

Emerging Insect Pest and Disease Problems on Tomato and Cabbage in Manipur and Its Impact to Vegetable Growers: A Survey Report

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ABSTRACT: From the investigation it was observed that due to unusual rainfall and uncontrolled use of pesticides in Manipur many pests on tomato and cabbage have increased, developed resistance to pesticides and often there are secondary outbreak of pest. Besides soil borne diseases like fungal disease, bacterial diseases are very common in tomato and cabbage as these are main offseason crops widely accepted by farmers in Manipur. Occurrence of fruit borer, leaf miner, cabbage moth, diamond back moth, aphids, cutworm, early blight, late blight, bacterial wilt, bacterial spot, bacterial canker are the common pests and diseases in tomato besides, calcium deficiency disease i.e. blossom end rot is common in tomato whereas in cabbage diamond back moth, cabbage looper, cabbage caterpillar, leaf blight, root rot, bacterial wilt are found to be common in Manipur. This paper reveals the developing insect pests and diseases in tomato and cabbage, their impact on vegetable growers and environment, problems in their management. Hence, capacity build up programme for farmers in Manipur are very much needed for right application of pesticides at the right time for specific pest and disease.

Keywords: Pest, disease, pesticides, vegetable growers, environment.

INTRODUCTION

Manipur is a small state in north eastern part of India rich in resources in terms of land, soil fertility, water, vegetation as well as one of the major biodiversity hotspots in India. Besides, prevalence of suitable agro-climatic conditions ranging from temperate to tropical and sub-tropical zones offers the scope for development of horticulture in the state. Despite these natural advantages, growth of horticulture in the state has remained far lack behind from other parts of India till recently due to wide gap between the technologies generated and their adoption by the farmers in their fields and orchards. Resource limitation for investment in the horticultural activities is another major factor for the lack of development of horticulture in the state. But farmers in Manipur started adopting commercial farming in vegetable crops though vegetable crops are planted as courtyard cultivation as smallholders in the past. Among the vegetables tomato and cole crops such as cabbage and cauliflower has been widely accepted as offseason crops in Manipur due to its favourable

climatic condition. During the last few years, the problems of pest and disease has increased in the state due to unusual rainfall in Manipur because of different environmental factors such as population growth, pollution, overexploitation of natural resources like deforestation for shifting cultivation etc. that has changed the climatic condition of Manipur.

Insect pests and diseases are among the major limitations in improving the production and productivity of vegetable crops all over the world. Protection of plants are mainly adapted towards chemical control by the farmers in Manipur at the present day. Insecticides, fungicides and herbicides are mainly used. In valley area such as Bishnupur District which is a major commercial vegetable producing place in the state farmers apply different chemical pesticides to the vegetable crops. Yet, despite several sprays, crop losses are still expected due to uncontrolled use of pesticide and natural factor like unseasonal rainfall that leads to the developing of various pests and diseases mainly in offseason

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crops such as tomato as well as cabbage. Thus, many fungal and bacterial diseases are known to attack the crops at different stages of the plant (Shibabaw *et al.*, 2013; Tesfaye 1985). Diseases, disorders and pest are among the important factors that contribute to the low yield, reduce quality of the crop (Shibabaw *et al.*, 2013; Tindall 1983) creating problems to the vegetable growers.

MATERIALS AND METHODS:

The survey was conducted during July 2014 to July 2015. Periodic field visits were conducted. 52 farm sites of tomato were investigated as well as 32 farm sites were investigated for cabbage. Face to face interviews were made with the vegetable growers by making a questionnaires (Adjrah *et al.*, 2013; Krishna *et al.*, 2011) where data was generated on application of pesticides on these crops. Leaves, roots, stems, fruits of the plants were inspected thoroughly. Each infected part of the plants were captured by camera and consulted with the subject expert about the disease and pest. Most of the fungal and bacterial disease were identified by field symptoms (Crew 1984). Likewise, insect pest data were recorded from the parts of the plant affected, symptoms observed, stages of insects, identify insect from farmers with local names and with help of entomologist and references with internet browsing. Informations were also collected from different horticulture experts, Farm science centre and agrochemical dealers.

RESULTS

Emerging Insect Pest and Diseases in Tomato

From the field investigation it was found that the most prominent emerging insect pests in tomato observed at the farm sites include fruit borer (*Helicoverpa armigera*) reported by 67.3% respondents, leafminer (*Liriomyza sp.*) by 51.9% respondents, cutworm (*Peridroma saucia*) by 40.3% respondents, aphids (*Macrosiphum sp.*) by 32.6% respondents, cabbage looper (*Helicoverpa zea*) by 13.2% respondents, cabbage moth larva (*Mamestra brassicae*) by 11.5% respondents, stem borer (*Symmetrischema tangolias*) and diamond back moth (*Plutella xylostella*) by 9.6% respondents, flea beetle (*Epitrix sp.*) by 7.6% respondents, white fly (*Bemisia tabaci*) by 3.8% respondents and minor emerging pest such as white butterfly (*Pieris rapae*) and wooly bear caterpillar (*Pyrrharctia Isabella*) were reported by 1.9% respondents as highlighted in Table 1.

Due to heavy rainfall during the month of April-Oct there was also the outbreak of various different fungal and bacterial diseases, deficiency of nutrients and disorders besides insect pests. 63.4% of vegetable growers have reported the case of early blight (by fungus *Alternaria solani*), 32.6% for bacterial wilt (*Pseudomonas solanacearium*), 19.2% for bacterial spots (*Xanthomonas compestris*), 11.5% for late blight (by fungus *Phytophthora infestans*), 9.6% for fusarium wilt (by fungus *Fusarium oxysporum*), 5.7% for bacterial specks (by bacteria *Pseudomonas syringae*) and 1.9% for southern blight (by fungus *Sclerotium rolfsii*), bacterial canker (*Clavibacter michiganensis*) as well as pith necrosis (*Pseudomonas corrugata*). Besides, deficiencies, disorder and other diseases of tomato have also been reported such as blossom end rot (Ca deficiency) by 25.5% of respondents, fruit cracking (due to fluctuating temperature and variable water supply) by 11.5% of respondents. The viral disease such as TMV (tomato mosaic virus) where leaves are curled with stunted growth and fern like was reported by 7.6% of respondents and TYLCV (Tomato Yellow leaf Curl Virus) caused by gemini virus where leaves becomes yellow and curled with stunted growth as reported by 3.8% of respondents, 5.7% of respondents have reported fruit rot soak with water *i.e.* fruit mold (excess water in soil *i.e.* wet condition of soil) as well as leaf and root reddening (P deficiency) and 1.9% of respondents have reported cat facing (due to temperature fluctuation) and leaf curling with stunted growth (may be viral disease or physiological disorder) as highlighted in Table 2.

Emerging Insect Pest and Diseases in Cabbage

The most common insect pests of cabbage were found to be Diamond back moth (*Plutella xylostella*) reported by 53.3% of respondents, Cabbage aphids (*Brevicoryne brassicae linnaeus*) and Cutworm (*Peridroma saucia*) by 40.3% of respondents, cabbage moth (*Mamestra brassicae*) by 23.3% of respondents, wooly bear caterpillar (*Pyrrharctia isabella*) by 20% of respondents, angoumois grain moth (*Sitotroga sp.*) by 16.6% of respondents whereas minor pests were found to be cabbage flea beetle (*Phyllotreta sp.*) and cabbage large white caterpillar (*Pieris brassicae*) by 6.6% of respondents as well as leaf miner (*Liriomyza sp.*), cabbage small white caterpillar (*Pieris rapae*), hoverfly larva (*Toxomerus geminatus*), red ants (*Solenopsis invicta*) and cabbage butterfly (*Pieris rapae*) by 3.3% of respondents as highlighted in Table 3.



