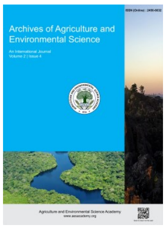
Archives of Agriculture and Environmental Science 9(1): 36-43 (2024)
https://doi.org/10.26832/24566632.2024.090106

e-ISSN: 2456-6632

This content is available online at AESA

Archives of Agriculture and Environmental Science

Journal homepage: journals.aesacademy.org/index.php/aaes



ORIGINAL RESEARCH ARTICLE

# Assessment of onion farming practices and purple blotch disease knowledge among farmers in varied agro-ecological zones of Nyeri County, Kenya

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**ARTICLE HISTORY**

Received: 29 November 2023
Revised received: 22 January 2024
Accepted: 13 February 2024

**Keywords**

Agro-ecological zones
Disease management
Farmer knowledge
Onion
Purple blotch

**ABSTRACT**

Onion (*Allium cepa* L.) is the second most produced vegetable globally, following tomato and plays a vital role in both cuisines and daily diets. However, the threat of diseases, such as purple blotch caused by *Alternaria porri*, poses a substantial risk to onion production, particularly in Nyeri County, Kenya. Despite its critical impact on farming, there is a lack of information on farmers' knowledge of purple blotch in this region. This study aimed to assess the onion farming practices and farmers' understanding of purple blotch disease across various agro-ecological zones (AEZs) in Nyeri County. Specifically, the study examines farmers' demographics, cultivated onion varieties, and their knowledge of purple blotch disease. Farms were selected using cluster random sampling. Data were collected from 100 onion farmers through semi-structured questionnaires, and statistical analysis was performed using the chi-square test in Scientific Analysis System (SAS) version 9.4 at α=0.05. The findings revealed that while the *Rucet* $F_1$ onion variety was popular among the farmers (52%), there is no significant association ($X^2$ (6, 100) = 11.947, $p$ = 0.063) between the choice of variety and AEZs. Similarly, the preferred source of onion seeds, mainly Agroshop (84%), showed insignificant association ($X^2$ (9, 100) = 7.153, $p$ = 0.621) with AEZs. Despite 65% of farmers reporting knowledge about onion diseases, there is no significant association ($p > 0.05$) between their awareness of purple blotch and AEZs. In conclusion, the study highlights a significant gap in farmers' understanding of purple blotch disease, emphasizing the need for training programs to enhance disease identification skills. Early detection can empower farmers to implement proactive measures, ultimately improving onion productivity. This study recommends diversifying onion varieties for disease resilience, promoting awareness and training on purple blotch identification, engaging women and youths in farming, and fostering collaborative networks for ongoing knowledge exchange and improvement in onion cultivation in Nyeri County.



**Citation of this article:** Isaboke, K. M., Muraya, M. M., Mwangi, M. J., & Ogolla, F. O. (2024). Assessment of onion farming practices and purple blotch disease knowledge among farmers in varied agro-ecological zones of Nyeri County, Kenya. *Archives of Agriculture and Environmental Science*, *9*(1), 36-43, https://dx.doi.org/10.26832/24566632.2024.090106

## INTRODUCTION

Onion (*Allium cepa* L.) holds a significant global position as the second most produced vegetable crop, renowned for its culinary versatility and nutritional richness. Its inclusion in dishes like soups, stews, and salads accentuates its esteemed status, while its composition of calcium, potassium, vitamin B6, B9, and E extends its utility beyond the kitchen. Remarkably, its antimicrobial properties offer therapeutic benefits in treating bacterial infections and therefore it is widely used in wound and ulcer management (Pareek *et al.*, 2017; MOA, 2019). Globally, onion production reaches an impressive 93 million tonnes annually, led by top producers like China and India, boasting 23 million and 19 million tonnes, respectively. Other significant contributors include Korea, the United States, Netherlands, Spain, Turkey, Russia, Iran, Brazil, and Mexico (Pareek *et al.*, 2017). In Africa, onions contribute substantially, yielding approximately 9.9 million tonnes annually, constituting about 10.7% of the global output. Egypt emerges as the primary onion producer in the continent, boasting an annual yield of about 3 million tonnes, signifying its pivotal role in African onion production (Hussain *et al.*, 2017; Semida *et al.*, 2017). Despite its global prominence, Kenya faces a deficit in onion production, generating only 75,000 tonnes annually, while its consumption surpasses double this amount, leading to the importation of the deficit from Tanzania (Kyalo, 2016; KilimoTrust, 2017; James, 2019). To meet local demand, Kenya requires an estimated 160,000 tonnes annually (KilimoTrust, 2017). Low onion production in Kenya is attributed to various challenges, including poor soil fertility, infestations by plant parasitic nematodes, pests like maggots, thrips, leaf miners, and diseases such as soft rot, bulb rot, center rot, sour skin, purple blotch, black mold, rust, white rot, downy mildew, and damping off (Meena and Verma, 2017; John *et al.*, 2018; MOA, 2019).

