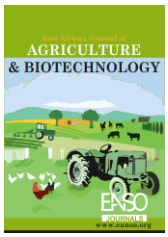
Article DOI : https://doi.org/10.37284/eajab.6.1.1262



East African Journal of Agriculture and Biotechnology
eajab.eanso.org
Volume 6, Issue 1, 2023
p-ISSN: 2707-4293 | e-ISSN: 2707-4307
Title DOI: https://doi.org/10.37284/2707-4307

EAST AFRICAN NATURE & SCIENCE ORGANIZATION

Original Article

Effect of Purple Blotch Farm Management Practices on Onion Production in Uganda

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Article DOI: https://doi.org/10.37284/eajab.6.1.1262

Date Published: *22 June 2023*

Keywords:

Allium cepa, Credit Facilities, Purple Blotch, Regions, Survey.

ABSTRACT

Onion is one of the most important commercial vegetable crops grown intensively in the world. Purple blotch found in all the growing regions is the most destructive of all onion diseases. Detailed studies on the disease's management practices had not been conducted in Uganda. The objective of this study was to establish the effect of purple blotch disease management practices on onion production. Kabale, Kasese, and Mbale regions were identified as the major onion-growing regions. Five farms/onion varieties/regions were surveyed using a semi-structured questionnaire administered to 52 farm owners who were interviewed. The results revealed the majority were small-scale peasant farmers with mean acreage of 0.64-1.94, which varied significantly p=.000, and Kasese had the highest. Eight onion varieties were recorded: Bombay red, Hazera, Hybrid, Malbec, Red coach, Red creole, S-Zee and Tanzania, with Red creole grown in all the regions. Kabale registered the highest number of farms (40.3%), Kasese district (25.0%), the highest mean production of 6,329.9 kg/season, and Namisindwa (21.1%) the second. The main source of seed was Agro input dealers. The use of artificial fertiliser was highest in Mbale (72.7%) and lowest in Kasese (50%), though it did not vary p>.05 significantly. Only farmers in Kabale and Kasese had access to credit facilities, agricultural extension workers and farmers' groups, with Kasese in the lead. Onion purple blotch disease and thrips were the main problem in all the regions and were controlled using chemicals: 100%, 90.9% and 88.3% in Mbale, Kabale, and Kasese, respectively. Weeding of farms was lowest in Mbale (mean = 3.88) and highest in Kasese (4 .84). In conclusion, growing the right onion variety, farmer groups, access to credit facilities, and genuine farm inputs are necessary for a sustainable onion agribusiness in Uganda.

APA CITATION

Mohammed, I., Ipulet, P. & Kangire, A. (2023). Effect of Purple Blotch Farm Management Practices on Onion Production in Uganda. *East African Journal of Agriculture and Biotechnology*, *5*(1), 219-232. https://doi.org/10.37284/eajab.6.1.1262

CHICAGO CITATION

Mohammed, Iliya, Perpetua Ipulet and Africano Kangire. 2023. "Effect of Purple Blotch Farm Management Practices on Onion Production in Uganda". *East African Journal of Agriculture and Biotechnology* 6 (1), 219-232. https://doi.org/10.37284/eajab.6.1.1262

HARVARD CITATION

Mohammed, I., Ipulet, P. & Kangire, A. (2023) "Effect of Purple Blotch Farm Management Practices on Onion Production in Uganda", *East African Journal of Agriculture and Biotechnology*, 6(1), pp. 219-232. doi: 10.37284/eajab.6.1.1262.

Article DOI : https://doi.org/10.37284/eajab.6.1.1262

IEEE CITATION

I. Mohammed, P. Ipulet & A. Kangire, "Effect of Purple Blotch Farm Management Practices on Onion Production in Uganda", *EAJAB*, vol. 6, no. 1, pp. 219-232, Jun. 2023.

MLA CITATION

Mohammed, Iliya, Perpetua Ipulet & Africano Kangire. "Effect of Purple Blotch Farm Management Practices on Onion Production in Uganda". *East African Journal of Agriculture and Biotechnology*, Vol. 6, no. 1, Jun. 2023, pp. 219-232, doi:10.37284/eajab.6.1.1262.

INTRODUCTION

Onion (*Allium cepa* L.) often called the Queen of 'kitchen', is one of the oldest bulb crops of the Family *Alliaceae* (Necola, 2007). It is among the most important commercial vegetable crops grown worldwide. In terms of global production, China is the largest world producer, with a production of 22,300,000 tonnes, while India is the second with 19,299,000 tons. Uganda ranked 47th accounting for 0.2% (FAO, 2013). Production of onions in Uganda is about 317,748 tonnes (FAO, 2020). The varieties grown most worldwide include Bombay red, Red passion, Red Pinoy, Yellow or Brown onion, White onion, Shallots onion, Scallions/Green onion, Pearl onion, Bermuda/Red onion, Spring onion, Red cornet, Jamba red, Afri seed, Walla walla onion etc.

