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# A SURVEY OF FARMERS KNOWLEDGE AND PRACTICE ON THE MANAGEMENT OF WATERMELON DISEASES IN HORTICULTURAL BELT OF MT. KENYA SLOPES

**Salome W. Kiarie**[1+]
**Susan S. Imbahale**[2]
**Sheila Okoth**[3]
**Mary Gikungu**[4]

[1,2]*School of Biological and Life Sciences, Technical University of Kenya, Nairobi, Kenya.*
[1]*Email: salome.thuo@yahoo.com Tel: +254727783153*
[2]*Email: sueimbahale@yahoo.com Tel: +254722478404*
[3]*School of Biological Sciences, University of Nairobi, Nairobi, Kenya.*
[3]*Email: dorisokoth@yahoo.com Tel: +254720006908*
[4]*The National Museums of Kenya, Nairobi, Kenya.*
[4]*Email: mgikungu@yahoo.com Tel: +254721791373*

*(+ Corresponding author)*

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## *ABSTRACT*

Horticulture is the largest sub-sector of agriculture, in Kenya, contributing 33% of the Agricultural GDP. Watermelon is the sixth among eight listed fruits which are economically important horticultural produce in Kenya. The fruit is grown mostly in dry areas of Kenya, however due to high demand, large acreage of land on the slopes of Mt. Kenya are now being cultivated with this crop. A study was carried out in July 2018 to examine watermelon farmers' knowledge and practice in the management of watermelon diseases on the slopes of Mt. Kenya. A semi-structured questionnaire was administered to 80 watermelon farmer's selected using Snowball technique from Karurumo, Gachoka, Kiritiri and Ishiara locations. The survey revealed that majority of farmers grew watermelon on 1-2 acres. Watermelon diseases were reported to attack the plant at all stages of growth. Among the diseases, blight was reported by most respondents at 63.8%, followed by fusarium wilt (41.3%) and powdery mildew (38.8%). Farmers experience of various diseases was not significantly different in the four locations except for Fusarium wilt (p=0.046) and powdery mildew (p=0.020). Cold weather was reported by 60% of respondents as most conducive condition for disease occurrence, followed by rainy conditions (17.5%). Most farmers in all the locations applied pesticides (97.6%) as the major method of disease control, with a few (27.5%) practicing crop rotation. This was attributed to agronomic support by extension workers in the area. The slopes of Mt. Kenya, have potential of increased production only if farmers receive support in disease management.

**Contribution/Originality:** This study is one of the very few studies which have investigated and documented the challenges faced by watermelon farmers in managing watermelon diseases, if support is provided in disease and pest management, production will increase and farmer livelihood improved in Mt. Kenya region.

## 1. INTRODUCTION

The agricultural sector contributes about 30% of Kenya's total Gross Domestic Product (GDP), accounting for 65% of national export earnings and over 75% of employment opportunities (CIA (Central Intelligence Agency), 2017). Rural households rely on agriculture for most of their income mainly from smallholder farming, which produces the majority of Kenya's agricultural output. Most families residing in rural and peri-urban areas of Embu town in Eastern Kenya depend on agriculture as their main source of economic livelihood (Njeru, Mutegi, &

Muraya, 2020) Watermelon (*Citrullus lanatus*) is an important horticultural crop providing a means of livelihood to most residents in Embu County by ensuring food security and creating employment opportunities for the people (Greenlife, 2020). Watermelon is a flowering vine-like plant of the family Cucurbitaceae. The fruit of watermelon is composed of 93% water, small amount of minerals, proteins, fats, carbohydrates, lycopenes and vitamins (Namdari, 2011). Its flesh is rich in citrulline; a source of arginine amino acid, which is a substrate for the synthesis of nitric oxide and is associated with cardiovascular and immune roles in humans (Dube, Ddamulira, & Maphosa, 2020).

