PACKAGE OF PRACTICES

CABBAGE IN NATURAL FARMING





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Technical and Training Material for Natural Farming programs of WASSAN.

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INTRODUCTION

Classification:

- Order: Brassicales
- Family: Brassicaceae
- Genus: Brassica
- Species: oleracea

Cabbage is a leafy vegetable producing a compact globular mass of crinkled leaves wrapped over each other known as head. The family Brassicaceae also known as Cruciferae family includes other vegetables such as kale, rape, mustard, broccoli, cauliflower, turnips, brussel sprouts etc. There are various cultivars available in the species B. oleracea. The cabbage belongs to Capitata cultivar. Other widely produced vegetables like cauliflower and broccoli belong to Botrytis cultivar.

The outer leaves are generally green and larger than the inner. The stem is short and stout. Inner leaves in the form of the head are edible with less calories, fat and carbohydrates. Cabbage is a rich source of vitamin C and A, and minerals like calcium, potassium, iron, sodium, magnesium, and phosphorus. It is a good source

of protein which contains all amino essential acids. particularly sulphur containing amino acids. It has substantial of amounts ß carotene. ascorbic acid, riboflavin, niacin and thiamine. The typical flavor in cabbage leaves is due to presence of alvcoside sinigrin. Cabbage is available in various head shapes, head firmness and colors i.e., green, red, purple, white.

SUITABLE VARIETIES



Most popular varieties available in India are Golden acre. Pusa Drum Head, Ganga, Pride of India, Copenhagen Market, Pusa Mukta, Pusa Synthetic, Midseason Market, September Early, Early Drum Head, Late Large Drum Head. K-1. Shriganesh Gol. Hariana. Kaveri, Bajrang etc.

Farmers should consider the following criteria in selection of suitable variety.

- Length of growth (days to reach maturity)
- Resistance to major diseases.
- Suitability for local growing conditions (soil, temperature etc.).
- Market availability.
- Type of head formed and colour in relation to consumers use.



SUITABLE CLIMATE, SOILS AND SEASON

Cabbage is suitable in cool and moist climate areas with temperature range of 15°-21°C. It is grown as a winter crop in plains.

Suitable soil types ranging from sandy loam to clay, however it grows best in well drained loamy soils having good moisture holding capacity. Early season crops prefer light soil while late sown crops perform better in heavy soil due to moisture retention properties. The crop requires a pH ranging from 5.5 to 6.5 for good productivity. Acidic and saline soils are not suitable for cabbage and related crops.

Sowing time depends upon the variety and the agro-climatic conditions of a particular region. In Hilly regions the crop can be planted during January – February, July – August and September – October. In Plains most suitable season is August – November.

LAND PREPARATION



The field should be ploughed to fine tilth by repeated ploughing operations with a sufficient interval between two ploughings. Planking should be done for levelling land. Based on climatic conditions, soil types and irrigation facilities the transplantation is done on flat land, ridges or in furrows.

For early planting, ridge methods are suitable especially in areas where the rain occurs at the time of planting. In rainfed areas where irrigation is available, construction of ridges is a good option. In dry areas transplanting on flat beds is recommended.



SOIL NUTRIENT MANAGEMENT

Farmer packages of practices that improve soil fertility, and soil nutrient management practices for lona term sustainability are very important in natural farming. Natural farmers usually maintain high levels of organic matter in the soil and apply bio stimulants such as Jeevamrutha for stimulating high soil biological activity in their fields. Soil microbes are important for many processes, including the decomposition of biomass. increasing the availability of soil nutrients by solubilization of certain nutrients and connecting plant roots to a large horizon for better absorption of water and nutrients.

Cabbage nutrient demand

Cabbage needs about 70 to 100 kilograms of nitrogen per acre in about 18 weeks. Other related crops such as broccoli and cauliflower need about 100 kilograms of nitrogen per acre for a good quality yield during the period of twelve weeks.

The following table indicates the requirement of major nutrient at different stages of crop.

Crop stage	Crop duration	N (%)	P (%)	K (%)
Transplanting to establishment	10	10	5	10
Head initiation stage	30	30	10	30
Head initiation to development stage	30	20	5	20
Harvesting stage	35	40	5	40
Total	105	100	25	100

SOURCES OF CABBAGE NUTRITION

Important sources of nitrogen in natural farming cabbage production are previously grown leguminous crops, green manures crops and cover crops. In Natural Farming growing cover crops in late rabi and pre-monsoon season are source of all nutrients and also

source of microbial growth in the soil.