Figure 1(a): Bacterial wilt of Tomato



Figure 1 (b): Blossom End Rot

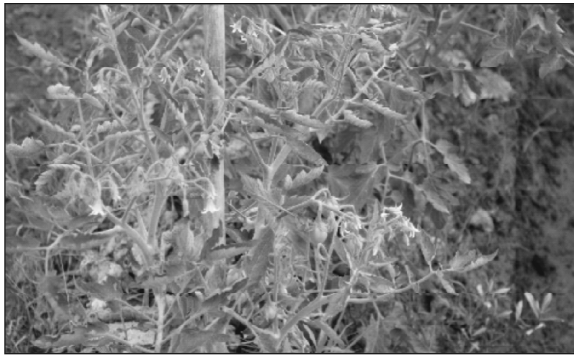


Figure 1(c): Tomato Mosaic Virus (Leaf curling fern like)



Figure 1(d): Bacterial spot in Tomato



Figure 1(e): Early Blight (Late Stage)



Figure 1(f): Fruit cracking and flea beetle in Tomato

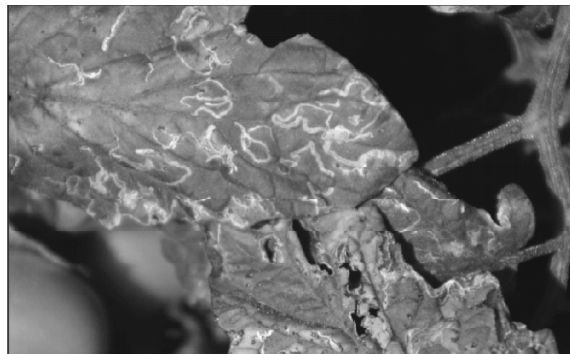


Figure 1(g): Leafminer in tomato leaf

Figure 1: Insect pest, disease and disorder in tomato



Figure 2(a): Cabbage leaf spot/ black leaf spot



Figure 2(b): Cabbage worm (Spodoptera litura)



Figure 2(c):



Figure 2(d): Cabbage leaf Spot



Figure 2(e): Black rot



Figure 2(f): Cabbage worm

Figure 2: Insect pest and disease in cabbage

Among the diseases cabbage leaf spot which was caused by fungus *Alternaria brassicicola* was found to be the most common disease as reported by 30% of the respondents and minor diseases and disorder were found to be clubroot (by fungus *Plasmodiophora brassicae*) by 10% of respondents, fusarium wilt (by fungus *Fusarium oxysporum*) and Black rot (by bacteria *Xanthomonas campestris*) of cabbage by 6.6% of

respondents and some black speck which is a disorder was reported by a farmer (Table 4).

Some of the pictures insect pest and diseases of both tomato and cabbage are shown in figure1.

Problems Faced by Vegetable Growers

Vegetable growers in Manipur are mostly small farmers and face many constraints in managing the

Table 1
Distribution of insect pests in tomato

Name of farming site insect (common name)	Variety of Status	Growing season	Growth stage	Insect pest tomato used	Scientific name	Stage of of tomato
Khuman maning loukon near Chothe village	Chai tai, Amitabh	Jan-April	Fruiting and mature plant	Fruit borer, Stem borer	<i>Helicoverpa armigera</i> , <i>Symmetrischema tangolias</i>	mature, mature abundant, miner
Heinoubok Awang leikai (Namoi village) Bishnupur Ward no. 5	Suraksha, Amitabh 004 Amitabh	April-july Aug-Sept Feb-April Aug-Nov Feb- May	Mature plant Mature plant Young stage	Aphid	<i>Macrosiphum euphorbiae</i>	abundant
Thongngam Heinoubok makha	Amitabh, Abhishhek	June-Sept	Fruiting	Diamond back moth, Cutworm, leaf miner	<i>Plutella xylostella</i> , <i>Helicoverpa armigera</i>	average miner
Teraurak , Keinou thongthak	Amitabh, Abhishhek	June-Sept	Fruiting	Fruit borer	<i>Helicoverpa armigera</i>	abundant
Keinou thongthak	Badshah, Sinjeta017	Dec- March Jan-April July-Oct	Fruiting, mature plant Fruiting, young plant	stem borer	<i>Symmetrischema tangolias</i>	abundant
Khoijuman ward no.4	Namdhari 501	July-Oct	Fruiting, young plant	Fruit borer, cutworm	<i>Helicoverpa armigera</i> , <i>Peridroma saucia</i>	larva average, miner
Leimaram awang leikai	Amitabh, Allround	Jan-March July-Oct	Young plant, Flowering/ mature plant	Cutworm, Aphid	<i>Peridroma saucia</i> , <i>Macrosiphum euphorbiae</i>	Miner, abundant
Toubul awang leikai	Amitabh 501	June-Sept	Mature plant	Cabbage looper	<i>Helicoverpa zea</i>	abundant
Leimaram awang leikai	Amitabh 004	Feb-April	Young plant, fruiting, fruiting	Cutworm, fruit borer, flea beetle	<i>Peridroma saucia</i> , <i>Helicoverpa armigera</i> , <i>Epitrix sp.</i>	Miner, average, miner
Kwasiphai maning leikai	Namdhari	April-July	Fruiting, Mature plant, young and mature plant, mature plant	Fruit borer, White fly, leaf miner, cabbage moth, diamond back moth	<i>Helicoverpa armigera</i> , <i>Bemisia tabaci</i> , <i>Liriomyza sp.</i> , <i>Mamestra brassicae</i> , <i>Plutella xylostella</i>	Miner, miner, miner, average
Kwasiphai a wang leikai	Namdhari 501	June-Sept	Fruiting, young and mature plant	Fruit borer, leaf miner	<i>Helicoverpa armigera</i> , <i>Liriomyza sp.</i>	Miner, miner
Bishnupur mamang leikai ward no. 11	Namdhari 501	June-Aug	Mature plant	Aphid	<i>Macrosiphum euphorbiae</i>	abundant
Toubul mamang leikai	Namdhari 501	May-Aug	Young plants, fruiting, young and mature plant	Cutworm, Fruit borer, leaf miner	<i>Peridroma saucia</i> , <i>Helicoverpa armigera</i> , <i>Liriomyza sp.</i>	Miner, abundant, miner
Toubul awang leikai	Rakshak, Alka	July-Sept	Young plant, mature plant	Cutworm, leafminer	<i>Peridroma saucia</i> , <i>Liriomyza sp.</i>	Miner, miner
Toubul mayai leikai	Namdhari 563, Amitabh	Sept-Nov	Fruiting, young plant, mature plant	Fruit borer, cutworm, leaf miner	<i>Helicoverpa armigera</i> , <i>Peridroma saucia</i> , <i>Liriomyza sp.</i>	Miner, abundant, miner
Toubul mayai leikai	NS 563	June-Aug	Young plant, fruiting, mature young and mature plant	Cutworm, fruit borer, aphid, cabbage looper, leafminer	<i>Peridroma saucia</i> , <i>Helicoverpa armigera</i> , <i>Macrosiphum euphorbiae</i> , <i>Helicoverpa zea</i> , <i>Liriomyza sp.</i>	Miner, miner, abundant, miner

