Maize

(Adapted from “Package of Practices for Organic Production of Important Crops in NEH Region” Network Project on Organic Farming**,** ICAR Research Complex for NEH Region, Umaiam, Meghalaya.
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Maize an important cereal crop

Maize (*Zea mays* L.) is one of the most important cereal crop in the world used as food and feed. It has very high yield potential. There is no cereal on the earth which has so immense potentiality and that’s why it is called ‘Queen of Cereals’. Maize is grown in almost all the states of India. It is next to rice, wheat and sorghum with regards to area and production in India.

Soil and Climate

Maize is best suited to well drained sandy loam to silty loam soils. Water stagnation is harmful to the crop, therefore, proper drainage is a must for success of the crop especially during *kharif* season. Optimum pH ranges between 5.5 and 7.5. The alluvial soils are very suitable for growing maize crop.

Maize is warm weather plant. It grows from sea level to 3000m altitude. It can be grown under diverse conditions. It is grown in many part of the country. *Kharif* season is main growing season in northern India. In the south, however maize is sown any time from April to October. The most suitable temperature for germination is 21^{o}C and for growth 32^{o}C. Extremely high temperature and low humidity during flowering damages the foliage, desiccates the pollen and interferes with pollen germination.

Photo – Maize in Sikkim

Varieties

Maize

RCM1-1, RCM 1-2, RCM 1-3, DA 61-A, RCM 75, RCM 76, Vijay Composite, HQPM-1, HQPM-2, Ganga-11, Ganga-2

Baby corn:

HM-4, VL-42, Prakash

Land Preparation

Land should be ploughed 2-3 times to a depth of 20-25 cm. Planking should be done after each ploughing. A properly levelled and uniformly graded field is essential for good water management. Good drainage should be provided in maize field, because stagnation of water in the field is harmful to the crop.

Seed rate and Spacing

Optimum plant population is about 60-66 thousand plants per hectare for good yield. Maize seed should be planted at 60 cm row to row and 20-25 cm plant to plant spacing. Seed rate of 20-25 kg/ha is sufficient for sowing of one hectare land. Maize seed should be sown at a depth of 5-7 cm. For baby corn spacing between plant to plant can be reduced to 10 cm for accommodating more number of plants with increased seed rate of 30 kg/ha.


Photo – Maize field and maize cob

Time of planting

Date of planting will differ from place to place. *Kharif* season maize should be sown two weeks before the onset of monsoon, where irrigation facilities are available. In rainfed, condition, the sowing of maize is generally done with the onset of rains. The optimum time of sowing for *kharif* maize in different agro climatic regions is as follows

Agroclimatic region	Sowing Time
• North-western hills	April to early May
• North-eastern hills	April-May
• Peninsular region	May-June
• Indo-Gangetic plains	June –July

Manures and Fertilizers

i. Green manuring (dhaincha) and green leaf manuring (*Tephrosia*) duly incorporated into the soil is very good source of plant nutrients and may add up to 50-75 kg N/ha.
ii. Maize seed should be inoculated with N fixing microorganisms like *Azospirillum*, *Azotobacter*, etc. and phosphorus solubilizing bacteria (PSB) at 20 g/kg seed.
iii. Manures and fertilizers both play important role in the maize cultivation. Well decomposed FYM at 15 t/ha should be applied 20 days before sowing of crop with150 kg rockphosphate.
iv. Crop residue of maize plant after harvesting should be incorporated in the field.
v. FYM doses can be reduced up to 10 t/ha if vermicompost is applied @ 2-3 t/ha along with rockphosphate @150 kg/ha.
vi. Neem cake can also be added @150 kg/ha to the field for effective control of soil borne insect pests.

vii. Maize plant should be intercropped with legume crops or legumes should be incorporated in the cropping systems.

Earthing up

One earthing up may be given along with first weeding at 30-35 days after sowing to protect the plant from lodging.

Water Management

Maize is very sensitive both to excess water and moisture stress. Never allow water to stand in a maize field during its life cycle. Water stagnation even for 6-7 hours continuously can damage the crop. Maize can tolerate heavy rains provided water does not stand in the field for long periods. Therefore, drain out excess water by making drains of adequate capacity at the lower end of the field. A good crop of maize require about 500-600 mm of water during its life cycle. Tasseling and silking is most critical stage for irrigation. At critical growth stage water shortage even for 2 days can reduce maize yields by about 20 per cent.

