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Onion Farming Practices in Eastern Region of Ghana: Implications for Research

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ABSTRACT---- ***A survey was carried out in the river Afram basin of the Eastern region of Ghana to investigate the farming practices of onion farmers and to identify potential research areas to improve onion production. Fifty six onion farmers selected randomly were interviewed. Ten of these farmers were purposively selected for key informants' interviews, and their nurseries and farms monitored from sowing till harvest. All the respondents (100%) cultivated onion only in the rainy season when fungal diseases and onion thrips were prevalent. Majority (89%)of the respondents planted later than the recommended time; 94.6% cultivated only Malavi which is susceptible to insect pest and diseases and89.3 % did not practice crop rotation. All the respondents (100%) applied inadequate chemical fertilizer and irrigation water; provided inadequate weeding of farms and used chemical fungicides and insecticides indiscriminately; onion farms were harvested at the immature stage; harvested bulbs were exposed to the unfavourable environmental conditions. Onion bulb yield ranged from only 3.0 -7.4 t ha^{-1}. These findings may suggest that seasonality in planting; late planting; minimum improved technology use; poor nursery and farm management practices, diseases and insect pests; poor harvesting and post harvesting practices contribute to poor onion yields and are limitations to commercial onion farming.***

Keywords---- onion cultivars, fusarium basal rot, onion thrips, insecticides, fungicides

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1. INTRODUCTION

Onion (*Allium cepa*) is a vegetable and a highly valued spice used widely in Ghana and many parts of the world for flavouring, seasoning foods and for medication (Van der Meer, 1997; Cheema *et al*., 2003). The food habits of Ghanaians are such that a bulb of onion is used in almost every food preparation. The average yield of onion in Ghana of about 17kg/ha (SRID/ MoFA, 2012) this is low compared to that of other onion producing countries in Africa (FAO, 2000). Ghana's onion consumption needs exceed its onion production and so about five million dollars is spent annually to import dry onion bulbs from neighbouring countries (Ghanaweb, 2012).

Commercial onion farming in the river Afram basin of the Eastern Region which contribute to Ghana onion production (SRID/MoFA, 2012) have several limitations. These include seasonal production, adverse environmental conditions (weather extremities), inadequate access to inputs and insect pest and disease attack.

Tarpaga *et al*. (2011) reported that onions cultivated in the normal season in the Sudano-Sahelian climatic conditions gave the highest yield compared to the early and the late seasons. In Nigeria, Ibrahim (2010) observed that onion yield declined from 40 t ha^{-1} to less than 20 t ha^{-1} andfrom 48 t ha^{-1} to less than 20 t ha^{-1} when seedlings were transplanted in March instead of November and December respectively.

Improve varieties contribute up to 30% of crop yield (Shaikh *et al*., 2002). Combined application of chemical fertilizers and organic manure in onion production increases yield compared with the application of only chemical fertilizers (Abdelrazzag 2002; Blay *et al*., 2006). Four hand weeding per season has been demonstrated as optimum for

effective weed control in onion cultivation (Hassan and Malik, 2001). Soil water stress imposed at any growth stage of the onion plant reduces total yield, but the effect is greatest when irrigation is withheld both at the 3- and 7-leaf stages of development.

Light infestations of onion thrips, (*Thrips tabaci* Lindeman (Thysanoptera: Thripidae)) can lead to yield losses of up to 40%, while severe attack can reduce yield by almost 60% (Kisha, 1979). Fusarium basal rot (FBR) also known as onion bulb rot can cause 90% seedling loss (Barnockzine, 1986), reduce yields of susceptible onion cultivars by 50% and can lead to 30% loss in storage (Mishra *et al*., 2014). Long rotations with unrelated crops, sterilization of nursery soil prior to sowing and the application of chemical insecticides and fungicides have controlled insect pests and diseases effectively in onion production (Ngatindriatun, 2012;Ibrahim and Adamu 2008; Helyer and Brobyn 2008; Lesly *et al*., 2002; Rajapakse and Edimanna, 2002). The consistent use of these chemical pesticides poses a threat to the environment and human health and also facilitates resistance evolution in the target organism (Okigbo, 2004; Carvalho, 2004). Hence the cultivation of resistant/tolerant cultivar could be the solution to a reliable onion production (Alberto *et al*., 2002; Coleman *et al*., 1997). In Burkina Faso, the onion variety PREMA 178 has been found to be tolerant to high humidity and high rainfall and can produce yields as high as 25 t ha^{-1} (USAID/West Africa, 2013).

