

Full Length Research Paper

Assessing the effect of farmers' practices on the severity of groundnut rosette virus disease in Uganda

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Groundnut rosette virus disease is the most destructive disease of groundnut in Sub-Saharan Africa, Uganda inclusive. Over the past years, a wide range of management options for this disease have been developed and recommended for farmers in Uganda. Relevant efforts have also been made by researchers in disseminating improved technologies to farmers in several parts of the country. However, questions on the extent to which farmers are currently utilizing these technologies and their effectiveness in controlling the disease in their fields remain unanswered. This study aimed at assessing the effect of farmers' practices on the severity patterns of groundnut rosette virus disease in Uganda. A survey was conducted within five agro-ecological zones in Uganda to obtain information on the various practices farmers employ in the management of the crop and disease in their fields using a structured questionnaire. Disease severity was scored in each farmer's field. Farmers were found to be employing a range of practices in groundnut production, including: early sowing, intercropping, use of improved groundnut genotypes, crop rotation; and uprooting and burning diseased plants among others. However, only two management practices: early sowing and use of improved varieties were found to significantly ($P < 0.05$) reduce rosette severity in groundnut fields. Special consideration should therefore be given to these two GRVD management strategies while developing and promoting management packages for this disease.

Key words: Groundnut, rosette, incidence, severity, farmers, management.

INTRODUCTION

The groundnut (*Arachis hypogaea* L.), also known as peanut, is the second most important food legume in Uganda after beans (*Phaseolus vulgaris* L.) (UBOS, 2013; Okello et al., 2014). It is a very popular crop, especially in the eastern and northern regions of the country where it has become part of the peoples' culture (Mahmoud et al., 1991). Its production however, has

been constrained by numerous factors including pests and diseases, unreliable rains with recurrent droughts, poor agronomic practices, low access to high yielding cultivars and low levels of input use (Mahmoud et al., 1991; Adipala et al., 1998; Okello et al., 2013). This situation has led to extremely low yields at farmer level averaged at 0.8 tons per hectare of dried pods which is in

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contrast to yields as high as 2.5 to 3.0 tons per hectare reported at research stations within Uganda and other countries with developed agriculture (ICRISAT, 1986; Busolo-Bulafu, 2004; Okello et al., 2014).

Groundnut rosette virus disease (GRVD) is the most destructive disease of groundnut in Uganda. Over the past years, a wide range of management options for GRVD have been developed and recommended for farmers in the Uganda (NARO, 2001; Adipala et al., 2001; Okello et al., 2013, Okello et al., 2014). These include the use of improved varieties, chemical control, and cropping practices that delay the onset and spread of GRVD such as early sowing, maintaining a dense uniform stand of groundnuts, close spacing (45×15 and 30×10 cm) and removal of wild hosts. Relevant efforts have also been made by researchers from the National Groundnut Improvement Programme- at National Semi-Arid Resources Research Institute (NaSARRI) Serere and Makerere University in disseminating these research technologies to farmers in several parts of the country (Adipala et al., 2002; Okello et al., 2014). However, questions on the extent to which farmers are currently utilizing these technologies and their effectiveness in GRVD control in their fields remain unanswered. Thresh (2003) emphasized that much detailed research and a thorough knowledge of farming practices is required before an effective integrated virus disease management programme can be developed and promoted because virus spread within a given crop is facilitated by some cropping practices and impeded by others. This study aimed at investigating the current practices being employed by farmers in GRVD management and to what extent they are influencing disease severity.

MATERIALS AND METHODS

Study area

A survey was conducted in 2012 that covered 5 major groundnut producing agro-ecological zones (AEZ) of Uganda including the Lake Victoria Crescent, Kyoga Plains, South Western Farmlands, North Eastern Savannah Grasslands and the North Western Savannah Grasslands. In each zone the districts, sub counties and parishes were selected purposively based on production levels, giving preference to those which produced more groundnuts. Farmers that participated in the study were randomly selected with the help of field assistants based in the respective areas. Farmers' fields were monitored over a period of two weeks and the level of GRVD severity was visually assessed in each field and recorded. This was done when the groundnut crop in farmers' fields were between the stage of pod filling and physiological maturity.

Data collection and analyses

A structured questionnaire was developed and used to obtain information on the current management practices employed by farmers in groundnut production. In each farm, 10 plants were randomly selected. Severity of GRVD was scored using a scale of 1 to 9 based on the intensity of disease attack according to the scale: 1-3 = Low severity (mild rosette/less than ¼ of entire groundnut

plant stunted).

