International Journal of Agriculture Innovations and Research
Volume 2, Issue 4, ISSN (Online) 2319-1473

Impact of Farmer Field Schools on Cabbage Production in Two Districts of Ashanti and Brong Ahafo Regions of Ghana

Mochiah M. B.
CSIR-Crops Research Institute, P. O Box 3785, Kumasi, Ghana
mochiah63@yahoo.com

Osei M. K.
CSIR-Crops Research Institute, P. O Box 3785, Kumasi, Ghana

Osei K.
CSIR-Crops Research Institute, P. O Box 3785, Kumasi, Ghana

Pfeiffer D.
Department of Entomology, Virginia Tech, Blacksburg, Virginia, 24061 USA

Muniappan R.
IPM Innovation Lab, OIRED, Virginia Tech, Blacksburg, Virginia, 24061 USA

***Abstract* – Cabbage production is constrained by myriad of pest infestations reducing the farmers' profit margin substantially. The objectives of the present study was to evaluate the effect of different land preparation methods, reduce the use of conventional toxic pesticides in the management of cabbage pests, and make comparison of recorded parameters to determine change in pest density, injury and yield in two regions of Ghana. The effect of three different land preparation methods: planting on the flat, ridge and raised bed on pest infestations and yield of cabbage was investigated in 2012 and 2013 at Asiwa and Dormaa Ahenkro in Ghana respectively using Farmer Field School (FFS). This is a participatory method of learning, technology development, and dissemination. In the IPM fields, every pest management/ intervention was preceded by regular monitoring of pest populations to determine the need for chemical intervention. Data collected included insect pest population, plant injury and yield. Results indicated that there were no significant differences (P > 0.05) among the three different land preparation methods under both research (IPM) and Farmers practice for any of the parameters measured. However, comparison of recorded parameters to determine either per cent decrease or increase over farmers practice gave some remarkable difference from both locations. IPM technologies generated and transferred to the farmers through FFS would reduce the use of conventional pesticides in the management of cabbage pests, thus resulting in vegetables that are safer to produce and consume.**

***Keywords* – Cabbage Production, Farmer Field Schools, IPM, Land Preparation Methods, Ghana.**

***Running Title* – Farmer Field Schools on Cabbage Production in Two Districts.**

I. INTRODUCTION

In Ghana and other parts of Africa vegetable growers frequently apply synthetic insecticides to manage insect pests [1]-[4]. Synthetic insecticides work relatively quickly, easy to apply and not too labour intensive [5]. Notwithstanding the usefulness and good benefits of these insecticides in crop protection, they have over the years been associated with hazards to human and animal health, environmental pollution, pest resistance, being expensive and are limited to the peasant farmers especially those in the hinterlands[6]-[10]. Farmers in Ghana spend substantial amounts of money in applying insecticides to manage pests on cabbage. Over the years, there has been an increase in the resistance of the diamond back moth (DBM) and other insect pests of cabbage to insecticides, thus making their management in a sustainable manner difficult [2],[4],[6]. This dilemma of the poorly resourced farmers has caught the attention of researchers.

To avert the misuse and over-use of synthetic insecticides, IPM technologies have been introduced to farmers. In an effective and more sustainable manner, an IPM package was adopted and transferred through Farmers‟ field schools (FFSs) on cabbage production from two cabbage growing locations in Ghana. They include participatory method of learning, technology development, and dissemination based on adult learning principles such as experiential learning [11]. This concept is a popular education and extension approach worldwide. Such FFS use experiential learning and group approach to Farmers‟ decision-making, problem-solving and absorption of new techniques [12]. However it must be pointed out that the farming system employed might influence pest density and diversity [13]. The objectives of the present study was to evaluate the effect of different land preparation methods, reduce the use of conventional toxic pesticides in the management of cabbage pests, and make comparison of recorded parameters to determine change in pest density, injury and yield in two regions of Ghana.

