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A survey of brassica vegetable smallholder farmers in the Gauteng and Limpopo provinces of South Africa

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Abstract

A study was taken to investigate the types of brassica vegetables mostly grown by smallholder farmers in two provinces of South Africa. Thirty-one smallholder vegetable farmers in the Gauteng province and Waterberg district in the Limpopo province were surveyed. In addition, the study also sought to establish the common diseases, the management strategies used and problems encountered by the farmers. Farmers were interviewed using a questionnaire with closed and open–ended questions. The results indicated that the smallholder farmers mostly grew cabbage (93.6 %) as their main brassica crop followed by rape (41.2 %). Thirty percent of farmers could not identify or name the predominant disease/s encountered in their fields. Major diseases encountered by farmers surveyed were an unknown disease/s (33.3 %), black rot (26.7 %), Alternaria leaf spot (6.7 %) and white rust (6.7 %). Smallholder farmers have inadequate technical information available especially relating to crop diseases, their identification and control. Farmers encountered challenges with black rot disease especially on cabbage, rape and kale and the disease was a problem during winter and summer. Generally, the smallholder farmers used crop rotation (74.2 %) as a major practice to manage the diseases experienced. They rotated their brassica vegetables with other crops/vegetables like tomatoes, onions, beetroots and maize. Most of the farmers interviewed (61.3 %) did not use chemicals to control diseases, whereas 38.7 % of them used chemicals. This was mostly because they lacked information and knowledge, high costs associated with use of chemical fungicides and some were shifting towards organic farming. From the study it was noted that there was a need for technical support to improve farmers' knowledge on disease identification and control within the surveyed areas.

Keywords: smallholder farmers, brassicas, pathogens, disease control

1 Introduction

Brassica vegetables including cabbage, broccoli, mustard, rape and turnips are an important group of crops grown by smallholder farmers in South Africa (KwaZulu-Natal Department of Agriculture and Environmental Affairs, 2005). Cabbage (*Brassica oleracea* var. *capitata* L.) is the most popular brassica crop grown by the farmers. Other leafy brassicas, such as kale (*B. oleracea* var. *acephala* L.), are cultivated mostly in peri-urban smallholder farms within the northern part of the country (Mariga *et al.*, 2012). The non-heading Chinese cabbage (*B. rapa* L. ssp. *chinensis*) is also grown by farmers in Limpopo province whereas rape (*B. napus* L.) is popular in Limpopo and Mpumalanga provinces. The production of these leafy brassica crops by smallholder farmers also extends to the Gauteng province (Jansen van Rensburg *et al.*, 2007). Brassica crops are an important source of food as they are rich in dietary vitamins and minerals. Within the urban and rural communities, cabbage, rape, kale and mustard are valuable sources

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of relish (Mhazo *et al.*, 2011; Rop *et al.*, 2009). Traditionally, smallholder farmers used to produce these vegetables for home consumption but recently production also includes marketing through informal local markets, fresh produce (urban) markets and chain stores (Department of Agriculture, Forestry and Fisheries, South Africa, 2012).

Brassica production by smallholder farmers can occur throughout the year especially for farmers that have access to supplementary irrigation or as winter cropping depending on the province. Although the farmers are trying to intensify the production of such vegetable crops in areas with irrigation to meet commercial levels, they experience pest and disease challenges. The diseases limit production, reduce crop yield and crop quality (van der Wolf *et al.*, 2008). Some of these diseases are seed-borne or seed-transmitted. Some of the diseases that affect brassicas grown by smallholder farmers include black rot and Alternaria leaf spot. Massomo *et al.* (2004) reported that in Tanzania black rot disease is a major challenge to cabbage production by the smallholder farmers. Rop *et al.* (2009) reported that black spot disease (Alternaria leaf spot) is a common disease of brassicas grown by smallholder farmers in Kenya. Black rot is a destructive seed-transmitted disease caused by the bacterium *Xanthomonas campestris* pv. *campestris* (Pammel) Dowson (Xcc) (Mguni, 1996; Wulff *et al.*, 2003). Alternaria leaf spot is caused by a complex of three species namely *Alternaria brassicicola* (Schwein.) Wiltshire, *A. brassicae* (Berk.) Sacc. and *A. japonica* Yoshii. Other diseases that can affect vegetable brassicas in South Africa include white rust (*Albugo candida* (Pers. Ex. Lev.) Kuntze), downy mildew (*Peronospora parasitica* (Pers. ex Fr) Fr.), black leg (*Phoma lingam* (Tode) Desm), club-root (*Plasmodiophora brassicae* Woronin), and bacterial leaf spot (*Pseudomonas syringae* pv. *maculicola*) to name a few (Department of Agriculture, Forestry and Fisheries, South Africa, 2012; Trench *et al.*, 1992).