Boyette *et al*., (2008) found that onion bulbs harvested at 10% - 20% top fall over maximized yield and quality. Abd-el Rahman and Ebeaid(2009) noted that the process of curing of onion bulbs is most effective if the harvested bulbs are removed from the field for drying within 48 hours of topping.

The objective of this study was to investigate the farming practices of onion farmers in the river Afram basin of the Eastern region of Ghana and to identify the potential research areas to improve onion production.

2. METHODOLOGY

2.1Study area and sampling procedures

The study was carried out in the 2011 major cropping season in the onion growing area in the Eastern region of Ghana which occupies the northern part of the Fanteakwa district and the southeastern part of the Kwahu South district. The Fanteakwa district lies within longitude 0^0 32.5 W and latitudes 6^o 15' N and 6^o40' S. The Kwahu South district is situated at 6^0 31^0Sand 7^0 N at 6°22′N, 0°23′ W of Ghana (GSS, 2014a; 2014b). The study area has annual mean rainfall of about 1600 mm and monthly mean temperatures ofabout 26^{o}C in the wet season and about 30^{o}C in the dry season. The humid period is from May to October but there is normally a reduced rainfall from July to August. Due to decreasing precipitation over the past few decades, this area which used to have a bi-modal type of rainfall has now a uni-modal rainfall pattern. Consequently rain-fed agriculture can only be carried out once in a year (Opoku-Ankomah, 2000). The soils are generally poor and characterized by savannah ochrosols and haplic luvisols. The river and few streams in the area are seasonal; overflow their banks during the rainy season and become dry in the dry season (Opoku-Ankomah, 2000).

A total of 56 farmers selected randomly from 80onion farmers in onion growing communities in the Fanteakwa and Kwahu South districtsof the Eastern Region of Ghana with the assistance of the Districts Agricultural Extension Agentsparticipated in the survey.

2.2Data collection

A structured questionnaire was used to collect information from the 56 respondents on their gender, age, level of education, number of years of onion farming, scale of operation, mode of land acquisition and sources of funding for onion farming operations. Information was also gathered on time of planting,onion cultivars grown, cropping system, soil amendment practices, frequency of irrigation and weeding, sources of inputs, insect pest and disease management and other constraints. Key informants interviews were conducted with ten respondents purposively selected from the 56 respondents on their nursery and farm management practices and constraints. These farmers were selected on the basis that they have experience in commercial onion farming and have been in the business for at least five years. The onion nurseries and farms of these respondents were monitored from sowing till harvest and onion yields were measured at harvest.

2.3Identification of disease pathogens and insect pests

The selected onion nurseries and farms were sampled for insect and disease infected plants during routine visits. Insects collected were identified by using a dissecting microscope. Sections of the diseased plant tissue were surface sterilizedwith 1% Sodium hypochlorite solution placed on potato dextrose agar (PDA) in 90millimetre diameter Petri dishes and incubated at 26± 2^{o}C for 48-72hours. Pure cultures obtained were sub-cultured on to PDA plates after 72 hours incubated at 22-24± 2^{o}C under 12hours alternating light and darkness. Fungal identification was carried out based on cultural growth characteristicssupplemented with microscopic observations as described by Barnett and Barry (1972). Pathogenicity tests were conducted to confirm the disease causing organism(s) as described by Agrios (2005).

2.4Data analysis

Data from the survey were coded and analyzed using SPSS Version 17.0.Descriptive statistics and the chi-squared testswere used to analyze the data. Qualitative information obtained from the key informants interviews guided the interpretation of the survey data.