The purple blotch disease, caused by *Alternaria porri*, poses a significant threat to onion crops, affecting both leaves and bulbs. Its symptoms start with small white spots on the foliage, which eventually develop into purplish blotches surrounded by yellow margins, particularly affecting older leaves (Sonawane *et al.*, 2020). Simultaneously, the bulbs display orange rot starting from the neck (John *et al.*, 2018). This disease results in substantial global yield losses, impacting between 5 to 50% of onion crops and leading to a 20 to 60% loss in bulb yield, combined with 30 to 50% postharvest losses (Petropoulus *et al.*, 2017; John *et al.*, 2020; Uddin *et al.*, 2020). The ability of *Alternaria porri* to persist in various sources, including seeds, soil, infected bulbs, plant debris, and weed roots, poses challenges in detection and management (Uddin *et al.*, 2020; Sarnobat *et al.*, 2020). Its development and invasion in onion crops are favored by specific environmental conditions, such as high relative humidity and optimal temperatures (John *et al.*, 2018; Sarnobat *et al.*, 2020; Sonawane *et al.*, 2020). This complexity underscores the critical need for sustainable disease management strategies that address the challenges posed by *Alternaria porri* in onion cultivation while mitigating environmental and health risks associated with traditional control methods. Management of this disease typically involves the application of fungicides like Mancozeb®, Floupyram®, Trifloxystrobin®, and Pyraclostrobin® (Mandi *et al.*, 2020; Ravikumar *et al.*, 2020; Paneru *et al.*, 2020; Sarnobat *et al.*, 2020). However, concerns over the environmental impact and risks to human health arise due to the continued use of such chemicals (Uddin *et al.*, 2020; Haroon *et al.*, 2020). Alternatives such as biological control using organisms like *Pseudomonas fluorescens* and *Trichoderma* spp have shown promise, but their limited availability in the market hampers their widespread use (Bayoumi *et al.*, 2019; Nainwal *et al.*, 2020; Sarnobat *et al.*, 2020). Meanwhile, cultural practices, including crop rotation, field sanitation, intercropping, optimal spacing, good drainage, and the utilization of resistant varieties like *Red Star* $F_1$, *Red Pinoy* $F_1$, *and Red Passion* $F_1$, have demonstrated effectiveness in managing purple blotch disease (Ahmed *et al.*, 2018; MOA, 2019).

Diverse agro-ecological zones, each characterized by its own unique climatic conditions, have an impact on the occurrence and severity of the purple blotch disease (Sarnobat *et al.*, 2020; Paneru *et al.*, 2020). Further, the adoption of susceptible onion varieties has been reported to play a pivotal role in influencing the occurrence of diseases that include purple blotch diseases. Onions are cultivated across diverse agro-ecological zones within Nyeri County, potentially leading to variations in farmers' adoption of distinct management practices that could influence the occurrence of diseases such as purple blotch (Jaeztold and Schmidt, 2010). Despite these anticipated variations, there is a significant dearth of information regarding farmers' knowledge about purple blotch disease within this region. Consequently, the present study aimed to assess onion farmers' demographics, farm characteristics, cultivated onion varieties, and their understanding of purple blotch disease. This assessment seeks to gather essential information crucial for devising sustainable management strategies against purple blotch disease in onion farms across various agro-ecological zones in Nyeri County.

## MATERIALS AND METHODS

### Description of study area

The study was carried out in Nyeri County of Kenya where onion cultivation is done in large scale. The County is located in Central Kenya, 0˚25' 46.55"S 36˚57' 0.89"E with an area coverage of 3337.10 km$^2$. The County borders Laikipia County to the North, Murang'a County to the South, Kirinyaga and Meru Counties to the East and Nyandarua County to the West. Nyeri County lies between the Eastern base of the Aberdare Ranges (Nyandarua) which forms part of the Eastern end of the Great Rift Valley and the Western slopes of Mount Kenya. It lies on an altitude of 1220 mm to 2400 mm above sea level. The rainfall ranges from 980 mm to 1004 mm annually. During the months of April, May and August the region receives high rainfall compared to January and February which are the driest months. The average relative humidity is 61 % to 67 % annually with a temperature range of 13 ˚C to 26 ˚C. The Agro-ecological zones of Nyeri County are Lower Highland, Lower Midland, Upper Highland, Upper Midland and Tropical Alpine which are divided into either Humid, Sub-humid, Semi-arid and Transitional (Figure 1) (Nyeri County, 2023). The AEZs are characterized by different climatic conditions. Different crops do well in varying environmental conditions and therefore are grown in different AEZs. Similarly, distribution of pests and diseases differ with AEZ. The Tropical Alpine and parts of the Upper Highland Zone are under the National park and the forest reserve. Some parts of Upper Highland Zone grow cabbage, carrots and kale. Upper Midland Zone grows mainly Cofee and Tea but some parts grow sunflower and maize. Lower Highland Zone grow tea and maize (MOA, 2019). Onion farming is mainly done in four Agro-Ecological zones namely Upper Highland (UH2), Upper Midland (UM2), Lower Highland (LH2) and Lower Highland (LH4). These Agro-ecological zones have well drained fertile sandy loam soils of pH 5.8 - 6.8 and temperature range of 15.2 ˚C to 17.6 ˚C (Nderitu *et al.*, 2016).

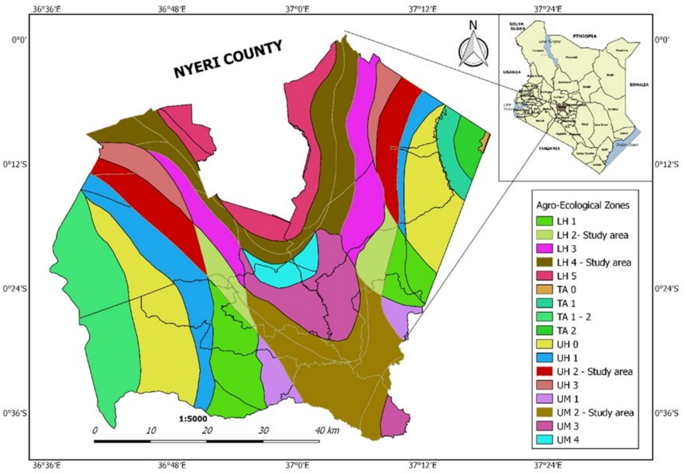


**Figure 1.** *Map of agro-ecological zones of Nyeri County.*

### Sample size determination, target population and sampling method

The target population was onion growing farms in Upper Highland (UH2), Upper Midland (UM2), Lower Highland (LH2) and Lower Highland (LH4) agro-ecological zones in Nyeri County. There were approximately 134 onion farms in the four agro-ecological zones that were targeted in this study. The size of the farms ranged from 0.25 to 1.5 acres under onion production.