II. MATERIALS AND METHODS

A. Study sites

Two IPM field trials on cabbage (*Brassica oleracea*) production under rainfed condition were conducted in 2012 and in 2013 at Asiwa and Dormaa Ahenkro, respectively. Asiwa in the Bosome Freho district of the Ashanti region is located at 6º 00′ N and 6º 26′ N and 1º 00′ W and 1º 30′ W; in a deciduous forest agro-ecological zone with Juaso-Manso soil series while Dormaa Ahenkro in the Dormaa Central district of the Brong Ahafo region of Ghana is located at 7º 00′ N and 7º 30′ N and 3º 00′W and 3º 30′W, in the forest belt with Bekwai-Nzema compound association. Cabbage is intensively cultivated in these districts and these locations were chosen based on earlier baseline survey conducted to generate information on farmers‟ knowledge on cabbage production.

B. Nursery and transplanting

The cabbage variety used for the trials was Oxylus. At Asiwa, the nursery was prepared on 26th June and seedlings transplanted on 25th July 2012, while the same operations were completed on 11th April and 22nd May 2013 at Dormaa Ahenkro. The nursery bed was heat

sterilized by burning dried wood shavings on it and seeded the following day. The sterilization was done to control plant parasitic nematodes, soil arthropods and weed seeds. The nursery bed was covered with gauze material after germination of seeds to prevent insect damage. After two weeks in the nursery, seedlings were sprayed with "Attack" (IPROCHEM Co. Ltd), a. i- Emamectin benzoate 1.9% at 250 ml/ha to manage insect damage.

C. Experimental design

The design was a Randomized Complete Block (RCBD) consisting of three treatments replicated three times. The seedlings were planted in the treatments of flat, raised beds and ridges. Each plot measured 6 m x 5 m. The spacing given was 100 cm x 50 cm and 100 cm x 30 cm between and within rows for IPM and farmers‟ fields, respectively.

D. Chemical application

Basal fertilizer (NPK-15:15:15) was applied at the rates of 250 Kilos/ha at 2 weeks after transplanting to both fields. In the IPM fields, regular monitoring occurred ten to fourteen days. Chemical intervention was made when populations exceeded threshold levels. This idea of pests monitoring was imparted to the farmers as against the calendar spraying often used. For the farmers‟ practice, the first insecticide application (on the farmers‟ fields) was done two weeks after transplanting with Golan (a.i. - Acetamiprid) using 30ml/16 l of water. Thereafter, insecticide application in farmers‟ fields was done at two weeks interval using Golan and Attack (15ml/15 l of water) till cabbage matured and harvested. In IPM field, however, intervention was preceded by regular monitoring of pests build up that warranted chemical intervention. In all there were three insecticide applications for the IPM fields at both locations as against eight on the farmers‟ fields.

E. Data Collection

Data collected included pest population, plant parameters such as plant height from the two middle rows which had an average of twenty (30) cabbage plants per plot/bed, head damage and yield. The assessment of the numbers of various insect pest species was done by carefully examining the selected cabbage plants; leaf by leaf and turning of leaves as well to collect any insects from the under-surface of the leaves. The insect pests collected from each plot were identified, counted and recorded. The extent of damage caused to the cabbage head by insect pests was estimated and scored using a scale of 0-5 standard procedure according to [14]. (Where 0 = No head damage, 1= 1 – 15% head damage, 2 = 15 – 30% head damage, 3= 30 – 45% head damage, 4= 45 – 60% head damage and 5 = 60% or more head damage). Fresh weights of the cabbage heads were taken at harvest. This was done by manually harvesting the above ground parts of the crops and cleaning them from traces of soil and then weighing the individual heads on a pan balance in the laboratory. The weights were recorded respectively for each plant taken randomly on each plot. Data from Research field where IPM practices or concepts were introduced and farmers‟ practice were compared.