3. RESULTS AND DISCUSSION

3.1Demographic and Socioeconomic characteristics of the respondents

Majority (71.4%) of the 56 respondents were males aged between 30 to 55 years. Fifteen of the respondents (26.7%) were females aged 30 to 53 years. Majority (76.8%) of the respondents had basic level of formal education: 62.5% had primary education; 14.3% had middle school/junior high school (JHS) level of education whilst few (23. 2%) had no formal education (Table 1). It is likely that most of the respondents have the motivation to adopt improve farming practices to enhance onion yields owing to their basic level of formal education. This assertion corroborates the World Bank (2007) report that completion of at least lower primary school increases the tendency of an individual to adopt a new technology than zero level of education. About 60% of the male respondents as compared to 12.5% of the female respondents had been in onion production for at least five years. These results may suggest that commercial onion farming in the study area is mainly undertaken by middle-aged males. Women's participation in the commercial onion farming business was limited probably due to their household responsibilities because commercial onion farming is a labor intensive venture (Kaaya *et al*., 2007). The respondents were mainly small scale farmers; 85.7% cultivated only a half of an acre to two acres of the crop (Table 1). This is not surprising because reports confirm that 80% of agriculture output in Ghana is produced by smallholder farmers (GSS, 2008).

Only few (7.1%) of the respondents cultivated a family land 53.6% rented whilst39.3% sharecropped. The respondents emphasized the difficulty in financing farming operations from their own personal resources. Although private money lenders were available during the cropping season, they were rarely patronized due to their high interest rates. Only 1.8 % of the respondents obtained credit from a private money lender, 5.4% obtained resources from relatives and friends whereas 92.8% used only their own resources to finance their onion farming operations. These findings could suggest that most of the respondents used lower levels of inputs in onion farming. Feder *et al.*, (1989); Petrick, (2004) and Nunung (2005) indicated that farmers facing cash constraint used lower levels of inputs in farm production.

Table 1: Socio-demographic Characteristics of the respondents

Variable	Number of respondents	Frequency (%)
Gender		
Male	40	71.4
Female	16	28.6
Level of education		
No formal education	13	23.2
Primary education	35	62.5
Middle School education/Junior Secondary	8	14.3
Number of years of onion farming		
≥ 5 years		
Male	33	58.9
Female	7	12.5
< 5 years		
Male	7	12.5
Female	9	16.1
Farm size		
≤ 2 acres	48	85.7
>2 acres	8	14.3
Type of land acquisition		
Rented	30	53.6
Sharecropping	22	39.3
Family owned	4	7.1
Sources of funding for onion farming operations		
Own only	52	92.8
Own + Family and friends	3	5.4
Private money lender	1	1.8

3.2Nursery and farm management practices

3.2.1Onion varieties cultivated and sources of onion seeds

Only two onion cultivars were cultivated. Malavi a local cultivarwhich was obtained as farmers' own grown seed from individual seed vendors from the neighbouring countries.Red Creole an imported cultivar was purchased as certified seeds from Accra located about 150 km from the study area. Malavi was cultivated extensively compared with Red Creole. All the respondents (100%) cultivated Malavi. Besides average cultivated area of Malavi and Red Creole was 0.2ha and 0.05ha respectively. The respondents indicated that Malavi seeds were readily available, relatively less costly but its seed viability was inconsistent and it was very susceptibility to bulb rot. Obviously onion seeds purchased from unapproved sources have no indication of the quality.These findings are consistent with the report of Baliyan (2014) that when seeds of improved onion varieties are expensive and difficult to obtain onion farmers go in for cheaper cultivars which may be less productive. The few respondents (5.4%) who cultivated Red Creole emphasized thatbeing an early maturing cultivar it provided a reasonable income at a time when cash was urgently required. It is evident from these findings that early maturing high yielding onion cultivars with good quality seeds, and resistant to diseases are required by the farmers to enhance onion production.