In Kenya, watermelons flourish in dry plains and hot coastal areas such as Machakos, Loitoktok, Kerio Valley, Garissa, Isiolo, Embu, Kirinyaga, Bura, Kitui, and parts of Meru (Greenlife, 2020). Watermelon is a warm seasonal crop, with an optimal crop growth at 38˚C and above in temperature and between 28-32˚C temperature for germination. It does not only tolerates hot weather but for better growth, it requires more heat than any other vegetable, flourishing in hot dry climate with plenty of sunshine. In rainy season, its growth is poor and continuous rainfall reduces the sugar content in the fruit. However, under high temperatures the sugar content is increased (Lilly, 2013). Embu county in eastern Kenya has two rainy seasons with the 'long rains' falling between April and June and 'short rains' in October to November, although there are deviations from year to year. The region has an annual mean temperature ranging from 17.4 to 24.5◦ C and average annual rainfall of 700 to 900 mm (Kisaka et al., 2015). About 74% of agricultural land in Embu County can be described as being arid or semi-arid because it receives less than 850 mm of annual rainfall (KNBS (Kenya National Bureau of Statistics), 2015). These weather conditions make the area conducive for watermelon farming.

Horticultural produce is the second most important foreign exchange earner after tea in Kenya (KNBS Kenya National Bureau of Statistics - Economic Survey, 2019). Watermelons are among the top four most profitable fruits exports of Kenya (Tridge, 2020). Local demand in the country is on the rise due to population increase especially in the urban areas, where fruits are sold in open air markets and by street vendors located in residential streets in towns and cities (Horticultural Crops Directorate (HCD), 2018; Research Solutions Africa, 2017). Consequently, both large scale and small-scale water melon farming can be profitable. While high yield is a major goal for watermelon farmers, the practice like most ventures, has risks. Possible challenges facing water melon farmers include bad weather, pests, and diseases (Horticultural Crops Directorate (HCD), 2016). The pests that threaten watermelon harvest include aphids, melon flies, beetles, red spider mites, thrips, nematodes, leaf miners, and fleas (Oluwasogo, 2015) . Blight, damping off, anthracnose, leaf-spotting, watermelon mosaic, Fusarium wilt, downy mildew and powdery mildew are some of the known watermelon diseases in Kenya (Greenlife, 2020). Watermelon is fast-growing fruit, soft and tender with a short life cycle of 80–110 days, which makes them very sensitive to pests and diseases (Balliu & Sallaku, 2017).

Farmers utilize intensive agricultural management and pesticides application to ensure high yields and quality but oblivious of their negative effects to pollinators and natural enemies (Whitehorn, O'connor, Wackers, & Goulson, 2012). Intensive use of agrochemicals is associated with pollinator decline and impairment of ecosystem services (Brittain, Vighi, Bommarco, Settele, & Potts, 2010). Reports on crop dependence on pollinators show that approximately 75% of global food crop benefit from biotic pollination (Winfree, 2008). Roughly translated, approximately one out of every four mouthfuls of food and drink that we consume are produced from pollination services provided by pollinators (Dively, Embrey, Kamel, Hawthorne, & Pettis, 2015). Pollinators are therefore vital to crop production in agriculture.

The survey study was designed: i) to determine the major disease constraints in the watermelon production system in Mt. Kenya region ii) to explore disease management methods used by watermelon farmers iii) to understand the agrochemical use patterns by watermelon farmers.

The study specifically describes the social-demographic characteristics of the farmers, determine diseases affecting watermelon farmers in the study area.