Onion is also among the most important horticultural crops with essential nutritious and health value. It is valued for its distinctive pungent smell (Ravichandra, 2012). Medicinally, its values are innumerable and one of the crops used as medicine in the olden days. It is anticancer and assists in minimising the chance of cardiovascular diseases (Smith *et al.,* 2016). Onions show variations in many characteristics, such as size, colour, shape, and pungency (Griffith *et al.*, 2002). The varieties are widely different in shape ranging from those with high dry matter content to those having soft bulbs with low dry matter content, also from high to low pungency (McCallum et al., 2001).

The most important biotic factors affecting onion production are diseases like downy mildew, basal rot, purple blotch, Stemphylium blight, and storage rots coupled with the absence of any resistant varieties. Purple blotch disease, commonly called leaf blight of onion caused by the fungus *Alternaria porri* (Ell.) Cif. is the most devastating (Marmath *et al.,* 2013), and it is prevalent in all onion-growing countries of the world (Kareem *et al.,* 2012). When the weather is favourable, it can cause yield loss of up to 100% and may reach an epidemic state during high relative humidity (80-90%) and an optimum temperature of 24 ºC (Yadav *et al.,* 2013). The fungus can bring down flower and leaf production by about 62%. Onion bulbs are affected via the neck, forming a red to bright yellow area resulting in complete drying and decay of the bulb scales (Black *et al.*,2012). The plant can also be infected through wounds on the scales or young and old leaves infested by thrips (Sandborn, 2012). Under favourable conditions, brownish-purple necrotic lesions form in the tissues and delay bulb formation and maturation (Black *et al*., 2012). A chemical method of control using fungicides like mencozeb, propineb and difenconazole (Chethana *et al*., 2012; Priya*et al*., 2015) has been used.

Onion in Uganda is known as '*Obutungulu*' (Luganda), and the common varieties grown include Jamba, Red creole, Red cornet, Bombay red, Afri seed, Pearl, Red passion, Red coach and Texas grano (Musokya, 2012). It is the second most important vegetable crop to tomato, grown especially by local people. It contributes to household income, especially in highland areas where it is grown purposely for sale (Bua *et al.,* 2017), with average productivity of 4.02 tons/ha, a very low yield compared to the world average of 19.7 tons/ha. Uganda lacks an onion breeding programme as it is not considered a priority crop by the National Agricultural Research Organization. Moreover, Purple blotch was reported in Uganda by CABI (1985). Due to the importance of onion in the country coupled with limited information regarding its production and disease, this research was conducted to establish the effect of purple blotch disease management practices on onion production.

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MATERIALS AND METHODS

The major onion growing areas were identified through consultations and literature review as three regions. A semi-structured questionnaire was used to interview five onion farmers per onion variety per region, focussing on their background and experiences with onion farming. Farmers/farm owners with onion gardens ≥0.25 acres were interviewed, and the researcher filled in the questionnaire.

Description of the Study Area

For the purpose of this research, the study area was divided into three regions, namely Kabale, Kasese and Mbale, with preliminary findings having given these as the major onion-growing areas in the country. Only the districts where the study was conducted are described below:

Kabale Region (South Western Uganda)

Kabale district: Is located between coordinates 1°15'0" S and 30°0'0" E in Southwestern Uganda. Latitude: 1º14'54.85" S. Longitude: 29º59'23.75" E. Altitude ranges from 1,219-2,347 m asl. The warmest month is January, with an average maximum temperature of 23 ºC, and the coldest month is July, with 22 ºC. Humidity is between 90-100% and rainfall is about 1,093.2 mm per annum. The major crops grown by farmers include maise, cassava, groundnuts, vegetables, banana, cocoyam, citrus and coffee.

Ntungamo District: It is located in southwestern Uganda. Latitude: 0º52'32.99″N Longitude: 30º15'33.00″E with an altitude of 1,400 m asl. The mean annual temperature of 26 ºC and the mean annual minimum of 14.5 ºC. Relative humidity ranges between 80-90%, and average rainfall is about 889-900 mm. The major crops grown include bananas, coffee, beans, millet, and groundnuts.

Rukiga District: It is located on Latitude: -1°4'59.99" and Longitude: 30°1'59.99" E, with an Altitude of 1,756 m. The average annual temperature is 22 °C and rainfall of about 922 mm with an average humidity of 75%. The major crops grown are beans, maise, ground nuts and millet.

Kasese Region (Western Uganda)

Kasese District: Is located north of Lake George in the Western region of Uganda with coordinates 0°13'48" N, 29°59'18" E. Latitude: 0°10'.99” N. Longitude: 30°04'.99" E. Altitude ranges from 1,200-2,400 m asl. Temperature varies so little throughout the year from 26-28 °C. It experiences significant seasonal variation in the perceived humidity; the muggiest day of the year is in April at 34% humidity. Annual rainfall ranges from 800-1,600 mm and falls throughout the year. Major crops cultivated by farmers include maise, cassava, groundnuts, vegetables, onions, banana, cocoyam, citrus and coffee.

Bunyangabu District: Its coordinates are 0°22'0" N and 30°10'0" E, with an altitude of 1,100 m and annual rainfall of 800-1600 mm. The district has a temperature of about 23 °C with a humidity of 65%. Major crops grown include maise, beans, bananas, and vegetables.