3.2.2Time of planting

All the respondents (100%) cultivated onion only in the rainy season due to lack of water for irrigation in the dry season. They emphasized that they were able to cultivate the cropbecause ismainly rain-fed and supplemented with irrigation water from river Afram or Dede stream.Table 2 shows the farming practices of the respondents. The initial clearing of farm land was mechanized using hired tractors while planting beds were raised manuallywith hoes using hired labour. The recommended planting time for onion in the study areais mid -June to mid- July to enable the crop to obtain a cool weather and adequate moisture during the initial growth period and warm and dry conditions for maturation, harvesting and curing of the bulbs to produce high quality bulbs and good yield (Ratnayake 1991). Only 23.2% of the respondents were able to prepare their farm land at the onset of the rains in April, when it was less difficult to cultivate the soils. These respondents were able to establish nurseries byMay and transplanted seedlings at the recommended planting time. Onion seedlings were transplanted six to eight weeks after sowing using hired labour. The delay in establishing nurseries at the appropriate time was attributed to lack of funds to either pay for land preparation or to purchase seeds before the cropping season. Nurseries that were established late got flooded at the early stages of seedling growth due to heavy rains. Sixty percent of the nurseries that were monitored were among these nurseries. Consequently a large proportion of the seedlingsbecame diseasedwhich limited available planting material and areas cultivated. Apparently, none of the respondents took any measure to sterilize the nursery soils nor treated the seeds with an appropriate fungicide before sowing. This may imply that seedlings in the nurseries were predisposed to soil-borne diseases. Lesly *et al*. (2002) found that in Sri Lanka onion farmers who did not sterilize nursery soil before sowing encountered diseases right from the nursery stage while those who sterilized the soil by burning straw or husk on the nursery bed before sowing had minimum disease infection. Abd-Elrazik *etal*., (1990) noted that onion seeds treated with a chemical fungicide prior to sowing were protected from damping-off disease caused by *Fusarium spp.* and *Rhizoctonia solani*in onion farms in Egypt. Bavistin and Benlate were found to be the most effectivefungicides.

3.2.3Cropping system

Majority (87.5%) of the respondents had established farms on the same piece of land for at least five years. Majority (80%) of these individuals were unable to relocate their farm due to lack of access to water for irrigation. Only 10.7 % of the respondents practiced crop rotation owing to the high cost of producing other vegetables such as pepper, okro and cowpea solely under irrigation in the dry season. The continuous cropping of onion on the same piece of land is likely to reduce soil fertility and also increase the buildup of disease pathogens in the soil (Entwistle, 1990).

3.2.4Soil amendment practices

None of the respondents practiced any soil amendments even though there were numerous kraals situated in the area. The respondents who were aware of the benefitsof improving soil fertility by combining chemical fertilizer with organic manure complained that hired labour would be required to apply cow dung in farms because it is a tedious work. Although the majority (80.4%) of the respondents broadcast 15-15-15 NPK fertilizer at four to six weeks after transplanting, it was applied at a rate of 20 kg/ha instead of the recommended 400 kg/ha. Few (17.9%) of the respondents applied a foliar fertilizer as a supplement. Those who did not apply any NPK fertilizer at all (19.6 %) only applied some foliar fertilizer which may not be adequate. Combining the application of the chemical fertilizer NPK with cow dung could improve soil fertility and enhance onion yields owing to the inherent poor soil fertility of the savanna ochrosols and haplic luvisols soils of the study area (Opoku-Ankomah, 2000). Blay *et al*. (2006) reported improvement in bulb yields when inorganic fertilizer application was combined with poultry manure in shallots cultivation in the sandy soils of Anloga in the Volta region of Ghana.

Table 2: Farming Practices of the respondents

Variable	Number of respondents	Frequency (%)
Time of planting		
Mid-June to mid July (Recommended time)	13	23.2
Later than recommended time	43	76.8
Cultivar(s) cultivated		
Malavi only	53	94.6
Malavi and Red creole	3	5.4
Number of years farm land has been cultivated		
≥ 5 years	49	87.5
<5 years	7	12.5
Cropping system		
Practice crop rotation		
Yes	6	10.7
No	50	89.3
Soil amendments practices		
a. Use Chemical fertilizer		
15-15-15 NPK+ foliar fertilizer	10	17.9
15-15-15 NPK only	35	62.5
Use only foliar fertilizer	11	19.6
b. Use Manure (cow dung)		
Yes	0	0
No	56	100
Frequency of irrigation		
Once/week	48	85.7
Two-Three times/week	8	14.3
Weed control		
Number of hand weeding done before harvest		
Two	46	82.1
Three	10	17.9