The sample size was determined using the Slovin's formula (Oribhabor and Anywanu, 2019).

$$n = \frac{N}{[1 + N(e^2)]}$$

where, n= sample size, N=population size, e=precision level

Given, N = 134, e = 5%

$$n = \frac{134}{[1 + 134(0.05^2)]} = 100.4$$

Therefore, n = 100 onion farms were sampled in this study

A cluster random sampling method was used to identify the 100 onion farms in the four AEZs. On each AEZ, a transect was laid out and an onion farm selected after approximately every one kilometre. Sample size distribution among the AEZs were as shown in Table 1.

**Table 1.** Sample size distribution among four agro-ecological zones.

| Agro-ecological zones | Targeted Farms (N) | Sample Size (n) |
|---|---|---|
| Upper Highland, $UH_2$ (sub humid) | 61 | 46 |
| Upper Midland, $UM_2$ (humid) | 34 | 25 |
| Lower Highland, $LH_2$ (sub humid) | 22 | 16 |
| Lower Highland, $LH_4$ (semi arid) | 17 | 13 |
| Total | 134 | 100 |

### Data collection

The study was carried out in the month of April 2022 and a crossection survey method was adopted in this study. A questionnaire was used to gather information from onion farmers on their gender (Male or Female), age (18-30, 31-50, 50 and above), education (no formal education, primary, secondary and tertiary), level of farming (subsistence or commercial), size of farm in acres (0.25, 0.5, 1 and 1.5), history of growing onion (1-10, 10-20, 20-30 40 years and above), onion varieties grown (most preffered), reasons for growing the onion varieties (high yield, early maturity, bigger bulbs), source of onion planting material (county organizations, Agroshop, own nursery, donations), knowledge about purple blotch disease (farmers' ability to identify purple bltch disease), source of knowledge (from friends or school).

### Data analysis

The dataset collected from onion farmers, covering onion farming practices, demographic details, disease knowledge, and variety preferences, was subject to rigorous analysis aimed at uncovering inherent associations and patterns. A series of chi-square ($X^2$) tests were conducted using Statistical Analysis Software (SAS) version 9.4, set at a significance level (α) of 0.05.

### Farmers' demographic and farm characteristics

The chi-square tests were used to explore potential relationships between agro-ecological zones and demographic variables. Hypotheses were formulated to assess the expected associations between gender, age groups, educational levels, and farming practices across different zones. The analysis aimed to determine whether agro-ecological variations influenced demographic distributions among onion farmers, postulating potential correlations between these variables.

### Source, reason, and varieties of onion cultivated

Another set of chi-square analyses sought to unveil patterns in onion variety preferences and reasons for their selection across AEZs. Expected relationships were hypothesized between specific varieties chosen, the reasons cited (yield, maturity, bulb size), and their prevalence in distinct zones. The examination aimed to identify potential influences of agro-ecological conditions on farmers' preferences for certain onion varieties and reasons behind their cultivation choices.

### Farmers' knowledge on purple blotch disease

In investigating farmers' knowledge regarding onion diseases, including the particularly relevant purple blotch disease, the chi-square tests were directed towards understanding potential associations between disease knowledge and AEZs. Hypotheses were formulated to ascertain the expected distribution of disease knowledge and its gaps across different zones, considering the influence of varying environmental conditions on farmers' awareness and understanding of these diseases.

## RESULTS AND DISCUSSION

### Farmers' demographic and farm characteristics in different agro-ecological zones of Nyeri County

The majority of onion farmers in Nyeri County are male, constituting 68% of the total, while females make up only 32% of onion producers. Among the AEZs, UH2 has the highest percentage of male farmers at 28%, and LH4 has the lowest at 8% (Table 2). In terms of female farmers, UH2 has the highest representation at 18%, while LH4 has the lowest at 5%. This gender distribution suggests that male farmers predominantly own the farms and have access to capital for onion production. The findings align with Yeshiwas *et al.* (2023), who observed a similar trend in Northern Ethiopia, where male dominance in onion farming is attributed to their high activity levels and secure land tenure. The study underscores the challenges faced by women in agricultural participation as articulated by Haile (2016), such as limited land tenure security, restricted access and control over land, limited market access, and insufficient knowledge of farming mechanisms. This gender disparity should be considered in discussions on agricultural policies and interventions to ensure equitable opportunities and benefits for all stakeholders. The majority of onion farmers (43%) fall within the age group of 31 to 40 years, and this demographic demonstrates a high level of farm ownership, activity, and knowledge of market requirements for onion production (Table 2). This aligns with the findings of Abrha *et al.* (2016) in Medebay Zana District, Tigray regional state, Northern Ethiopia, indicating that farmers in this age bracket tend to possess extensive experience in onion farming due to their many years of engagement in agriculture. Conversely, only 27% of the youth aged between 18 and 30 years are actively involved in onion production, mainly because they are pursuing tertiary education and not directly engaged in farming activities. Farmers aged 41 to 50 are fewer, indicating a transition to different businesses as they move away from onion farming. This observation is in line with the report by Farhana *et al.* (2022) in Bangladesh, highlighting that farmers tend to shift to alternative engagements in the face of challenges in onion production, such as reduced prices, perishability of onion bulbs, inadequate storage facilities, and market inaccessibility. The age distribution among onion farmers suggests a need for targeted support and interventions, particularly for the youth. Efforts to enhance their involvement in onion production should consider addressing challenges such as educational pursuits and the transition of older farmers to different business ventures, ensuring sustained engagement in onion farming for overall agricultural sustainability.