Mbale Region (Eastern Uganda)

Mbale district: is found in eastern Uganda and bordered by Sironko District to the north, Bududa District to the northeast, district of Manafwa to the southeast, Tororo District to the south, Butaleja District to the southwest, and Budaka District to the West. Pallisa District and Kumi District lie to the Northwest of Mbale. Coordinates 00º57' N, 34º20' E. Latitude: 0º56'59.99" N, Longitude: 37º19'60" E with an area of 518.8 km^2. Altitude ranges from 1,250-2,850 m asl. Annual rainfall is about 1,270 mm and varies with altitude, with high-elevation areas wetter than low-elevation areas. The mean annual temperature ranges from 21-23 ºC with humidity of 36-52%. Major crops cultivated by farmers include maise, cassava, groundnuts, vegetables, onions, oil palm, banana, cocoyam, citrus, and coffee.

Namisindwa District: Is situated in the easternmost part of the country near Mount Elgon National Park, right on the Uganda and Kenya border. It is a relatively new district established in 2017. Latitude and longitude coordinates are

Article DOI : https://doi.org/10.37284/eajab.6.1.1262

0º48'59" N, 34º22'57" E. The mean annual rainfall of about 1,400-1,800 mm, and altitude of 1000-2400 m. The mean annual temperature varies from 14-25 ºC with humidity of about 37-55%. The major crops include coffee, banana, beans, and maise.

Study Sites

The study sites were established during actual sampling for each onion variety as follows:

- Kabale region: Three districts: Kabale, Ntungamo and Rukiga -11 sites.
- Kasese region: Two districts: Kasese and Bunyangabu - eight (8) sites.
- Mbale region: One district: Namisindwa - five (5) sites.

Sampling Method

Five farmers for each onion variety per region were interviewed using a semi-structured questionnaire. Only onion farmers (were also the farm owners) were interviewed, e.g., one region: 5 onion varieties x 5 farmers = 25 farmers, = 75 farmers interviewed in total. The actual number of interviewees per region, however, was determined by the number of onion varieties grown. The questionnaire focused on farmers' background and experience concerning onion farming, variety preferred, pests and diseases, number of times of weeding, access to extension workers and credit facilities, knowledge of purple blotch disease, control, and other crops in the onion garden were recorded. Only garden sizes ≥0.25 acres were considered. The questionnaire was filled out by the researcher. The method is adopted from Yeboah *et al.* (2003), who used 50 respondents (all of whom were onion farmers).

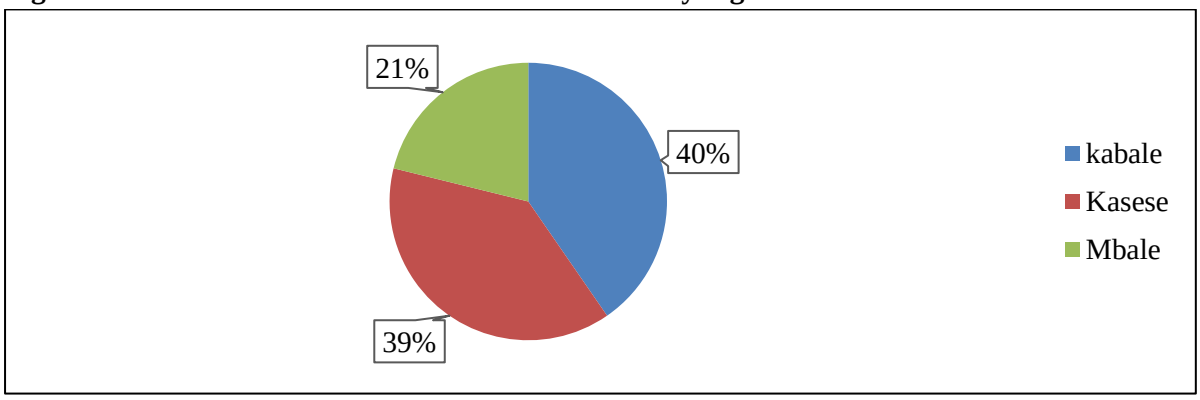
Data Analysis

The data collected was entered into an MS Excel package. Descriptive statistics and percentages were computed where appropriate. Some of the data were subjected to statistical analysis using SPSS 14.00: chi-square test, and One Way ANOVA was calculated at $p \leq 0.05$. Some data was presented as tables and figures.

RESULTS

A total of 52 farmers were interviewed: 21 (40%) were from 11 villages of the Kabale region, making this the main onion-growing region in Uganda (*Figure 1*). The next was the Kasese region, and from eight villages, the Mbale region had the lowest with five villages.

Figure 1: Number of farmers interviewed in each study region



Acreage of Onion Farms

Land allocated for onion production was of a mean average of 0.64-1.94 acres (Table 1). One-way ANOVA showed a highly significant difference among regions (P=0.000). The farmers in Kasese had the highest acreage with a mean average of 1.94; the land was given to the farmers by the management of Mubuku Irrigation Scheme on a hire basis at a rate affordable to them.