3.2.5Irrigation

All the respondents had their nurseries and farms located either on the bank of the river Afram or close to the Dede stream to ensure easy access to water for irrigation. Only 14.5% of the respondents owned an irrigation facility which consisted of mini-sprinklers, a water pump and irrigation pipes and so the majority rented the equipment for irrigation. The frequency of irrigation of the farms was determined by the prevailing weather conditions without considering the growth stage of the crop. Onion is a shallow rooted crop which requires frequent irrigation at short interval. Adequate water is required at critical periods such as during initial plant establishment and at bulb development through maturity to produce a good yield (Hamasaki *et al*., 1999). However, majority (85.7%) of the respondents irrigated their farms once per week due to the high cost involved. Respondents' inability to provideadequate sufficient water during the critical periods of the crop is likely to reduce potential yield. Pelter *et al*., (2004) confirmed that withholding irrigation at both the 3- and 7-leaf stages reduced total yield of onion by 26% compared with the control.The few (14.3%) who irrigated their farms at 2-3 days per week indicated that irrigation was done every other day in prolonged dry periods and less frequently in cloudy weather conditions to prevent high disease incidences. This view is consistent with the observation of Abdel-Razak *et al*., (1988) that a high irrigation frequency favoured a high incidence of the blasting disease of onion seed-heads caused by the fungus *Botrytis allii* in onion farms in Egypt. It isessential that onion cultivars that are adapted to bulbingin limited soil moisture conditions are made available to farmers to enhance production.

3.2.6Weed control

Weed management involved herbicide application and manual/hand weeding. The pre-emergent herbicide glyphosate was used for initial weed control in both onion nurseries and farms and this was followed up with hand picking of weeds. Labour for herbicide application and hand picking of weeds was mainly provided by hired labour. Hand picking of weeds was carried out throughout the nursery stage of the onion crop while farms were weeded from four to ten weeks after transplanting, depending on the effectiveness of the herbicide treatment. *Cyperus rotundas* (purple nut sedge) was the dominant weed recorded in all the farms. Majority (82.1%) of the respondents carried out two hand picking of weeds in farms before harvest; the few (17.9%) who provided three hand picking of weeds before harvest received assistance from

family members. The two to three hand weeding of farms per season may be inadequate for effective weed control and affect crop yield. Studies by Hassan and Malik (2001) confirmed that four hand weeding per season provided maximum weed control in a tested onion crop in farms in Pakistan. However, with the limited choice of herbicides for onion production because onion poorly competes with weeds for soil water and nutrients due its shallow root and the constraint of high labor cost in manual weeding, an integrated weed management method which combines chemical, cultural and biological methods should provide efficient weed control (Appleby, 1996; Koehler *et al*., 2006; Gill 1982; Bannaon *et al*. 1988; Smith *et al*., 2008).

3.2.7Diseases and insect pests' incidence

A high incidence of seedling damping-off disease was observed in nurseries that got flooded. There was also root rot of older plants in 60% of the ten farms investigated, and all these farms showed symptoms of bulb rot at harvest. The fungus *Fusarium oxysporum* f. sp.ce*pae*was identified as the disease causing organism. These results confirm the report of Abawi and Lobber (1971) that the soil borne fungus *Fusarium oxyposum* f. sp. *cepae* attacks onion at all the growth stages; seedlings, older plants and bulbs. The occurrence of these fungal diseases could be attributed to the build-up of the *Fusarium oxysporum* f. sp. *cape* in the soil because the farmers cultivated onion continuously on the same piece of land without crop rotation (Entwistle, 1990). Besides *Fusarium oxysporum* f. sp. *cepae*might have survived in the soil as mycelium on crop debris, or as micro- and macro conidia or as chlamydospores in the absence of the onion crop (Brayford, 1996; Cramer *et al*., 2000; Agrios, 2005). Moreover, the prolonged wet weather conditions of the rainy season might have provided a soil environment conducive for the fungus to infect the onion plants. Similarly Green (1972) observed that the favourable weather condition of the wet season caused a high incidence of the purple blotch disease caused by the fungus *Alternaria porri* in onion trials at the Institute of Agricultural Research in Samaru Nigeria. The results obtained confirm that of Awuah *et al*. (2006) who had previously identified *Fusarium oxysporum* f. sp. *cepae* as the pathogen of onion bulb rot in the South Kwahu district of the Eastern region of Ghana.

