Technical Bulletin On Maize Production Technologies in Meghalaya

Subhash Babu
K.P. Mohapatra
Jayanta Layek
D.M. Firake
Amit Kumar
G.T. Behere
Bagish Kumar
N. Prakash

ICAR Research Complex for NEH Region,
Umiam, Meghalaya-793 103

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Dr. Subhash Babu
Mr. Banshanlang Rynjah

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Dr. Subhash Babu, Dr. Raghavendra Singh, Dr. Anup Das, Dr. Jayanta Layek and Dr. D.M. Firake

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Telephone: 0364-2570257
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Authors

Subhash Babu, K.P. Mohapatra, Jayanta Layek, D.M. Firake, Amit Kumar, G.T. Behere, Bagish Kumar and N. Prakash

ICAR Research Complex for NEH Region,

Umiam, Meghalaya-793 103

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Authors are hopeful that this publication will be helpful to the various stakeholders for improving maize productivity and resource use efficiency under diverse situation of Meghalaya.

Authors

Content

1. Introduction

Meghalaya (currently has 11 districts) is basically an agrarian state, about 80% of its population depends on agriculture for their livelihood. Being a mountainous state only 10% of the geographical area of Meghalaya is under cultivation. Maize, queen of cereals is the second most important food crop of Meghalaya after rice occupies about 18000 ha area (8% of total area) with an average yield of 2150 kg/ha. Per unit productivity of maize in Meghalaya is lagging behind the national average of the India. In Meghalaya, maize is mainly cultivated in upland traces during *kharif* season. The unique feature of this crop is interior diversity. Among the different maize/corns, grain maize, sweet corn, baby corn and popcorn are mainly cultivated in Meghalaya. Maize is usually eaten after it boiled in water, fried or burnt over fire. It sustains hunger for a longer period than rice. Populace of Meghalaya usually prepares food cooked with rice and maize. Firstly, grounded maize is boiled with water and then afterwards rice grains are added. This is a specially prepared dish which has a taste of its own and at the same time sustains hunger much longer. Apart from that maize is an important feed ingredient for cattle, poultry and piggery feed. Being a C_4 plant, maize has better-withstanding capacity to climate change than other major cereal grain crop. Due to C_4 mechanism of carbon fixation in maize, loss of CO_2 during photosynthesis is very less and energy conversion efficiency is very high. Higher water use efficiency has resulted with higher CO_2 concentration with optimum inputs. But climate change is detrimental to maize production in Meghalaya where soils have degraded to an extent that they no longer provide adequate nutrients to buffer crops against multiple stresses. These effects will be most severe, if drainage is not available to remove the excess water from the field. Improving genetic adaptation to multiples stresses alone will not address these problems; there is also a need for innovative agronomic interventions. In Meghalaya, maize faces problems during reproductive stage, if stress affects in the form of drought, water logging etc. Poor drainage during *Kharif* seasons leads to increased anthesis-silking interval (ASI) and resulted in poor economic yield. Being nutrients exhaustive crop maize is very sensitive to soil pH change and nutrient imbalance. Among the cereals for changing climate, maize is the best option but still to prepare it as a future crop with appropriate agronomic interventions. Sustainable maize production technique is the set of site-specific management strategies aimed to reduces the vulnerabilities to multiple stresses and improve the resilience of the production systems. Good quality seed, timely planting, proper drainage, optimum crop geometry, balance fertilization, crop establishment

techniques, weed management and proper crop rotation is the key for obtaining higher maize yield in Meghalaya. Therefore, an improved multidimensional crop management practice has been presented in this bulletin.

2. Types of maize cultivated in Meghalaya

2.1 Dent corn (*Zea mays indenata* Sturt)

Dent corn is mainly used as livestock feed, in industrial products, or to make processed foods. This is basically characterized by its dented appearance. The core of the kernel is soft and floury and extends to the crown of the endosperm. Once the corn is dried, the kernels collapse and looks indented.

2.2 Flint corn (Zea mays indurata Sturt*)*

Flint corn, also known as Indian corn, is used as dent corn. Flint corn is distinguished by a hard outer shell and kernels. The kernels are smooth and round, the ears are long and slender.

2.3 Sweet corn (Zea saccharata Sturt*)*

Sweet corn is primarily eaten on the cob, or it can be canned or frozen for future consumption. Sweet corn is not used as flour. Sweet corn is extra sweet because it contains more natural sugars (8-10%) than other types of corn. Its sugary gene prevents the sugar from converting to starch during endosperm development. Sweet corn is eaten while the ears are in the immature milk stage and the kernels are tender.

2.4 Popcorn (Zea mays everta Sturt*)*

Popcorn, a type of flint corn, has a soft starchy centre surrounded by a very hard exterior shell. When popcorn is heated the natural moisture inside the kernel turns to steam that builds up enough pressure for the kernel to explode the white starchy mass that is eatable. All types of corn will pop to some degree.

2.5 Baby corn

Maize cobs harvested 2-5 days after their emergence called baby corn, while the ears are still immature. The cobs/ears meant for baby corn not allowed to fertilized and set seed. It typically is eaten whole – cob included – in contrast to mature corn, whose cob is too

tough for human consumption. It is eaten both raw and cooked. Baby corn is common in stir fry dishes. Maize hybrids/varieties with multicobs are generally fit for this category.

2.6 Quality Protein Maize

The quality of grains used as feeds play an important role for food and nutritional security. In this respect, discovery of Opaque-2 (O2) and floury-2 (F2) mutant had opened tremendous possibilities for improvement of protein quality of maize which later led to the development of "Quality Protein Maize (QPM). QPM which is nutritionally superior over the normal maize and thus quite important not only for food and nutritional security but also for quality feed for poultry, piggery and animal sectors.

3. Climatic requirement

Maize is a warm season crop and not performance well in areas where the mean daily temperature is less than 19 ºC. Although the minimum temperature required for its germination is 10 ºC, however, optimum temperature for germination is ranges between 16 to 18 ºC. Temperature beyond the 32 ºC detrimentally affects the economic yield of maize. Maize is very susceptible to frost, it can damage the crop at any growth stages, and a frost-free period of 120 to 140 days is required to prevent damage.

4. Soil requirement

Maize can be grown on a wide variety of soils. However, soils with good organic matter content having high water holding capacity with neutral pH are considered good for higher productivity. Maize is very sensitive to excess moisture stress; hence, provision of proper drainage is essential for economic maize production. Meghalaya soils are rich in organic carbon, which is a measure of nitrogen supplying potential of the soil, deficient in available phosphorous and medium to low in available potassium. The reaction of the soils varies from acidic (pH 5.0 to 6.0) to strongly acidic (pH 4.5 to 5.0). Therefore, liming is very important to correct the soil acidity for successful maize production in the state. Furrow application of lime (80 mesh size) @ 200-400 kg/ha is recommended for the soil having pH <5.5. Lime can be applied with basal dose of fertilizers (part of N + full dose of P & K) manually or through seed cum fertilizer drill at the time of sowing.