F. Statistical analysis

Data were subjected to General linear Model procedure of SAS Version 9[15]. Mean separation was done using the Tukey‟s test ($P < 0.05$). Insect counts were transformed to the logarithm base 10 (x+1) whiles percentage head damage was arcsine square root transformed before analysis. Back transformed values are presented in tables 1 to 4.

III. RESULTS

There were no significant differences ($P > 0.05$) among the three different land preparation methods under both research (IPM) and Farmers practice for all the parameters measured; number of cabbage plants infested with aphid (*Brevicoryne brassicae* (L.)), Whitefly (*Bemisia tabaci* (Genn.)), cabbage webworm (*Helulla undalis* (F.)) as well as DBM (*Plutella xylostella* (L.)) at both locations. Similarly, plant height (cm), percentage head damage and yield were not significant difference ($P > 0.05$) among the three different land preparation methods at both locations However, comparison of recorded parameters to determine either per cent decrease or increase over farmers practice gave some remarkable differences from both locations. At Bosome Freho in 2012, on ridges, aphid infestation was 21.4% lower in IPM fields, relative to farmer practice, while in raised beds, this difference was only 10.7%.

The greatest reduction in whitefly populations in IPM fields relative to farmer fields was (21.4) recorded on cabbage grown on ridges whilst the least was (10.7) recorded on raised bed. For the cabbage webworm, the highest per cent decrease over farmers‟ practice was (21.4) recorded on cabbage grown on ridges whilst the least was 10.7 recorded on raised bed. Similarly, on ridges, DBM injury was 21% lower in IPM fields relative to farmer fields; on raised beds, DBM injury was only 10.7% lower in IPM plots relative to farmer plots (Table 1). For head damage the highest and least were (21.95) and (16.28) from ridges and raised bed whilst the yield of cabbage recorded the highest (17.07) and least (8.92) per cent increase from ridge and flat treatments respectively (Table 2).

Results from Dormaa Ahenkro in 2013 indicated that**,** on the flat, there were fewer plants infested with aphids in IPM fields than farmer fields (18% difference), while on raised beds there were 7.7% fewer aphid infested plants in IPM plots relative to farmer practice. The highest per cent decrease over farmers‟ practice for whitefly was (17.46) recorded on cabbage grown on flat land whilst the least was (14.29) recorded on ridges. For the cabbage webworm, the highest per cent decrease over farmers‟ practice was (21.43) recorded on cabbage grown on ridges whilst the least was 18.18 recorded on raised bed. Similarly, diamond-back moth recorded the highest per cent decrease over farmers‟ practice (16.67) on cabbage grown on flat land whilst the least (5.59) was recorded on raised bed (Table 3). The highest and least per cent decreases over farmers‟ practice for mean plant height were (0.67) and (0.40) from flat land and ridges; for head

International Journal of Agriculture Innovations and Research
Volume 2, Issue 4, ISSN (Online) 2319-1473

damage the highest and least were (8.33) and (5.80) from raised bed and ridges whilst the yield of cabbage recorded the highest (13.34) and least (8.97) per cent increase from ridge and flat treatments respectively (Table 4).

Although some predators (coccinellids and spiders) and other insect pests (*Zonocerus variegatus* and *Spodoptera* sp) were observed from isolated plots, their numbers recorded from the various plots were too low to be considered as a measurable parameter.

Table 1: Mean populations of insect pests of cabbage (Brassica oleracea var. oxylus) grown under different land preparation method at Bosome Freho, 2012

Comparison of recorded parameters to determine per cent decrease or increase over farmers practice