However, there is insufficient information available on diseases affecting brassicas produced by smallholder farmers. In South Africa not as much attention has been given to the diseases that affect crops grown by the smallholder farmers compared to the commercial farmers (Adey *et al.*, 1998).

This paper provides information on brassica vegetable production by smallholder farmers in representative areas of Gauteng province and Waterberg district in Limpopo province of South Africa focusing on the disease challenges. The objectives of the study were to conduct a survey on production practices, disease management strategies and to investigate the major disease problems encountered by the smallholder farmers.

2 Materials and methods

2.1 Study area

A preliminary survey of brassica smallholder farmer production areas in the Gauteng and Limpopo provinces (not presented) identified four districts namely, Sedibeng, Ekurhuleni, Tshwane and the Waterberg districts as representative areas to conduct the survey (Figure 1). Gauteng province consists of only 1.4 % of South Africa's land area with the larger part being urbanised and industrialised. However, the agricultural activities of farmers supply fresh produce like vegetables to the surrounding towns and cities (Elsenburg, 2005; SouthAfrica.info, 2014). Gauteng province has an average annual rainfall between 600–700 mm, and the rainy season is in the summer months from October to March (Dyson, 2009). The Waterberg district, which is the largest district in the Limpopo province, contributes predominantly to the agricultural activity of the province, and crop production is one of its main activities (Mmbengeni & Mokoka, 2002). Smallholder farmers' agricultural activities are mostly livestock (goats and poultry) and vegetable production. The district has an average annual rainfall between 600–650 mm, usually from November–March (Waterberg District Municipality, 2014).

2.2 Data collection and analysis

The survey was conducted in Gauteng in May and August and in Limpopo in June and July 2013 with brassica vegetable producing smallholder farmers in the districts (Figure 1) using a list of farms/farmers provided by extension officers from the respective areas. The total number of smallholder farms producing vegetable brassicas provided a sample of 31 farms. An informal structured questionnaire prepared in English was used to collect information. It had both open-ended and closed questions. The questionnaire was designed by the respective research team at the Department of Plant Science (University of Pretoria). The Gauteng Department of Agriculture and Rural Development and the Limpopo Department of Agriculture were contacted, informed about the survey and extension officers from the various areas were present during the interviews with the farmers. Data of interest that was collected included the farmers name, gender, farm location, region, amount

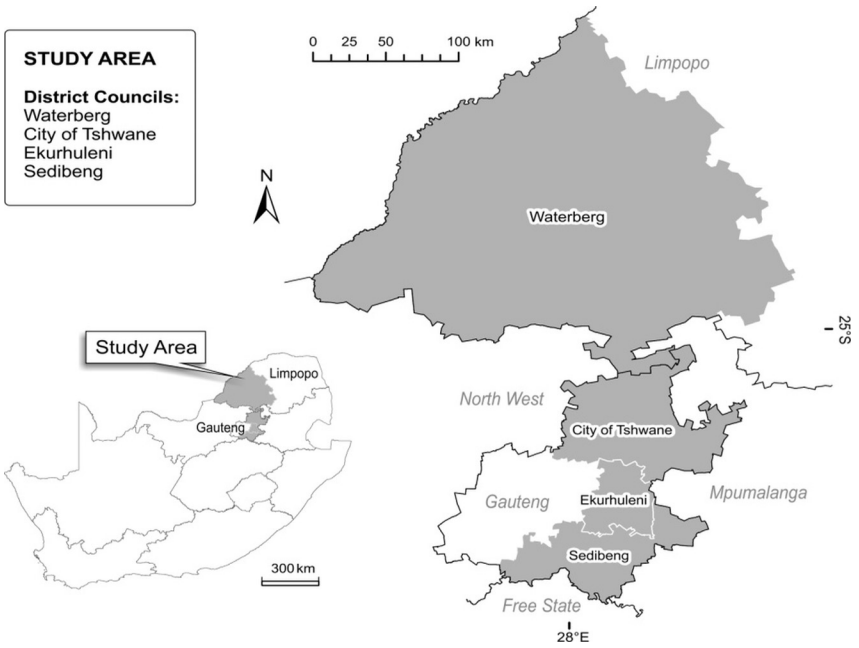

Fig. 1: *Map of the study area: Waterberg, City of Tshwane, Ekurhuleni and Sedibeng districts in the Gauteng and Limpopo provinces, South Africa*