**Table 2.** Onion farmers' demographic and farm characteristics in different agro-ecological zones of Nyeri County.

| | LH2 | LH4 | UH2 | UM2 | Total | $\chi^2$ | N | df | *p*-value |
|---|---|---|---|---|---|---|---|---|---|
| **Gender of onion farmer (%)** | | | | | | | | | |
| Male | 10.00 | 8.00 | 28.00 | 16.00 | 62.00 | 0.0703 | 100 | 3 | 0.995 |
| Female | 6.00 | 5.00 | 18.00 | 9.00 | 38.00 | | | | |
| Total (%) | 16.00 | 13.00 | 46.00 | 25.00 | 100 | | | | |
| **Age grouping of onion farmers (%)** | | | | | | | | | |
| 18-30 | 5.00 | 3.00 | 12.00 | 7.00 | 27.00 | | | | |
| 31-40 | 5.00 | 5.00 | 21.00 | 12.00 | 43.00 | 1.958 | 100 | 6 | 0.924 |
| 41-50 | 6.00 | 5.00 | 13.00 | 6.00 | 30.00 | | | | |
| Total (%) | 16.00 | 13.00 | 46.00 | 25.00 | 100.00 | | | | |
| **Education categories of onion farmers (%)** | | | | | | | | | |
| No education | 2.00 | 3.00 | 4.00 | 2.00 | 11.00 | | | | |
| Primary | 6.00 | 5.00 | 20.00 | 13.00 | 44.00 | 5.938 | 100 | 9 | 0.746 |
| Secondary | 8.00 | 4.00 | 20.00 | 10.00 | 42.00 | | | | |
| Tertiary | 0.00 | 1.00 | 2.00 | 0.00 | 3.00 | | | | |
| Total (%) | 16.00 | 13.00 | 46.00 | 25.00 | 100.00 | | | | |
| **Onion farming levels (%)** | | | | | | | | | |
| Subsistence | 5.00 | 5.00 | 18.00 | 9.00 | 37.00 | 0.339 | 100 | 3 | 0.953 |
| Commercial | 11.00 | 8.00 | 28.00 | 16.00 | 63.00 | | | | |
| Total (%) | 16.00 | 13.00 | 46.00 | 25.00 | 100.00 | | | | |
| **History of Growing onion (%)** | | | | | | | | | |
| 1-10yrs | 7.00 | 4.00 | 22.00 | 13.00 | 46.00 | | | | |
| 10-20yrs | 7.00 | 7.00 | 19.00 | 9.00 | 42.00 | | | | |
| 20-30yrs | 2.00 | 1.00 | 4.00 | 2.00 | 9.00 | 3.465 | 100 | 9 | 0.943 |
| Above 40yrs | 0.00 | 1.00 | 1.00 | 1.00 | 3.00 | | | | |
| Totals (%) | 16.00 | 13.00 | 46.00 | 25.00 | 100.00 | | | | |
| **Farm size used to cultivate onion (%)** | | | | | | | | | |
| 0.25 | 5.00 | 5.00 | 17.00 | 9.00 | 36.00 | | | | |
| 0.5 | 3.00 | 1.00 | 9.00 | 4.00 | 17.00 | | | | |
| 1 | 6.00 | 4.00 | 15.00 | 10.00 | 35.00 | 3.082 | 100 | 9 | 0.961 |
| 1.5 | 2.00 | 3.00 | 5.00 | 2.00 | 12.00 | | | | |
| Totals (%) | 16.00 | 13.00 | 46.00 | 25.00 | 100.00 | | | | |

The majority of onion farmers (44%) in the study had attained primary education, while a minimal percentage (3%) had tertiary education (Table 2). Agro-ecological zone UH2 had the highest proportion (20%) of farmers with primary and secondary education, respectively. Interestingly, no farmers (0%) in both LH4 and UM2 agro-ecological zones had attained tertiary education. The prevalence of basic education levels, particularly primary and secondary education, suggests that a significant number of farmers were equipped with the capacity to comprehend and apply pesticides effectively. This aligns with the findings of Birithia *et al.* (2021), whose study in three onion-growing agro-ecological zones in Kenya highlighted that farmers with formal education demonstrated the capability to apply the required amounts of pesticides to crops. The educational profile of onion farmers underscores the importance of tailored educational programs and support for pesticide application practices. Efforts to enhance farmers' knowledge and skills in pest management should consider the prevalent educational backgrounds, focusing on practical and effective strategies for pest control. The majority of onion farmers (63%) in the study engaged in commercial farming, while 37% practiced subsistence farming across all agro-ecological zones. The prevalence of commercial onion farming was highest in UH2 (28%) and lowest in LH4 (8%). On the other hand, subsistence farming was most common in UH2 (18%) and least common in LH2 and LH4 [(5%) Table 2]. Subsistence farmers often allocated smaller proportions of land to onion cultivation, incorporating crops like maize and potatoes. The limited quantities of onions produced in subsistence farming were mainly used as a spice for other foods, with the surplus sold in the local market. Interestingly, some subsistence farmers, upon obtaining sufficient capital from selling produce of other crops, transitioned to commercial onion production. This aligns with the findings of Koye *et al.* (2022), who reported that subsistence farmers receiving financial support gradually shifted towards commercial production. The prevalence of commercial onion farming indicates the economic significance of onion cultivation for many farmers. Strategies to support subsistence farmers in accessing capital and resources can potentially facilitate their transition to commercial onion production, contributing to improved livelihoods.