Bishnupur ward no. 7	Namdhari 501	June-Sept	Young plant, fruiting, mature plant, fruiting and mature plant	Cutworm, fruit borer, aphid, cabbage looper	<i>Peridroma saucia</i> , <i>Helicoverpa armigera</i> , <i>Macrosiphum euphorbiae</i> , <i>Helicoverpa zea</i>	Mature, mature, mature, larva	Miner, miner, abundant, abundant
Kwasiphai mayai leikai, ward no. 7	Namdhari 501	June-Sept	Fruiting, young plant, young and mature plant	Fruit borer, cutworm, leaf miner	<i>Helicoverpa armigera</i> , <i>Peridroma saucia</i> , <i>Liriomyza</i> sp.	Mature, mature, larva	Abundant, miner, abundant
Kwasiphai mamang leikai	Namdhari 501	June-Aug	Fruiting and mature plant, young and mature plant	Cabbage looper, leaf miner	<i>Trichoplusia ni</i> , <i>Liriomyza</i> sp.	Larva, larva	Average, abundant
Khoijuman maning leikai	Badshah	June-Sept	Mature plant	Leaf miner, cabbage moth	<i>Liriomyza</i> sp., <i>Mamestra brassicae</i>	Larva, larva	Abundant
Toubul maning leikai	Namdhari 501	Aug- Nov	Fruiting, mature plant	Fruit borer, leaf miner	<i>Helicoverpa armigera</i> , <i>Liriomyza</i> sp.	Mature, larva	Average, miner
Kakching sumac leikai	Abhishek	April-july	Fruiting, mature plant	Fruit borer, leaf miner	<i>Helicoverpa armigera</i> , <i>Liriomyza</i> sp.	Mature, larva	Average, miner
Khoijuman ward no. 1	Namdhari 501	July- Nov	Fruiting	Fruit borer	<i>Helicoverpa armigera</i> ,	mature	Average
Kwasiphai maning leikai	Namdhari 563	Aug- Nov	Young plant, mature plant	Cutworm, leaf miner	<i>Peridroma saucia</i> , <i>Liriomyza</i> sp.	Mature, larva	Miner, average
Khoijuman ward no. 1	Namdhari 501	June-Aug	Flowering and mature plant	Aphid, Leaf miner, fruit borer	<i>Macrosiphum euphorbiae</i> , <i>Liriomyza</i> sp., <i>Helicoverpa armigera</i>	Mature, larva	Abundant
Kwasiphai maning leikai	Namdhari 501	June-Aug	Young plant, fruiting, mature plant, and mature plant,	Cutworm, fruit borer, stem borer, cabbage looper, leaf miner, Aphid mature plant	<i>Peridroma saucia</i> , <i>Helicoverpa armigera</i> , <i>Synmetrischia tangolias</i> , <i>Helicoverpa zea</i> , <i>Liriomyza</i> sp., <i>Macrosiphum euphorbiae</i>	Mature, mature, larva, larva	Average, average, miner, average
Yurenjam	Namdhari 501	May-Aug	Fruiting, young plant, young and mature plant	Fruit borer, cutworm, leaf minor	<i>Helicoverpa armigera</i> , <i>Peridroma saucia</i> , <i>Liriomyza</i> sp.	Mature, mature, larva	Miner, average, average
Pheiyeng nongpok leikai	Amitabh	July-Sept	Young plant, fruiting, mature plant, mature plant	Cutworm, fruit borer, leaf miner, diamond back moth	<i>Peridroma saucia</i> , <i>Helicoverpa armigera</i> , <i>Liriomyza</i> sp., <i>Plutella xylostella</i>	Mature, mature, larva, larva	Average, average, average, miner
Pheiyeng sabal leikai	Shaktiman	March-July	Fruiting, mature plant	Fruit borer, aphid, cutworm, leaf miner	<i>Helicoverpa armigera</i> , <i>Macrosiphum euphorbiae</i> , <i>Peridroma saucia</i> , <i>Liriomyza</i> sp.	Mature, mature, mature larva, larva	Average, abundant, average, average
Lairenkabi mamang leikai	Amitabh	July-Oct	Fruiting, mature plant	Fruit borer, leaf miner	<i>Helicoverpa armigera</i> , <i>Liriomyza</i> sp.	Mature, larva	Average, average
Pheiyeng mamang leikai	Amitabh	Aug-Oct	Young plant, mature plant	Cutworm, aphid	<i>Peridroma saucia</i> , <i>Macrosiphum euphorbiae</i>	Mature larva, mature	Average, average, average
Pheiyeng awang leikai	Amitabh	July-Oct	Fruiting and mature plant	Cabbage looper,	<i>Trichoplusia ni</i>	Larva	miner
Lunghar village, ukhrul	Sura ksha, abhishek	April-June	Fruiting, mature plant, mature plant and fruiting	Fruit borer, leaf miner, flea beetle	<i>Helicoverpa armigera</i> , <i>Liriomyza</i> sp., <i>Epitrix</i> sp.	Mature, larva, mature	Average, average, miner
Wangoi Kabuikhul	Namdhari 501	Dec- March	Fruiting and mature plant, mature plant	Cabbage looper, aphid, leaf miner	<i>Trichoplusia ni</i> , <i>Macrosiphum euphorbiae</i> , <i>Liriomyza</i> sp.	Larva, mature, larva	Miner, abundant, average

Kameng sabal	NS-50, Suraksha, Amitabh	Oct-Jan	Fruiting, mature plant, mature plant	Fruit borer, leaf miner, aphid	<i>Helicoverpa armigera</i> , <i>Liriomyza</i> sp., <i>Macrosiphum euphorbiae</i>	Mature, larva, mature	Average, miner, abundant
Sangaithel mayai leikai	Namdhari	May-Aug	Fruiting, mature plant	Fruit borer, leaf miner	<i>Helicoverpa armigera</i> , <i>Liriomyza</i> sp.	Mature, larva	Abundant, miner
Chireng, sekmai	Local variety	June-Sept	Fruiting, mature plant	Fruit borer, stem borer	<i>Helicoverpa armigera</i> , <i>Symmetrischema tangolias</i>	Mature, larva	Abundant, miner
Tairenpokpi maning leikai	Badshah, Amitabh, Abhishek	July-Sept	Plant, flowering and fruiting	Fruit borer, white butterfly, cabbage moth	<i>Helicoverpa armigera</i> , <i>Pieris rapae</i> , <i>Mamestra brassicae</i>	Mature, mature, larva	Average, miner, average
Tairenpokpi makha leikai	Sanjita, Allrounder	June-Aug	Mature plant	Leaf miner	<i>Liriomyza</i> sp.	Larva	Average
Kameng sabal	Amitabh 004, Abhishek	All year round	Fruiting, mature plant, mature plant, mature plant	Fruit borer, aphid, leaf miner, woolly bear	<i>Helicoverpa armigera</i> , <i>Macrosiphum euphorbiae</i> , <i>Liriomyza</i> sp., <i>Pyrrharctia isabella</i>	Mature, mature, larva, mature	Average, average, miner, average
Tairenpokpi hill, sorapat	Emerald, Namdhari 501	May-Aug	Young plant, fruiting	Cutworm, cabbage moth	<i>Peridroma saucia</i> , <i>Mamestra brassicae</i>	Mature larva, larva	Average, average
Lamdeng mayai leikai	Rukshita	June-Aug	Mature plant, mature plant	Aphid, white fly	<i>Macrosiphum euphorbiae</i> , <i>Bemisia tabaci</i>	Mature, mature	Average, abundant
Kwasiphai mayai leikai	Namdhari 501, Amitabh	May-July	Fruiting, young plant	Fruit borer, cutworm	<i>Helicoverpa armigera</i> , <i>Peridroma saucia</i>	Mature, mature larva, mature	Abundant, average
Tiger camp, imphal east	Emerald, Amitabh	All year round	Fruiting	Fruit borer	<i>Helicoverpa armigera</i>	mature	abundant
Kabowakching mamang leikai	Chai tai, Amitabh	Feb- May	Fruiting, young plant, mature plant, mature plant and fruiting	Fruit borer, cut worm, aphid, flea beetle	<i>Helicoverpa armigera</i> , <i>Peridroma saucia</i> , <i>Macrosiphum euphorbiae</i> , <i>Epitrix</i> sp.	Mature, mature larva, mature, mature	Abundant, average, abundant, miner
Kabowakching maning leikai	Suraksha	May-June	Young plant, mature plant, fruiting	Cutworm, stem borer, fruit borer, aphid	<i>Peridroma saucia</i> , <i>Symmetrischema tangolias</i> , <i>Helicoverpa armigera</i> , <i>Macrosiphum euphorbiae</i>	Mature larva, larva, mature, mature	Miner, miner, average, abundant
Kabowakching makha leikai	Amitabh 004	Jan- March	mature plant	Fruit borer, aphid	<i>Helicoverpa armigera</i> , <i>Macrosiphum euphorbiae</i>	Mature, mature	Average, abundant
Balaram khul maning leikai	Amitabh 004	Nov-Jan	Mature plant, young plant, fruiting	Aphid, cutworm, diamond back moth	<i>Macrosiphum euphorbiae</i> , <i>Peridroma saucia</i> , <i>Plutella xylostella</i>	Mature, mature larva, larva	Abundant, miner, average
Kabowakching makha leikai	Namdhari 815	Dec- April	Mature plant and fruiting, mature plant, fruiting	Flea beetle, leaf miner, fruit borer	<i>Epitrix</i> sp., <i>Liriomyza</i> sp., <i>Helicoverpa armigera</i>	Mature, larva, mature	Miner, abundant, average
Feb- May							
Lairenkabi makha leikai, Heinoubok maning	Namdhari 501	July-Sept	Mature plant and fruiting, fruiting	Diamond back moth, cabbage moth	<i>Plutella xylostella</i> , <i>Mamestra brassicae</i>	Larva, larva	Average, miner
Khoijuman maning leikai	Amitabh	May-July	Fruiting, fruiting, mature plant	Fruit borer, cabbage moth, leaf miner,	<i>Helicoverpa armigera</i> , <i>Mamestra brassicae</i> , <i>Liriomyza</i> sp.	Mature, larva, larva	Average, miner, abundant