of rainfall, temperature, vegetable brassicas planted, total planting area, major diseases, disease management practices and chemical fungicide treatments.

Collected data from N=31 responses was summarized in frequency tables for each level within the category. Proportion of levels was compared using a Chi-Square (χ^2) test for equal proportions. Furthermore, meaningful combinations of categories were combined in two-way tables (Row × Column contingency tables) of frequencies observed and a Chi-Square (χ^2) test for independence or association was performed. Analysis was done using SAS statistical software (9.1) (SAS Institute Inc., 1999).

3 Results

Thirty–one brassica farmers were interviewed in this study. Of the farmers that were surveyed 51.5 % were female and 48.5 % were male.

3.1 Rainfall and temperature

The rainfall season occurs during summer in Gauteng and Limpopo provinces and ranges from October to March. Approximately 65 % of the respondents' farms received rainfall within the 200–400 mm range annually; 22.6 % within 401–600 mm and 12.9 % at <200 mm. The frequencies for amount of rainfall received annually were significant (χ^2=14, p=0.00, df=2). The average maximum summer temperatures ranged between 26–30°C for 48.4 % of the farmers, between 31–35°C for 41.9 % of the farmers, between 21–25°C for 3.2 % of the farmers and >36°C for 6.5 % of the farmers. Frequencies for average maximum temperatures in summer were significant (χ^2=20.48, p=0.00, df=3).

3.2 Brassica vegetable production

Most of the farmers (93.6 %) grew cabbage as their most common brassica vegetable. Drumhead was the most commonly grown cabbage cultivar with a frequency of 53.3 % and the second preferred cabbage cultivar was an unknown cultivar/s [1] with a frequency of 26.7 % (χ^2=46.53, p<0.001, df=6). A small proportion of the farmers grew other cultivars like Copenhagen (6.7 %), Conquistador (3.3 %), Cape Spitz (3.3 %), Star (3.3 %) and Tenacity (3.3 %). Rape was the second most commonly grown brassica vegetable with a frequency of 41.2 %, followed by broccoli (23.5 %) and mustard (17.7 %) though the frequencies were not significantly different (χ^2=6.24, p=0.18, df=4). Fifty–eight percent of the farmers that grew rape did not know the name of

[1] Some farmers would buy seedlings without asking information about the cultivar name or in some cases did not remember the name.

the cultivar they were growing and English Giant was the second popular rape variety (33.3 %) followed by Giant Essex at 8.3 %. Most of the farmers could not tell if the cultivars they were growing were hybrids or open pollinated varieties.

Most brassica vegetables were planted during February and March with 32.2 % of the farmers planting in February and 29 % in March (Table 1). The frequencies for planting time were significant (χ^2=11.77, p=0.04, df=2). Some of the farmers produced brassica vegetables twice in a year.

Table 1: *Vegetable brassica planting time in the Gauteng province and Waterberg district, Limpopo province*

Vegetable brassicas planting time	*%*	χ^2	*P value*
February	32.2	11.77	0.04
March	29.0		
April	6.5		
May	6.5		
September	12.9		
Throughout the year	12.9		

A large proportion of the farmers both in 2012 (45.2 %) and 2013 (51.6 %) grew brassica vegetables on an area of between 0.25–0.5 ha. A small proportion of the farmers (6.5 %) grew vegetables on an area of 0.5 ha to 1 ha. The frequencies for area planted with brassicas in 2013 were significant (χ^2=5.8, p=0.05, df=2).