Most onion farmers (46%) in the study had a cultivation history of 1–10 years, while those with 10–20 years of experience constituted 42%. Farmers with over 40 years of onion cultivation were only 3%. Notably, UH2 had the highest percentage of farmers with the longest onion farming experience (22%), while LH4 had the lowest [(4%) Table 2]. No farmer in LH2 had a history of cultivating onions for 40 years and above. The scarcity of farmers with over 20 years of onion cultivation could be attributed to factors such as shifting business interests and changing crops. This aligns with the findings of Alemu *et al.* (2022), who reported that farmers in Dambidollo, Western Ethiopia, often transitioned to crops with faster maturity periods to maximize profits. Additionally, Yeshiwas *et al.* (2023) observed that farmers with extensive onion cultivation experience might lose interest, become less active, and, with old age, transition to less involving businesses or crops like maize. The relatively short average period of onion cultivation highlights the dynamic nature of farmers' engagements, indicating the need for sustainable agricultural practices and support for those transitioning to onion farming for enhanced long-term benefits. The majority of onion farmers (36% and 35%) cultivated onion on 0.25 and 1 acre of land, respectively. In the UH2 agro-ecological zone, the majority of farmers cultivated onion on 0.25 acre of land (17%) and 1 acre [(15%) Table 2]. This distribution highlights a trend toward commercial-scale onion cultivation, as larger land sizes are associated with higher productivity. Studies, such as those by the Ministry of Agriculture (MOA, 2019), have demonstrated that cultivating onions on larger land areas, leading to higher production quantities, contribute to enhanced productivity. The prevalence of onion cultivation on 0.25 and 1 acre plots, especially in UH2, suggests a focus on commercial-level production, aligning with the broader trend observed in the agricultural sector. The choice of land size for onion cultivation, particularly in the UH2 zone, reflects a strategic emphasis on commercial-scale production, emphasizing the economic significance of onion farming in the region.

### Source, reason and varieties of onion cultivated in agro-ecological zones of Nyeri County

Farmers in various AEZs of Nyeri County grew three main varieties of onions: *Cylon* $F_1$, *Rucet* $F_1$, *and Jambar* $F_1$ (Table 3). The distribution of these varieties varied across zones, with Cylon $F_1$ being grown in AEZ LH2 (18%) and UH2 (10%), Rucet $F_1$ grown in all AEZs with the highest percentage in UH2 (28%), and Jambar $F_1$ primarily cultivated in the LH4 and UH2 AEZs (23%). The statistical distribution of onion varieties emphasizes the influence of agro-ecological conditions on farmers' choices, considering factors such as yield capacity, maturity rate, and bulb size (MOA, 2019; Ahmed *et al.*, 2021). The statistically significant distribution of onion varieties across AEZs underscores farmers' strategic decisions based on specific environmental conditions to optimize yield and quality in their onion cultivation practices. The study found no significant ($X^2$ (6, 100) = 11.947, $p$ = 0.063) association between the reasons why farmers chose to grow a specific onion variety and the AEZs. Farmers' preferences for specific traits varied, with 2% to 15% opting for high-yielding varieties, 6% to 17% favouring early-maturing traits, and 3% to 14% prioritizing larger bulb traits across different AEZs (Table 3). Notably, high-yielding varieties tended to mature late but promised higher profits, while early-maturing varieties fetched better prices due to off-season harvesting, aligning with the findings of Baliyan (2014), Salari *et al.* (2021), and Alemu *et al.* (2022) carried out studies in Botswana, Agriculture Research Farm of Kabul University and Dambidollo Western Ethiopia respectively. Farmers' decisions on onion variety selection were influenced by the desire for increased income. Farmers strategically choose onion varieties based on specific traits, considering factors such as yield, maturity period, and bulb size to maximize profits in different agro-ecological zones. The sources of onion seedlings showed no significant ($\chi^2$ (9, 100) =

**Table 3.** Source, reason and varieties of onion cultivated in agro-ecological zones of Nyeri County.

| | LH2 | LH4 | UH2 | UM2 | Total | $\chi^2$ | N | df | *p*-value |
|---|---|---|---|---|---|---|---|---|---|
| **Varieties of onion grown by farmer (%)** | | | | | | | | | |
| *Cylon* | 7.00 | 0.00 | 18.00 | 0.00 | 25.00 | NA | 100 | NA | NA |
| *Rucet* | 9.00 | 13.00 | 28.00 | 2.00 | 52.00 | | | | |
| *Jambar* | 0.00 | 0.00 | 0.00 | 23.00 | 23.00 | | | | |
| Total | 16.00 | 13.00 | 46.00 | 25.00 | 100.00 | | | | |
| **Reason why farmer grow given onion variety (%)** | | | | | | | | | |
| Higher yield | 3.00 | 4.00 | 15.00 | 2.00 | 24.00 | | | | |
| Early Maturity | 10.00 | 6.00 | 17.00 | 9.00 | 42.00 | 11.947 | 100 | 6 | 0.063 |
| Bigger bulb | 3.00 | 3.00 | 14.00 | 14.00 | 34.00 | | | | |
| Total | 16.00 | 13.00 | 46.00 | 25.00 | 100.00 | | | | |
| **Sources of onion seeds by farmers (%)** | | | | | | | | | |
| County Org | 0.00 | 0.00 | 3.00 | 2.00 | 5.00 | | | | |
| Agroshop | 15.00 | 13.00 | 35.00 | 21.00 | 84.00 | 7.153 | 100 | 9 | 0.621 |
| Own nursery bed | 1.00 | 0.00 | 5.00 | 1.00 | 7.00 | | | | |
| Donations | 0.00 | 0.00 | 3.00 | 1.00 | 4.00 | | | | |
| Total | 16.00 | 13.00 | 46.00 | 25.00 | 100.00 | | | | |

7.153, $p$ = 0.621) association with the AEZs. Farmers predominantly acquired seedlings from agro-shops, ranging from 13% in LH4 to 35% in UH2. Minimal seedling sourcing was observed from County organizations (0% in LH2 and LH4 to 3% in UH2), own nurseries (0% in LH4 to 5% in UH2), and donations [(0% in LH2 and LH4 to 3% in UH2) Table 3]. The majority of farmers preferred purchasing certified onion seeds from local Agroshops due to their perceived high performance, freedom from pests and diseases, and reliable germination. This trend aligns with the increased adoption of certified seeds, encouraged by national and county government initiatives to provide qualified seeds through licensed Agroshops (MOA, 2019). The widespread adoption of certified onion seeds underscores farmers' recognition of their benefits, emphasizing the impact of government-led initiatives in promoting the use of quality seeds.