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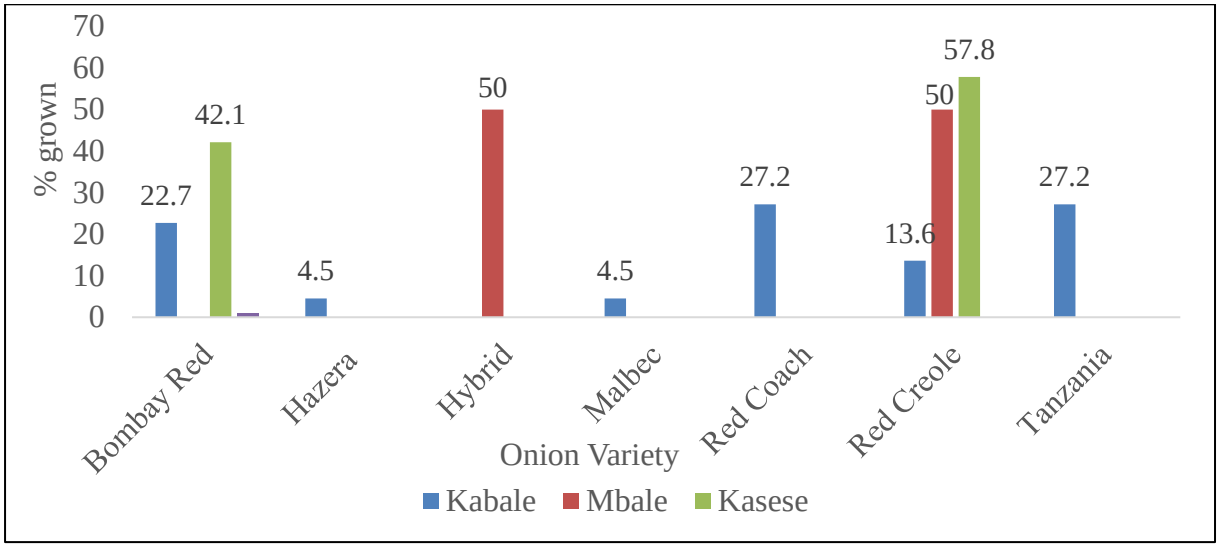
Table 1: Average size of onion gardens in acres for the three study regions

Region	No. of farmers	Mean	Std. Deviation	F	p-value
Kabale	21	0.64(0.259 ha)	0.39		
Mbale	11	0.66 (0.267 ha)	0.53	7.66	0.000
Kasese	20	1.94 (0.785 ha)	1.78		

Varieties of Onions Grown

Altogether **e**ight (8) onion varieties were recorded: Bombay red, Hazera, Hybrid, Red coach, Red creole, Malbec, S-zee and Tanzania (Kutia). Six varieties were grown in Kabale except for Hybrid and S-Zee. Two varieties, Red Creole and Bombay Red, were grown in Kasese and three varieties in the Mbale region: Red Creole, Hybrid and S-Zee. However, S-Zee was not in season at the time of the survey. Red creole had the highest per cent production (*Figure 2*).

Figure 2: Percentage of onion varieties grown per region



Onion Varieties Grown According to Districts

Kabale region had the highest percentage of farms (40.3%), producing six onion varieties in three districts. However, the Kasese district in the Kasese region and Namisindwa districts in the Mbale region had the highest numbers of farms. Red creole was grown in 5/6 of the districts, and Bombay red in 3/6. Hazera and Malbec varieties were the least grown each by one farm (*Table 2*).

Table 2: Percent number of onion farms per district

Onion variety	Study district / % number of farms						
	Kabale region			Kasese region		Mbale region	Total
	Kabale	Rukiga	Ntungamo	Kasese	Bunyangabu	Namisindwa	
Bombay red	-	-	9.6 (5) *	9.6 (5)	7.7 (4)	-	26.9 (14)
Hazera	-	1.9 (1)	-	-	-	-	1.9 (1)
Hybrid	-	-	-	-	-	9.6(5)	9.6 (5)
Red coach	-	-	9.6 (5)	-	-	-	9.6 (5)
Red creole	1.9 (1)	5.8 (3)	-	15.4 (8)	5.8 (3)	11.5(6)	40.4 (21)
S-Zee	-	-	-	-	-	Not in season	0 (0)
Malbec	-	1.9 (1)	-	-	-	-	1.9 (1)
Tanzania	3.8 (2)	5.8 (3)	-	-	-	-	9.6 (5)
Total	5.7 (3)	15.4 (8)	19.2 (10)	25. 0 (13)	13.5(7)	21.1 (11)	99.9 (52)
		40.3 (21)		38.5 (20)		21.1 (11)	99.9(52)