4-6 = Moderate severity (moderate rosette/between ¼ and ¾ of plant stunted).

7-9 = High severity (severe rosette symptoms /more than ¾ of plant stunted).

The average severity score for each field was then computed. Data on farmers' management practices and severity for each field were entered and analyzed using the Statistical Package for Social Scientists, 15th edition (SPSS Inc., 2006). Regression analysis was carried out to establish the relationship between the management practices employed by farmers and GRVD severity. Linear regression was run with disease severity as the dependent variable and the management practices as the independent variables. Descriptive statistics such as frequencies and percentages were obtained for all continuous variables. Graphs and charts were also generated from the data using an excel program (Microsoft Office, 2007).

RESULTS

General characteristics of respondent farms and practices used

Of the 105 farmers interviewed during this study, 44 (42%) were male and 61 (58%) were female. Farmers planted groundnuts on an average acreage of 0.58 acres, with the majority (81.6%) operating on acreages less than 0.5 acre. A very small percentage of farmers (1.8%) planted groundnuts on land exceeding 1 acre. The most dominant ploughing method used by groundnut farmers was the hand hoe (94%) whereas fewer farmers used tractors (7%) or oxen (4%) in their fields.

Farmers in all the five agro-ecological zones visited used a wide range of plant spacings, ranging from 40 × 20 cm to 75 × 50 cm. However the majority (52%) of groundnut farmers did not use any particular spacing. Most of the farmers purchased their seeds from either the local market, input suppliers or from fellow farmers (48.6%) while 35.2% used seed they had saved from the previous harvest. Some farmers (16.2%) obtained improved seed from either NARO or the NAADS sub-county offices in the surrounding area (Figure 1).

With regard to cropping system, 65% farmers intercropped groundnut with other crops including: Maize (42%), cassava (27%), perennials (21%) and legumes (7%) (Figure 2). Minor crops (3%) not indicated in the chart but found intercropped with groundnuts included: vegetables, sorghum, okra, potato, simsim and millet.

Groundnut varieties being grown by farmers included the Serenut series, specifically Serenut 1, 2, 3 and 4 (34%). The main local varieties grown by farmers included: Red beauty (21%) and Erudurudu (16%); others included Igola, Etesot, Egoromoit, Kabonge and Omgwere (Figure 3).

Improved varieties (mainly of the Serenut series) were mainly grown in the Kyoga plains (Pallisa and Kumi districts) and the North Eastern (Lira district) and North Western (Arua district) savannah grasslands. Farmers in the Lake Victoria Crescent (Jinja and Kayunga districts)