## 2. METHODOLOGY

### *2.1. Study Area*

The study was carried out in four ecological zones within Mt. Kenya region that is, Karurumo, Gachoka, Kiritiri and Ishiara. These locations are at the foothills of Mt. Kenya at an altitude height of up to 1406 m above sea level (Googgle Maps, 2018). The lowest ecological zone was Ishiara ($0^0$ 27' 12" S; $37^0$ 46' 54" E) at 791m above sea level. The ecological zone with highest altitude was Karurumo ($0^0$ 49' 16" S; $37^0$ 46' 57" E) at 1239 m above sea level. Gachoka ($0^0$ 42' 37" S; $37^0$ 31' 5" E) and Kiritiri ($0^0$ 41' 34" S; $37^0$ 39' 5" E) lie at 1208m and 1143m above sea level respectively (Googgle Maps, 2018).

### *2.2. Knowledge and Practice Survey*

The survey was designed to explore farmers' knowledge about watermelon diseases, as well as the methods employed in disease management. Potential confounding factors such as marital status, age, gender, education level, farm ownership and land size and other characteristics were also noted.

A semi-structured questionnaire was prepared and pre-tested before administration to the selected farmers. The questionnaires contained 58 questions among which 30 were closed ended while 28 were open ended, focusing on farmer practice, knowledge of diseases, disease management and information source. Before each respondent was interviewed, the purpose of the study was explained and that their participation was voluntary, and their privacy and confidentiality were assured. The information obtained from the farmers was noted down on the spot.

### *2.3. Data Analysis*

The questionnaires were cleaned and responses coded, after completion of the survey. All data were entered in Excel spreadsheets and then transferred and analyzed using the statistical software for social scientists (SPSS) version 20. Descriptive statistics were used to report the socio-demographic profiles of respondents, the knowledge and practices regarding watermelon diseases as well as their management. Chi square and analysis of variance (ANOVA) were used to determine if differences existed among the study sites. Chi square was used to assess the association between categorical study variables respectively.

## 3. RESULTS AND DISCUSSION

### *3.1. Socio-Demographic Characteristics of Respondents*

Composition of the respondents by gender showed that a high percentage of respondents (73.8%) were male with only 26.2% females. Gender distribution across the four zones was statistically different with $p<0.001$ at 95% confidence level with female participation in watermelon farming being low in Ishiara (10%), Kiritiri (30%) and Karurumo (5%) but high in Gachoka (60%). This is a clear indication that women are lugging behind in the watermelon farming sector, which might be related to land ownership. According to Mwaura (2015) it is greater a challenge for women to obtain capital to buy land in developing countries like Kenya than men. Dalla (2012) asserts that, many women face additional constraints in accessing financial services due to their higher rates of restricted liberty of action and lack of consent of family member; much of which can be traced to gender discrimination embedded in societal norms and cultural practices (Njeru & Mwangi, 2015). These factors could be constraining women engagement in land ownership and farming. Mulema, Jogo, Damtew, Mekonnen, and Thorne (2019) suggest that empowering women to participate in farming and agriculture in general is a key strategy for sustainable agricultural development which has the potential to improve their roles in agricultural production while enhancing nutrition and food security. According to USAID (2011) amplification of opportunities for women in agriculture can have widespread impact on productivity and agriculture-led growth. Significant involvement of men in watermelon production reported in this study (73.8%) is in line with the works of Tange (2019) showing that agricultural sector is male dominated.

There was a great disparity on marital status with 87.5% married while only 12.5% were single. This could be attributed to the general age of respondents since most were between 36-45 years of age except in Gacoka where majority were between 46-65 years old. Age distribution was marginally significantly different (p=0.049 at 95%) across the four zones.

In terms of formal education, 36.2% had primary education (standard 1-8), while majority of respondents (63.8%) had attained secondary education. However, only 23.8% had progressed to college or university level. There was a statistically significant difference across the regions on the respondents level of education (p=0.03) with high number of farmers in karurumo (60%) having only attained primary level of formal education. In their study (Isaac & Kibera, 2016) established a statistically significant relationship between farmer characteristics and performance of commercial farmers. Their findings indicate that, education increases the capacity and resourcefulness of a farmer in undertaking commercial decisions that improve their productivity. This incite elucidates that farmers can be more empowered to enhance their performance through education.