Table 2
Distribution of diseases and disorders in tomato
Diseases, deficiencies and disorders

Name of farming site	Variety of tomato used	Stages of tomato plant	Fungal	Fungus	Symptom	Bacterial	Bacteria	Symptom	Deficiencies/ disorder/ other diseases	Causes	Status
Khuman maning loukon near Chothe village	Chai tai, Amitabh	-	-	-	-	-	-	-	-	-	-
Heinoubok Awang leikai (Namoi village)	Suraksha, Amitabh 004	Young plant	-	-	-	-	-	-	Leaf reddening	Phosphorus deficiency	Medium
Bishnupur Ward no. 5	Amitabh	Mature plant, fruiting	Early blight	<i>Alternaria solani</i>	Medium	Bacterial spot	<i>Xanthomonas campestris pv.vesicatoria</i>	Medium	-	-	-
Thonggam	Amitabh, Abhishek	Mature plant, fruiting	Early blight	<i>Alternaria solani</i>	Severe	-	-	-	-	-	-
Heinoubok makha	Amitabh, Abhishek	Mature plant, fruiting	Early blight	<i>Alternaria solani</i>	Medium	-	-	-	-	-	-
Teraurak, Keinou thongthak	Badshah, Sinjeta 017	Fruiting	-	-	-	Bacterial speck	<i>Pseudomonas syringae pv. tomato</i>	Mild	Fluctuating temp. and variable water supply	Mild	-
Keinou thongthak		Fruit cracking	-	-	-	-	-	-	-	-	-
Khoijuman ward no. 4	Namdhari 501	-	-	-	-	Bacterial wilt	<i>Pseudomonas solanacearium</i>	Severe	-	-	-
Leimaram awang leikai	Amitabh, Allround	Mature plant	-	-	-	-	-	-	Leaf yellowing	-	Medium
Toubul awang leikai	Amitabh 501	-	-	-	-	-	-	-	-	-	-
Leimaram awang leikai maning	Amitabh 004	Mature plant, fruiting	Early blight	<i>Alternaria solani</i>	Severe	-	-	-	Fruiting cracking	Fluctuating temp. and variable water supply	Mild
Kwasiphai maning leikai	Namdhari	Mature plant, fruiting	Early blight	<i>Alternaria solani</i>	Severe	-	-	-	-	-	-
Kwasiphai awang leikai	Namdhari 501	Mature plant, fruiting	Early blight	<i>Alternaria solani</i>	Severe	Bacterial wilt	<i>Pseudomonas solanacearium</i>	Medium	Blossom end rot	Ca deficiency	Medium
Bishnupur mamang leikai ward no. 11	Namdhari 501	Mature plant, fruiting	Early blight	<i>Alternaria solani</i>	Medium	Bacterial wilt	<i>Pseudomonas solanacearium</i>	Medium	-	-	-
Toubul mamang leikai	Namdhari 501	Mature plant, fruiting	Early blight	<i>Alternaria solani</i>	Severe	Bacterial wilt	<i>Pseudomonas solanacearium</i>	Medium	Blossom end rot	Ca deficiency	Severe
Toubul awang leikai	Rakshak, Alka	Mature plant	Fusarium wilt	<i>Fusarium oxysporum sp. lycopersici</i>	Severe	-	-	-	Leaf curling,	Virus/physio-logical disorder	Medium
Toubul mayai leikai	Namdhari 563, Amitabh	-	-	-	-	-	-	-	-	-	-

Location	Variety	Plant Part	Onset	Pathogen	Severity	Pathology	Pathogen	Severity	Pathology	Leaf curling	Virus/physiological disorder	Medium
Toubul mayai leikai	NS 563	Mature plant, fruiting	Early blight	<i>Alternaria solani</i>	Severe	Bacterial spot, bacterial wilt	<i>Xanthomonas campestris pv. vesicatoria</i> , <i>Pseudomonas solanacearum</i>	Severe, mild	Leaf curling	Virus/physiological disorder	Medium	
Bishnupur ward no. 7	Namdhari 501	Mature plant, fruiting	Early blight	<i>Alternaria solani</i>	Severe	-	-	-	Blossom end rot, fruit cracking	Ca deficiency, Fluctuating temp. and variable water supply	Severe, medium	
Kwasiphai mayai leikai, ward no. 7	Namdhari 501	Mature plant, fruiting	Fusarium wilt	<i>Fusarium oxysporum sp.lycopersici</i>	Severe	-	-	-	Leaf curling	Virus/physiological disorder	Medium	
Kwasiphai mamamg leikai	Namdhari 501	Mature plant, fruiting	Fusarium wilt, early blight	<i>Fusarium oxysporum sp.lycopersici</i> , <i>Alternaria solani</i>	Severe, severe	Bacterial spot, bacterial canker,	<i>Xanthomonas campestris pv. vesicatoria</i> , <i>Clavibacter michiganensis</i>	Medium, medium	Blossom end rot, leaf curling, fruit mold	Ca deficiency, excess water in soil	Severe, medium, severe	
Khoijuman maning leikai	Badshah	Mature plant, fruiting	Early blight	<i>Alternaria solani</i>	Severe	Bacterial wilt, bacterial spot	<i>Pseudomonas solanacearum</i> , <i>Xanthomonas campestris pv. vesicatoria</i>	Medium, severe	Fruit cracking, leaf curling, blossom end rot, fruit mold, root rot	Fluctuating temp. and variable water supply, Ca deficiency, excess water in the soil	Mild, mild, severe, severe, medium	
Toubul maning leikai	Namdhari 501	Mature plant, fruiting	Early blight	<i>Alternaria solani</i>	Medium	Bacterial wilt	<i>Pseudomonas solanacearum</i>	Mild	Blossom end rot, fruit mold	Ca deficiency, due to wet condition of soil	Medium, severe	
Kakching sumac leikai	Abhishek	Mature plant, fruiting	Early blight	<i>Alternaria solani</i>	Medium	Bacterial spot	<i>Xanthomonas campestris pv. vesicatoria</i>	Medium	Blossom end rot	Ca deficiency	Medium	
Khoijuman ward no. 1	Namdhari 501	Mature plant, fruiting	Early blight, late blight, Powdery mildew	<i>Alternaria solani</i> , <i>Phytophthora infestans</i> , <i>Leveillula taurica</i>	Medium, medium, mild	Bacterial spot, bacterial wilt	<i>Xanthomonas campestris pv. vesicatoria</i> , <i>Pseudomonas solanacearum</i>	Severe, mild	-	-	-	
Kwasiphai maning leikai	Namdhari 563	Mature plant	Early blight	<i>Alternaria solani</i>	Severe	-	-	-	-	-	-	
Khoijuman ward no. 1	Namdhari 501	Mature plant	Late blight	<i>Phytophthora infestans</i>	Severe	-	-	-	-	-	-	
Kwasiphai maning leikai	Namdhari 501	Mature plant	-	-	-	Bacterial wilt	<i>Pseudomonas solanacearum</i>	Severe	-	-	-	