5. Time of sowing/planting

Being a photo-insensitive and day neutral plant, maize can be grown in all seasons *viz; kharif*, post kharif monsoon, *Rabi* and spring. However, in Meghalaya maize is mostly grown during pre-*kharif*/*kharif* season as a rainfed crop. Farmers of the Meghalaya are generally not cultivated maize during winter season mainly due to lack of irrigation facilities. Temperature

plays a pivotal role in germination of maize, practically no germination or growth of maize takes place below 10 ºC. Meghalaya has very high and intense rainfall during *kharif* season. Hence, sowing/planting of maize should planned in such a way that heavy rainfall should not be coincides with tasseling stage because causes disease, pests to maize crop leading to fewer kernels in cobs. Considering all the factors, the optimum sowing time of *kharif* grain/popcorn in Meghalaya is April-May.

6. Seed rate and planting geometry

Optimum plant population is the key factor for achieving the higher productivity and resource-use efficiency in any production system.

Importance of plant population / crop geometry

- ✓ Yield of any crop depends on final plant population
- ✓ Under rain fed conditions, comparatively lower plant population is require to utilize soil moisture judiciously in contrary when soil moisture and nutrients are not limited high plant population is necessary to utilize the other growth factors like solar radiation efficiently.
- ✓ Under low plant population individual plant yield will be more due to poor completion for the growth resources. In contrary, under high plant population individual plant results in poor economic yield due higher competition for available resources between plants.
- ✓ Yield per plant decreases gradually as plant population per unit area is increased, but yield per unit area increases up-to certain level of population. That level of plant population is called as optimum population. So to get maximum yield per unit area, optimum plant population is necessary.

The seed rate varies depending on purpose, seed size, plant type, season, soil type, sowing methods etc. The following crop geometry and seed rate should be adopted for profitable maize production in Meghalaya. The optimum seed rate and planting geometry is given in Table-1.

Table-1: Optimum seed rate and planting geometry of maize

Purpose of cultivation	Seed rate (kg/ha)	Planting geometry (Row x Plant cm)
Normal/QPM grain/green cob	18-20	60x20 for inorganic management 50x20 for organic management
Fodder	50-60	30x10
Pop corn	12-15	50x20
Baby corn	25-30	45x15-20

7. Sowing depth

Depth of sowing mainly related to coleoptile length and food reserve of the seed, however it also depends on soil type and management practices, in general sowing depth bold seeded crops are comparatively more than the small seeded crops. As a thumb rule maize seed should not be sown beyond the 5-7 cm, otherwise crop emergence and plant population affected adversely. Planting depth of maize varies from 5 to 10 cm, depending on the soil type and planting date. As a rule, planting should be shallower in heavier soils than in sandy soils.

8. Varieties/hybrids

Genotype choice, if correctly planned, can make a great contribution to risk reduction and should constitute an important part of production planning. Varietal selection to a particular location is a key determinant for getting higher productivity and profitability of maize.

Evaluation of different varieties of maize under organic farming

ICAR Research Complex for NEH Region, Umiam, Meghalaya evaluated eleven maize varieties were screened amongst which eight were composites, one hybrid and two local varieties under Network Project on Organic Farming. Yield attributes and yields of different variety of maize were significantly affected under organic production system (Table 2). The longest cob length was recorded with variety RCM 1- 61 (14.3 cm) followed by local yellow (13.9cm). However, shortest cob length was recorded in the variety local white (11.4 cm). Cob weight was maximum in variety RCM 1- 61 (223.8 g) followed by RCM-75 (219.4 g). Green cob yield was recorded maximum in RCM 1- 61 (5.59 t/ha) followed by RCM-75 (5.50 t/ha). With respect to seed yield among the tested varieties/lines RCM 1- 61 (3.39 t/ha) recoded maximum seed/grain yield followed by RCM-76 (3.29 t/ha). Lower seed yield was recorded in the variety local white (2.67t/ha) followed by RCM-1-2 (2.94 t/ha). The harvest index determines how much photosynthates are transformed into economic yield the harvest index was recorded non-significant among the varieties. However, the highest harvest index was observed in RCM 1- 61 (30.4%) followed by RCM-1-1 (30.1%). Whereas, the minimum harvest index was found in local yellow and local white (28.8 % and 28.1%, respectively).

Table 2: Yield attributes and yields of different varieties of maize under organic production system

Varieties	Cob Length (cm)	Cob weight (g)	Green cob yield (t/ha)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
RCM-1-1	13.3	210.8	5.10	3.07	7.13	30.1
RCM-1-2	12.8	201.6	4.68	2.94	6.86	30.0
RCM-1-3	13.3	212.8	5.28	3.27	8.01	29.0
RCM-75	13.8	219.4	5.50	3.29	7.98	29.2
RCM-76	13.7	211.8	5.36	3.26	7.98	29.0
Vijay composite	13.1	197.0	4.69	3.14	7.81	28.6
Hemant	12.6	190.9	4.61	3.01	7.19	29.5
RCM 1- 61	14.3	223.8	5.59	3.39	7.75	30.4
Hybrid (JKMH - 501)	12.9	196.2	4.53	3.00	7.30	29.1
Local Yellow	13.9	179.5	3.90	2.78	6.93	28.8
Local White	11.4	164.7	3.84	2.67	6.83	28.1
SEm (±)	0.34	4.9	0.22	0.12	0.22	1.00
CD(P=0.05)	1.00	14.5	0.66	0.35	0.64	NS

Table: 3 Maize composites/hybrids suitable for Meghalaya

Maize type	Important varieties/ hybrids
Normal grain maize	RCM1-1, RCM 1-76, RCM1-3 RCM 1- 61, Vivek Maize Hybrid 51 &25, RCM- 75 &76
QPM	HQPM 1 & 5
Baby Corn	VL Makka 42, VL-45, MTH-14, RCM 1-1, RCM 1-3, HM-4 VL Baby corn-1
Pop corn	Local, RCM-1-2
Fodder maize	African tall, RCM -75

9. Tillage and crop establishment

Tillage and crop establishment is the main driver of the crop yield. Crop establishment depends on interactions of seed, sowing depth, soil moisture dynamics, method of sowing, fertilization, water management etc but, the method of sowing/ planting plays a vital role for better establishment of crop under a set of growing situation. Being a kharif crop, maize experiences very intense rainfall and subjected to heavy lodging. Lodging of plants has a monetary implication for the farmers, because a number of cobs may be laying on the soil, making it uneconomical to be picked up by hand. Good progress has been made with cultivars showing less lodging, but differences among cultivars still occur. Therefore it is very important that different situations require different sowing methods for achieving higher yield as described below:

9.1 Raised bed (ridge) and furrow sowing

Generally the raised bed planting is considered as best planting/sowing method for maize in Meghalaya under excess moisture availability. Sowing should be done on the top or side of the ridge however, the southern side of the east-west ridges helps in good

germination. The furrows facilitate the removal of excess water and crop can be saved from excess soil moisture stress. For realizing the full potential of the bed planting technology, permanent beds are advisable in mid slope areas wherein sowing can be done in a single pass without any preparatory tillage.