### Farmers' knowledge on purple blotch disease in agro-ecological zones of Nyeri County

There was no significant ($\chi^2$(3, 100) = 2.162, p = 0.539) association observed between farmers' knowledge of onion diseases and the AEZs. Farmers acknowledging awareness of onion diseases ranged from 7% in AEZs LH4 to 29% in UH2, while those reporting a lack of knowledge varied from 6% in AEZs LH2, LH4, and UM2 to 17% in UH2 (Table 4). Despite 65% of farmers having knowledge about onion diseases, younger farmers tended to lack awareness. Those gaining knowledge through farm experience were significantly higher (50.77%), whereas those learning from friends were lower (15.38%). These findings align with Haile *et al.* (2016) study in Masha District, Southwest Ethiopia, emphasizing that farmers primarily acquire knowledge about onion diseases through hands-on experience during onion production. Commonly reported diseases include powdery mildew and early blight. While a significant proportion of farmers possess knowledge about onion diseases, the study highlights a generational gap, emphasizing the need for targeted educational interventions to bridge the knowledge divide, particularly among younger farmers. There was no significant ($\chi 2$ (6, 65) = 3.198, $p$ = 0.784) association observed between the occurrence of purple blotch in onion farms and the AEZs. Farmers reporting the occurrence of purple blotch ranged from 4.62% in LH2 to 23.08% in UH2, while those reporting no occurrence varied from 1.54% in LH4 to 12.31% in UH2. Farmers unable to determine the occurrence of purple blotch ranged from 3.08% in LH2 and LH4 to 9.23% in AEZ UH2 (Table 4). Despite 49.2% of farmers claiming knowledge about purple blotch disease, a significant portion remained unaware. This lack of awareness might lead to the application of inappropriate disease control measures, hindering effective prevention or eradication. Previous studies, such as Birithia *et al.* (2021), have highlighted the consequences of farmers applying inadequate disease control measures due to a lack of knowledge about onion diseases. A substantial percentage of farmers, despite having some knowledge, remain unaware of purple blotch disease. This knowledge gap emphasizes the importance of targeted education and extension services to improve farmers' understanding of the disease and enhance the effectiveness of disease control measures.

There was no significant ($\chi^2$ (3, 51) = 6.913, $p$ = 0.075) association observed between the source of knowledge about purple blotch and the AEZs. Farmers reporting learning about purple blotch from friends ranged from 5.88% in LH2 and UM2 to 23.53% in UH2. Those learning from school ranged from 1.96% in LH4 to 23.53% in UM2 (Table 4). The awareness of purple blotch disease among farmers primarily stems from formal education, learning from friends, and interactions with fellow farmers. According to MOA (2019), effective communication among farmers plays a crucial role in disseminating agricultural knowledge, promoting sustainable onion production, and ensuring the adoption of proper farming practices, including disease management. The study highlights that awareness of purple blotch disease is significantly influenced by formal education, learning from friends, and communication among farmers. This underscores the importance of fostering communication networks and educational programs to enhance farmers' knowledge of onion diseases.

**Table 4.** Farmers' disease experience in agro-ecological zones of Nyeri County.

| | LH2 | LH4 | UH2 | UM2 | Total | $\chi^2$ | N | df | *p*-value |
|---|---|---|---|---|---|---|---|---|---|
| **Do you know any onion disease? (%)** | | | | | | | | | |
| Yes | 10.00 | 7.00 | 29.00 | 19.00 | 65.00 | | | | |
| No | 6.00 | 6.00 | 17.00 | 6.00 | 35.00 | 2.162 | 100 | 3 | 0.539 |
| Total | 16.00 | 13.00 | 46.00 | 25.00 | 100.00 | | | | |
| **How did you know onion disease? (%)** | | | | | | | | | |
| Farm experience | 4.62 | 3.08 | 30.77 | 12.31 | 50.77 | | | | |
| Training by EO | 4.62 | 7.69 | 10.77 | 10.77 | 33.85 | 14.294 | 65 | 6 | 0.027 |
| Learn from friends | 6.15 | 0.00 | 3.08 | 6.15 | 15.38 | | | | |
| Total | 15.38 | 10.77 | 44.62 | 29.23 | 100.00 | | | | |
| **Have you experienced any of the diseases in your onion farm? (%)** | | | | | | | | | |
| Yes | 13.85 | 10.77 | 43.08 | 26.15 | 93.85 | 1.712 | 65 | 3 | 0.634 |
| No | 1.54 | 0.00 | 1.54 | 3.08 | 6.15 | | | | |
| Total | 15.38 | 10.77 | 44.62 | 29.23 | 100.00 | | | | |
| **Which onion disease do you experience in your onion farm? (%)** | | | | | | | | | |
| Mildew | 7.69 | 6.15 | 23.08 | 21.54 | 58.46 | | | | |
| Blight | 7.69 | 4.62 | 21.54 | 7.69 | 41.54 | 2.655 | 65 | 3 | 0.448 |
| Total | 15.38 | 10.77 | 44.62 | 29.23 | 100.00 | | | | |
| **Have you ever experienced cases of purple blotch disease? (%)** | | | | | | | | | |
| Yes | 4.62 | 6.15 | 23.08 | 15.38 | 49.23 | | | | |
| No | 7.69 | 1.54 | 12.31 | 7.69 | 29.23 | 3.198 | 65 | 6 | 0.784 |
| I cannot tell | 3.08 | 3.08 | 9.23 | 6.15 | 21.54 | | | | |
| Total | 15.38 | 10.77 | 44.62 | 29.23 | 100.00 | | | | |
| **How did you know about purple blotch disease? (%)** | | | | | | | | | |
| Friends | 5.88 | 7.84 | 23.53 | 5.88 | 43.14 | | | | |
| School | 9.80 | 1.96 | 21.57 | 23.53 | 56.86 | 6.913 | 51 | 3 | 0.075 |
| Total | 15.69 | 9.80 | 45.10 | 29.41 | 100.00 | | | | |