**Actual number of farms (in brackets)*

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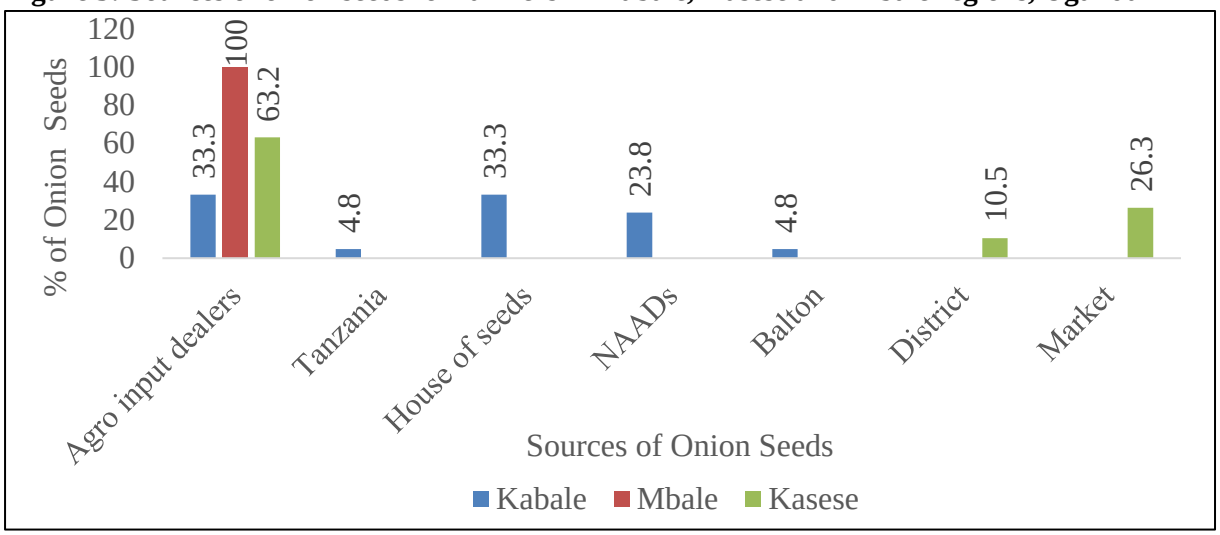
Onion Planting Seasons and Sources of Seeds

The planting seasons for the Mbale region were January - February for the S-Zee variety, August - September for Red Creole and Hybrid, February-March for Kabale farmers and July-August for Kasese farmers. The majority of the farmers got their seeds from Agro input dealers: Kabale 7(33.3%), Mbale 11(100%) and Kasese 12(63%). However, other sources included the House of Seeds, NAADS, and markets (*Figure 3*).

Figure 3: Sources of onion seeds for farmers in Kabale, Kasese and Mbale regions, Uganda



Commonly grown varieties had relatively cheaper seeds: 250g of Red creole cost 50,000 Ugandan shillings (USD 14), and 36,000 shillings (USD 16.1) for Bombay red, as compared to Malbec and Red coach, which were sold 400g at 350,000 shillings (USD 98.2) and 330,000 shillings (USD 93) respectively). In addition, they also have a long shelf life, marketability, higher bulb yield and earliness, and strong pungency coupled with resistance to diseases.

Crops Interspersed with Onion Farms

The major crops interspersed with onion fields in all the regions were beans, maise, and banana, while only one farmer in Kabale interspersed with soya beans, passion fruits, and sweet potatoes. A farmer in Kasese interspersed onion with avocado (*Table 3*)

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Table 3: Crops commonly interspersed with onion gardens in the different regions

Crop	Region (% farmers)		
	Kabale	Kasese	Mbale
Bananas	20.0 (4)*	52.6 (10)	27.3 (3)
Coffee	0.0 (0)	21.1(4)	36.4 (4)
Cabbage	0.0 (0)	0.0 (0)	18.2 (2)
Cassava	10.0 (2)	31.6 (6)	9.1 (1)
Beans	75.0 (15)	36.8 (7)	45.5 (5)
Maise	20.0 (4)	57.9 (11)	36.4 (4)
Sorghum	15.0 (3)	0.0 (0)	0.0 (0)
Ground nuts	20.0 (4)	0.0 (0)	9.1 (1)
Irish potato	35.0 (7)	0.0 (0)	9.1 (1)
Avocado	0.0 (0)	5.3 (1)	0.0 (0)
Tomatoes	5.0 (1)	15.8 (3)	9.1 (1)
Eucalyptus	5.0 (1)	10.5 (2)	9.1 (1)
Yams	0.0 (0)	5.3 (1)	9.1 (1)
Passion fruits	5.0 (1)	0.0 (0)	0.0 (0)
Eggplant	0.0 (0)	5.3 (1)	0.0 (0)
Sukumawiki	0.0 (0)	0.0 (0)	36.4 (4)
Sweet potatoes	5.0 (1)	0.0 (0)	0.0 (0)
Rice	0.0 (0)	31.6 (6)	0.0 (0)
Soya beans	5.0 (1)	0.0 (0)	0.0 (0)

**Actual number of farmers (in brackets)*

Farmer and Customer Preference of Onion Varieties

Red Coach was the most preferred variety by both farmers and customers in the Kabale region by 46.2% and 70.6%, respectively. Those from Kasese preferred Red creole and Bombay red. In contrast, Mbale farmers preferred Red creole, while the customers preferred the Hybrid variety (*Table 4*). Hazera grown only in the Rukiga district in the Kabale region was neither preferred by farmers nor customers.