9.2 Zero-till sowing

The no-till system is a specialized type of conservation tillage consisting of a one-pass planting and fertilizer operation in which the soil and the surface residues are minimally disturbed. The surface residues of such a system are of critical importance for soil and water conservation. Maize can be successfully grown under no-till situation. In the slopping terraces, the planting is done by manually by making small holes of 2-5 cm depth and drills the seed into it. No-tillage systems eliminate all pre-planting mechanical seedbed preparation except for the opening of a narrow (2-3 cm wide) strip or small hole in the ground for seed placement to ensure adequate seed/soil contact. The entire soil surface is covered by crop residue mulch. No-tillage maize production conserves soil and water and reduces capital investment in machinery for land preparations and intercultural operations, but most important to many producers, no-tillage can improve maize yields. No-till leaves the soil undisturbed from harvest to planting. This practice also leaves crop residues on the surface after planting, which promotes infiltration of rain falling months. However, use of appropriate planter having suitable furrow opener and seed metering system is the key of success of the no-till technology.

Following conventional no till based land configurations for achieving higher maize productivity in high rainfall area of north east India.

- ✓ Conventional tillage with flatbed planting: - 4 ploughing with the help of power tiller and plots should be prepared to ground level.
- ✓ Conventional tillage with ridge and furrow planting: The ridges and furrows are made from the surface, 15 cm deep furrow should be made and the removed soil should be placed on ridges, finally making 30 cm ridges from base.
- ✓ Conventional tillage with raised bed planting-the plots were ploughed conventionally but raised the planting area for about 15 cm above the ground.
- ✓ No-till with flatbed planting - residues of previously grown crop is left on the soil surface; a hand hoe should be used to open planting/sowing point.
- ✓ No-till with ridge and furrow planting - the ridges and furrows are made from the surface, 15 cm deep furrow should be made and the removed soil should be placed on

ridges, finally making 30 cm ridges from base made in previous season and repaired in planting season to maintain no-till condition.

- ✓ No-till with raised bed planting (NT-RB) - the plots should be ploughed conventionally but raised the planting area for about 15 cm above the ground in previous season and repaired in planting season to maintain no-till condition.

10. Nutrient management

Maize is a most nutrient exhaustive crop and very responsive to external nutrients application. N, P and K are the three major yield governing nutrients in maize production. Deficiency of all three nutrients appears on lower leaves of younger plants. Nitrogen deficiency produces pale, light green or yellow colour leaves, and during later stages older leaves produces characteristic inverted V-shape. However, due to deficiency of phosphorus leaves turns dark green with reddish-purple tips and margins. In contrary, potassium deficiency is initially noted as yellow or necrotic leaf margins, beginning at the lower leaves and spreading to the upper leaves. K deficiency increases the lodging tendency of mature maize plant. Application of RDF (80:26.2:33.2 kg NPK/ha) +lime (250 kg/ha in furrows) + FYM (5 t/ha in furrows) [RDF + lime + FYM] substantially improves maize growth and productivity besides brought positive change in soil chemical properties. In general following fertilizer schedule should be adopted for achieving the maximum maize yield in Meghalaya

- ✓ Application of biofertilizer: 20-25 kg *Azospirillum* +*Phosphobacteria*/ha or Azophos 4 kg/ha should be applied before the sowing of the crop.
- ✓ Organic nutrient management: Integrated organic nutrient management strategies should be followed without excess reliance to any one organic sources of nutrient for economic maize production. Hence, 8-10 tonne FYM + 1.5-2 tonne vermicompost + 2 tonne poultry/pig manure along with rock phosphate @150 kg/ha should be applied in

furrow for achieving optimum yield of maize crop. Neem cake can also be added @150 kg/ha to the field for effective control of soil borne insect pests.

- ✓ Inorganic nutrient management: 60-80 kg N+40 kg P_2O_5+ 40 kg K_2O/ha along with 25 kg $ZnSO_4$/ha should be applied for grain maize however, 25% higher dose of N is recommended for baby corn production. The general full dose of phosphorus and potassium and half dose of nitrogen should be applied as band-placement P at 5 cm to the side and 5 cm below the seed. Remaining half dose of nitrogen should be applied at knee high stage.

11. Water management

Maize is susceptible to both excess and deficit moisture stress, adequate moisture supply is necessary to harvest good crop without negative yield penalty. Water stagnation even for 6-7 hours continuously can damage the crop. Maize needs 450 to 600 mm of water per season, which is mainly acquired from the soil moisture reserves. It has been estimated that the maize crop requires more than 50% of its total water requirement in about 30 to 35 days after tasselling and lack of moisture at the grain filling stage results in the poor yield of shriveled grains. In entire growth period, each maize plant consumed about 250-300 l of water. Maize is grown as a rainfed crop in Meghalaya, hence didn't apply any irrigation. However, excess water is a problem due to high rainfall. Therefore, proper drainage is necessary for successful maize production in the state.

12. Weed management

Profitable cultivation of maize mainly depends on the efficacy of weed management. Weed control during the 45-60 days after planting/sowing is vital, because weeds compete energetically with crop for available resources during this period. Due to continuous rain during kharif season weed control in maize is often more difficult in Meghalaya than in plain areas. Application of forest litter and/or weed biomass @ 5-7.5 t/ha is recommended to suppress the weed flora in maize. In addition, during sunny days, application of atrazine @ 0.25 kg/ha as pre emergence on 3-5 days after sowing (DAS) using 500 l should be used to reduce the weed pressure under inorganic management. However, if maize is intercropped with pulses, spray of Pendimethalin @ 0.75 kg/ha as pre emergence is recommended. Under organic management 2-3 hand weeding along with *in-situ* weed biomass mulching is most suitable to reduce the weed problem.