Weed Management

In *kharif* season weed problem is more due to abundant rainfall. Weeds emerge with the germination of maize seeds and grow along with plants till early growth period. This causes severe crop-weed competition. Failure of timely weed control gives heavy loss to crop yield. Mechanical weeding should be done 15-20 days after sowing of maize, which provide aeration to soil and also manage the weeds. Second weeding (Hand weeding) was done after 30-35 days of sowing and third after 50-55 days of sowing. Mulching in between two rows of maize with weed biomass effectively control the weeds.

Cropping System

Intercropping

It is better to grow a legume as intercrop in maize. In high altitude, Maize + soybean (one row of soybean in between two rows of maize) is 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.

Cropping sequence

• High altitude	Maize + soybean
• Mid & low altitude	Maize-French bean, maize- mustard and 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

Pest Management

Important Insect pests

1. **Cob Borer** (***Stenachroia elongella and Helicoverpa armigera*****)**

   Symptoms - Adult moths starts egg laying at cob initiation stage and continues up to 80 DAS. The newly emerged larvae puncture the cobs and excrement on the cob is the clear symptom of pest. Sometimes the larva bores into the stem causing multiple damage. 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*.

   Management

   Cultural - Use of resistant varieties (RCM 1-1 and local yellow are tolerant to cob borer), 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

   Control measures - Spraying of lantana extract 10% and Panchgavya 5% is effective in control. 2-3 Prophylactic spray of neem oil (3%) starting before cob emergence.

Photo – Maize Cob borer (left) Damage by stem borer (middle and right)

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.

Management

Cultural - Deep ploughing in the month of March/April. Destruction of the crop residues of previous crop. Early planting in the month of March/April

Control Measures - Spraying of lantana extract 10% and Panchgavya 5% is effective in control. 2-3 Prophylactic spray of neem oil (3%) starting before cob emergence. Spray of 2% neem oil+2% karanj oil can manage the pest if used as prophylactic spray

3. **Cut worm (*Agrotis ipsilon*)**

Symptoms - 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

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

Control measures - Application of neem cake @ 250kg/ha along with compost. Soil application of *Metarhizium anisopliae* and *Bauveria bassiana* @1x10^{12} viable spores/ha as soil treatment. Entomopathogenic nematode *Steinernema carpocapsae* @ 2billion IJs ha^{-1} can also help in management of pest.

Photo – Fall Army worm damage (left) worm (right)

4. **Fall armyworm: (*Spodoptera frugiperda*)**

Symptoms - 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.

Management

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

Control measures - 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. 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.

Biological - Mass trapping of male moths using pheromone traps @ 15/acre. 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.

Control measures - 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. *Bacillus thuringiensis* var. kurstaki formulations @ 2g/1itre (or) 400g/acre.

5. **Oriental Army Worm (*Mythimna separata*)**

Symptoms - 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.

Management – Same as for Fall Armyworm

6. **Aphids (*Rhopalosiphum maidis*)**

Symptoms - 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.

Management - Regular spray of insecticidal soap. NSKE 5% with soap solution. Neem oil 3% with insecticidal soap.

Important Diseases

7. **Turcicum leaf blight (TLB) (*Exserohilum turcicum*) (formerly - *Helminthosporium turcicum*)**

Symptoms - 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

Seed treatment with *T. harzianum* (6 g/kg of seeds) and 2 sprays of 3% Nimbicidin at 40 and 50 DAS. Seed treatment with *T. harzianum* and three sprays of lime sulphur at 30, 40 and 50 days interval

Photo - Turcicum leaf blight (leaf) and Maydis leaf blight (right)

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

   Symptoms - 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

9. **Banded leaf and sheath blight (BLSB)**

   Symptoms - 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. Stripping of 2 lower leaves along with leaf sheath also gives effective control of the disease.

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

Symptoms - 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 - Plant resistant hybrids. Application of sulphur dust or lime sulphur provide some degree on control and reduce disease severity; Control measures are effective when the amount of secondary inoculum is still low, generally when plants only have a few rust pustules per leaf.

11. **Downy mildews (DM)**

Symptoms - 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.

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

Harvesting

Crop should be harvested by removing the mature cobs from the plants and keep the standing stalks in the field itself for putting mulch in succeeding crop. In baby corn, harvesting of cobs should be done immediately after emergence of the silk. Five to six harvesting can be done at two days interval in baby corn.

Shelling

Use maize sheller developed by the ICAR Research Complex for NEH Region, Umiam, Meghalaya for shelling the dry cobs to save money, time and increase efficiency of labourers. After shelling seed should be sundried to keep the grain moisture at 8-12 %.

Yield

A good crop of maize produces a grain yield of about 4.0 to 5.0t/ha under organic production system.