level of education	Used PPE	%	Didn't use PPE	%
Primary 96	26.5	9	2.4	
Secondary	201	55.4	21	5.8
College	27	7.4	4	1.1
University	4	1.1	1	0.3
Total	90.4	9.6		

The use of PPE was high (55.4%) among those with secondary level of education followed by those with primary (26.5%). This is attributed to the fact that this group are the main people at home and doing farming. There was no statistical significance between the use of PPE and the level of education among the tea growers.

Table 2: PPE use in age categories

AGE (yrs)	use PPE	%	Didn't use	%
Below 25	50	13.8	1	0.3
25-40	174	47.9	22	6.0
Above 40	104	28.7	12	3.3

Forty seven point nine (47.9%) of those using PPE were aged between 25-40 years while 28.7% were above 40 years and 13.8% were below 25 years. This indicates that they were adults who were able to understand and make good judgement about safety and benefits of using PPE. There was no significant statistical difference between the ages and use of PPE by tea growers.

Table 3: Use of PPE by growers with different experience in tea growing

Experience (yrs)	PPE use	%	Didn't use
1-5	71	19.6	8
6-10	153	42.1	21
Above 10	104	28.7	6

The use of PPE was not biased on any category of growers with varying experience. The level of use was at 19.6% in 1-5years category, 42.1% in the 6-10 years group and 28.7% in the above 10 years category. There was no statistical significance in one's experience and the use of PPE.

The use of PPE was high (81.8%) among the male growers. There was statistical significance between one's gender and the use of PPE ($\chi^2 = 16.3$, $p < 0.005$, $df = 328$).

FAO (2002) supported the findings that PPE should be used according to the instructions on the container label in open field when mixing, decanting or spraying. The PPE in use should be appropriate to the task, suitable for the wearer, readily available, clean and in full operational condition.

The study established that growers may not use all types of PPE during spraying with most of them resorting to combine as shown in Table 4. Combination of gumboots, overall and respirators (36%) was preferred followed by a combination of gumboots, overall and respirators (33%). This is a good indication that growers know the risk of using herbicide without proper protection.

The choice of different type of PPE was not affected by one's experience with those 6-10 years experience constituting 47.5%. The choice of different type of PPE was high (61.4%) among those with secondary education while those of primary formed 28.6%.

It was also noted that PPE should be used according to the instruction provided eye protection should be worn to protect one from chemical splash or flying objects either by using safety glasses, goggles, a face shield or full face respirator. Respiration protection is worn to avoid inhalation of spray, vapour or dust (Cornell 1992).

Type of protective used by respondent.	Frequency	Percentage
Gumboots	17	4.7%
Overall	26	7.2%
Apron	12	3.3%
Respirator	5	1.4%
Hat/Cap	49	13.5%
Gumboots, Overall and Respirator	132	36.4%
Gumboots, Apron and Respirator	119	32.8%
None	3	0.8%
Total	363	100.0%

Although the usage of PPE is high there is need to investigate the suitability of the same in preventing personal exposure.

Conclusion

The study has established the extent and level of awareness of tea growers on safe use of herbicide is high. The study showed that there is an existing gap in training, handling and storage of herbicides among tea growers. The study recommends that the KTDA as well as other relevant stakeholders to address the problem as it has major impacts on health and safety of growers, their workers and family.

Since the tea extension service assistants are the officers mostly in contact with the farmers, there is need for capacity building for these officers in the area of occupational safety and health including pesticide safety. There is also a need to develop a comprehensive pesticide safety training programme for farmers. This can

be developed in collaboration between KTDA and other relevant stakeholders including directorate of occupational safety and health services (DOSH) and Tea Research Foundation of Kenya (TRFK).

In addition to the pesticide label on the containers the farmers should be provided with Material Safety Data Sheets (MSDS) which should be provided by manufacturers/suppliers for further information on pesticide handling and safety. It is also necessary to translate the label and MSDS into Kiswahili language for the benefit of those who may not be fluent in English.

KTDA in collaboration with other stakeholders should facilitate periodical medical examination (including biological monitoring) of the farmers to ascertain the extent to which the pesticides have been absorbed into the body thereby prevent the development of chronic effects due to pesticides handling.

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References

- Agarwala S.D. (1971). Weed control in tea in India. Third Asian-pacific weeds science and sociology conference, Kuala Lumpur, Malaysia.
- Anon. (2002). Tea growers' handbook, 5th edition, Tea research foundation of Kenya, Kijabe printing press, Kijabe, Kenya.
- Anon. (2010). A list of fully registered pest control products for use in Kenya (Revised edition). Kijabe printing press, Kijabe, Kenya
- Bartlett II J. E., Kotrlik J. W. and Higgins C. C. (2001). Organizational research: Determining appropriate sample size in survey research.
- Barua I. C., D.J. Rajkhowa. Bhuyan R. P. and Yadunju N. T. (2005). Weed management in tea. Technical bulletin
- Cornell J S. (1992). Safety precaution in the use of herbicides
- Food and Agriculture organization. (2002). International code of conduct on the distribution and use of pesticides, Retrieved on 2012-12-05.
- George W. (1980). Complete guide to pest control, pp 35-37.
- Green B.M. (1976). Pesticides, Boon or Bane. Paul Flek, London p11.
- Lorenz E. (2009). Potential health effects of pesticides. AG communications and marketing (2009), pp 1-8.
- [Http://www.edis.ifas.ufl.edu](http://www.edis.ifas.ufl.edu). Retrieved on 6/11/2011.
- Kamotho A. (2004). Pesticide handling, use and disposal- A guide for smallholder farmers.
- Mathews G.A. (1985). Pesticide application method. English language Book society edition, Longman Group limited, Great Britain pp 260-268.
- Mugenda and Mugenda. (1999). Research Methods; Qualitative & Quantitative Approaches. ACTS press, Nairobi-Kenya
- PCPB (2004). Pest Control Products Board- July 2003-June 2004 annual report .Accessed on 2011-06-11