The majority of the farmers (96.8 %) used certified seed. The remainder bought uncertified seed or seedlings for brassica production. The farmers who bought seeds raised their own seedlings, however data was not captured for analysis. With regards to fertiliser use, 61.3 % of the growers used fertilisers. Among the farmers using fertilisers, 25.8 % used the compound fertiliser (N:P:K) 2:3:2 (22) + 0.5 % Zn; 19.4 % used limestone ammonium nitrate (LAN 28 %/KAN 28 %); 9.7 % used the compound fertiliser (N:P:K) 3:2:1 (25) + 0.5 % Zn; 3.2 % used mono-ammonium phosphate and 3.2 % used ammonium sulphate. The frequencies of types of fertilisers were significantly different (χ^2=18.35, p=0.00, df=5).

All the farmers (100 %) irrigated their crops of which 45.2 % used sprinkler irrigation, 16.1 % used drip irrigation, 16.1 % used garden hose pipes, 9.7 % used flood irrigation and the remainder (12.9 %) used other methods. The frequencies for the types of irrigation differed significantly (χ^2=12.71, p=0.013, df=4).

3.3 Diseases

The majority of farmers (87.1 %) encountered diseases on the brassica crops they were growing but 12.9 % did not know or could not tell if they had any diseases (χ^2= 17.065, p=0.001, df=1). Farmers were asked to list the major diseases they encountered. According to the respondents the major diseases were an unknown disease/s [2] (33.3 %) and black rot (26.7 %). Further diseases encountered are listed in Table 2. The frequencies of the major diseases encountered were significantly different (χ^2=21.33, p=0.002, df=5). Farmers were asked to rate the severity of the diseases however they were unable to do so.

Table 2: *Major diseases encountered by the smallholder farmers in the Gauteng province and Waterberg district, Limpopo province*

Major diseases encountered	*%*	χ^2	*P value*
Black rot	26.7	21.33	0.002
Downy mildew	3.3		
Alternaria leaf spot	6.7		
White rust	6.7		
Unknown disease/s	33.3		
No major disease reported	23.3		

Cabbage, the most popular grown brassica vegetable was the most susceptible crop to diseases with a frequency of 35.5 %. Rape was less susceptible with a frequency of 3.2 % whilst 61.3 % of the farmers did not know which crop was more susceptible to diseases. In addition, 19.4 % of the farmers mentioned that cabbage Drumhead variety was more susceptible to diseases compared to the other varieties grown like Cape Spitz at 3.2 % and Copenhagen at 3.2 %. However, 74.2 % of the farmers could not tell which cabbage cultivar was more prone to disease infection. The frequencies for the crop and cultivar most susceptible to diseases were significantly different (χ^2=15.74, df=5, p=0.00 and χ^2=48.16, df=5, p<0.001). Farmers experienced disease problems whether they used certified seed or not. Of those that used certified seed, 86.7 % had disease challenges whilst all of those that used uncertified seed faced disease challenges. However, the frequencies were not significantly different (χ^2=0.15, p=0.6, df=1).

[2] The farmers could see symptoms of disease but they did not know the name.

Summer temperatures had an effect on the major diseases encountered by the farmers. The unknown disease/s had a frequency of 100 % within mean daily temperatures of 21–25° C; 35.7 % within a range of 26–30°C and 30.8 % within a 31–35°C temperature range. Black rot had a frequency of 21.4 % within 26–30°C and 38.5 % within 31–35°C temperature ranges. Alternaria leaf spot had a frequency of 7.1 % within 26–30°C and 7.7 % within 31–35°C. Downy mildew had a frequency of 50 % at temperatures at 36°C and above, white rust had a frequency of 7.7 % within the 31–35°C temperature range and 50 % at 36°C and higher (Figure 2). The frequencies for summer temperatures and major diseases encountered were significant (χ^2=26.52 p=0.03, df=15). The unknown disease/s and black rot were the major disease problems even in winter within temperature ranges of 1–5°C, 6–10°C and 11–15°C although the frequencies were not significantly different. Leaf spot and downy mildew diseases were not common during winter. Some farmers reported that they did not experience any diseases.