13. Maize based cropping systems in Meghalaya

Productivity of rainfed monocropping systems in Meghalaya is very low and high risk economic activity. Hence, ICAR Research Complex for NEH Region, Umiam, Meghalaya has designed series of resource efficient cropping systems along with innovative management practices. Multiple cropping (intercropping, relay cropping and mixed cropping) with multi-canopy structure provide continuous vegetative cover throughout the year improves farm productivity besides reducing soil erosion. The slopping lands are 3-4 times less efficient than the plains in meeting the caloric and protein needs of their populations. Hence, sustainable intensification is the need of hour for enhancing the farm productivity in hilly regions. Sustainable intensification is an agricultural production strategy that pursues to increase and optimize the benefits that can be derived from making better use of available natural resources. There is always need to consider agricultural options in context, taking full account of the factors and interactions of time and space so that field operations can conducted in a timely way, with land area optimally occupied by crops in system mode. Cropping system diversity can help build greater agro ecosystem resilience by suppressing biotic pressures and by mitigating effects of extreme and more variable weather. Following maize based cropping systems are suggested for higher income, employments and better soil health in upland terraces of Meghalaya

- ✓ Maize-Frenchbean
- ✓ Maize-Toria
- ✓ Maize-Buckwheat
- ✓ Maize- Black gram/Green gram
- ✓ Maize-Frenchbean-Lentil
- ✓ Maize- Black gram/Green gram-Vegetable pea/Toria
- ✓ Maize + soybean-French bean/Carrot/tomato
- ✓ Maize-vegetables
- ✓ Maize-pea (for vegetable purpose, 70 days duration)
- ✓ Maize (fodder)-Rice (early variety sown at the end of June)
- ✓ Maize + Soybean (2:2) - mustard

14. Crop residue management (CRM) in maize based cropping systems

The proper management of crop residue provides a significant amount of nutrients for crop production, besides it improves the soil physical, chemical and biological properties. Crop residue/stubble on the soil surface are known to reduce soil erosion either by affecting

directly the physical force involved in erosion or indirectly by modifying the soil structure and soil biological regimes through organic matter (OM) addition. Crop stubbles/residues can be used as mulch which increases infiltration by reducing surface sealing and decreasing runoff velocity. The decomposition of the stubble and residues start after certain period of time and can have both positive as well as negative effect on crop production and environment. The crop residues serve as a habitat for insect-pest and disease pathogens which is considered as a major drawback of crop residue management (CRM). Hence, to increase the positive effect of CRM with minimum adverse effect on the environment, the crop residues and stubbles should be well managed. Leaving vegetative cover on the field through stubble and crop residues helps to 'sew' the soil and protect it from water erosion. These crop residues act as a feed for micro-organisms, thus enhance the biological activity which plays an important role in nutrient cycling. Composts from plant debris and animal manures added to the soil along with integrated biological pest and weed management, crop rotation and mechanical cultivation also helps to sustain and enhance soil productivity and fertility without the use of synthetic N fertilizer and pesticides. The handling of crop residues also has an impact on net carbon gains.

15. Maize based intercropping systems in Meghalaya

The most common goal of intercropping is to produce a greater yield on a given piece of land by making better utilization of available resources or ecological processes that would otherwise not been utilized by a single crop, leading to higher productivity per unit area. Cereal + legume intercropping reduces competition for N, since legume depends mainly on its own N_2 which is fixed by nodule into soil itself, while cereals use available mineral N. Legumes, with their adaptability to different cropping patterns and their ability to fix N, may offer opportunities to sustain and enhance soil health in hill ecosystem. Intercropping systems have proved to a remunerative enterprises compared to sole cropping either of maize or legumes in mid hill sub-humid condition of Meghalaya. Legumes in maize-based cropping systems are considered to be better alternatives for securing nitrogen economy and increasing yield of maize besides bonus yield, greater productivity per unit time and space hence, intercropping is a less risky technology especially under changing climatic scenarios. The infertile land requires more nitrogen for proper plant growth and better yield and thus the demand for soil nitrogen in Himalayan rainfed agriculture is increasing day-by-day. Unique characteristics like high protein content (2-3 times more than cereals), nitrogen fixing ability, soil ameliorative properties and ability to thrive better under unfavorable conditions make

pulses an integral component of agriculture in Himalaya. When non-leguminous crops like, maize grown with legumes, it provide support for climbing to legumes, minimizes disease and weed problems and alleviates the negative impacts of continuous cereal cultivation on soil fertility. In high altitude, maize + soybean (two rows of soybean in between two rows of maize) are very good intercropping practice for the region. In maize + soybean inter cropping, soybean detopping is necessary in high rain fall area, which adds 8-10 kg N/ha and also improve the productivity of soybean. In mid and low altitude area Maize + arhar (1:1 ratio) or Maize + groundnut/soybean and maize + rice bean is highly promising intercropping system. Paired row planting (2:2 row ratio) should be done for intercropping by adjusting spacing of the maize crop.

Following maize based intercropping systems are suggested for improving land and water productivity in Meghalaya.

- ✓ Maize+Groundnut
- ✓ Maize+Rice bean
- ✓ Maize+ Soybean
- ✓ Maize+Cowpea

Maize+ soybean (2:2 ratio)

Maize+ frenchbean (replacement series)

Maize+ ramie (2: 1 ratio)

Maize+ rice bean (additive series)

Following tips for management of intercropping systems in Meghalaya:

- ✓ Seedbed preparation should be done as per the needs of base or main crop.
- ✓ The peak demand of growth resources of component crops should coincide with main crop.
- ✓ Component crops varieties should be less competing with the base crop
- ✓ Climatic and agronomic requirements of component crop should match with main crop.
- ✓ If required, sowing practices would be slightly altered to accommodate component crop in such a way that it charges less competition to base crop. For example, if the line to line spacing for sole maize is 60cm, to accommodate a intercrop it can be modified as 50 cm between the paired lines/rows and 70 cm between the two pairs of maize lines/rows and thereby leaving ample space for a intercrop in between 70 cm row spacing . And the maize population will be remained unchanged.
- ✓ The intercrop may be sown along with the main crop or it may be altered as per the need of the crop.
- ✓ Fertilizer dose should be applied more than the recommended dose for base crop. If the component crop is a legume, generally the fertilizer required for main crop is sufficient. The phosphorus dose may be increased by about 25 % to meet the requirement of intercrops.
- ✓ Select the component crop which should not be more labour consuming.

Strategies for nutrient conservation and fertilizer economy in maize based systems

In Meghalaya, farmers applied very low level of fertilizers with less efficiency. A number of nutrient management practices are used to enhance fertilizer use efficiency (FUE) and

reduces the nutrient losses. The following management practices are suggested for minimizing the soil erosion and maximizing the FUE:

- ✓ Inclusion of at least one leguminous crop in crop rotation to fix the atmospheric nitrogen into the soil. Cover crops like groundnut should be planted between crop seasons to tie up and preserve nutrients, in contrast to continuous planting of the maize and not planting any cover crops.
- ✓ Grasses are grown on the bunds to mitigate soil erosion and conserve the nutrients.
- ✓ Application of manure, organic waste based manure and incorporation of other byproducts into the soil should follow in nutrient management plan.
- ✓ Assessing nutrient need through annual or regular soil testing before applying nutrients.
- ✓ Timing of nutrient application to tailor feeding to meet plant growth requirement is important, for example, split application of nitrogen fertilizer in contrast to single application before planting.
- ✓ Application of conservation effective crop management practices like modified tillage and organic farming practices etc.