Yurenjam	Namdhari	Mature plant, fruiting	Early blight	<i>Alternaria solani</i>	Medium	Bacterial spot, bacterial wilt	<i>Xanthomonas campestris pv. vesicatoria, Pseudomonas solanacearum</i>	Medium, medium	Blossom end rot, leaf reddening, fruit cracking	Ca deficiency, P deficiency, Fluctuating temp. and variable water supply	Medium, mild, mild, severe, medium
Pheiyeng nongpok leikai	Amitabh	Mature plant, fruiting	Early blight	<i>Alternaria solani</i>	Medium	Bacterial wilt	<i>Pseudomonas solanacearum</i>	Severe	-	-	-
Pheiyeng sabal leikai	Shaktiman	Mature plant, fruiting	-	-	-	Bacterial speck	<i>Pseudomonas syringae pv. tomato</i>	Severe	Reddening of root stalk and stem, blossom end rot	Ca deficiency, p deficiency	Mild, severe
Lairenkabi mamang leikai	Amitabh	Mature plant, fruiting	Early blight	<i>Alternaria solani</i>	Severe	Bacterial wilt	<i>Pseudomonas solanacearum</i>	Severe	Blossom end rot	Ca deficiency	Medium
Pheiyeng mamang leikai	Amitabh	-	-	-	-	-	-	-	-	-	-
Pheiyeng awang leikai	Amitabh	Mature plant	-	-	-	Bacterial wilt	<i>Pseudomonas solanacearum</i>	Medium	Leaf curling and stunted growth	Virus infection/physiological disorder	Medium
Lunghar village, ukhrul	Suraksha, abhishek	Mature plant, fruiting	Early blight, late blight, fusarium wilt	<i>Alternaria solani, Phytophthora infestans, Fusarium oxysporum sp. lycopersici</i>	Medium, severe, severe	-	-	-	-	-	-
Wangoi Kabuikhul	Namdhari	Mature plant, fruiting	Early blight	<i>Alternaria solani</i>	Severe	Bacterial wilt	<i>Pseudomonas solanacearum</i>	Medium	-	-	-
Kameng sabal	NS-50, Suraksha, Amitabh	Mature plant, fruiting	Early blight	<i>Alternaria solani</i>	Medium	-	-	-	-	-	-
Sangaithele mayai leikai	Namdhari	-	-	-	-	-	-	-	-	-	-
Chireng, sekmai	Local variety	-	-	-	-	-	-	-	-	-	-
Tairenpokpi maning leikai	Badshah, Amitabh, Abhishek	Mature plant, fruiting	Early blight	<i>Alternaria solani</i>	Severe	Bacterial wilt	<i>Pseudomonas solanacearum</i>	Severe	Blossom end rot, cat facing, yellowing leaves and purpling on edge of leaves with stunted growth, leaf curling and purple on back of leaves	Ca deficiency, temp. fluctuation, tomato yellow leaf curl virus (TYLCV) geminivirus, virus	Severe, mild, medium, medium

Tairenpokpi makha leikai	Sanjita, Allrounder	Mature plant, fruiting	Early blight	<i>Alternaria solani</i>	Severe	-	-	-	-	-
Kameng sabal	Amitabh 004, Abhishek	Mature plant	Early blight	<i>Alternaria solani</i>	Mild	-	-	-	-	-
Tairenpokpi hill, sorapat	Emerald, Namdhari 501	-	-	-	-	-	-	-	-	-
Lamdeng mayai leikai	Rukshita	Mature plant	Early blight	<i>Alternaria solani</i>	Severe	Bacterial wilt	<i>Pseudomonas solanacearum</i>	Medium	-	-
Kwasiphai mayai leikai	Namdhari 501, Amitabh	Mature plant	Early blight, southern blight on stem	<i>Alternaria solani</i> , <i>Sclerotium rolfsii</i>	Medium	Bacterial wilt	<i>Pseudomonas solanacearum</i>	Medium	-	Medium
Tiger camp, imphal east	Emerald, Amitabh	Mature plant, fruiting	Early blight, late blight	<i>Alternaria solani</i> , <i>Phytophthora infestans</i>	Severe, severe	Bacterial spot	<i>Xanthomonas campestris pv. vesicatoria</i>	Severe	Blossom end rot	Ca deficiency Severe
Kabowakching mamang leikai	Chai tai, Amitabh	-	-	-	-	-	-	-	-	-
Kabowakching maning leikai	Suraksha	-	-	-	-	-	-	-	-	-
Kabowakching makha leikai	Amitabh 004	Mature plant, fruiting	Early blight	<i>Alternaria solani</i>	Severe	-	-	-	-	-
Balaram khul maning leikai	Amitabh 004	Mature plant, fruiting	Early blight	<i>Alternaria solani</i>	Severe	-	-	-	-	-
Kabowakching makha leikai	Namdhari 815	Mature plant, fruiting	Early blight, Late blight, fusarium wilt, Powdery mildew	<i>Alternaria solani</i> , <i>Phytophthora infestans</i> , <i>Fusarium oxysporum sp. lycopersici</i>	Medium, medium, severe	Bacterial spot, Pith necrosis	<i>Xanthomonas campestris pv. vesicatoria</i> , <i>Pseudomonas corrugata</i>	Severe, mild	Blossom end rot, leaf curling and yellowing with purpling on edge of leaves	Ca deficiency, TYLCV i.e. geminivirus Medium
Lairenkabi makha leikai, Heibongpokpi maning	Namdhari 501	Mature plant, fruiting	Early blight	<i>Alternaria solani</i>	Medium	-	-	-	Leaf curling and stunted growth of leaves and plant fern like	Tomato mosaic virus Medium
Khoijuman maning leikai	Amitabh	Mature plant, fruiting	Early blight, late blight	<i>Alternaria solani</i> , <i>Phytophthora infestans</i>	Severe, severe	Bacterial spot, bacterial speck	<i>Xanthomonas campestris pv. vesicatoria</i> , <i>Pseudomonas syringae pv. tomato</i>	Severe, medium	Fruit cracking, blossom end rot, fluctuating temp. and variable water supply, Ca deficiency	Mild, severe