Planted area had an effect on major diseases encountered by the farmers. In 2012 plots ≤ 0.5 ha encountered only black rot, Alternaria leaf spot and the unknown disease/s. The frequencies for black rot was 53.9 % (land area of 0.25–0.5 ha), Alternaria leaf spot 7.7 % (0.25–0.5 ha), and the unknown disease/s had frequencies of 44.4 % (< 0.25 ha) and 30.8 % (0.25–0.5 ha). As the land size planted with brassicas increased above 0.5 ha other diseases started occurring such as downy mildew (16.7 %) and white rust (33 %) (Table 3). The frequencies of planted area vs. major diseases encountered for 2012 were significantly different (χ^2=28.64, p=0.01, df=15). The pattern for area planted to brassicas vs. major diseases encountered for 2013 was slightly different to 2012 with black rot having frequencies of 22.2 % on an area < 0.25 ha and 37.4 % on 0.25–0.5 ha. The unknown disease/s was common in all land sizes planted to brassicas, with frequencies of 22.2 % (land area < 0.25 ha); 43.7 % (0.25–0.5 ha) and 20 % (> 1 ha). Downy mildew, white rust and leaf spot were all encountered at 20 % on land areas > 1 ha. The frequencies of planted area vs. major diseases encountered were also for 2013 significantly different (χ^2=18.13, p=0.05, df=10, Table 3).

The vegetable growers used different irrigation types and these had different effects on the major diseases encountered. As for the farmers that used sprinkler irrigation, 28.6 % encountered black rot problems, 7.1 % Alternaria leaf spot, 14.3 % white rust, 42.9 % the unknown disease/s, and 7.1 % reported no major disease challenges. Of the farmers using flood irrigation 50 % had problems with the unknown disease/s and 50 % were unaware of any major diseases. The farmers that used garden hosepipes, 20 % encountered black rot problems and 80 % reported no major diseases. As for the farmers using drip irrigation, 60 % had challenges with the unknown disease/s, 20 % with black rot and 20 % with Alternaria leaf spot. Lastly the farmers that used other irrigation methods, 50 % encountered black rot challenges, 25 % downy mildew problems and 25 % were unaware of any major disease problems. However, the frequencies for irrigation type vs. major disease encountered were not significant (χ^2=27.24, df=20, p=0.13).

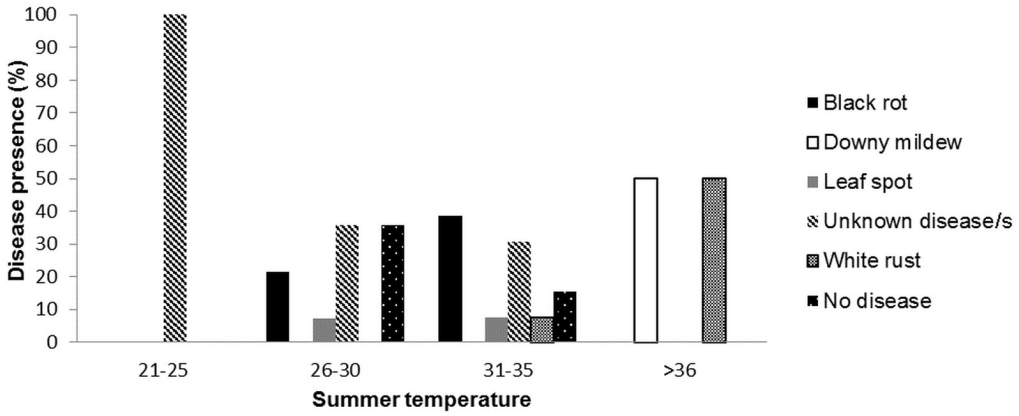

Fig. 2: *Summer temperatures vs. major diseases encountered in the Gauteng province and Waterberg district, Limpopo province*

Table 3: *Planted area under brassica vegetables vs. major diseases encountered by farmers in 2012 and 2013 in the Gauteng province and Waterberg district, Limpopo province*

Year	Planted area (ha)	Major diseases encountered (%)						Chi-square	P value
		Black rot	Downy mildew	Alternaria leaf spot	Unknown disease/s	White rust	No disease		
2012	<0.25	0	0	0	44.4	0	55.6	28.64	0.01
	0.251–0.5	53.9	0	7.7	30.8	0	7.7		
	0.51–1	50	0	0	50	0	0		
	>1.00	0	16.7	16.7	16.7	33.3	16.7		
2013	<0.25	22.2	0	0	22.2	0	55.6	18.13	0.05
	0.251–0.5	37.4	0	6.3	43.7	6.3	6.3		
	>1.00	0	20	20	20	20	20		

3.4 Disease Management

The farmers used a number of measures/control practices to manage the diseases experienced. As for the cultural and sanitation methods, the most commonly used practice was crop rotation (74.2 %) with other crops/vegetables like tomatoes, onions, beetroots and maize (Table 4).