	No. of plants infested with Aphids			No. of plants infested with whiteflies			No. of plants infested with cabbage webworms			No. of plants infested with Diamond back moth		
Land Preparation	Research Field	Farmer Practice	% decrease Over FP	Research Field	Farmer Practice	% decrease Over FP	Research Field	Farmer Practice	% decrease Over FP	Research Field	Farmer Practice	% decrease Over FP
On Flat	2.43±0.12	2.86±0.60	15.03	3.60±0.45	4.20±0.54	14.29	4.40±0.76	5.20±0.56	15.38	2.92±0.26	3.40±0.69	14.12
Raised Bed	2.32±0.18	2.60±0.42	10.77	3.80±0.36	4.30±0.24	11.63	4.60±0.51	5.40±0.23	14.81	2.80±0.49	3.40±0.51	17.65
On Ridges	1.65±0.20	2.10±0.45	21.43	2.70±0.42	3.50±0.36	22.86	3.90±0.48	5.20±40	25.00	2.60±0.49	3.20±0.49	18.75
P > F	0.7434	0.8253		0.6635	0.6532		0.7874	0.6835		0.7123	0.7256	

Table 2: Mean plant height, head damage and yield of cabbage (Brassica oleracea var. oxylus) grown under different land preparation methods at Bosome Freho, 2012

Comparison of recorded parameters to determine per cent decrease or increase over farmers practice

	Plant height (cm)			% head damage			Yield (g)/head		
Land preparation	Research Field	Farmer Practice	% increase Over FP	Research Field	Farmer Practice	% decrease Over FP	Research Field	Farmer Practice	% increase Over FP
On Flat	15.26±0.17	15.16±0.62	0.64	13.40±0.65	14.20±0.58	19.05	1.12±0.10	1.02±0.04	8.92
Raised Bed	15.37±0.67	15.20±1.44	1.11	13.60±0.41	14.30±0.24	16.28	1.20±0.14	1.01±0.13	15.83
On Ridges	15.32±0.48	15.00±1.22	2.09	13.20±0.48	14.10±0.40	21.95	1.23±0.12	1.02±0.10	17.07
P > F	0.8871	0.9932		0.7521	0.9584		0.7965	0.7603	

Table 3: Mean populations of insect pests of cabbage (Brassica oleracea var. oxylus) grown under different land preparation method at Dormaa Ahenkro, 2013

Comparison of recorded parameters to determine per cent decrease or increase over farmers practice

	No. of plants infested with Aphids			No. of plants infested with whiteflies			No. of plants infested with cabbage webworms			No. of plants infested with Diamond back moth		
Land preparation	Research Field	Farmer Practice	% decrease Over FP	Research Field	Farmer Practice	% decrease Over FP	Research Field	Farmer Practice	% decrease Over FP	Research Field	Farmer Practice	% decrease Over FP
On Flat	2.44±0.16	2.98±0.62	18.12	3.40±0.65	4.12±0.58	17.46	3.40±0.76	4.20±0.56	19.05	3.00±0.62	3.60±0.49	16.67
Raised Bed	2.40±0.18	2.60±0.44	7.69	3.50±0.41	4.22±0.24	17.06	3.60±0.51	4.40±0.23	18.18	3.22±0.77	3.40±0.50	5.59
On Ridges	2.34±0.09	2.70±0.22	13.33	3.00±0.48	3.50±0.40	14.29	3.30±0.48	4.20±40	21.43	2.89±0.56	3.20±0.45	9.69
P > F	0.6410	0.6493		0.5746	0.5421		0.7495	0.5085		0.9364	0.9195	

Table 4: Mean plant height, head damage and yield of cabbage (Brassica oleracea var. oxylus) grown under different land preparation methods at Dormaa Ahenkro, 2013

Comparison of recorded parameters to determine per cent decrease or increase over farmers practice