16. Land development for enhancing maize productivity and reducing soil erosion

Slopping land comprises the major area in Meghalaya plateau and vulnerable to different kind of soil losses. Maize cultivation practices with appropriate agronomic interventions on slopping land accelerated the soil erosion. Hence, inward slopping narrow bench terraces are suggested to arrest the soil and nutrient loses and enhances the maize productivity. These are the trenches excavated along the contours to break the slope length for reducing the velocity of surface runoff. Planting of fodder grasses on terrace riser is advocated to reduce the soil erosion and nutrients losses besides providing the fodder to home cattle's. Perennial forage grasses like guinea grass is most suitable for growing on the terrace rises or bunds in Meghalaya. Contour-based cultivation, particularly when combined with grass planted in contour strips, is considered to be effective both in terms of controlling soil erosion and production costs in maize cultivation. Conservation bench terraces have been found effective for maize cultivation on slopping lands. Bench terraces are generally more effective on slopes steeper than 12%.

17. Techniques of hybrid maize seed production

Production of pure and disease free seed by proper seed production techniques have not been practiced in Meghalaya. However, production of quality seeds of HYV/hybrids of maize

is the basic need for increasing production and sustaining farmer's income. Varietal purity of seed has to be maintained in order to produce high quality seed.

Hybrid is the first generation progeny of a cross between two genetically different plants. This is generally developed by crossing two inbreds is known as a single-cross hybrid. All plants of a single-cross hybrid are genetically similar. Inbred line is a genetically homozygous genotype which is developed by means of self-pollination followed by selection. A hybrid produced by crossing two inbreds developed from different but equally productive open-pollinated varieties usually will produce a more vigorous hybrid. Double cross hybrids and three way cross hybrids are not popular as these are not commercially viable as compared to single cross hybrids

Table 4: A comparison of different hybrids

Hybrid	Male parent	Female parent	Yield/ plant	Uniformity
Single cross	Inbred line	Inbred line	Highest	Uniform
Double cross	Single cross hybrid	Single cross hybrid	High	High variation
Three way cross	Inbred line	Single cross hybrid	High	Low variation
Varietal cross	Open pollinated variety	Open pollinated variety	Moderate	High variation

When a single-cross hybrid is allowed to open-pollinate (as in farmer's field), approximately half the hybrid vigour is lost. The crop produced from open-pollinated seed harvested from a single-cross hybrid will not be as productive as the original single cross. Thus, systematic multiplication of inbreds is quite necessary in order to produce hybrid seeds in larger quantity.

17.1 Steps for development of a commercial corn hybrid

- ✓ Selection and development of superior germplasm.
- ✓ Development of superior inbred lines.
- ✓ Evaluation of inbreds in various cross combinations.
- ✓ Identification of a superior cross combination.
- ✓ Multi-location testing of the pre-commercial hybrid.
- ✓ Large scale seed production of identified hybrids.

The breeders perform various crosses of inbreds to determine which combination will produce the most desirable hybrids. Once these combinations are identified, the large scale multiplication is possible. One inbred is designated the "male" while the other is designated the "female." These inbreds are planted in the same field, typically in alternating blocks of four female rows and one male row. The tassels from female plants have to be removed. The

male plants have to keep their male parts (the tassel). This process leaves the male tassels untouched while eliminating the undesired female tassel. Once the flowering season has ended, the male plants have to be eliminated. This ensures ears on the male plant (which have presumably been fertilized by pollen from the male tassels) are not harvested. Males are also often planted around the seed corn field as a barrier to block pollen from neighbouring corn fields. This also increases the amount of desired male pollen in the area.

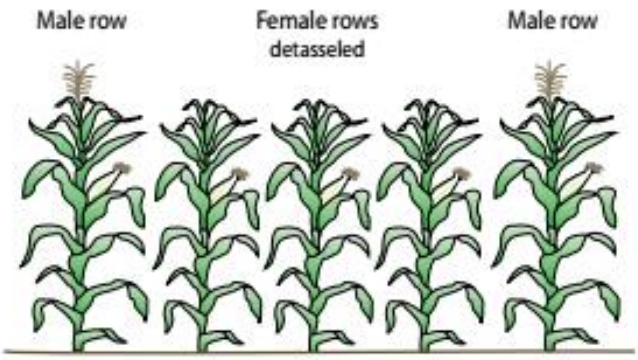

Fig. 1 A schematic view of hybrid maize production

There are several factors that determine the success and quality of hybrid seed production.

- ✓ Female and male parent purity and performances.
- ✓ Ratio of female to male rows in the seed field.
- ✓ Synchronised flowering of the female and male plants.
- ✓ Timely removal of the tassels from the female plants before they shed pollen and before silk emergence.
- ✓ Avoidance of contamination of female silks with unwanted pollen, particularly from females, off type males and foreign pollen.
- ✓ Avoidance of seed mixtures between and within the male and female plants.

17.2 Precautions to be taken while detasseling

- ✓ Hold the stem below the boot leaf in left hand and the base of the tassel in right hand and pull it in a single pull.
- ✓ No part should be left on the plant as it causes contamination.
- ✓ It should be uniform process done daily in the morning in a particular direction.
- ✓ Don’t break the top leaves as removal of one leaf causes 1.5% loss in yield.
- ✓ Immature detasseling should be discouraged as this may lead to reduced yield and contamination.
- ✓ Mark the male rows with marker to avoid mistake in detasseling.

- ✓ Look out for shedders (shedding tassel) in female rows as they may cause contamination.
- ✓ After pulling out the tassel drop it there itself and buried in soil. Otherwise late emerging pollen from detasseled tassel may cause contamination.
- ✓ Don't carry the tassel through the field as any fall of pollen may lead to contamination.

17.3 Nicking

It is important that the male and female plants flower at the same time and that the pollen is shed from the male plants when the female silks are receptive, in order to produce a maximum amount of seed. This is called nicking. It is to be noted that Pollen shedding begins 1-3 days before the silks emerge from the cob. It is estimated that a normal tassel produces 2, 50, 00,000 pollen grains. Pollen is viable for 12-18 hours. Silk remains receptive for 8-10 days. Anthesis continues up to 2 weeks.