## Conclusion and recommendations

Onion farming in Nyeri County exhibits a notable gender disparity, predominantly favoring male participation. To diversify and strengthen the agricultural landscape, it is recommended that government interventions focus on encouraging greater involvement of women and youth in onion farming. This not only promotes inclusivity but also has the potential to enhance overall yield and income generation. Farmers are advised to embrace the cultivation of diverse certified onion varieties, emphasizing the avoidance of repeated cultivation of the same varieties. This strategic approach aims to bolster productivity and minimize the risks associated with onion diseases and pests. The choice of onion variety should be informed by a comprehensive consideration of factors such as high yield, early maturity, and larger bulb size. Furthermore, the study underscores the importance of tailored awareness programs for farmers, addressing the specific reasons behind their choice of onion varieties in different AEZs. For optimal results, farmers should be informed about the benefits of cultivating varieties that encompass high yield, early maturity, and larger bulb traits. The assessment of farmers' knowledge regarding purple blotch disease reveals a significant reliance on formal education and peer learning. However, the study highlights a concerning lack of awareness among farmers about this onion disease. To address this gap, there is a crucial need for targeted training programs focused on basic disease identification. These initiatives will empower farmers with the necessary knowledge and skills to identify and manage purple blotch disease effectively within the AEZs of Nyeri County.


## Authors contribution

Conceptualization, acquisition of funds, methodology, investigation, writing—original draft preparation, writing—review and editing, resources, K.M.I.; Methodology, investigation, data curation and analysis, review, and editing, F.O.O.; Investigation, Review and editing, supervision, M.M.M.; Investigation, Review and editing, supervision, M.J.M. All authors have read and agreed to the published version of the manuscript. This distribution clearly outlines the specific contributions of each author to the manuscript.

**Conflict of interest:** The authors declare no conflict of interest.

**Ethical approval:** Not applicable.

**Data availability:** The data that support the findings of this study are available on request from the corresponding author.




## REFERENCES

Abrha, T., Emanna, B., & Gebre, G. G. (2016). Factors affecting Onion Market supply in Medebey Zana district Tigray regional state,Northern Ethiopia. *Food science and Technology*, 6(1), 1712144.

Ahmed, S., Quddus, A. R., Kamrozzaman, M. M., & Uddin, R. S. (2018). Integrated approaches for controlling purple blotch of onion for true seed production in Faridpur of Bangladesh. *Fundamental and Applied Agriculture*, 390-397.

Ahmed, S., Rahim, A., Moniruzzaman, M., & Khatum, M. A. (2021). Effect of Bulb Sizes on the Seed Yield of Two Onion (*Alliun cepa* L.) varieties. *Journal of Agriculture*, *18*(2), 51-65.

Alemu, D., Kitila, C., Ramaswamy, K., Garedew, W., Tesfaye, L., Badassa, B., et al. (2022). Growth, yield and yield variables of Onion (*Allium cepa* L.) varieties as influenced by planting spacing at DambiDollo Western Ethiopia. *Scientific Reports*, *12*(1), 20563.

Baliyan, S. P. (2014). Evaluation of Onion Varieties for productivity performance in Botswana. *World Journal of Agricultural Research*, *2*(3), 129-135.

Bayoumi, Y., Taha, N., Shalaby, T., Alshaal, T., & El-Ramady, H. (2019). Sulfur promotes biocontrol of purple blotch disease via Trichoderma spp and enhances the growth, yield and quality of onion. *Applied Soil Ecology*, *134*, 15-24.

Birithia, R. K., Subramanian, S., & Kuria, D. K. (2021). Farmers' preference for onion varieties and implications of knowledge of Iris yellow spot disease in Kenye. *African Crop Science Journal*, *29*(2), 229-239.

Farhana, M. A., Nahar., A., Ruhul, A., Culas, J. R., & Ahmed., A. (2022). Empirical assessment of Onion supply chain constraints in Bangladesh: A pre-covid and covid situation. *Journal of Agriculture and Food Research*, 10, 100418.

Haile, B., Worojie, T. B., & Hailu, A. (2016). Constraints on Production of Onion (*Allium cepa*. L) in Masha District Soutwest Ethiopia. *Global Journal of Agriculture and Agricultural Sciences*, *4*(2), 314-321.

Haile, F. (2016). Factors Affecting women farmers' participation in Agricultural Extension Services for improving production in Rural District of Dendi West Shoa Zone, Ethiopia. *International Journal of Agricultural Research, Sustainability, and Food Sufficiency*, *3*(4), 69-82.