**Table-1.** Socio-demographic characteristics of respondents.

| N (%)u | Gacoka, N=20 | Ishiara, N=20 | Karurumo, N=20 | Kiritiri, N=20 | $X^2$ | Df | p-value |
|---|---|---|---|---|---|---|---|
| Gender | | | | | | | |
| Female | 12(60) | 2(10) | 1(5) | 6(30) | 19.306 | 3 | <0.001 |
| Male | 8(40) | 18(90) | 19(95) | 14(70) | | | |
| Marital status | | | | | | | |
| Married | 17(85) | 20(100) | 18(90) | 15(75) | 7.878 | 3 | 0.049 |
| Single, | 3(15) | 0(0) | 2(10) | 5(25) | | | |
| Age category | | | | | | | |
| 18-35 | 3(15) | 3(15) | 5(25) | 5(25) | 9.29 | 9 | 0.411 |
| 36-45 | 5(25) | 10(50) | 8(40) | 10(50) | | | |
| 46-65 | 11(55) | 5(25) | 7(35) | 4(20) | | | |
| 66-75 | 1(5) | 1(10) | 0(0) | 1(5) | | | |
| Education level | | | | | | | |
| Primary school | 5(25) | 7(35) | 12(60) | 5(25) | 18.434 | 9 | 0.03 |
| Secondary school | 8(40) | 10(50) | 7(35) | 7(35) | | | |
| College | 6(30) | 1(5) | 1(5) | 8(40) | | | |
| University | 1(5) | 2(10) | 0(0) | 0(0) | | | |
| Farm size | | | | | | | |
| < 1 acre | 5(25) | 6(30) | 5(25) | 4(20) | 5.168 | 9 | 0.819 |
| 1-2 acre | 11(55) | 12(60) | 13(65) | 10(50) | | | |
| 2-5 acre | 2(10) | 2(10) | 1(5) | 3(15) | | | |
| > 5acre | 2(10) | 0(0) | 1(5) | 3(16) | | | |
| Purpose for growing watermelons | | | | | | | |
| Sale | 14(70) | 20(100) | 18(90) | 18(90) | 13.308 | 6 | 0.038 |
| Domestic & Sale | 6(30) | 0(0) | 2(10) | 2(10) | | | |
| Years for growing watermelons | | | | | | | |
| 1-5 | 11(55) | 16(80) | 13(65) | 13(65) | | | |
| 6-10 | 8(40) | 3(15) | 4(20) | 1(5) | 17.662 | 9 | 0.047 |
| 11-15 | 0(0) | 1(5) | 1(5) | 4(20) | | | |
| 16-20 | 1(5) | 0(0) | 2(10) | 2(10) | | | |

Most respondents (57.5%) were working solely on their own land while a further 26.3% had combined own land with leased land to add to their production. Majority of farmers (57.5%) managed between 1-2 acres of land. There was no significant difference in land ownership or land size between the three zones ($p > 0.05$). This study has revealed that 25 % of the farmers in the study area own less than one acre of land and only 7.5% owned five acres and above. Those who owned between 1 – 2 acres were 57.5 % while the remaining 10% comprised of those

who owned between 2 – 5 acres of land, with no significant differences observed among the four sites. Scale of farming due to limited land size was as much a problem especially in Ishiara and Karurumo where 90% of the farmers operated in less than 2 acres of land. This was attributed to by densely populated constituencies in Embu County (KNBS (Kenya National Bureau of Statistics), 2015) resulting to urbanization which has consequently led to pressure on agricultural land (Murimi, Njeru, Gichimu, & Ndirangu, 2019). According to Ndirangu (2017) declining size of the farm holdings in most high agricultural potential areas as a result of continuous land fragmentation is currently a major policy concern in Kenya. Recent studies have shown that land fragmentation is the cause of declining farm sizes in both ownership and use, which logically implies dis-economies of scale in food production, currently a major concern in Sub-Saharan Africa (Kiplimo & Ngeno, 2016). In response to the challenges of land fragmentation the Kenya National Land Use Policy (GOK, 2016) acknowledges that land fragmentation is a major challenge and recommends for determination of viable minimum land sizes based on ecological and land use carrying capacities. The policy also calls for measures to discourage cultural practices that promote land fragmentation. Other studies suggest that land leasing can serve as a safety net for poor smallholder farmers and also improve the living conditions of these farmers (Muraoka, Jin, & Jayne, 2018).