Table 4: Percent preference of onion varieties by farmers and customers

Reason	Variety	Region		
		Kabale	Kasese	Mbale
Most preferred by farmers	Tanzania	19.2 (5)*	0.0 (0)	0.0 (0)
	Bombay red	15.4 (4)	42.1(8)	0.0 (0)
	Red coach	46.2 (12)	0.0 (0)	0.0 (0)
	Red Creole	0.0 (0)	58.0 (11)	52.9 (9)
	No preference	19.2 (5)	0.0 (0)	17.6 (3)
	Hazera	0.0 (0)	0.0 (0)	0.0 (0)
Attracts customers most	Tanzania	5.9 (1)	0.0 (0)	0.0 (0)
	Bombay red	5.9 (1)	42.1 (8)	0.0 (0)
	Red coach	70.6 (12)	0.0 (0)	0.0 (0)
	Red Creole	0.0 (0)	57.9 (11)	0.0 (0)
	Hybrid	0.0 (0)	0.0 (0)	29.4 (5)
	Hazera	0.0 (0)	0.0 (0)	0.0 (0)
	Malbec	17.6 (3)	0.0 (0)	0.0 (0)

**Actual number of farmers/customers (in brackets*

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Use of Fertilisers, Number of Times of Weeding and Onion Production

The highest usage of artificial fertilisers was in the Kasese region (72.7%), and the lowest was in Mbale with 50%. The $\chi 2$ test showed no significant difference across regions (p>.05). Use of artificial fertilisers to improve production cut across all the study regions (*Table 5*), farmers who could not afford to use local organic manure.

Table 5: Use of artificial fertiliser in the onion farms

Response	Region and Percent use			Chi-square	p-value
	Kabale	Kasese	Mbale		
Yes	57.1	72.7	50.0		
No	42.9	27.3	50.0	1.506	.471
Total	100	100	100		

According to Mbale farmers, some onion varieties could not be grown without using fertilisers, e.g., Bombay red and Red creole. The fertilisers applied by the farmers in all the sites included Di-ammonium Phosphate (DAP), Nitrogen, Phosphorous and Potassium (NPK) and Urea. The use of fertilisers was a welcome development, especially in Kasese, which recorded production of an average mean of 6,329.9kg per season, against Kabale with 1,665.0 kg (*Table 6*).

The mean number of weeding was highest in Kabale, with 4.84 and lowest in Mbale (3.88). One-way ANOVA revealed the difference was not statistically different p=.154. The quantity of onion produced per season ranged from 1,655.3-6,329.9 kg, with Kasese ranking highest and Kabale the lowest (*Table 6*), and the quantities did not vary significantly (p = .297).

Table 6: Number of times farms were weeded and production of onion

		N	Mean	Std. Dev	Min.	Max.	F	P-Value
Number of times of weeding	Kabale	20	4.84	1.675	2	8	1.954	.154
	Mbale	8	3.88	1.808	1	5		
	Kasese	19	4.05	.999	2	6		
	Total	47	4.34	1.478	1	8		
Quantity of onions (in kg) produced per season	Kabale	19	1655.3	1527.2	300.0	6000.0	1.250	.297
	Mbale	9	3477.8	3682.8	450.0	10000.0		
	Kasese	18	6329.9	14034.5	360.0	60000.0		
	Total	46	3841.1	9070.6	300.0	60000.0		

Access To Credit Facilities, Agricultural Extension Services and Farmers' Groups

There was limited access to key services: credits, agricultural extension services and farmers' groups, and only to Kabale and Kasese regions. All these services were highest in the Kasese region. None of the farmers in the Mbale region had access to any of these facilities. The results of the chi-square show highly significant variation (P<.05) among the Kabale and Kasese regions regarding access to credits (*Table 7*).

Table 7: Access to services: credits, extension services and farmers' groups

Access		Region (% access)			Chi-square	p-value
		Kabale	Mbale	Kasese		
Have access to credits	Yes	57.9	0	59.0	10.688	.005
	No	42.1	0	42.1		
Have access to extension workers	Yes	30.0	0	47.4	1.242	.265
	No	70.0	0	52.6		
Belong to any farmer's group	Yes	20.0	0	47.4	3.284	.070
	No	80.0	0	52.6		

Article DOI : https://doi.org/10.37284/eajab.6.1.1262

Onion Diseases and Pests

The results show that purple blotch, downy mildew, caterpillars, and thrips were the diseases/pests affecting the crop in the study sites, with Kabale reporting 5/6 parameters studied. However, purple blotch was the most familiar and destructive disease symptom in the sites surveyed; Kabale recorded the lowest rate (15.8%) and was highest in Mbale (100%). Thrips (44.8%) and caterpillars (50%) were recorded as the major pests (*Table 8*).