Table 3
Distribution of insect pests in cabbage

Name of farming site	Variety of cabbage used	Growing season	Growth stage of cabbage	Insect pest (common name)	Scientific name	Stage of insect	Status
Khuman maning loukon near Chothe village	Rareball	March-June	Mature plant	Cabbage looper	<i>Trichoplusia ni</i>	Early larva and mature larva	average
Teraurak, Keinou thongthak	Rareball, green hero	April-July	Mature plant, young plant	Woolly bear caterpillar, cabbage flea beetle	<i>Pyrrharctia Isabella</i> , <i>Phyllotreta sp.</i>	Mature, mature	Abundant, miner
Keinou thongthak	Rareball	Oct-Jan	Young and mature plant, mature plant	Diamond back moth, cabbage butterfly, Flea beetle	<i>Plutella xylostella</i> , <i>Pieris rapae</i> , <i>Phyllotreta sp.</i>	Mature larva, mature, mature	Abundant, average, miner
Kwasiphai maning leikai	Rareball	April-July	Young plant, young plant, mature leaves, young plant	Cabbage aphid, cabbage looper, diamond back moth, angoumois grain moth	<i>Brevicoryne brassicae</i> , <i>Linnaeus</i> , <i>Trichoplusia ni</i> , <i>Plutella xylostella</i> , <i>Sitotroga sp.</i>	Mature, larva, mature larva, mature	Abundant, average, average, miner
Khoijuman mamang leikai	Rareball	Jan-April	Mature plant, young plant	Woolly bear caterpillar, cutworm	<i>Pyrrharctia Isabella</i> , <i>Peridroma saucia</i> ,	Young and mature, mature larva	Miner, miner
Bishnupur ward no. 7	Rareball	March-June	Young leaves and mature leaves, mature leaves, mature plant	Cabbage looper, diamond back moth, woolly bear caterpillar	<i>Trichoplusia ni</i> , <i>Plutella xylostella</i> , <i>Pyrrharctia Isabella</i> ,	Young and mature larva, mature larva, mature	Average, abundant, miner
Bishnupur ward no. 11	Drumhand	June-Sept	Mature plant and flowering	Woolly bear caterpillar	<i>Pyrrharctia Isabella</i> ,	Mature	Average
Bishnupur ward no. 7	Rareball	April-June	Young leaves and mature leaves, young and mature plant	Cabbage moth, diamond back moth	<i>Mamestra brassicae</i> , <i>Plutella xylostella</i>	Mature larva, mature larva	miner, abundant
Lamdeng mayai leikai	Green hero, Rareball	June-Aug	Young plant, young and mature leaves	Cabbage aphid, cabbage moth	<i>Brevicoryne brassicae innaeus</i> , <i>Mamestra brassicae</i>	Mature, larva	Abundant, average
Oinam sawom bung makha leikai	Green hero	June-Sept	Young plant, plant, young and mature young plant	Cabbage aphid, diamond back moth, cutworm	<i>Brevicoryne brassicae</i> , <i>Linnaeus</i> , <i>Plutella xylostella</i> , <i>Peridroma saucia</i>	Mature, larva, mature larva	Abundant, miner
Chabung company makha leikai	Sheetal, green hero, rareball	Jan-April	Young plant, young and mature plant, young plant, mature plant	Cabbage aphid, leafminer, cutworm, cabbage small white caterpillar	<i>Brevicoryne brassicae</i> , <i>Linnaeus</i> , <i>Liriomyza sp.</i> , <i>Peridroma saucia</i> , <i>Pieris rapae</i>	Mature, larva, mature larva, larva	Abundant, miner, miner, average
Chabung company yurenbam leikai	Rareball	Sept-Nov	Young and mature leaves, young plant	Cabbage moth, cutworm	<i>Mamestra brassicae</i> , <i>Peridroma saucia</i>	Early larva, mature larva	Average, miner
Tiger camp, Imphal east	Rareball	Sept-Nov	Mature plant, mature plant	Cabbage looper, large cabbage white caterpillar	<i>Trichoplusia ni</i> , <i>Pieris brassicae</i>	Mature larva, mature larva	Average, abundant
Bishnupur ward no.7	Rareball	April-June	Young plant, mature plant, mature plant	Cabbage moth, woolly bear caterpillar, large cabbage white caterpillar in cluster	<i>Mamestra brassicae</i> , <i>Pyrrharctia Isabella</i> , <i>Pieris brassicae</i>	Larva, mature, larva	Average, miner, abundant

Khoijuman ward no. 1	Rareball	Sept- Dec	Young and mature plant, young plant, young and mature plant, young plant, young plants	Cabbage looper, hoverfly larva, diamond back moth, cutworm, cabbage aphid	<i>Trichoplusia ni</i> , <i>Toxomerus geminatus</i> , <i>Plutella xylostella</i> , <i>Peridroma saucia</i> , <i>Brevicoryne brassicae linnaeus</i>	Larva, mature larva, mature larva, mature	Average, average, abundant, miner, abundant
Kakching near air field	Green hero	June-Sept	Young plants	Woolly bear caterpillar	<i>Pyrrharctia Isabella</i> ,	Mature	Abundant
Khoijuman ward no. 1	Green hero, 510	Dec-March	Young plant, young plant	Cabbage moth, cabbage aphid, diamond back moth	<i>Plutella xylostella</i> , <i>Brevicoryne brassicae linnaeus</i>	Larva, mature, larva	Average, abundant, abundant
Lunghar village, Ukhrul	Rareball	April-June	Mature plant, young plant, young and mature plant	Diamond back moth, cutworm, cabbage moth	<i>Plutella xylostella</i> , <i>Peridroma saucia</i> , <i>Mamestra brassicae</i>	Larva, mature larva	Abundant, miner,
Samurou makha leikai	Rare ball	Aug-Oct	Mature plant, young plant, mature plant	Red ants, cutworm, cabbage looper	<i>Solenopsis Irvicita</i> , <i>Peridroma saucia</i> , <i>Trichoplusia ni</i>	Mature, mature larva, larva	Miner, miner, average
Wangoi kabuikhul	Rareball	Dec-March	Young plant, young and mature plant	Cutworm, cabbage looper	<i>Peridroma saucia</i> , <i>Trichoplusia ni</i>	Mature larva, larva	Miner, average
Oinam sawombung awang leikai	Rareball	April-June	Young and mature plant, mature plant	Diamond back moth, cabbage aphid	<i>Plutella xylostella</i> , <i>Brevicoryne brassicae linnaeus</i>	Larva, mature	Abundant, abundant
Sangaitheh mayai leikai	Green hero	Nov-Feb	Mature plant, young and mature plant	Cabbage moth, diamond back moth	<i>Mamestra brassicae</i> , <i>Plutella xylostella</i>	Larva, larva	Average, average
Samurou awang leikai	White ireland	June-Aug	Young plant, mature plant, mature plant	Cutworm, diamond back moth, cabbage looper	<i>Peridroma saucia</i> , <i>Plutella xylostella</i> , <i>Trichoplusia ni</i>	Mature larva, larva	Miner, average, average
Khoijuman ward no. 5	Rareball	April-July	Young and mature plant, young plant, mature plant	Diamond back moth, cabbage aphid, cutworm, angoumois grain moth, cabbage looper	<i>Plutella xylostella</i> , <i>Brevicoryne brassicae</i> , <i>Linnaeus</i> , <i>Peridroma saucia</i> , <i>Sitotroga sp.</i> , <i>Trichoplusia ni</i>	Larva, mature, mature larva, mature, larva	Abundant, abundant, miner, miner, miner
Khoijuman maning leikai	Green hero	June-Sept	Young nad mature plant, young plant	Diamond back moth, cabbage aphid	<i>Plutella xylostella</i> , <i>Brevicoryne brassicae linnaeus</i>	Larva, mature	Average, abundant
Khoijuman maning leikai	Rareball	Nov-Feb	Young plant, young plant	Diamond back moth, cabbage aphid	<i>Plutella xylostella</i> , <i>Brevicoryne brassicae linnaeus</i>	Larva, mature	Average, average
Kwasiphai mayai laeikai	Rareball	April-July	Young plant, mature plant, young and mature plant	Cutworm, angoumois grain moth, cabbage looper	<i>Peridroma saucia</i> , <i>Sitotroga sp.</i> , <i>Trichoplusia ni</i>	Mature larva, mature, larva	Miner, miner, miner
Khoijuman ward no. 4	Rareball	Aug-Nov	Young plant, mature plant	Diamond back moth, cabbage aphid	<i>Plutella xylostella</i> , <i>Brevicoryne brassicae linnaeus</i>	Larva, mature	Miner, average
Leimaram awang leikai	Rareball	Jan-April	Young plant, mature plant, young plant	Cutworm, cabbage aphid, angoumois grain moth	<i>Peridroma saucia</i> , <i>Brevicoryne brassicae Linnaeus</i> , <i>Sitotroga sp.</i>	Mature larva, mature, mature	Miner, minor abundant, miner
Khoijuman ward no. 1	Rareball	July-Oct	Young plant, young plant, mature plant, young plant	Diamond back moth, cabbage aphid, cutworm, cabbage looper, angoumois grain moth	<i>Plutella xylostella</i> , <i>Brevicoryne brassicae Linnaeus</i> , <i>Peridroma saucia</i> , <i>Trichoplusia ni</i> , <i>Sitotroga sp.</i>	Larva, mature, mature larva, larva, mature	Abundant, average, miner, average, miner