Those who had been farming watermelon for the longest period (16-20 years) composed of 6.2%. About 87.5% of the farmers engaged in the watermelon farming for commercial purpose. Though the remaining 12.5% cited domestic and fodder purposes, they still engaged to some extent in commercial farming. This is supported by Horticultural Crops Directorate (HCD) (2016) and Tridge (2020) reports which indicate that, watermelon is commonly a commercially grown horticultural crop in Kenya. Table 1 provides the socio-demographic characteristics of the farmers interviewed.

### *3.2. Farmers' Knowledge of Watermelon Diseases*

Farmers from all the four zones were familiar with various diseases that attack watermelons as illustrated in Table 2. Among the diseases, blight was the most common disease reported by respondents at 63.8%, followed by fusarium wilt (41.3%) and powdery mildew (38.8%). Stem rot was the least prevalent disease reported at 1.3%. The farmers' experience of the various diseases was not significantly different in all the four eco-zones except for fusarium wilt (p=0.046) and powdery mildew (p=0.020). The results obtained are similar with existing reports from other studies Abderrahmane and Lahcen (2015); Alao, Adebayo, and Olaniran (2016) and Said and Fatiha (2018) of the diseases commonly attacking watermelon.

**Table-2.** Diseases outlined by respondents.

| N (%) | Gacoka, N=20 | Ishiara, N=20 | Karurumo, N=20 | Kiritiri, N=20 | $X^2$ | Df | p-Value |
|---|---|---|---|---|---|---|---|
| **Diseases** | | | | | | | |
| Fusarium wilt | 9(45) | 10(50) | 3(15) | 11(55) | 7.995 | 3 | 0.046 |
| Powdery mildew | 11(55) | 9(45) | 2(10) | 9(45) | 9.849 | 3 | 0.02 |
| Blight | 10(50) | 13(65) | 15(75) | 13(15) | 2.759 | 3 | 0.43 |
| Mosaic virus | 4(20) | 1(5) | 4(20) | 3(15) | 2.353 | 3 | 0.502 |
| Leaf spot | 1(5) | 1(5) | 0(0) | 0(0) | 2.051 | 3 | 0.562 |
| Stem rot | 0(0) | 1(5) | 0(0) | 0(0) | 3.038 | 3 | 0.386 |
| Fruit spot | 2(10) | 1(5) | 0(0) | 0(0) | 3.810 | 3 | 0.283 |

Diseases reported mainly occurred during the vegetative, flowering and fruiting stages. This observation supports the findings of Oluwasogo (2015) and Keinath, Wintermantel, and Zitter (2017) who found similar results during their study where farmers reported crop failure due to attack by diseases during these stages. Awareness of watermelon diseases is encouraging, since one of the tenets for sustainable disease management is proper identification of the disease. The disease types did not differ from location to location, it is therefore relevant for exchange of ideas on effective disease management techniques.