Table 8: Type of onion diseases/pests recorded in the regions

Disease / Pest	Region and % response			Total
	Kabale	Kasese	Mbale	
No diseases/pests	36.8	0.0	0.0	36.8
Purple blotch	15.8	38.9	100.0	154.7
Downy mildew	15.8	0.0	0.0	15.8
Thrips	10.6	0.0	34.2	44.8
Do not know the name	21.1	11.1	0.0	32.2
Caterpillars	0.0	0.0	50.0	50.0

Control of Onion Diseases/Pests

The application of chemicals was very high and was applied depending on the growth stage of the crop and disease intensity. This was 100% in the Mbale region and lowest in Kasese with 88.3%. Other methods of control included crop rotation, ridges making, and manure application (*Table 9*). The most common chemicals used were Rodimil, Mencozeb, Dithene and Rocket.

Table 9: Methods used by farmers to control onion purple blotch disease

Method	Region and % response		
	Kabale	Kasese	Mbale
Chemicals control	90.9	88.3	100.0
Crop rotation	9.1	0.0	0.0
Ridges making	0.0	5.9	0.0
Manure application	0.0	5.9	0.0
Total	100	100	100

DISCUSSION

Major Onion Growing Regions, Varieties Grown, Acreage, Onion Seasons, and Sources of Seed

The results presented here represent the first extensive studies on onion growing in Uganda. The Kabale region emerged as the largest onion-growing region in Uganda, while Kasese and Namisindwa districts had the highest yields. Altogether eight (8) onion varieties were recorded; Red creole was the most-grown variety in all three regions, followed by Bombay red in two regions. The preference for these two varieties may be attributed to the relatively cheaper seeds, marketability, higher bulb yield and earliness coupled with resistance to diseases. The statement agrees with the findings of Kimani *et al.* (1991), who reported the Red Tropical F1 hybrid yielded the best among the locally grown varieties, which included Red creole. Musokya (2012) reported nine (9) varieties grown in Uganda: Jamba, Red creole, Red cornet, Bombay red, Afri seed, Pearl, Red passion, Red coach and Texas grano. The discrepancy may be because there is a tendency to have other varieties in different parts of the country.

Land allocated for onion production was significantly variable and ranged from a mean average of 0.64 (0.26 ha) to 1.94 (0.785 ha); it was highest in the Kasese region, which also had the highest yields. Aklilu *et al*. (2015) reported average land allocation to onion production between 1.1 to 1.7 ha in Amibara and Fentale in Ethiopia, generally larger farms than in this study. According to FAO (2004), these are Smallholders,

Article DOI : https://doi.org/10.37284/eajab.6.1.1262

small-scale farmers who manage areas <1-10 hectares.

The main planting season for the Mbale region was August - September for Red Creole and Hybrid, February-March for Kabale farmers and July-August for Kasese farmers. Teshome *et al.* (2014) in northern Ethiopia showed a significant effect of planting dates, where bulbs planted in October had better growth, yield, and quality than those planted in November, the plausible reason for the varying planting seasons in the study regions.

The majority of the farmers got their planting materials from Agro input dealers and three other major sources. Malbec was about x20 the cost of Red creole and Bombay red seeds, and the quality of those purchased from illegitimate sources was not known. These findings are in line with Baliyan (2014), who showed that when seeds of improved onion varieties are expensive and hard to obtain, onion farmers go for cheaper varieties which may be less productive. The results are also in agreement with Mamiro *et al.* (2014), who reported that the cost of seeds in onion production differed a lot in Tanzania. Farmer's own produced seeds were sold between TSh. 5,000/= (US$ 2.14) and 20,000/= (US$ 8.57) per one litre-tin (approximately 1kg). Seeds from other sources like Arusha and other agro-dealers were relatively expensive, with prices as high as TSh. 200,000 (US$ 86.39) per kg.

Crops Interspersed with Onion Farms

Beans, maise, and bananas were the major crops commonly interspersed with onion fields in all the sites. Ramertg and Lennartsson (2002) showed that intercropping crops with onion gardens reduce the proportion of susceptible host tissues and production, therefore, impacting the amount and efficiency of the disease inoculums and reducing the spread and development of the disease. It may also serve as an alternative to farmers instead of total loss in case of a bad harvest.

Customer Preference for Onion Varieties

The red coach was the most preferred variety by customers in the Kabale region, and the Red creole in both Mbale and Kasese regions. This is in agreement with Miruts *et al.* (2021) in the Central Rift Valley area of Ethiopia; customers preferred the Nafis variety to Nasik Red and Bombay Red because of its marketability, deep red colour, medium bulb size, pungency, and longer shelf life.

Use of Fertilisers, Number of Times of Weeding and Onion Production

Though statistically insignificant, the use of artificial fertilisers cut across all the study regions with Kasese that had the highest yields reporting the highest use. This is in line with Islam *et al.* (2017), who showed that organic fertilisers support and sustain healthy ecosystems, food production and overall economy in terms of human health. Fatideh and Asil (2012) reported that the use of nitrogen fertiliser at a level of 150 kg/ha produced more bulbs and gave a high dry matter yield. The mean number of weeding was 3.88-4.84, much higher than the recommendation by MoARD (2005) from 2-3 times: the initial weeding from 15 days from transplanting, the next at 30 days after transplanting, and the third 50 days after transplanting, to loosen the soil around the root zone. The higher number of weeding tends to produce crops of high quality and quantity.