	Plant height (cm)			% head damage			Yield (Kg)/head		
Land preparation	Research Field	Farmer Practice	% increase Over FP	Research Field	Farmer Practice	% decrease Over FP	Research Field	Farmer Practice	% increase Over FP
On Flat	15.00±0.67	14.90±0.62	0.67	13.10±0.65	14.20±0.58	7.74	0.85±0.13	0.78±0.11	8.97
Raised Bed	15.16±0.83	15.10±1.44	0.40	13.20±0.41	14.40±0.24	8.33	0.98±0.40	0.88±0.08	10.20
On Ridges	15.20±0.76	15.10±1.22	0.66	13.00±0.48	13.80±0.40	5.80	1.27±0.10	1.10±0.29	13.34
P > F	0.8966	0.6814		0.6855	0.8414		0.0506	0.4335	

IV. Discussion

In this study reduced insecticide applications were recorded for the IPM fields at both locations as against farmers‟ fields. Generally, this resulted in remarkable per cent decrease over farmers practice from both locations for the pests parameters recorded from the three different seed preparation methods. This observation is one of the lessons learned by the participating farmers. It has been shown that FFS helps to increase farmer knowledge16, and studies in several Asian countries demonstrated that FFS can be effective in reducing the excessive use of chemical pesticides e.g. [17], [18].

Plant height is growth parameter and also described as one of the „vegetative and reproductive traits‟ of plants [19]. In this study per cent increase over farmers practice

for plant height as a measured parameter were 2 and < 1 (Tables 2 and 4) from Bosome Freho and Dormaa Ahenkro respectively from the three different land preparation methods. This probably suggests inherent expression of traits that were not remarkably affected by the treatments as again indicated by [19] and [13].

Weight of the cabbage heads used as yield factor and expressed as per cent increase over farmers practice indicated a remarkable increase of more than 10% from raised and ridge treatments from the two locations compared to the flat treatments which were relatively lower giving less than 9%. In addition to that planting distances were much reduced for cabbages on farmers‟ plots. Thus competition for soil nutrients, water and other resources from farmer fields was higher compared to those of IPM fields. Ridge seed bed preparation was a much improved method of tillage compared with the flat seed bed preparation. Ridge treatment therefore produced larger cabbage leaves which resulted in comparatively bigger heads of cabbage.

The remarkable per cent decrease over farmers practice from both locations for the pests parameters recorded from the three different land preparation methods and yield potential of ridge method of planting render it the preferred seed bed preparation method for the cultivation of cabbage. The effect of seed bed preparation on yield of crops has been documented [20]. In a similar study, [21] concluded that good seedbed preparation is necessary for improving sunflower production.

During field school exchanges farmers learnt that there was the need to adopt nursery bed sterilization to control soil borne pests, cover the nursery bed with gauze material after germination of seed to prevent insect damage, use appropriate planting distances and engage in monitored as against calendar spraying. Results from this study share the same sentiments with IPM practitioners that agricultural education, extension, and advisory services are a critical means of addressing rural poverty, because such institutions have a mandate to transfer technology, support learning, assist farmers in problem solving, and enable farmers to become more actively embedded in the agricultural knowledge and information system [22]. Extension is responsible to almost one billion small-scale farmers worldwide. It is thus urgent to seek the best ways to support such farmers in terms of information, technology, advice, and empowerment.

In conclusion, this study has indicated that IPM technologies generated together with the farmers would reduce the use of conventional toxic pesticides in the management of cabbage pests, thus making vegetables safer to produce and consume. It is believed that this study would increase the competence of the extension systems to provide farmer education that responds more effectively to cabbage production, establish a networking capacity for exchanging FFS experiences within and among African countries and contribute information on the reliability and effectiveness of the FFS as an alternative and sustainable extension vehicle to increase income of vegetable growers.

ACKNOWLEDGMENT

The authors thank Technicians from Entomology and Horticulture Units of CSIR-Crops Research Institute for assistance in the field collections and Mr. Augustine A. Darkwa for assistance in compilation of data. This study was supported by USAID, IPM CRSP (Cooperative Agreement Number EPP-A-00-04-00016-00).

REFERENCES

[1] A. Gerken, J-V Suglo and M. .Braun. Pesticides use and policies in Ghana. Pesticide Policy Project, Publication series, 2001, 10: 90.