### *3.3. Watermelon Disease Patterns*

The cold weather was reported by 60% of the respondents as the most conducive for disease occurrence, followed by rainy season (17.5%). Dry weather (1.3%) and windy conditions (1.3%) were reported as least conducive to disease occurrence. On the other hand, diseases reported mainly occurred during the vegetative (31.3%), flowering (32.5%) and fruiting stages (35%). Diseases were least prevalent (5%) after fruiting. There were no significant differences in respondents' responses on the same from all the study zones. The period between June and August was reported as the peak season for diseases as reported by 56.3% of respondents Figure 1. About a third (31.3%) of the respondents reported September to November, while December to February had low prevalence period for diseases (13.8%). Data provided by Kenya Meteriological Department (2016) indicates that, the hottest month of the year in the areas under study is March with an average high of 28°C and low of 16°C. The cold season lasts from June to August, with an average daily high temperature of 22°C and an average low of 14°C. September to November is the period of short rains, coinciding with reported periods and conditions of highest disease prevalence (Kisaka et al., 2015).

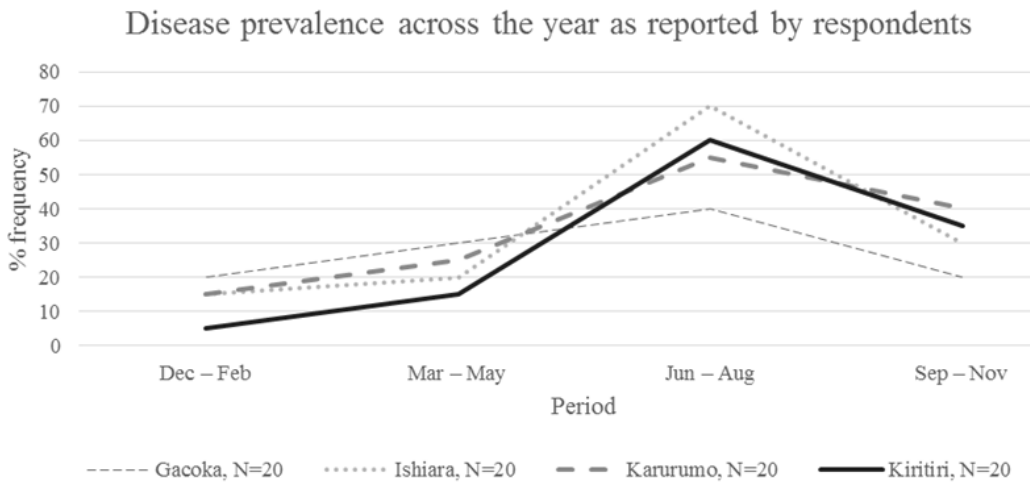


**Figure-1.** Annual trend of watermelon disease prevalence.

The weather conditions related to disease occurrence were significantly different among the sites during the months for peak (Jun-Aug, p=0.0017) and lowest (Dec-Feb, p=0.009) disease prevalence, with the strength of the relationships being strong and moderately strong, Cramer's V values of 0.522 and 0.386 respectively Table 3.

**Table-3.** Association between disease conducive weather conditions and disease prevalent month of the year.

| | Month category | Statistic ($X^2$, Fisher's test) | df | Exact Sig. (2-sided) | Cramer's V |
|---|---|---|---|---|---|
| Weather Condition | Dec-Feb | 15.277 | 5 | 0.009 | 0.522 |
| | Mar-May | 9.854 | 5 | 0.079 | 0.347 |
| | Jun-Aug | 13.832 | 5 | 0.017 | 0.386 |
| | Sep-Dec | 10.969 | 5 | 0.052 | 0.352 |

### *3.4. Watermelon Disease Control Methods*

Farmers were asked the methods that they use to control pests and diseases. The findings of this study revealed that use of pesticides is the most common disease control method practiced by nearly all (97.6%) of the respondents Figure 2. In addition, crop rotation was employed as the main subsidiary method of disease control which is used by 27.5% of the respondents. Other minor methods used by few farmers included destruction of affected crops (2.5%) as well as leaving the soil fallow for a period (1.3%). Chi square analysis showed no significant differences in disease control methods (p=0.197) as reported by the respondents from all the four ecological zones.