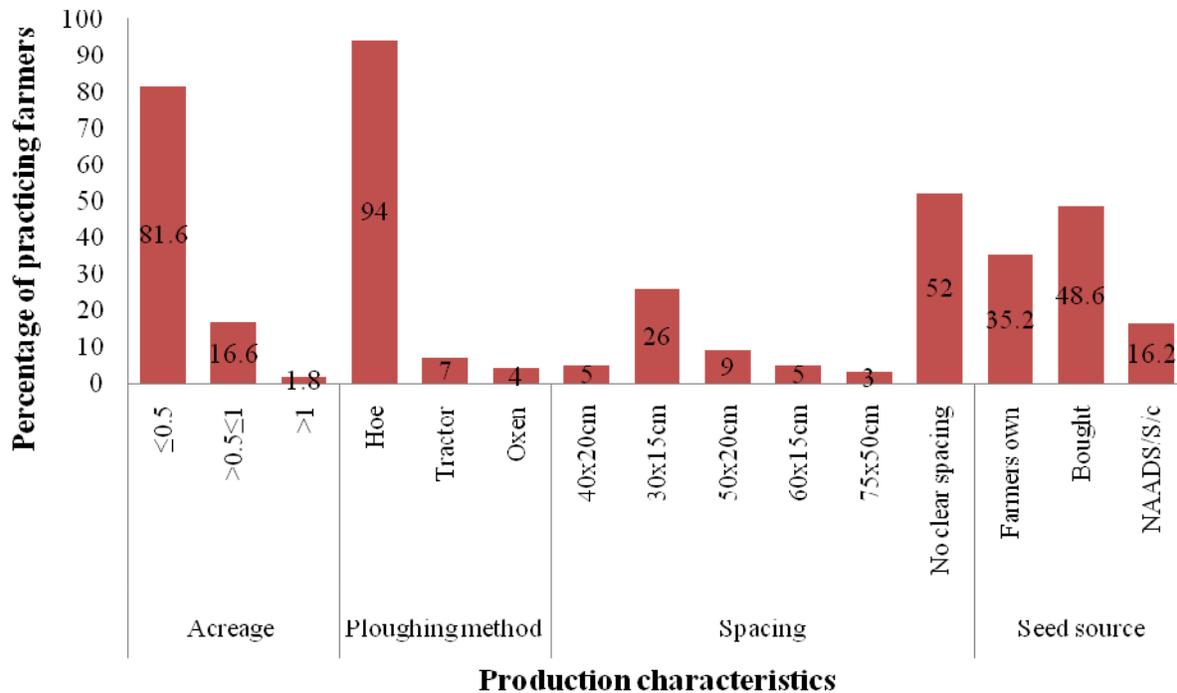


Figure 1. Groundnut production characteristics of farmers' fields visited during survey.

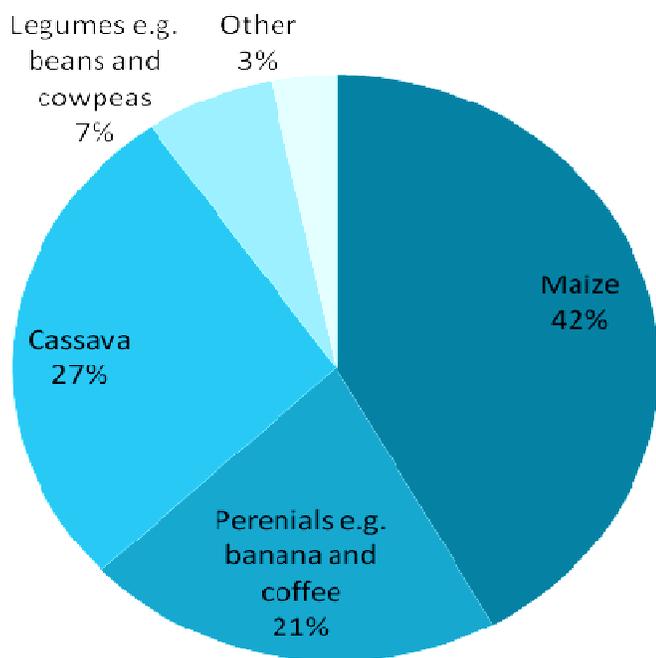


Figure 2. Major groundnut intercrops observed in the study.

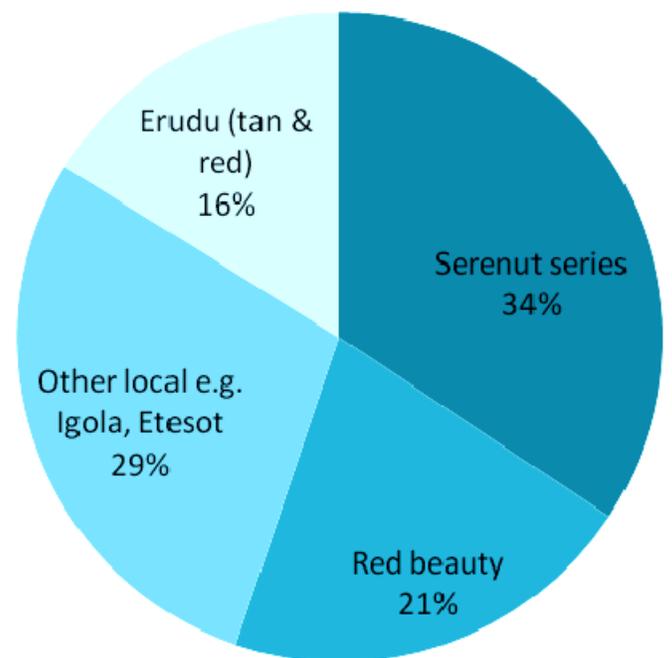


Figure 3. Major groundnut varieties planted by farmers in Uganda.

and South Western Farmlands (Mbarara district) were primarily planted local varieties (Figure 4). Different plant times were used by farmers; at the time of the survey groundnut was at different levels of physiological maturity

with most (58.1%) of the crop at flowering stage, 23.8% had attained harvest maturity and 18.1% were in the pegging and pod filling stage (between flowering and maturity).