[2] W.J. Ntow, H. J. Gijzen, P. Kelderman and P. Drechsel Farmer perceptions and pesticide use practices in vegetable production in Ghana. Pest Manag Sci., 2006, 62: 356-65.

[3] M. Obopile, D. Munthali and B. Matilo. Farmers‟ knowledge, perceptions and management of vegetable pests and diseases in Botswana, 2008, Crop Protect, 27: 1220-4.

[4] D. Grzywacz, A. Rossbach, A. Rauf, D. Russell, R Srinivasan and A. Shelton. Current control methods for diamondback moth and other brassica insect pests and the prospects for improved management with lepidopteran-resistant Bt vegetable brassicas in Asia and Africa, 2010, Crop Protect., 29: 68-79.

[5] K. Weinberger and R. Srinivasan. Farmers' management of cabbage and cauliflower pests in India and their approaches to crop protection. J of Asia-Pacific Entomol., 2009, 12: 253-9.

[6] I. Macharia, B. Löhr and H. De Groote. Assessing the potential impact of biological control of Plutella xylostella (diamondback moth) in cabbage production in Kenya. Crop Protect., 2005, 24: 981-9.

[7] J. Rathi and S. Gopalakrishnan. Insecticidal activity of aerial parts of Synedrella nodiflora Gaertn (Compositae) on Spodoptera litura (Fab.). J of Central European Agric., 2006, 6. pp. 223-228.

[8] R de Cássia Seffrin, I. Shikano, Y. Akhtar and M. B. Isman. Effects of crude seed extracts of Annona atemoya and Annona squamosa L. against the cabbage looper, Trichoplusia ni in the laboratory and greenhouse. Crop Protect. 2010, 29: 20-4.

[9] K. O. Fening, M. Owusu-Akyaw, M. B. Mochiah, B. Amoabeng, E. Narveh and S. Ekyem. Sustainable management of insect pests of green cabbage, Brassica oleraceae var. capitata L. (Brassicaceae), using homemade extracts from garlic and hot pepper. Third Scientific Conference of the International Society of Organic Agriculture Research (ISOFAR), 17th IFOAM Organic World Congress. Namyangju, Korea: Organic crop production, 2011, pp. 567-70.

[10] M. B. Mochiah, B. Banful, K. Fening et al. Botanicals for the management of insect pests in organic vegetable production. J Entomol Nematol., 2011, 3: 85-97.

[11] K. Davis and N. Place Non-governmental organizations as an important actor in agricultural extension in semiarid East Africa. J of Int Agric and Ext Edu., 2003, 10: 31-6.

[12] K. Davis, E. Nkonya, E. Kato, et al. Impact of farmer field schools on agricultural productivity and poverty in East Africa. World Dev., 2012, 40: 402-13.

[13] M. B. Mochiah, P. K. Baidoo and G. Acheampong. Effects of mulching materials on agronomic characteristics, pests of pepper (Capsicum annuum L.) and their natural enemies population., 2012, Agriculture and Biology Journal of North America 3: 253-261.

[14] E. Aboagye. Biological studies and insecticidal control of cabbage worm (Hellula undalis). Faculty of Agriculture. Kumasi: Kwame Nkrumah University of Science and Technology, 2006.

[15] SAS. SAS Users guide. SAS Users guide. Cary, NC, USA: SAS Institute, 2008.

[16] E.M. Godtland, E. Sadoulet, A. De Janvry, R. Murgai and O. Ortiz. The impact of farmer field schools on knowledge and productivity: A study of potato farmers in the Peruvian Andes. Eco Devt and Cultural Change, 2004, 53: 63-92.