Some farmers used chemicals to control diseases on brassica vegetables (38.7 %), but the majority did not apply chemicals. Of the farmers that used chemicals to control diseases, different fungicides were applied in the field. These included copper based compounds like Copper count-N (copper ammonium acetate 316 g/l) at 19.4 % of the farmers, Bravo (chlorothalonil 720 g/l) at 9.7 %, Funginex (triforine 190 g/l) at 3.2 %, and 6.4 % could not remember the names of the chemicals they used (Table 4). Copper count-N was the most frequently used fungicide by the farmers. Amongst the respondents that used chemicals, 35.5 % used the spray method. Some of the farmers decided to apply the fungicides by following a regular spray programme whether diseases were present or not (16.1 %); some whenever they saw the presence of a disease (16.1 %) and others only when there was a heavy disease manifestation (6.5 %) (Table 4).

Farmers were asked if they had specific areas of needs / research suggestions and the responses were as follows: training on disease identification and control in brassicas and other vegetables, use of pesticides/chemicals, evaluation of cabbage and other brassica cultivars that are disease resistant and high yielding cultivars.

Table 4: *Disease management practices and fungicide use by the farmers in the Gauteng province and Waterberg district, Limpopo province*

Characteristic	%	χ^2	P value
Disease management practices			
Burning of diseased plants	3.2	91	0.0001
Removal of infected plants	3.2		
Use of disease free plants	6.5		
Use of resistant varieties	3.2		
Crop rotation	74.2		
Other	6.5		
No management practice	3.2		
Chemical fungicides used			
Bravo 720	9.7	35.29	<0.001
Copper based compounds	19.4		
Funginex	3.2		
Unknown chemical name	6.4		
No application	61.3		
Chemical application method			
Spraying	35.5	15.74	0.0004
Through irrigation water	3.2		
No application	61.3		
Decision on when to apply chemicals			
Use regular spray programmes	16.1	22.55	0.0001
When disease infestation is high	6.5		
Whenever they see a disease	16.1		
No application	61.3		

4 Discussion

Cabbage was the most commonly grown brassica vegetable by the smallholder farmers in the Gauteng province and Waterberg district of Limpopo province. This also concurs with the experience of farmers in other African countries like Kenya, Mozambique and Tanzania (Massomo *et al.*, 2004; Wambani *et al.*, 2007; Bila *et al.*, 2009). In Africa, including South Africa, cabbage production by smallholder farmers is for home consumption and for markets providing a source of income (Wambani *et al.*, 2007). Cabbage stores well after harvesting even with no refrigeration when compared to the other leafy brassicas. The production of rape within the surveyed areas, especially Gauteng province, seems to be on the rise. Jansen van Rensburg *et al.* (2007) and Mariga *et al.* (2012) reported that production of leafy brassicas such as rape or kale is common in Mpumalanga and Limpopo provinces and its cultivation by the smallholder farmers is spreading to the Gauteng province. Farmers producing rape mentioned that its production was mainly for markets as it was in demand by foreign nationals in the urban areas and it was very profitable. In a study in Zambia, Nyirenda *et al.* (2011) reported that rape vegetable generates high market value and it accounts for a 95 % share of the informal fruit and vegetable market.

It was evident that quite a number of the farmers did not know or remember the cultivars of cabbage or rape they were growing. The main reason was unidentified but it could be that the agro-dealers/retailers or vendors selling the seed / seedlings do not provide the information or the farmers regard this information as not important.