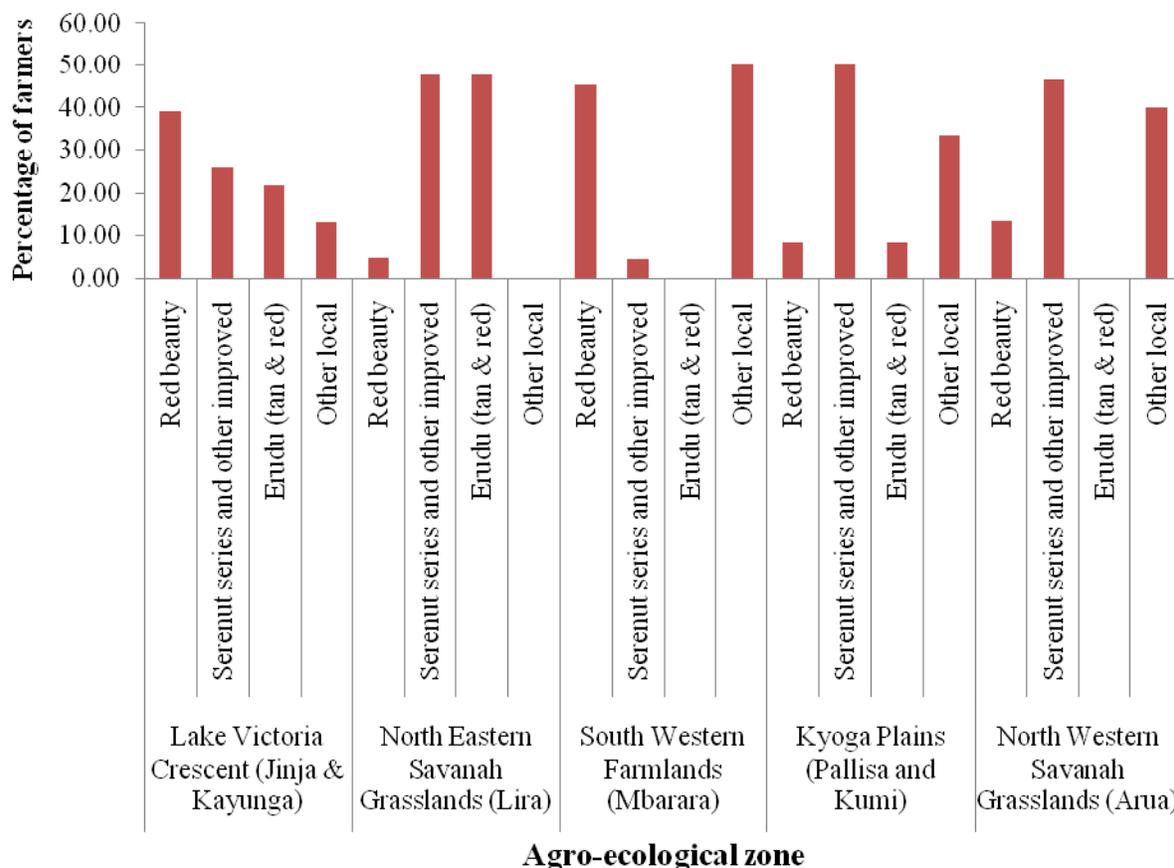


Figure 4. Groundnut varieties grown in the different agro-ecological zones.

Trends of GRVD severity within five agro-ecological zones of Uganda

Results of the survey revealed that 41% of the fields visited had moderate levels of GRVD severity whereas 52.4% exhibited low levels of disease severity. Only 6.7% of the fields visited were severely affected by GRVD. Among the fields that were severely affected by GRVD, 50% were from the Lake Victoria Crescent agro-ecological zone, 25% from the Kyoga plains and only a few from the North Western Savannah grasslands (8.3%), North Eastern savannah grasslands (8.3%) and South Western Farmlands (8.3%) (Figure 5).

Management practices employed by farmers in groundnut production

Farmers employed a range of practices in groundnut production which included: early planting, use of improved varieties, intercropping, pesticide application, crop rotation, uprooting and burning diseased plants and fallowing among others (Table 1). Among the recommended GRVD management practices, early sowing was the most common and was being practiced

by 80% of the farmers, the majority of whom were women (Figure 6). Pesticide application was the least employed, with only 7.6% of farmers interviewed implementing it. Improved varieties such as the Serenut series were being used by 35.2% of the farmers interviewed while 64.8% of farmers planted local varieties such as Etesot, Egoromoit and Kabonge.