Access to Credit Facilities, Agricultural Extension Services and Farmers' Groups

The results of the chi-square show a highly significant variation $p<.05$ as regards access to credit facilities. A few farmers in Kabale and Kasese were able to access credit facilities to fund onion cultivation, albeit at exorbitant interest rates. They also had access to agricultural extension services and farmers' groups. Farmers in the Mbale region had no access to all these services, though they had higher yields than Kabale. This is in disagreement with Rahimeto (2007), who stated that it is very important to strengthen and expand credit facilities for a

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farming community. Mesfin (2005) reported that access to agricultural extension services increases production and is a key determinant of the adoption of new knowledge and the use of modern technologies and farming practices (IFPRI, 2010). This is not true in all cases.

Diseases and Pests

Diseases and insect pests were recorded in all three study regions, with purple blotch disease at 100% in Mbale. This is in agreement with Islam *et al.* (2001), who stated that purple blotch is a major disease throughout the world, and Yadav *et al.* (2013b), who indicated it is among the most common destructive diseases. Most of the farmers were not aware of the disease associating the symptoms with overuse of chemicals, thrips, aphids, maggots, heavy continuous rainfall, and wind spread in the farms. This was partially true since its spores are spread by wind, even in the absence of rain, and mostly by splashing water (Schwartz & Mohan, 2008). Diaz *et al.* (2011) showed that thrips infest the crop at an early stage, causing twisting and curling of leaves. According to Mbale farmers, the damage due to thrips infestation caused a serious reduction in yields. Agegnehu *et al.* (2013) noted onion thrips and cutworms as the most common and important insect pests of onions for smallholder farmers. In Kasese, where the infestation was minimal, the yields were highest at 6,329.9 kg per season, against Kabale, where the effect was higher and had the lowest yield of 1,655.3 kg. They also affect the harvest, processing, and marketing stages for the local and export market (Mishra *et al.*, 2014).

Methods of Onion Disease/Pest Control

The use of the chemicals Rodimil, Mencozeb, Dithene and Rocket ranged from 88.3-100%. This is in line with Jhala*et al.* (2017), who showed that mencozeb, difenaconazole, tebuconazole and azoxystrobin were effective in controlling purple blotch. Abdel *et al*. (2013) recorded 100 % mycelial inhibition of *A. porri* with mencozeb (0.3%) and propineb (0.3%) under in vitro conditions. Desalegn and Aklilu (2003) recommended the use of fungicides Mencozeb and Rodimil at 3.5 kg per ha mixed with 600 litres of water.

CONCLUSION

The main onion-growing regions in Uganda were Kabale, Kasese and Mbale with Kabale as the main region, Kasese and Namisindwa districts having the highest production. Eight onion varieties were grown with Red creole being grown in all the regions. Most of the farmers were small-scale peasant farmers with the highest mean acreage of 1.94 in the Kasese region. The main source of agricultural materials, i.e., onion seed, organic fertilisers, and chemicals, was agro-input dealers, and farmers sourced the most affordable. Beans, maise, and bananas were the major crops neighbouring onion gardens. The use of artificial fertilisers to improve onion production cuts across most of the farms as a key input. Only farmers in Kabale and Kasese had access to credit facilities, extension workers and farmers' groups. Onion yield was hindered by purple blotch disease and was found in all the areas surveyed, 100% in Mbale. However, diseases and pests were the major problems in the Kabale region, which had the lowest onion yield.

Recommendations

- Cultural practices. Farmers should buy seeds from certified sources. Sanitation of the farms should be done immediately after harvesting to get rid of resting sites for pests and diseases. Thrips are the most important insect pest of onion. Other means to reduce pests should be sought since farmers are weary of the overuse and misuse of agricultural chemicals like pesticides, and organic fertilisers should be encouraged.
- Farmers should exercise judicious use of chemical control to minimise negative effects on the environment.
- Agricultural extension programmes and credit facilities should be adequately provided by the government to support the farmers.

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- More research work is needed as regards to effective control of onion purple blotch disease in all the varieties grown in Uganda.
- The National Agricultural Research Organisation should utilise these findings to prioritise the onion crop.
- The Kasese region with the lowest use of agricultural chemicals, the highest use of organic fertilisers, the highest weeding, and access to credit facilities, had the best onion farming practices since it had the highest yields. Other regions should emulate and use it as the model region.
- Government should provide farmers with subsidies to obtain inorganic fertilisers and high-quality seeds etc.

ACKNOWLEDGEMENTS

We are highly indebted to the Tertiary Education Trust Fund (Nigeria) and the management of Federal University Dutsinma Katsina for sponsoring the study. We also take this opportunity to thank the management, drivers, and technical staff of the National Crops Resources Research Institute (NaCRRI), and National Agricultural Research Organization (NARO), who was involved in the fieldwork, lab work and screen house experiments. Special thanks go to the Doctoral committee members and technical staff of the Molecular lab at the Department of Plant Sciences, Microbiology and Biotechnology, Makerere University. All those involved in other capacities to support this research are highly appreciated.

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