Insect pests collected from the onion nurseries and farms monitored included grasshoppers, stink bugs and *Spodoptera spp.*These insects caused minimum damage in the form of abrasion of the leaf lamina. However, the respondents emphasized that onion thrips (*Thrips tabaci*) infestation during long dry periodswas a major constraint to onion farming because they cause stunting of the plants and total crop failure in severe infestations. The respondents indicated that the levels of thrips infestation often remained high even after several applications of insecticides and so severely infested farms were abandoned. In generally the respondents seem to have a good level of awareness of the damage caused by the onion thrips but they were limited in the ability to manage this insect pest effectively.

3.2.8Insect pest and disease management

Chemical fungicides and insecticides purchased from local agrochemical input dealers were applied routinely as foliar sprays to control foliar and bulb diseases and insect pests (Table 3). This was expected since farmers in Ghana regarded chemical pesticides as the only effective means of controlling vegetable pests and diseases (Amoah *et al*., 2005; Yeboah, 2013). Dinham (2003) estimates that about 87% of vegetable farmers in Ghana use pesticides on their crops. The respondents depended on the advice from local agrochemical input dealers and experience of one another on the type, amount and the frequency of application of the chemical pesticides. Whilst 80.4% of the respondents listed a total of eight commercial brands of insecticides and fungicides as the products the others could not remember the names of the chemical pesticides used. In general fungicides and insecticides with relatively lower prices were preferred irrespective of their effectiveness. The major fungicide and insecticide used was Topsin M 70WP (Thiophanate methyl) by about 76.4% of the respondents and Karate 5% EC (Lambda-cyhalothrin) by 78.6 % of the respondents respectively (Table 3). These chemical pesticides are amongst the most commonly used on vegetables in Ghana due to their relatively lower cost compared to other pesticides available (Awuah, 1997; Ntow *et al*., 2006)

Though the respondents complained about the high cost of the chemical pesticides yet 71.4% sprayed the insecticides and fungicides after every rainfall; 67.8% used higher than the recommended dosages of these chemical pesticides and 60.7% used more than one insecticide product per season. The principal reason cited by the respondents for these bad practices was to ensure effective insect pest and disease control. Given that on average it takes four months for the crop to mature, farmers may make at least five applications of the chemical pesticides before harvest. Frequent application of a particular insecticide or fungicide with a specific mode of action could facilitate resistance evolution in the target organism and eventual loss of efficacy of the chemical (Carvalho, 2004). The indiscriminate and non-judicious use of Topsin M 70WP (Thiophanate methyl) and Sidalco Defender (Copper oxychloride) might have limited the control of onion root and bulb rot diseases. Therefore the farmers rouged out diseased plants from farms consistently which created numerous bare patches in farms and reduced onion yields at harvest. Besides the misuse of Dimethoate (Dimethoate 400 g/L) and Karate 5% EC (Lambda cyhalothrin) might have led to the high levels of thrips infestation despite several applications of these insecticides. Huggenberger *et al*., (1984) reported reduced efficacy of Fenarimol in field grown cucumbers only two years after was used became intensive for the control of powdery mildew. Martin *et al*., (2003) found that the resistance of thrips to Deltamethrin, a synthetic pyrethroid declined fairly rapidly when thrips were not exposed to it. As the management of thrips in one onion field is often affected by conditions that prevail in neighboring fields (Reitz, 2014) farmers would have to adopt appropriate cultural practices to facilitate the control of the thrips and not excessive use of

insecticides. The excessive use of the chemical fungicides and insecticides does not only increase production cost without any benefits, but also potentially expose consumers to toxic pesticide residues. An evaluation of the non-cancer risks to human health associated with the consumption of five common vegetables in Ghana (cabbage, tomatoes, eggplant pepper and onion), indicated that onion was the largest contributor to Lambda-cyhalothrin exposure (Botwe *et al*., 2011). Afari-Sefa *et al*., (2015) indicated that farmers' perception of the effectiveness of some chemical pesticides based on advice provided by agrochemical input dealers might be a major contributing factor to the excessive use or misuse of chemical pesticides. The key to minimize onion yield loss caused by the thrips and the fungal diseases is the development of an integrated crop and pest management (ICPM) strategy that combines cultural and chemical control methods and the use of resistant/tolerant varieties.