Forty percent of the farmers practiced crop rotation in their fields while 31.4% reported that they carry out fallowing in their gardens. Among the farmers interviewed, 34.3% reported that they uproot and burn diseased plants, especially during the time of weeding. A larger number (59%) of farmers weeded their gardens twice during the growing season while 37.1% weed only once during the season and 3.8% carried out hand weeding three times during the growing season. Other practices that were rarely practiced by farmers included fertilizer application (8.6%), mulching (2.9%) and herbicide use (1.9%).

Relationship between farmers' management practices, gender and GRVD severity

The ANOVA for regression analysis of farmers

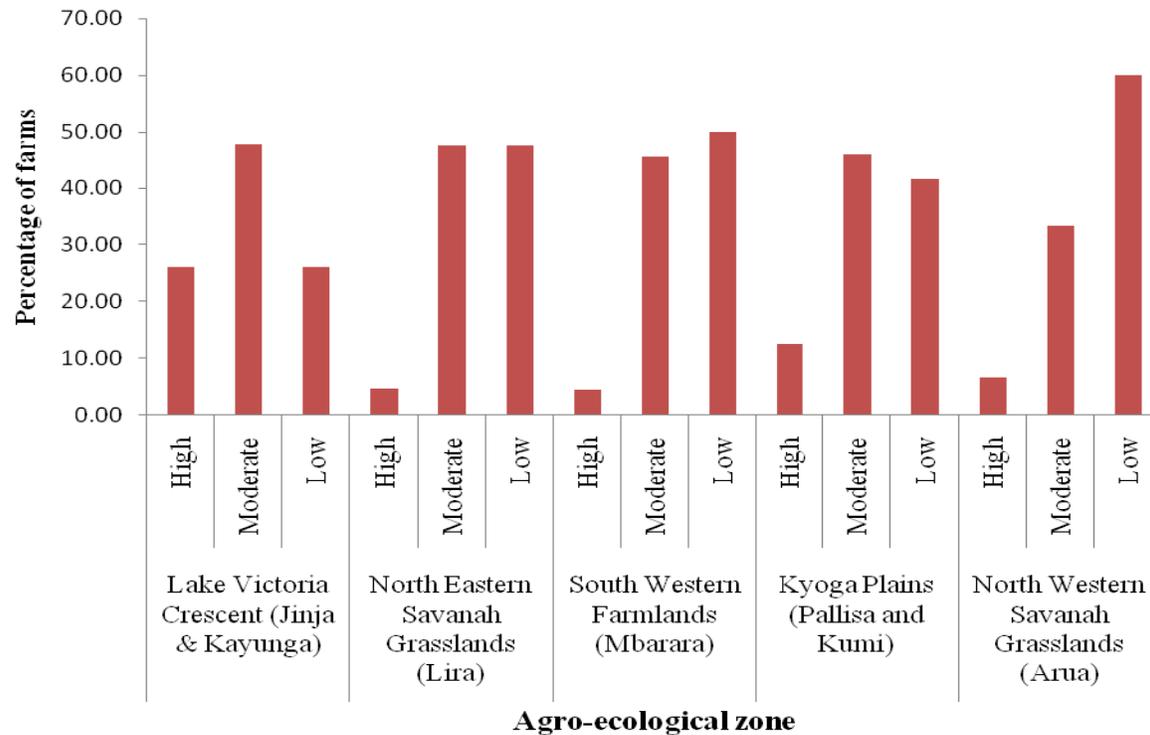


Figure 5. GRVD severity trends within five agro-ecological zones.