17.4 Mechanical admixtures

These can be avoided taking due precaution at harvesting, seed setting, bagging and storing operations etc.

17.5 Rouging

Based on distinct and diagnostic characters furnished by the breeder, rouging has to be performed in seedling stage, flowering stage and at the time of harvesting.

17.6 Physiological maturity of the crop

The crop should be harvested at proper stage of maturity to minimize qualitative the losses. The moisture content of seed should be 35% and cob sheath should turn straw yellow in colour.

17.7 Seed rate and spacing

A plant population density of 50-55 thousands/ha is ideal to attain maximum yield.

Hybrids: Female 10kg/ha

Male 4 kg/ha

Spacing: 60 - 75cm row spacing and plant to plant 25 -30cm.

17.8 Stages in commercial hybrid seed production

Production of the Breeder seed

The breeder selects and produces the seed for the inbred lines. Breeder seed is used for foundation or basic seed production.

Production of Foundation seed

Foundation seed is the first multiplication of the breeder seed (inbred lines). This is also the stage in which the single cross hybrid will be produced for the three way or double-cross hybrids. Enough seed of the parents should be produced in order to produce the hybrid seed.

Production of Certified seed

It is the last stage in seed multiplication. This may be performed by capable farmers to plant the foundation seed to ensure genetic purity and to produce enough seed for the farmers. Throughout the production of hybrid seed, the Government institutes/seed company have to follow standardized certification standards.

- ✓ The seed fields are constantly checked for isolation, off-types and purity,
- ✓ Harvested seed is verified for defects, adequate germination rate and freedom from pests and diseases.

Choice of parental lines

There are several factors that have to be considered while choosing the parental/inbred lines for generating high yielding hybrids:

- ✓ Parental lines must have synchronous pollen shedding and silking.
- ✓ The male parent should be taller than the female parent for better pollination.
- ✓ For three-way crosses, vigorous inbred lines with good pollen production should be used as the male line while the single cross is used as the female parent.

Number of female to male rows/ planting ratio

Since the hybrid seeds are harvested from the female parent, these should be more number of female rows. The male rows should be planted so that effective pollination can be assured and thus we could get better seed set. It also depends on the quantity of pollens produced by male parents.

Table:5 Female and male ratio in different crosses in hybrid seed production

Hybrid	Female: Male
Single cross hybrid	4:2
Double cross	6:2
Three way cross	6:2
Varietal cross	6:2

18. Insect pests and diseases of maize and their management

a. Important insect pest and their management

Several insects are reported on maize crop in the NEH region, but few of them cause economic losses in different growth stages of maize crop. Amongst, the cob borer and stem borer are the common important pests of maize, however recently fall armyworm appeared as a most severe pest of maize in almost all the northeastern states of India. List of insect pests attacking maize is indicated in Table 6.

Table 6: Insect pests found on maize crop in Meghalaya

S.N.	Common name	Scientific name	Order	Family
1	Fall Armyworm	*Spodoptera frugiperda*	Lepidoptera	Noctuidae
2	Stem borer	*Chilo partellus*	Lepidoptera	Crambidae
3	Shoot fly	*Atherigona* spp.	Diptera	Muscidae
4	Cob borer	*Stenochroia elongella*	Lepidoptera	Pyralidae
5	Cob borer	*Helicoverpa armigera*	Lepidoptera	Noctuidae
6	Aphid	*Rhopalosiphum maidis*	Hemiptera	Aphididae
7	Aphid	*Rhopalosiphum padi*	Hemiptera	Aphididae
8	Oriental Armyworm	*Mythimna separata*	Lepidoptera	Noctuidae
9	Termite	*Microterms obesi*	Isoptera	Termitidae
10	White grub	*Leucopholis lepidophora*	Coleoptera	Scarabaeidae
11	Elephant beetle	*Xylotrupes siamensis*	Coleoptera	Scarabaeidae
12	Flea beetle	*Monolepta quadriguttata*	Coleoptera	Chrysomelidae
13	Tobacco caterpillar	*Spodoptera litura*	Lepidoptera	Noctuidae
14	Leaf hopper	*Cofana lineate*	Hemiptera	Cicadellidae
15	Leaf hopper	*Bothrogonia tibetana*	Hemiptera	Cicadellidae
16	Grasshopper	*Chrotogonus roberstoni*	Orthoptera	Pyrgomorphidae
17	Grasshopper	*Oxya chinensis*	Orthoptera	Acrididae
18	Grasshopper	*Aularchis meliaris*	Orthoptera	Pyrgomorphidae

1. Fall armyworm: *Spodoptera frugiperda*

The Fall Armyworm (FAW) is the most devastating pest of many economically important crops, native to the tropical and subtropical region of America. It has invaded many African countries and caused huge economic losses. FAW has been reported for the first time in India during May 2018 in Karnataka and subsequently it has spread into the several states of India within a short span. Recently, severe incidence of FAW on maize crop has also been observed in Mizoram, Nagaland, Tripura, Manipur, Sikkim, Meghalaya and Arunachal Pradesh in North East India. Female moth lays more than 1000 eggs in single or in multiple clusters on maize or other host plants. Incubation period lasts for 4-6 days. Soon after hatching, tiny larvae disperse from the group and reach to the epidermal layer of the younger and start scraping the leaf surface. Afterwards, larvae enter inside the whorl and feed on the central shoot and nearby tissues. Larval period completes in 14-17 days. Mature larvae drop down inside the soil and form pupae. After 7-8 days of pupal period, adult moths emerge and can survive up to 7 days (Source: https://iimr.icar.gov.in/attachment/articles/37/FAW%20folder_compressed.pdf)

Fall armyworm larva

Caterpillar of fall army worm

Male moth of fall armyworm

Following action plan has been suggested for the management of fall armyworm in Maize (Ref: OM: F. No. L3-L60/2019-SD.lV, dated 6th May 2019)

Monitoring: Installation of pheromone traps @ 5/acre in the current and potential area of spread in crop season and off-season.

Scouting: Start scouting as soon as maize seedlings emerge

- ✓ At Seedling to early whorl stage (3-4 Weeks after emergence). Action can be taken, if 5% plants are damaged.
- ✓ At mid whorl to late whorl stage (5-7 weeks after emergence) -action can be taken if 10 % whorls are freshly damaged in mid whorl stage and 20% whorl damage in late whorl stage.
- ✓ At tasseling and post tasseling (Silking stage) - Do not spray insecticides (No insecticide application). But 10% ear damage needs action.