Table 3: Insect Pests and Disease management Practices of the respondents

Variable	**Number of respondents**	**Frequency(%)**
Chemical fungicides used		
Topsin M 70WP (Thiophanate methyl)	43	76.4
Sidalco Defender (Copper oxychloride)	13	23.6
Chemical insecticides used		
Karate 5% EC (Lambda-cyhalothrin) only	10	17.9
Furadan (Carbofuran) only	4	7.1
Dimethoate (Dimethoate 400 g/L) only	8	14.3
Karate 5% EC + Dimethoate/Furadan	34	60.7
Dosages of chemical pesticides used		
Recommended dosages	3	5.4
Above recommended dosages	38	67.8
Below recommended dosages	15	26.8
Frequency of application of fungicides and insecticides		
After every rainfall	40	71.4
Fortnightly	10	17.9
Weekly	6	10.7

3.2.9Harvesting and post harvest practices

Matured onion bulbs were harvested from four months after planting. The farms that were infected with root rot during the growing stages also showed severe FBR before maturity and so immature bulbs were harvested in fear of total crop loss. Farms that were planted in June were harvested in October while those that were planted later than June were harvested in November and December which coincided with the dry season. Harvesting of onion bulbs was done manually by women and children. After topping the harvested bulbs were heaped in the sun without any shade and were exposed to the prevailing weather conditions. The high environmental temperatures of the dry season are likely to hasten the deterioration of the bulbs and reduce bulb quality particularly for the November and December harvests. Environmental temperatures of 18-20^{o}C at curing are reported to increase sprouting and decay and reduce the quality of harvested onion bulbs (Grahame 2005; Marita 2006).

Farm sanitation was very poor as harvested diseased plants and plant debris were scattered on farms. Though this practice was intended to improve soil fertility, the diseased plant debris could be potential source of inoculum for subsequent plantings (Entwistle, 1990).

3.3Onion yields

Farms that were transplanted in mid- June to mid July produced relatively high yields (5.2 - 7.4 t ha^{-1}) than those planted later (3.0 - 4.1 t ha^{-1}). For the same onion cultivar sown on different dates, the length of the vegetative growth is different but bulb initiation occurs at more or less the same time. The plants that were sown later than May and were transplanted after mid July might have completed the vegetative growth phase early and switched to bulb initiation when they were still young. On the other hand the onion plants that were sown in May and were transplanted at the recommended period (mid- June to mid July) obviously had a longer growing season before bulb initiation; produced more vegetative growth and larger leaf canopy area that intercepted more light and produced higher bulb yields that those sown later than May (Pakyürec *et al*., 1994; Munlugu *et al*., 1998). These findings are consistent with the report of Tarpaga *et al*. (2011) and Ibrahim (2010) that onion crop planted at the recommended time in Botswana,Burkina Faso and Nigeria produced a higher bulb yield than the late sown crop.

4. CONCLUSIONS

The respondents cultivated onion only in the rainy season because they have access to both rainfall and irrigation water but seedling damping off, root rot of older plants and fusarium basal rot diseases and thrips infestations were prevalent during this period.Majority (89.3%)of the respondents planted later than mid-June to mid July;94.6% cultivated only Malavi a local onion cultivar which is susceptible to both fusarium basal rot and onion thrips; 89.3 % did not practice crop rotation.All the respondents (100%) applied less than the recommended rate of 15-15-15 NPK fertilizer;none applied organic manure;majority (85.7%)applied irrigation water once a week irrespective of the stage of crop growth,82.1% provided only two hand picking of weeds in farms before harvest and 71.4% applied chemical fungicides and insecticides after every rainfall.Onion farms were harvested at the immature stage due to FBR and the harvested bulbs were exposed to the prevailing weather conditions. Bulb yield ranged from only 3.0 -7.4 t ha^{-1}. These findings may suggest that undertaking onion farming only in the rainy season when diseases and insect pests are more prevalent;planting later than the recommended time; minimum improve technology use; poor nursery and farm management practices;poor harvesting practices and inappropriate post harvesting techniques contribute to very poor onion yields and are limitations to commercial onion farming.

There is the need for research to address these limitations by developing and introducing high yielding onion cultivars with tolerance to high temperatures, moisture stress (low and high) and resistant to FBR and onion thrips. Efficient intercropping systems are required to obstruct the life cycle and reduce the population of onion thrips and also suppress the build-up of *Fusarium oxysporum* f. sp. *cepae*in soils.

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