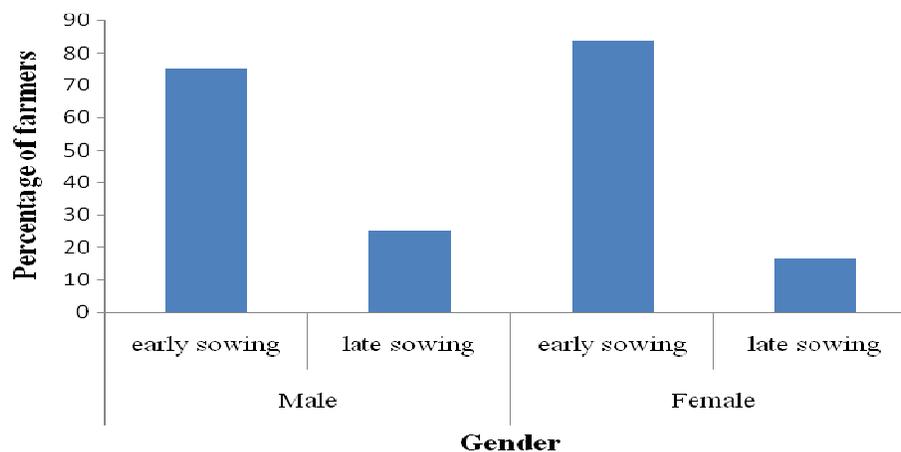


Figure 6. Planting times for female and male farmers obtained during the survey.

management practices, their gender and GRVD severity revealed that management practices and gender significantly ($P \leq 0.05$) affected GRVD severity. The model obtained from linear regression revealed that planting date, variety planted and gender were the only variables that significantly ($P \leq 0.05$) affected GRVD severity in farmer fields. Variables which were found to have no significant effect on disease severity ($P \leq 0.05$) included: crop rotation, uprooting and burning diseased plants, pesticide application, fertilizer application, mulching,

number of times the crop is weeded and fallowing among others (Table 2). A summary of the model is expressed in the following regression equation:

$$\text{GRVD severity} = 3.7 - 0.3 \text{ gender} + 0.3 \text{ planting date} - 0.6 \text{ variety planted}$$

The equation implies that, holding all other factors constant, GRVD severity is lower for female managed gardens compared to male managed gardens. In

Table 1. Management practices currently employed by groundnut farmers in Uganda.

| Management practices | | No. of practicing farmers | Marginal percentage (%) |
|--------------------------------------|----------------|---------------------------|-------------------------|
| Variety planted | Improved | 37 | 35.2 |
| | Local | 68 | 64.8 |
| Weeding regime | Once | 39 | 37.1 |
| | Twice | 62 | 59.0 |
| | Thrice | 4 | 3.80 |
| Intercropping | Yes | 68 | 65.0 |
| | No | 37 | 35.0 |
| Pesticide application | Yes | 8 | 7.60 |
| | No | 97 | 92.4 |
| Fertilizer application | Yes | 9 | 8.60 |
| | No | 96 | 91.4 |
| Crop rotation | Yes | 42 | 40.0 |
| | No | 63 | 0.0 |
| Uproot and burn diseased plants | Yes | 36 | 34.3 |
| | No | 69 | 65.7 |
| Fallowing fields | Yes | 33 | 31.4 |
| | No | 72 | 68.6 |
| Planting date | Early planting | 84 | 80.0 |
| | Late planting | 21 | 20.0 |
| Other (e.g. mulching, herbicide use) | Yes | 5 | 4.80 |
| | No | 100 | 95.2 |
| Total | | 105 | 100 |

particular, the GRVD severity in female managed gardens is lower by 34.99% ($[(e^{0.3}) - 1] * 100$) in comparison to male managed fields. A delay in planting (late planting) increases GRVD severity by 34.99% ($[(e^{0.3}) - 1] * 100$) compared to early planting. GRVD severity is 82.2% ($[(e^{0.6}) - 1] * 100$) higher in local varieties compared to improved varieties.

DISCUSSION

This study was aimed at assessing the effect of farmers' management practices on the severity of GRVD in Uganda. Farmers were found to be utilizing a range of management practices. However, these practices influenced GRVD severity in different ways and to different degrees. Results revealed that it was planting date (early planting vs. late planting) and variety planted (improved vs. local) which significantly ($P < 0.05$) affected GRVD severity. Farmers who planted their groundnuts during the earlier part of the season had significantly

($P < 0.05$) less GRVD affecting their groundnut crop compared to those who planted late. The same was also true for farmers who used improved varieties in comparison to those who planted local varieties. Improved varieties (Serenut series) have host plant groundnut rosette resistance (Okello et al., 2014). Earlier research (Farrell, 1976a) reported that farmers seldom practice early sowing of groundnuts since they prefer sowing their main staple food crops first. The results of this study, however, are divergent from this report. Out of all the farmers interviewed, 80% reported that they had planted their groundnuts at the start of the rainy season and the lesser 20% planted later along the season. It possible that over the years, some farmers may have realized through experience that late sown crops end up more severely affected by GRVD and has therefore chosen early sowing as one of the practices for disease management. Different researchers have reported that GRVD incidence is generally low when groundnuts are planted early in the season compared to the late sown crop (Farrel, 1976b; Subrahmanyam and Hildebrand,