Table 4
Distribution of diseases and disorder in cabbage

Name of farming site	Variety of cabbage used	Stages of cabbage plant	Diseases, deficiencies and disorders						Status			
			Fungal	Fungus	Symptom	Bacterial	Bacteria	Symptom		Deficiencies/ disorder/ other diseases	Causes	
Khuman maning loukon near Chothe village	Rareball	-	-	-	-	-	-	-	-	-	-	-
Terarak, Keinou thongthak	Rareball, green hero	-	-	-	-	-	-	-	-	-	-	-
Keinou thongthak	Rareball	-	-	-	-	-	-	-	-	-	-	-
Kwasiphai maning leikai	Rareball	-	-	-	-	-	-	-	-	-	-	-
Khoijuman mamang leikai	Rareball	-	-	-	-	-	-	-	-	-	-	-
Bishnupur ward no. 7	Rareball	-	-	-	-	-	-	-	-	-	-	-
Bishnupur ward no. 11	Drumhand	Mature plant, half grown plant	Cabbage leaf spot, wilting of half grown plant i.e clubroot	<i>Alternaria brassicicola</i> , <i>Plasmiodiophora brassicae</i>	Severe, medium	-	-	-	-	-	-	-
Bishnupur ward no. 7	Rareball	-	-	-	-	-	-	-	-	-	-	-
Lamdeng mayai leikai	Green hero, Rareball	-	-	-	-	-	-	-	-	-	-	-
Oinam sawombung makha leikai	Green hero	Mature plant	Cabbage leaf spot, Fusarium wilt	<i>Alternaria brassicicola</i> , <i>Fusarium oxysporum</i>	Medium, medium	-	-	-	-	-	-	-
Chabung company makha leikai	Sheetal, green hero, rareball	-	-	-	-	-	-	-	-	-	-	-
Chabung company yurenbam leikai	Rareball	-	-	-	-	-	-	-	-	-	-	-
Tiger camp, Imphal east	Rareball	-	-	-	-	-	-	-	-	-	-	-
Bishnupur ward no. 7	Rareball	Mature plant	cabbage leaf spot	<i>Alternaria brassicicola</i>	Severe	Black rot	<i>Xanthomonas campestris</i>	Severe	-	-	-	-
Khoijuman ward no. 1	Rareball	-	-	-	-	-	-	-	-	-	-	-
Kakching near air field	Green hero	Mature plant	Cabbage leaf spot	<i>Alternaria brassicicola</i>	Severe	-	-	-	-	-	-	-
Khoijuman ward no. 1	Green hero, 510	-	-	-	-	-	-	-	-	-	-	-
Lunghar village, Ukhrul	Rareball	Mature plant	club root, cabbage leaf spot	<i>Plasmidio-phora brassicae</i> , <i>Alternaria brassicicola</i>	Medium, severe	Black rot	<i>Xanthomonas campestris</i>	Severe	-	-	-	-

pesticides in order to manage pest and disease has resulted in various health problems to farmers as reported such as headache, eye irritation, dizziness, vomiting, stomach upset, skin irritation and allergy since proper protective measures were not used during the use, handling and spraying of pesticides. The problem of pesticide residues in food, soil, water and air that seriously contaminate the environment through which there may be the chronic health problems to the humans, wild as well as domestic animals and the surroundings.

DISCUSSION

The field investigation and face to face interviews on the application of pesticides in major commercial plantation of tomato and cabbage in Manipur also reveals the emerging pests and diseases as well as deficiencies and disorders to these crops. Heavy rainfall and unusual shower as well as uncontrolled use of pesticides has resulted to increase in insect pests and outbreak of different fungal and bacterial diseases of tomato and cabbage in Manipur.

Tomato fruit borer (*Helicoverpa armigera*) was found to be the most common pest in tomato from field investigation which has resulted to the serious fruit damage and affects the economy of vegetable growers due to yield losses. It is the key insect inflicting fruit damage of 33.5% to 55.5% in the country as reported by Singh and Chahal, 1978; Ram and Singh, 2011. It can reduce the yield of tomato as high as 70% due to fruit boring (Abbas *et al.*, 2015). Leaf miner (*Liriomyza sp.*), Cutworm (*Peridroma saucia*) and aphids (*Macrosiphum sp.*) were also the major pest next to fruit borer which were frequently seen in tomato plants. These insects also encourage the yield losses and low production of crop along with fruit borer that largely give major constraints to the economy of growers in Manipur. Thus, tomato is very prone to many insect pest infestations (Mailafiya *et al.*, 2014; M.M and A.E, 2014) particularly the devastating fruit borer which is a serious pest in both rainy and dry season. It is also a serious pest of tomato in Nigeria and other tomato growing countries (Trenbath, 1993; Pino *et al.*, 1994; Degri and Mailafia, 2013).

In the present survey more fungal diseases had come across as compared to the other diseases in tomato. Early blight disease of tomato plant and fruits caused by the fungus *Alternaria solani* is the most common disease of tomato found in Manipur during

the investigation period. This disease has also contributed to the increase in yield loss and affects the growers. As the frequency of unusual weather events increases the emergence of different diseases is favoured *i.e.* dry weather tends to favour insect and viruses whereas wet weather favours fungal and bacterial pathogens (Anderson *et al.*, 2004; Agrios, 1997). Thus, this fungus *Alternaria solani* has the ability to grow over a wide range of temperatures (4°C to 36°C) as reported by Vloutoglou and Kalogerakis, 2000; Pound, 1951. It can infect tomato as well as potato plants under both dry and wet conditions as mentioned by Waggoner and Horsfall, 1969. Therefore, early blight disease of tomato caused by this fungus is economically the most important disease of tomatoes in India, USA, Australia, UK and Israel where significant reduction in yield (35% to 78%) have been reported by Jones *et al.*, 1993; Datar and Mayee, 1982; Basu, 1974. Thus, this disease is also one of the economically important disease in Manipur as observed from investigation. Next to early blight the major disease of tomato commonly found in Manipur is bacterial wilt caused by *Pseudomonas solanacearum*. This disease is also a devastating disease of crops (Hayward, 1991) that occurs widely in tropical and subtropical regions of the world (Maji and Chakrabartty, 2014; Kelmen, 1998) causing severe losses in yield. As Manipur falls under this region this disease is becoming a common disease in tomato plants. It is difficult to control this disease and no single strategy has 100% efficiency in control of disease so far as mentioned by Chempoiseau and Momol, 2009. Besides, fungal and bacterial diseases nutrient deficiency disease is also becoming common in Manipur. Blossom end rot disease of Tomato is the most common as observed from investigation. This is a calcium deficiency disease. Other minor disease found are bacterial spots, bacterial specks, fruit cracking, tomato mosaic virus, tomato yellow leaf curl virus etc.

Along with tomato, cabbage is also one of the important offseason crop in Manipur. From the field inspection and investigations with farmers many emerging pest and diseases were found in cabbage. The most common insect was found to be the larva of diamond back moth (*Plutella xylostella*) which pose a serious damage to the cabbage plant. It causes yield and quality losses as informed by farmers and as reported by Hasheela *et al.*, 2010. This larva of diamond back moth can cause serious damage even

with the application of several different insecticides because of its ability to develop resistance to almost all the insecticides used (Hill and Foster, 2000; Shelton *et al.*, 1993; Tabashnik *et al.*, 1990; Sun *et al.*, 1986; Georghiou, 1981) which is the main reason for it to be a major pest of cabbage. Besides, cabbage leaf spot was found to be a major disease in Manipur caused by fungus *Alternaria brassicicola*. This disease does not show much damage to farmers' income as the lower infected parts are removed before selling.