[17] R. Tripp, M. Wijeratne and V.H. Piyadasa. What should we expect from farmer field schools? A Sri Lanka case study. World Dev., 2005, 33: 1705-20.
[18] Y.T. Winarto. Seeds of knowledge: the beginning of integrated pest management in Java, 2004.
[19] L. Aboagye and S. Bennett-Lartey. Characterization and preliminary evaluation of groundnut (Arachis hypogaea L.) germplasm in Ghana. J of the Ghana Sci Asso., 2004, 3: 1-16.
[20] B.B. Mohamed, H.A. Fadlalla and E.A. Elhadi. Effects of seedbed preparation and potassium application on alfalfa yield, 2009, J. Sci. Tech.., 10, 1-10.
[21] L. A. Yousif and S.B.M Ahmed. Effect of Seedbed Preparation and Nitrogen Fertilizer on the Performance of a Sunflower (Helianthus annuus L.) Hybrid under Rain-fed Conditions. Research J of Agric and Environ Manag., 2013,2: 027-32.
[22] I. Christoplos and A. Kidd. Guide for monitoring, evaluation and joint analyses of pluralistic extension support. Guide for monitoring, evaluation and joint analyses of pluralistic extension support., 2000.

AUTHOR'S PROFILE

Dr. M. B. Mochiah

was born in Ghana on 6th May 1963 and holds a B.Sc. (Hons.) degree in Zoology/Botany and M.phil (Entomology) from the University of Cape Coast, and Ph.D (Agricultural Entomology) from University of Cape Coast/ International Centre of Insect Physiology and Ecology (ICIPE) in Nairobi Kenya under a split programme. He also holds Diploma in Education from University of Cape Coast, Ghana. He was a researcher and demonstrator during his M.phil programme at the Department of Zoology of the University of Cape Coast in 1994/5. He was a postgraduate research fellow at International Centre of Insect Physiology and Ecology (ICIPE) in Nairobi Kenya under the German Academic Exchange (DAAD) PhD fellowship.

He has varied research interests in Integrated Pests Management (IPM), ecology of insect pests and beneficial insects leading to biological control. He is currently involved in the development of integrated management strategies for pests of vegetables (cabbage, tomatoes, okra, pepper and eggplant), root and tuber crops (cassava and cocoyam), legumes (cowpea and groundnut) and other CRI mandated crops.

Dr. Mochiah has the following local and international affiliations: 1) Member of the African Association of Insect Scientists (AAIS), 2) Member of the International Society of Organic Agriculture Research (ISOFAR), 3) Member of African Regional Postgraduate Programme in Insect Science Scholars Association (ASA) and 4) Member of CSIR-Research Staff Association (RSA). He has a good number of peer reviewed publications in international journals (three of such are listed below):

1. Mochiah, M.B., Owusu-Akyaw, M., Bolfrey-Arku, G., Osei, K., Lamptey, J.N.L., Adama, I., Amoabeng, B.W., Brandenburg, R.L and Jordan, D.L. (2013). The use of sugar baits for the integrated management of soil arthropod pests in peanut (Arachis hypogaea L.) in Ghana, West Africa. African Entomology. 21 (2): pp. 267-272.
2. Mochiah, M.B., Baidoo, P.K. and Acheampong, G. (2012). Effects of mulching materials on agronomic characteristics, pests of pepper (Capsicum annuum L.) and their natural enemies " populations. Agriculture and Biology Journal of North America 3(6): 253-261.
3. Mochiah M.B., Banful B., Fening K.O., Amoabeng B.W., Offei Bonsu K., Ekyem S.O, Braimah H. and Owusu-Akyaw M. (2011). Botanicals for the management of insect pests in organic vegetable production. Journal of Entomology and Nematology Vol. 3 (8): 85-97.