Table 2. Regression results for the relationship between farmer management practices, gender and GRVD severity.

| Regression model ^a | Coefficients | Std. Error | t-value | p-value |
|-------------------------------|--------------|------------|---------|---------|
| (Constant) | 0.715 | 3.725 | 5.210 | 0.000 |
| Gender | 0.108 | -0.284 | -2.619 | *0.010 |
| Planting date | 0.142 | 0.294 | 2.067 | *0.042 |
| Variety planted | 0.113 | -0.621 | -5.491 | *0.000 |
| Weeding regime | 0.098 | 0.010 | 0.104 | 0.918 |
| Fertilizer application | 0.188 | 0.243 | 1.293 | 0.199 |
| Pesticide application | 0.200 | -0.050 | -0.250 | 0.803 |
| Herbicide application | 0.398 | -0.372 | -0.935 | 0.352 |
| Crop rotation | 0.110 | -0.068 | -0.614 | 0.541 |
| Uproot and burn | 0.113 | 0.116 | 1.025 | 0.308 |
| Fallowing | 0.124 | -0.114 | -0.919 | 0.360 |
| Mulching | 0.318 | -0.346 | -1.085 | 0.281 |

^aDependent variable: disease severity in field; *Significance at 5% level.

1994; Naidu et al., 1999; Adipala et al., 2001; Okello et al., 2014). The early sown crops cover the ground before the aphids' main period of flight activity and largely escape infection because aphids prefer younger crops and often alight preferentially on widely spaced plants. The results of this study are in line with these findings; late planting was found to lead to an increase of 34.9% in GRVD severity compared to early planted crops in farmers' fields. Furthermore, experiments conducted on integrated management of groundnuts by researchers at the International Crops Research Institute for the Semi Arid Tropics (ICRISAT) (Subrahmanyam et al., 2000) as well revealed that using early sowing and improved genotypes in combination while planting at optimum plant population, exhibited the best performance of groundnuts under high disease situations. The results of this study, which show that use of improved varieties and early sowing are the two major practices that can significantly reduce GRVD severity in farmers' fields are consistent with their reports.

Gender, a variable that is not one of the management practices, was also found to affect GRVD severity significantly ($P < 0.05$), with female managed fields having less disease severity compared to male managed ones. This is probably because a greater percentage of women were found to be engaged in early planting compared to the men. Earlier reports have indicated that groundnut in Sub Saharan Africa and Uganda inclusive, are primarily produced by small holder farmers, the majority of whom are women (Naidu et al., 1999, VECO, 2011; Okello et al., 2014). This was confirmed in this study where the majority (81.6%) of groundnut farmers were found operating on acreages less than 0.5 acres and with a greater percentage being women (58%). This is also in line with reports that females make up approximately 75% of agricultural employment in Uganda (EPRC, 2009).

This study demonstrated that management practices such as intercropping, planting at close spacing, pesticide application and rouging did not significantly reduce the incidence and severity of GRVD in farmers' fields. Intercropping groundnut with crops such as beans and sorghum has previously been reported to be effective in reducing GRVD incidence (Farrell, 1976; Alegbejo, 1997). It is possible that intercropping was not found to reduce GRVD severity in farmers' fields because beans share aphids with groundnuts hence more GRVD. More still, farmers were practicing it in a haphazard manner, with no clear spacing which is in contrast to intercropping experiments in which recommended spacings were used. According to the survey results, 65% of the farmers were engaged in intercropping groundnuts with other crops such as maize and cassava. This is supported by reports by Okello et al. (2010), which indicated that the groundnut crop in Uganda is mainly grown as an intercrop with maize and cassava. Intercropping together with varietal mixtures are now recognized by agronomists and other researchers as forms of crop diversity that are important in providing farmers with some degree of resilience and stability that contribute to reliable yields and avoids total crop failure (Smithson and Lenne, 1996). Planting groundnut at close spacings (45×15 and 30×10 cm), has also been reported to lead to reduction of GRVD levels. During the survey, the closest spacings that farmers were found to be using were 40×20 cm (5% of the farmers) and 30×15 cm (26%), which differs from the recommended. The recommended spacing is that of national average pooled from major groundnut growing areas. Spacing has strong relation to the fertility of the land and the intercrop regiment. This could explain why they were not realizing any significant reduction in GRVD severity in their fields.