The farmers principally got their supplies from agrochemical (agro vet shops) dealers (100%), while a few were obtained from area extension workers (5%) with few engaging in biological control (Only 2.6%). The huge preference for chemical control by vegetable and fruit farmers has been reported in many parts of Kenya (Route to Food, 2019) and other parts of the Africa (Tange, 2019).

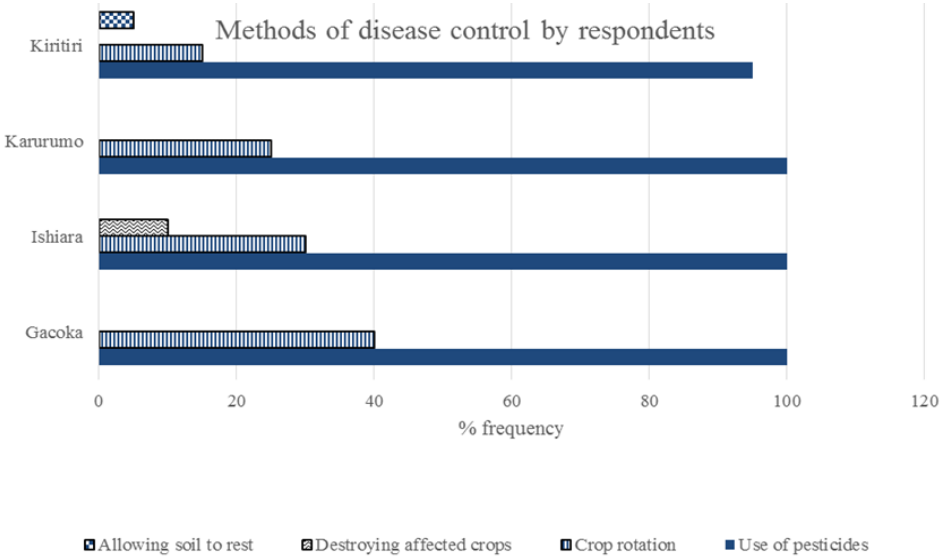


**Figure-2.** Respondents' disease control methods.

### *3.5. Frequency and Timing of Use of Pesticides*

Most respondents (87.5%) were spraying their crop either once or twice a week. Majority of farmers conducted spraying in the morning hours (61.3%) and in the evening hours (58.8%). Responses on the question on plant stage of spraying shows that, 85% of the farmers had no specific stage of growth when they sprayed their crop Table 4. This study showed that majority of the farmers (55%) applied pesticides on weekly basis.

**Table-4.** Respondents' pesticide use frequency and timing.

| N (%) | Gacoka, N=20 | Ishiara, N=20 | Karurumo, N=20 | Kiritiri, N=20 | $X^2$ | Df | p-value |
|---|---|---|---|---|---|---|---|
| **Freq. of spraying** | | | | | | | |
| Daily, | 0(0) | 2(10) | 0(0) | 2(10) | 21.492 | 12 | **0.044** |
| Twice a week | 10(50) | 3(15) | 8(40) | 5(25) | | | |
| Weekly | 10(50) | 10(50) | 12(60) | 12(60) | | | |
| Every two weeks | 0(0) | 2(10) | 0(0) | 1(5) | | | |
| When there is attack | 0(0) | 3(15) | 0(0) | 0(0) | | | |
| **Time of spraying** | | | | | | | |
| Morning (6-9hrs) | 13(65) | 14(70) | 9(45) | 12(60) | 26.447 | 24 | 0.331 |
| Mid-morn(9-12hrs) | 0(0) | 0(0) | 3(15) | 1(5) | | | |
| Afternoon (12-15hrs) | 1(5) | 0(0) | 0(0) | 0(0) | | | |
| Evening (15-18hrs) | 10(50) | 14(70) | 12(60) | 11(55) | | | |
| Any time of day | 0(0) | 0(0) | 2(10) | 0(0) | | | |
| **Stage of spraying,** | | | | | | | |
| Seedling, | 0(0) | 0(0) | 0(0) | 1(5) | 34.158 | 27 | 0.162 |
| Before flowering | 0(0) | 1(5) | 1(5) | 1(5) | | | |
| Flowering | 0(0) | 5(25) | 2(10) | 2(10) | | | |
| Fruiting | 1(5) | 1(5) | 0(0) | 0(0) | | | |
| All/ every stage | 19(95) | 14(70) | 18(90) | 17(85) | | | |
| When there is attack | 0(0) | 1(5) | 0(0) | 0(0) | | | |