M. K. Osei

is a Research Scientist of the CSIR-Crops Research Institute, Kumasi, Ghana. He holds a B.Sc. (Agriculture) and MSc. (Plant Breeding) from the University of Cape Coast (UCC) and Kwame Nkrumah University of Science and Technology, Kumasi (KNUST), Ghana respectively. He also holds a Diploma in Vegetable breeding and Certificate in Plant Breeders" Right from the AVRDC-World Vegetable Center, Arusha-Tanzania and Wageningen, Netherlands respectively. He has participated in a number of other professional or short training courses and workshops in Online e-resources on the PROTAbase Programme (South Africa), Science and Technology- Europe Africa Project (ST-EAP) Training (Kenya), 2nd Marker Assisted Selection Training (Legon, Ghana) among the rest. He has attended several international conferences in the USA, Kenya, Ethiopia and Burkina Faso and serves on several CSIR-CRI committees.

Michael is the first Ghanaian scientist to have reported the discovery of three new distinct tomato virus strains associated with Tomato Yellow Leaf curl Virus (TYLCV) disease in Ghana. This outstanding discovery has been published in the American Plant Disease Journal. His research interest include using IPM technology together with breeding techniques to mitigate tomato viruses in tomato growing areas in Ashanti, Brong Ahafo and Upper East regions of Ghana where farmers have ignorantly been using pesticides but to no avail. He has published and presented papers on a wide range of vegetables including tomato, garden eggs and African Indigenous leafy vegetables. Three of such are listed below:

1. M.K.Osei, K.O.Bonsu, A. Agyeman, H.S. Choi (2014) Genetic diversity of Tomato germplasm in Ghana using morphological characters. International Journal of Plant & Soil Science 3(3):220-231, 2014 Article no. IJPSS.2014.001
2. M.K.Osei, K. Osei, H. Braimah, M.B. Mochiah, J.N.Berchie, G. Bolfrey-Arku, J.N.L. Lamptey (2013) Practices and Constraints to cabbage production in urban and peri-urban Ghana: Focus on Brong Ahafo and Ashanti regions. Basic Research Journal of Agricultural Science and Review Vol. 2(1) pp. 05-14
3. K. Osei, M.K.Osei, M.B. Mochiah, J.N.L. Lamptey, G. Bolfrey-Arku, J.N. Berchie (2012) Plant Parasitic Nematodes associated with tomato in Ghana. Nematol. medit. (2012), 40 : 33-37

Dr. K. Osei

was born at Ejura in the Ashanti region of Ghana on the 4th of April 1959. He holds a BSc and MSc degrees in Crop Science and Plant Protection (Nematology option) from the Kwame Nkrumah University of Science and Technology, Kumasi, Ghana respectively, MSc in Nematology from the Royal University of Gent, Belgium and PhD (Agriculture, Nematology option) University of Reading, England. Dr. Osei was a postdoc. Fellow at Indian Agricultural Research Institute under the CV Raman Fellowship for African Researchers.

He is a senior research scientist at the CSIR-Crops Research Institute, Kumasi and his research interests include; Integrated Pest management (IPM), the use of antagonistic plants and organic amendments in the management of plant parasitic nematode populations, host resistance studies and the employment of molecular tools in research.

Dr. Osei is affiliated to the following international and local organizations: Organization of Nematologists of Tropical America (ONTA), Ghana Science Association (GSA) and CSIR-Research Staff Association of Ghana (RSA). He supervises post graduate research students, has written two books and twenty-eight peer reviewed publications in international journals (Three of such are listed below):

1. Osei, K. 2011. Leguminous cover crops in nematode suppression and soil improvement. ISBN: 978-3-8443-2719-9 LAP Lambert Academic Publishing, 2011, Germany, 110 pp.
2. Osei, K., Otoo, E., Danso, Y., Adomako, J., Agyeman, A and Asante, J. S. 2013. Organic soil amendments in nematode management in yam production. Nematropica 43 (1): 78-82.
3. Osei, K., Osei, M. K., Mochiah, M. B., Lamptey, J. N. L., Bolfrey-Arku, G & Berchie, J. N. 2012. Plant parasitic nematodes associated with tomato in Ghana. Nematologia Mediterranea 40: 33-37.