Cultural measures

- ✓ Deep ploughing is recommended before sowing. This will expose FAW pupae to predators.
- ✓ Timely sowing is advised. Avoid staggered sowings.
- ✓ Intercropping of maize with suitable pulse crops of particular region. (eg. Maize+ pigeon pea/black gram/green gram).
- ✓ Erection of bird perches @ 10/acre during early stage of the crop (up to 30 days)
- ✓ Sowing of 3-4 rows of trap crops (eg. Napier) around maize field and spray with 5% NSKE or Azadirachtin 1500 ppm as soon as the trap crop shows symptom of FAW damage.
- ✓ Clean cultivation and balanced use of fertilizers.
- ✓ Cultivation of maize hybrids with tight husk cover will reduce ear damage by FAW.

Mechanical control

- ✓ Hand picking and destruction of egg masses and neonate larvae in mass by crushing or immersing in kerosine water.
- ✓ Application of dry sand in to the whorl of affected maize plants soon after observation of FAW incidence in the field.
- ✓ Mass trapping of male moths using pheromone traps @ 15/acre.

Bio control

- ✓ In situ protection of natural enemies by habitat management: Increase the plant diversity by intercropping with pulses and ornamental flowering plants which help in build-up of natural enemies.
- ✓ Augmentative release of release of *Trichogramma pretiosum* or *Telenomus remus* @ 50,000 per acre at weekly intervals or based on trap catch of 3 moths/trap.

Biopesticides: Suitable at 5% damage in seedling to early whorl stage and 10% ear damage with entomopathogenic fungi and bacteria.

- ✓ **Entomopathogenic fungal formulations**: Application of *Metarhizium anisopliae* talc formulation ($1x10^8$ cfu/g) @ 5g/litre whorl application at 15-25 days after sowing. Another 1-2 sprays may also be given at an interval of 10 days depending on pest damage or *Nomuraea rileyi* rice grain formulation (1 x $1x10^8$ cfu/g) @ 3g/litre whorl application at 15-25 days after sowing. Another 1-2 sprays may also be given at an interval of 10 days depending on pest damage.
- ✓ **Entomopathogenic bacterial formulations**: *Bacillus thuringiensis* var. *kurstaki* formulations @ 2g/1itre (or) 400g/acre.

Chemical control

- ✓ **Seed treatment**: with *Cyantraniliprole* 19.8% + *Thiomethoxam* 19.8% @ 4 ml per kg seed reported to offer protection up to 2-3 weeks after germination. *(Note: This formulation is not registered in India and also has not been evaluated in AICRP programme. However, based on the feedback from seed growers this insecticide is giving protection for* 2- 3 *weeks after germination)*
- ✓ **First Window (seedling to early whorl stage)**: To control FAW larvae at 5% damage to reduce hatchability of freshly laid eggs, spray 5% NSKE *or* Azadirachtin 1500ppm @ 5ml/l of water.
- ✓ **Second window (mid whorl to late whorl stage):** To manage 2nd and 3rd instars larvae at 10-20 % damage spray *Emamectin benzoate @ 0.4g/l of water* OR *Spinosad@ 0.3 ml/l of water* OR *Thiamethoxam* 12.6% + *lambda cyhalothrin 9.5% @0.5 ml/l of water* OR *Chlorantraniliprole18.5% SC@0.3 mill of water.*

  Poison baiting: Poison baiting is recommended for late instar' larvae of second window. Keep the mixture of 10 kg rice bran + 2 kg jaggery with 2-3 litres of water for 24 hours to ferment. Add 100g thiodicarb just half an hour before application in the field. The bait should be applied into the whorl of the plants.
- ✓ **Third Window (8 weeks after emergence to tasseling and post tasseling):** Insecticide management is not cost effective at this stage. Hand picking of the larvae is advisable.

Important considerations

- ✓ All the sprays should be directed towards whorl and either in the early hours of the day or in the evening time.
- ✓ Capacity building and mass awareness

- ✓ Application and timely plant protection measures to avoid spread of the insect from the abandoned crop.
- ✓ Creation of awareness among important stake holders through trainings /group discussions.
- ✓ Community based and area-wide approach for implementing management strategies.

2. Stem Borer (*Chilo partellus*)

The maize stem borer attacks every part of maize plant. Newly hatched larvae scrap the central leaves of the whorl and soon tunnel into the stem through the whorl. The new emerging leaves of the whorl show small pinholes and called as shot hole injury**.** Grown up larvae produce bigger holes in the whorl leaves, the severe attack results in drying of central whorl of the plant, which is called "dead heart". The plants showing dead hearts do not show usual leaf injury symptoms, remain stunted in growth and no flowering takes place. The larvae also damage the emerging tassels, silk and developing grains on the cobs and pupate inside the stem. The major loss in grain yield is due to dead-hearts and stunting of growth.

Stem borer larvae inside the damaged stem

External symptoms of stem borer damage

Management

- ✓ Deep ploughing in the month of March/April exposes the hibernating stages of the pests to the predators and sunlight
- ✓ Destruction of the crop residues of previous crop to destroy the over wintering stages i.e. larvae and pupae of stem borer.
- ✓ Early planting in the month of March/April can also desynchronize the pest occurrence with susceptible stage of the crop.
- ✓ Spraying of Thiamethoxam 12.6% + Lambda cyhalothrin 9.5% ZC @ 0.25 ml/litre of water or Dimethoate 30 EC @ 1.32 ml/litre water.

3. Cob borer (*Stenachroia elongella*)

The cob borer is one of the important pests of maize since it causes huge indirect losses than by actual feeding. Adult moths emerge during the third week of June and the egg laying starts two days after eclosion, at cob initiation stage and continues up to 80 DAS. The adult female lays 70-80 eggs singly on the base of the cobs between two cob sheaths. The eggs are small cream colour and hatch in 5-8 days. The newly emerged larvae puncture the cobs and excrement on the cob is the clear symptom of damage by cob borer. Sometimes the larva bores into the stem causing multiple damage. The presence of 3-5 larvae per cob is sufficient to damage the cob completely. Total life cycle of the pest is 45 days. There are four larval instars over a period of 28-30 days. Pupation occurs within the cob or between the cob sheath and pupal period is of 6-8 days. Adult male lives for 8-10 days and female lives for 10-15 days. The sex ratio is 10 female to every 12 males. There are three to four overlapping generations from July to end of the September. The late sown crop suffers heavily compare to early sown crop. Larval excrement material and webbing is clearly seen on damaged cobs. Cobs are also damaged by another species of cob borer, *Helicoverpa armigera*.