It was noticed that especially in the areas having warmer winter season and cooler summer season brassicas were grown throughout the year. According to Kfir (2003), brassicas like cabbage and kale are now grown throughout the year because of the availability of heat tolerant cultivars that can withstand high summer temperatures. When summer temperatures were cooler (21–25 ºC) the unknown disease/s had a very high incidence in the farmers' fields. Temperatures ranging from 21–25 ºC and the availability of moisture due to summer rainfall could have favoured the development and spread of the unknown disease/s. Farmers that grew vegetable brassicas on a land size below 0.5 ha used these mainly for home consumption as well as for marketing of surplus through local market. Production on land size of ≥ 0.5 ha was mainly for larger fresh produce markets in cities, retail shops but also for local markets. However, the results showed that an increase in land size under vegetable production may also cause a build-up of pests/ diseases. As land size under brassica production increases there is also a possibility that crop densities increase and farmers then struggle with disease challenges. According to Gilbert (2002), an increase in crop densities promotes the availability of hosts and increases the chances of infection resulting in high disease incidence and severity. Brassicas are said to be fairly heavy soil feeders that require relatively high nitrogen and potassium nutrients (KwaZulu-Natal Department of Agriculture and Environmental Affairs, 2001). Farmers were aware of the high nutrient requirements of brassica vegetables and most of them applied fertilisers.

Farmers could not identify or name the predominant disease/s experienced in their fields. It may be one disease or a complex of diseases or even insect pest problems. This relates to work done by Shao *et al.* (2004) in South Africa on smallholder farmers that there is inadequate technical information available to the farmers especially relating to disease control and identification. In addition, a study carried out by Mmbengeni & Mokoka (2002) highlighted that identification of diseases was noted as a skill required by smallholder farmers in Limpopo province. According to the farmers, the major disease problems they encountered were the unknown disease/s, black rot, Alternaria leaf spot and white rust. This is consistent with literature from other parts of Africa such as Tanzania, Mozambique and Zimbabwe where diseases like black rot are a major challenge in production of brassica by smallholder farmers (Bila *et al.*, 2009; Massomo *et al.*, 2004). The disease is difficult to control (especially in humid tropical environments) because of its seed-borne nature and due to non-availability of efficient chemical control methods (Massomo *et al.*, 2005). Besides seeds being the primary source of inoculum for the *X. campestris* pv. *campestris* pathogen that causes black rot, infected plant debris in the soil can also be a source of infection (Bila *et al.*, 2009). Farmers practising monoculture production of kale grow it as a perennial using side suckers and apical cuttings. This provides a continuous source of inoculum for especially black rot which was consistently present. It was found that most disease problems were encountered during summer cropping season with temperatures of 26 °C and higher. A study by Sangeetha & Siddaramaiah (2007) showed that diseases like Alternaria blight, white rust and downy mildew in a mustard crop were favoured by temperatures from 26–29 °C and average relative humidity of more than 65 %. Farmers have adopted some measures to control and manage diseases including cultural practices and use of chemicals/fungicides. Farmers understood that crop rotation

with non-host plants breaks the cycle of a disease. It was also noted that other practices such as use of resistant cultivars/varieties constituted a small proportion of the disease management practices and methods like biological control were not even mentioned as an option. This is in agreement with Sibanda *et al.* (2000) who reported that the use of other methods like seed of resistant varieties is expensive and availability is limited to the smallholder farmers. Pesticide selection was based on what was available on the local market influenced by the suppliers. Farmers received informal advice from friends, neighbours and local agro-dealers on spraying programmes as found also by Ngowi *et al.* (2007), Dinham (2003) and Sibanda *et al.* (2000) in Southern and Eastern Africa. Further, the farmers were not sure at which stage of disease infestation fungicides should be applied or they could not understand the labels on the fungicide product.

5 Conclusion

This study provided valuable information on disease problems of brassica vegetables cultivated by smallholder farmers and their control practices. The study has shown that smallholder farmers need training on disease identification and control on brassica crops. They could not identify the predominant disease/s that were problematic within their crops. In addition, smallholder farmers lack information on pesticide (fungicide) application and guidelines on their use. One potential solution to disease identification and control challenges may be the use of the farmer field schools concept. Farmers in the same area get together and study different diseases (identification and control) with the help of extension workers, research institutes and various farmer organisations. The farmers could get educated in reduced chemical usage, additional cultural control methods and the use of alternative methods like biological control that are cost-effective and environmentally friendly. There is also the need for capacity strengthening of the extension workers in terms of vegetable diseases identification and control. Also, extension workers need to train farmers on the importance of knowing the crop cultivars they are growing and include the information as part of their farm records. This calls for further investigation on the source of seedlings and other inputs such as fertilisers to find out where the farmers are buying them.

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