Above all the problems caused by insects and disease vegetables growers face many problems such as lack of facility in controlling, lack of transport facility, lack of technical knowledge, health hazards from excessive use of pesticides etc. in managing such damages caused by pests and diseases.

CONCLUSION

From the investigation it was observed that the farmers in Manipur need capacity build up programmes for technical knowledge development in managing the pest and disease problems, right application of pesticides in combating such constraints from the concerned departments, Farm science centre and related research scientist especially for offseason vegetable growers.

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REFERENCES

- Abbas G, Hassan N, Farhan M, Haq I, Karar H (2015), Effect of selected insecticides on *Helicoverpa armigera* Hubner (Lepidoptera: Noctuidae) on tomato (*Lycopersicon esculentum* Miller) and their successful management. *Adv. Entg.* **3**, 16-23.
- Adjrah Y, Dovlo A, Karou SD, Gadegbeku KE, Agbonan A, de Souza C, Gbeassor M (2013), Survey of pesticide application on vegetables in the littorial area of Togo. *Ann. Agri. Env. Med.* **20**, 715-720.
- Anderson PK, Cunningham AA, Patel NG, Morales FJ, Epstein PR, Daszak P (2004), Emerging infectious diseases of plants: pathogen pollution, climate change and agrotechnology drivers. *Tren. Eco. Evol.* **19**, 535-544.
- Agrios GN (1997), Plant Pathology. *Academic Press*.
- Basu PK (1974), Measuring early blight, its progress and influence on fruit losses in nine tomato cultivars. *Can. Plnt. Dise. Sur.* **54**, 45-51.
- Champoiseau PG, Momol TM (2008), Bacterial wilt of tomato. Pp. 1-11, USDA- NRI Project: *R.solanacearum* race 3 biovar 2: detection, exclusion and analysis of a select Agent educational modules. The United States Department of Agriculture-National Research Initiatives programme (2007-2010). *Plant path. ifas. ufl. edu*.
- Crew (1984), Manual of assessment keys for plant diseases.
- Datar VV, Mayee CD (1982), Conidial dispersal of *Alternaria solani* in tomato. *Ind. Phyto.* **35**, 68-70.
- Degri MM, Mailafiya DM (2013), Potentials of *Mitracarpus villosus* (L.) and *Balanites aegyptiaca* (Del.) plant extracts and cypermethrin in the management of tomato fruit worm (*Helicoverpa armigera* Hubner) damage in Maiduguri Nigeria. *Intl. J. Agri. Res. Sustain. Food Sufficy.* **1**, 1-6.
- Georghiou GP (1981), The occurrence of resistance to pesticides in arthropods. Food and Agriculture Organization of the United Nations, Rome.
- Hasheela EBS, Nderitu JH, Olubayo FM (2010), Evaluation of border crops against infestation and damage of cabbage by diamondback moth (*Plutella xylostella*). *Tunis. J. Plnt. Protc.* **5**, 99-105.
- Hayward AC (1991), Biology and epidemiology of bacterial wilt caused by *Pseudomonas solanacearum*. *Ann. Rev. Phytopathol.* **29**, 65-87.
- Hill TA, Foster RE (2000), Effect of insecticides on the diamondback moth (Lepidoptera: Plutellidae) and its parasitoid diadegma insulare (Hymenoptera: Ichneumonidae). *J. Econ. Entomol.* **93**, 763-768.
- Jones JB, Jones JP, Stall RE, Zitter TA, eds (1993), Compendium of tomato diseases. St. Paul, Minnesota, USA: *Ame.Phyto.Soc.*
- Kelman A (1998), One hundred and one years of research on bacterial wilt. In: Prior P, Allen C, Elphinstone J. (eds). Bacterial wilt: Molecular and Ecological Aspects, Pp. 1-5. INRA Editions, Paris, France, Kelman A, Person LH. 1961.
- Krishna MB, Ravinder B, Upendra K, Kumar S, MK, BP (2011), Use of pesticides in commercial vegetable cultivation in Khamamm, Andhra Pradesh, India during 2011 (A survey report). *Pharm. An. Intl. J. Adv. Pharml. Sc.*
- Maji S, Chakrabartty PK (2014), Biocontrol of bacterial wilt of tomato caused by *Ralstonia solanacearum* by isolates of plant growth promoting rhizobacteria. *Aus. J. Crp. Sc.* **8**, 208-2014.
- Mailafiya DM, Degri MM, Maina YT, Gadzama UN, Galadima IB (2014), Preliminary studies on insect pest incidence on tomato in Bama, Borno State, Nigeria. *Intl. Lett. Nat. Sc.* **5**, 45-54.

- MMD, AES (2014), Impact of intercropping tomato and maize on the infestation of tomato fruit borer (*Helicoverpa armigera* Hubner). *J. Agri. Crp. Res.* **2**, 160-164.
- Pino M, de-Los A, Bertoh M, Espinosa R (1994), Maize as a protective crop for tomato in conditions of environmental stress. *Cult. Trop.* **15**, 60-63.
- Pound GS (1951), Effect of air temperature on incidence and development of the early blight disease of tomato. *PhytoPathol.* **41**, 127-135.
- Ram S, Singh S (2011), Evaluation of botanical, microbial and chemical insecticide on the fruit damage inflicted by fruit borer in tomato. *Veg. Sc.* **38**, 162-164.
- Shelton AM, Wyman JA, Cushing NL, Apfelbeck K, Dennehy TJ, Mahr SER, Eigenbrode SD (1993), Insecticide resistance of diamondback moth (Lepidoptera: Plutellidae) in North America. *J. Econ. Entomol.* **86**, 11-19.
- Shibabaw A, Zegeye W, Belay B, Asaregew F, Worku A, Belay D, Mehretu E, Alemayehu G (2013), Diseases, insect pests and parasitic weeds of common crops and their importance under irrigation conditions of Rib areas. *Curr. Res. Microbiol. Biotechnol.* **1**, 262-265.
- Singh D, Chahal BS (1978), Control of tomato fruit borer *Heliothis armigera* (Hubner) in Punjab. Haryana. *J. Hort. Sc.* **7**, 182-186.
- Sun CH, Wu TK, Chen JS, Lee WT (1986), Insecticide resistance in the diamondback moth. pp 359-372. In N.S. Talekar and T.D. Griggs (eds), Diamondback moth management. Proceedings, 1st International Workshop at Asian Vegetable Research and Development Center, 11-15 March 1985, Shanhua, Taiwan.
- Tabashnik BE, Cushing NL, Finson N, Johnson MW (1990), Field development of resistance to *Bacillus thuringiensis* in diamondback moth (Lepidoptera: Plutellidae). *J. Econ. Entomol.* **83**, 1671- 1676.
- Tesfaye (1985), Review of crop protection research in Ethiopia, Proceedings of the First Ethiopian crop protection symposium Pp. 447-463.
- Tindall HD (1983), Vegetable crop in the tropics Pp. 14-25, Hongkong, China, Judith Wolf (1991).
- Trenbath BR (1993), Intercropping for the management of pests and diseases. *Field Crp. Res.* **34**, 381-405.
- Vloutoglou I, Kalogerakis SN (2000), Effects of inoculum concentration, wetness duration and plant age on development of early blight (*Alternaria solani*) and on shedding of leaves in tomato plants. *Plnt. Pathol.* **49**, 339-345.
- Waggoner PE, Horsfall JG (1969), Epidem: A simulator of plant disease written for a computer. Bulletin No. 698. New Haven, Connecticut: Connecticut Agricultural Experimental Station.

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