Haroon, M., Bhat, A. S., Prakash, N. B., Rangaswamy, K. T., & Lingaraiah, H. B. (2020). Effect of silicon on prevalences and severity of purple blotch disease ( *Alternaria porri* (Ellis) Cif) in onion (*Allium cepa* L.). *International journal of current Microbiology and applied sciences*, 9(2), 429-439.

Hussain, W. A., Elzaawely, A. A., El-Sheery, N. I., Ismail, A. A., & El-Zahaby, H. M. (2017). Biological control of onion white rot disease caused by *Sclerotium cepivorum*. *Environment, Biodiversity and Soil security*, *1*, 101-107.

James. (2019). The introductory Guide to Onion farming in Kenya. Retrieved on 17.06.2020 from *Smartbusiness.co.ke*

Jaeztold, R., & Schmidt, H. (2010). *Farm Management Handbook of Kenya-Natural Conditions and Farm Management Information*. Nairobi: Ministry of Agriculture and German Agricultural Team.

John, V., Maurya, A. K., Murmu, R., & Pant, H. (2020). Eco-Friendly management of preand post-harvest diseases of onion (*Allium cepa* L.). *Current research and innovations in Plant Pathology*, 188.

John., V., Simon, S. D., Maurya, A. K., & Lal, A. A. (2018). Survey of purple blotch diseases of onion (*Alternaria porri*) of Allahabad District, India. *International journal of current microbiology and applied sciences*, *7*(10), 74-78.

KilimoTrust. (2017). *Characteristics of markets for red bulb onions in the East Africa community*. Regional East Africa Community Trade In Stapes (REACTS).

Koye, T. D., Koye, A. D., & Amsalu, Z. A. (2022). Analysis of technical efficiency of irrigated onion (*Allium cepa* L.) production in North Gondar Zone of amhara regional state, Ethiopia. *Plos one, 17*(10), e0275177.

Kyalo, J. (2016). A beginner guide to onion farming in Kenya. Nairobi. Retrieved on 18.06.2020 from *www.agrifarming.in*

Mandi, N., Nayak, B. S., Sahoo, B. B., Prasad, G., & Khada, C. (2020). Efficancy of novel fungicides against purple blotch in onion (*Allium cepa* L.) in the Western Undulating zone of Odisha, India. *International Journal of Current Microbiology and Applied Sciences*, *9*(4), 1970-1976.

Meena, L., & Verma, A. K. (2017). Fungal diseases of onion and their biological control. A Review. *International Journal of recent Scientific Research*, *8*(8) 19441-19445.

MOA. (2019). Bulb Onion Production. *Smallholder horticulture empowerment and promotion project for local and up scaling*.

Nderitu, M., Oludhe, C., Ali, A. A., Omondi, P., & Makui, P. (2016). Analysis of rainfall and temperature variability in Kieni; Nyeri County. *International Journal of Innovative Research and Development*, *5*, 67-76.

Nainwal, D., Tewari, S. D., & Vishuvanal, K. (2020). Purple blotch disease in onion; Management through biological agents. *Journal of International and Phytochemistry*, *9*(3) 1624-1627.

Oribhabor, C. B., & Anyanwu, C. A. (2019). Research sampling and sample size determination: a practical application. *Journal of Educational Research (Fudjer)*, *2*(1), 47-57.

Paneru, N., Adhikari, P., & Tandan, P. (2020). Management of purple blotch complex of onion (*Allium Cepa* Cv Red Creole) Under field condition in rukum-West, Nepal. *Malaysian Journal of Sustainable Agriculture*, *4*(2), 71-74.

Pareek, S., Sagar, N. A., Sharma, S., & Kumar, V. (2017). Onion (allium cepa L.). *Fruit and Vegetable Phytochemicals: Chemistry and Human Health*, 2nd Edition, 1145-1162.

Petropoulus, S. A., Ntatsi, G., & Ferreira, I. C. (2017). Long-term storage of onion and the factors that affect its quality. *Food Reviews International*, 1, 62-83.

Ravikumar, M. R., Harish, D. K., Kumara, B. H., & Kumar, A. (2020). Evaluation of pre-mix fungicide; fluopyrum and trifloxystrobin 250sc against purple blotch disease of onion in Karnataka. *Current Journal of Applied Science and Technology*, *39*(8), 44-50.

Salari, H., Antil, R. S., & Saharawat, Y. S. (2021). Responses of Onion growth and yield to different planting dates and land management practices. *Agronomy Research*, *19*(4) 1914-1928.

Sarnobat, D. H., Zanajre, S. R., Surywanshi, A. V., & Shela, V. R. (2020). Purple blotch of onion and its management. *International journal of chemical studies*, *8*(2), 839-845.

Semida, W. M., El-Mageed, T. A., Mohamed, S. E., & El-Sawah, N. A. (2017). Combined effect of deficity irrigation anf foliar applied salicylic acid on physiological responses, yield and water use efficiency of onion plants in saline calcareous soil. *Archives of Agronomy and Soil Science, 63*(9), 1227-1239.

Sonawane, R. B., Dhemre, J. K., Badgujar, M. P., & Gaikwad, S. D. (2020). Survey of purple blotch of onion (*Alternaria porri*) in major growing areas in Nashik, India. *International Journal of current Microbiology and Applied Sciences*, *9*(1), 1549-1554.

Uddin, N., Naseer, A., Shahid, M., Muhammad, N., & Ali, N. (2020). In vitro evaluation of fungicide and plant extracts to control purple blotch disease of onion in Pakistan. *Plant Pathology Journal*, 77-88.

Yeshiwas, Y., Alemayehu, M., & Adgo, E. (2023). The rise and fall of onion production; its multiple constraints on pre-harvest and post-harvest management issues along supply in Northwest Ethiopia. *Heliyon*, *9*, e15905.