The use of pesticides for management of GRVD, though recommended, is associated with several

challenges. One is the fact that the relationships between viruses and their vectors are complex and a decrease in vector populations does not necessarily achieve a corresponding decrease in virus spread (Thresh, 2003). Improper use of pesticides has also been reported to alter the delicate balance between aphids and their natural enemies, possibly resulting into the development of insecticide resistant biotypes (Naidu et al., 1999). More still, financial constraints also limit the use of pesticides by small holder farmers. Thresh (2003), reported that it is inappropriate to promote the use of pesticides on subsistence crops whose value is seldom sufficient to cover the cost of treatment. In this study, only 7.6% of the farmers mentioned that they applied pesticides (Dimethoate) for aphid control at some point during crop growth. Financial limitations among the groundnut farmers, most of who cultivate on less than an acre of land, could have contributed to the lesser usage of this technique in GRVD management. In this study, results revealed that pesticide usage was not significantly reducing GRVD in the fields of farmers practicing this control technique. This could also be attributed to financial constraints since it has been reported that even farmers who opt for chemical control at times find it difficult to treat their crops throughout their entire vulnerable growth periods (Thresh, 2003). This could lead to unscheduled pesticide applications which may not be effective in GRVD control in the long run.

Roguing (uprooting of diseased plants) was being practiced by about 34% of the farmers. However, this approach has been reported to be most effective against viruses that do not spread quickly or far in any considerable amount (Putter, 1980), which is not the case for GRVD. Roguing has also been reported to be unpopular with some farmers who may not be prepared to allocate the time and effort required to inspect crops and identify and remove diseased plants or others who are reluctant to remove any diseased plants that may contribute some little yield (Thresh, 2003). This, to some extent, explains why this practice may not have significantly contributed to reduction in GRVD severity.

The highest levels of GRVD severity during the survey were recorded in the Lake Victoria Crescent agro-ecological Zone (LVCZ), confirming past reports that identified this location as one of the hotspots of the disease (Okello et al., 2010, 2014). Approximately 50% of the most severely affected fields were found to be located in this zone. Results of the survey revealed that improved varieties for instance Serenut 1, 2, 3 and 4, were majorly being grown in the northern and eastern areas of Uganda, with farmers in the LVCZ utilizing less of these varieties. Farmers within this zone mainly grew local varieties for instance Red Beauty, which are more susceptible to GRVD.

The high levels of GRVD in Jinja could therefore be partially attributed to the low utilization of improved varieties within the region compared to the Northern and

Eastern regions of Uganda. It has recently been reported that farmers in Eastern Uganda are more likely to acquire information regarding research outputs from external sources as compared to those in Busoga region where Jinja district is located (Thuo et al., 2014). The existence of a known hotspot for rosette in this zone, Nakabango, compounded with the use of landraces could exacerbate GRVD severity in the area.

CONCLUSION AND RECOMMENDATIONS

This study was aimed at evaluating the influence of farmers' management practices on the severity of GRVD. It was observed that farmers were utilizing a number of management strategies for the disease. However, only two major practices significantly reduced GRVD severity in their fields: early sowing (planting at the onset of the rains) and the use of improved varieties. Farmers' practices are therefore important factors influencing GRVD severity in groundnut fields. This information contributes to our understanding as to which practices farmers are currently employing in groundnut production in Uganda, to which extent they are being utilized and which particular ones are contributing significantly to the reduction of GRVD severity.

While promoting GRVD management packages, special attention should be given to the use of improved varieties and early sowing since they were found to be more effective in controlling GRVD in farmers' fields. Government agencies such as the National Agricultural Advisory Services (NAADS) and non-governmental organizations, which provide inputs to farmers and conduct trainings for farmer groups should emphasize the use of an integrated approach mainly based on the two cropping practices rather than a single practice such that farmers can exploit their synergistic interactions, thereby increasing the potential for GRVD management. Researchers on the other hand should continue to focus on developing improved varieties that have high levels of resistance to GRVD.

Conflict of Interest

The authors have not declared any conflict of interest.

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