Cob damaged due to *S. elongella*

Cob damaged due to *H. armigera*

Management

- ✓ Early planting of maize in the month of March/April to overcome cob borer attack.
- ✓ Destruction of crop residues of previous crops
- ✓ Sorghum crop can be used as trap crop for *S. elongella*
- ✓ Spraying of chemical pesticide should be avoided since cob borer damage generally higher during maturity stages

4. Oriental Army Worm (*Mythimna separata*)

The full-grown caterpillar is stout, 4 cm long and dusky brown in color with pale/brown longitudinal stripes, the dorsolateral stripes being broken into spots. The outbreak of this pest occurs suddenly and farmers generally notice it after it has already caused considerable damage. The caterpillars generally feed at night and hide in whorls of plants during day. The caterpillars march from field to field and voraciously feed on foliage. They appear after the heavy rains or early floods.

Oriental armyworm larva

Oriental army worm larva inside the whorl

Management

- ✓ Deep ploughing in the month of March/April exposes the larval/ pupal stages of armyworms
- ✓ Collection and destruction of the grown up larvae of armyworm gives good control.
- ✓ Trench digging in the borders of the field can prevent migration of the swarm.
- ✓ Whorl application of soil mixed with entomopathogenic fungus, *Metarhizium anisoplae* can reduce the infestation

5. Aphids (*Rhopalosiphum maidis*)

Both apterous and pterous aphids infest the upper half of the plant. Long dry spells increase the incidence of this insect. Nymphs and adults suck the sap from the leaves/shoots and exude honeydew, on which a sooty mold grows, giving the leaves a black appearance and thus affect photosynthesis badly.

Aphid colonies on maize leaf

Management

- ✓ Seed treatment of Thiamethoxam 70% WS @ 350 g/100 kg seeds.
- ✓ Spraying of Thiamethoxam 12.6% + Lambda cyhalothrin 9.5% ZC @ 0.25 ml/litre of water.
- ✓ Spraying of neem formulations as per the label claim of CIB, India.

6. Termites (*Microterms obesi*)

Termites are polyphagous pests. These social insects live in colonies known as termitarium, which consists of a queen, king, soldiers and workers. The damage is done by the workers. The winged termites or sexual forms come out of the termitarium with the onset of rains; they shed their wings, pair, and mate and re-enter the soil to start new colonies. Seven to ten days after swarming the mated female becomes queen and lays first batch of eggs numbering 100 to 130. The oviposition continues for several years and the number of eggs laid per day also goes on increasing. The queen can lay up-to 30,000 eggs per day that shows the phenomenal rapidity of multiplication of this pest. This pest feed on roots of maize causing severe damage and leads to yellowing of plants.

Termite damage to maize stem

Management

- ✓ Destruction of the colonies of the termites in the vicinity of field gives protection against the termites.

7. Cutworms *(Agrotis ipsilon)*

Cutworms are nocturnal in habit. The larval colour varies from light glossy to grayish black or brown. The larvae feed at night and plants are cut at or below the surface of the ground. This is generally observed during pre *kharif* and *Rabi* seasons. It cuts the emerging seedlings at the base of the shoot results in complete loss.

Management

- ✓ Collection and destruction of the grown up larvae of cutworms.

8. Field crickets (*Brachytrypes protentosus*)

Crickets are important pests of maize in the early stages of its growth and causes severe damage in certain areas. Eggs are laid at the end of rainy season, when the females make burrows in moist soil and lays 40 to 50 eggs in each burrow, on hatching the nymphs make fresh burrows in the soil. It is the appearance of fresh excavated soil near the holes that indicates the presence of this pest. Nymphs and adults cut the seedlings above the ground level and carry it to the hole at night and devour on them during day.

Management

- ✓ Deep ploughing in the month of March/April exposes the eggs of grasshoppers and crickets to the sunlight and gets killed.

b. Important disease and their management

1. Turcicum leaf blight (TLB) (*Helminthosporium turcicum*)

It occurs during May to September. Long, elliptical, grayish green or tan lesions (2.5-15 cm) appear on lower leaves progressing upward. At later stages the spots will become cigar-shaped and 3 to 15 cm long. At the final stages the spots become elliptical and tan colour, developing dark areas as they mature that are associated with fungal sporulation. The disease is prevalent in cooler condition with high humidity.

Management

- ✓ Grow recommended variety for the region followed by need based sprays of Mancozeb (with adjuant @ 0.05%) at 8-10 days interval as per the recommendation of CIB, India

2. Maydis leaf blight (MLB) (*Bipolaris maydis*)

It occurs during May to September. Lesions on the leaves elongated between the veins, tan with buff to brown or dark reddish brown borders. Lesion size may vary in inbreds and hybrids due to different genetic background.

Management

- ✓ Grow recommended maize varieties/hybrids for the region like VL-42, Prabhat, KH-5901, PEMH-1, PEMH-2, PEMH-3
- ✓ Spray formulations of Zineb as per the recommendation of CIB, India at 8-10 days interval after first appearance of symptoms of disease.

3. Banded leaf and sheath blight (BLSB)

At appearance of the disease, white lesions develops on leaves and sheath. Purplish or brown horizontal bands present on white lesions characterize the disease.

Management

- ✓ Seed treatment with *Trichoderma harzianum* 2.0% WP @ 20 g/kg of seeds for control (Kumar *et al.,* 2014)
- ✓ Stripping of 2 lower leaves along with leaf sheath also gives effective control of the disease.

4. Common rust (CR) (*Puccinia sorghi*)

It appears at the time of tasseling. The circular to elongate, golden brown to cinnamon brown pustules are visible over both leaf surfaces changing to brownish black at plant maturity.

Management

- ✓ Spray of Mancozeb 75% WP @ 1.5 to 2 kg/l of water at first appearance of pustule. 2-3 sprays of fungicide at 15 days interval are recommended if needed (Kumar *et al.,* 2014)

5. Downy mildews (DM)

The main symptoms of downy mildew are legends developing on lower leaves as narrow chlorosis strips. Strips extend in parallel fashion, well defined margined delimited by veins. Downy whitish to creamy growth usually on the ventral surface of the infected leaves appears corresponding to stripes.

- ✓ The infected plants should be rogue out and destroyed.
- ✓ The planting of crop before onset of rains minimizes the incidence of mildew.

19. Harvesting

Maize crop for grain purpose should be harvested 25-30 days after tasseling, at this stage maize grain contains 22-25% moisture and husk turns pale brown colour. The harvesting of cob and stalk should be done separately or stalk cut method of whole plant harvesting followed by manual picking of cobs. The grain maize should be dried up to 12% moisture to reduce the post-harvest losses during storage. However, fodder maize should be

harvested at any time before anthesis because after anthesis fodder quality deteriorated rapidly similarly harvesting of baby corn should also be started before anthesis when unfertilized cobs become 1-3 cm long (silk).

20. Yield

A good crop of maize produces a grain yield of about 4.0 to 5.0 t/ha in Meghalaya.

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भाकृअनुप
ICAR

ICAR Research Complex for NEH Region,

Umiam, Meghalaya-793 103

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ICAR - RCNEH