**Source:** Field survey , 2018.

This high frequency of spraying of pesticides is costly and often lead to high levels of pesticide residue levels in water, soil, vegetables and fruits (Abong'o, Wandiga, & Jumba, 2018; Kenya Plant Health Inspectorate Service (KEPHIS), 2018) resulting in death of non-target organisms such as beneficial insects (Valk & Koomen, 2012). The large numbers of farmers using pesticides and the frequency of spray can also cause a decline in pollinator population especially bees in the area (Foley et al., 2011).

### *3.6. Farmer Information and Pesticide Source*

Farmers had different sources of information on watermelon farming and pesticides usage. Main sources of information for farmers were extension workers (48.8%), associates (40.0%) and agrochemical companies (37.5%). A small percentage (6.7%) relied on seed companies, radio, internet or books as their main source of information. All the farmers however relied on their personal experiences and agro vets for recommendation on what to apply. The sources of pesticides did not statistically differ across the locations. The farmers principally got their supplies from agrochemical (agro vet shops) dealers (100%), while a few were obtained from state extension workers (5.0%) as a subsidiary source. This is similar to observations made by Nyakundi, Magoma, Ochora, and Nyende (2017) and Achiri, Akotsen-Mensah, and Afreh-Nuamah (2017) in their research work. It was also noted that, the farmers and the casual laborers adhered to minimal use of personal protection equipment (PPE) during pesticide application. In some cases, they used what they had to improvise rather than sophisticated recommended PPE. Handkerchiefs improvised as masks were largely used during pesticide application by farmers from these regions in order to reduce chemical exposure and the resultant chronic health effects, whose symptoms may develop years after exposure. A few studies in Kenya established a link between pesticide exposure and acute and chronic health effects (Tsimbiri, Moturi, Sawe, Henley, & Bend, 2015). In terms of chronic health effects, pesticides can be classified as causing carcinogenicity, mutagenicity / genotoxicity, reproductive toxicity and neurotoxicity (United Nations (UN), 2017).

Overall, the farm size hindered amplification of farming scale. Climatic conditions such as amount of rainfall and temperature contributed to crop success or failure by favoring or discouraging disease occurrence. Prevalence of watermelon diseases remains a militarizing factor among the watermelon farmers in the horticultural belt of Mt. Kenya slopes.

## 4. CONCLUSION

The study revealed that there are a number of diseases constraining watermelon production around Mt. Kenya region. Consequently, there is a high intensity of chemical pesticide use as the main disease control method in the region. Pesticide application is done at all stages of the plant growth. Farmers' knowledge is still wanting as majority needs to be enlightened on the negative effects of pesticides on ecosystems and the importance of personal protection.

## 5. RECOMMENDATION

Based on the key findings, the study recommends policy interventions and better farmer education with a view of reducing chemical pesticide use in watermelon farms. In addition, adoption of ecofriendly disease management practice for the rural farmers in Kenya is key. The role of governments is to find responsible balance between enabling judicious pesticide use where such use is necessary to achieve desirable crop production levels, and reducing the adverse health, environmental and agronomic risks (International Labour Organization (ILO), 2010). This will be important to enable attainment of improved food production and sustainable development in Kenya. Further research needs to be carried out in other regions in order to come up with a comprehensive program for enhancing improved and sustainable watermelon farming systems in Kenya.

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