COVER CROPS (PRE-MONSOON DRY SOWING):



A minimum of 9-21 types of crop seeds comprising group of crops viz., cereals, millets, oil seeds. pulses. vegetables (including leafy vegetables) and spices are to be broadcasted from second half of March to second half of May, depending on the harvest of annual or rabi or summer crops. Large size seeds may be seed pelleted with Ghanajeevamrutham and clay soil for better and effective germination. The remaining seeds should be treated with Beejamrutham before broadcasting.

After broadcasting field should be covered with mulch material and sprinkled with *Drava* *jeevamrutham.* Seeds will germinate by using soil moisture or using the moisture of *Drava jeemarutham* or after summer showers. All the PMDS crops (after reaching 45 to 60 days period) should be incorporated into soil at the time of land preparation. Some crops may be grazed for cattle.

CROP RESIDUES

Harvested crop residues can be important source of an nitrogen. When incorporated into the soil, a large proportion of the nitrogen from the crop residues become available for the following crop as the residues decompose and release nutrients. Crop residues contain phosphorus, magnesium. potassium and which are also mobilised in quantities large upon decomposition.



MANURE AND COMPOST

As a basal dose:

It is very crucial for natural farming fields to apply composts and well-rotted farmvard before manure planting. Animal based manures and composts are primarily suitable as basal applications which are suppliers of nitrogen, phosphorus, potassium and, importantly they add organic matter to the soil.

For better yields, apply welldecomposed FYM @ 8-10 tonnes/acre and incorporate into the soil before 4 weeks of transplanting. Mix the following biofertilizers with FYM;

- 1 kg of Azospirillum
- 1 kg of Pseudomonas
- 1 kg Trichoderma.

Apply 100 kg of Neem Cake per acre as a basal dose

During crop stage:

To cover the nitrogen requirement sufficiently during the vegetative stage, another 30 to 40 kilograms of nitrogen per acre are necessary from another source such as *Ghana Jeevamruth*, liquid manures and green mulching etc.

FERTIGATION

Fertigation of *Drava Jeevamruth* and other liquid manures through irrigated channel or drip system is highly recommended.

GROWTH PROMOTERS

Foliar spray of 3% *Panchagavya* or *Dasagavya* at 15 days interval from 30 days after planting, on cabbage and intercrops.

Spraying 10% vermiwash 5 times at 15 days interval from one month after sowing on cabbage and intercrops.

Spraying of Saptha Dhanyankura kashayam after 45 days of sowing on Cabbage and intercrops.

Spraying of Fish Amino acids, Egg Amino acids at 15 days interval after 15 days of sowing on Cabbage and intercrops.

NUTRIENT DEFICIENCIES IN CABBAGE AND THEIR CAUSES

Nutrient deficiencies can arise from many causes, such as,

• Soils with poor nutrients will not support successful



cabbage growth without significant amendments to the soil.

- Acidic soils and alkaline soils and soils with low organic matter reduce the availability of phosphorus and other nutrients.
- As organic matter is a key source of phosphorus and other nutrients, low levels of organic matter in soils lead to low nutrient availability to

plants due to little or no release of nutrients from organic sources.

WHAPSA ENHANCING MICROBIAL GROWTH AND NUTRIENT AVAILABILITY

Vegetable crops like cabbages, root crops, and others that have a long growing period respond well to regular hoeing.



The Whapsa condition created through periodical hoeing, application of Drava Jeevamruth and mulching microorganism enhances activity and, in the process, helps to mineralise nitrogen from the organic matter and other sources in the soil and make it more available for plant uptake.



CROP ROTATION



As a rule, cabbages must not be grown after another cabbage crop nor another Brassica crop as this will perpetuate pests and diseases.

Being heavy feeders, cabbages are ideally planted after a light feeder or a legume crop in a rotation sequence to avoid nutrient depletion. The cabbages should be rotated with vegetables from other families like carrots, different types of peas, beans, tomatoes, onions, pumpkins, and other crops.

CABBAGE WITH CROP DIVERSITY

Intercropping with companion crops

The following are benefits of practicing intercrops with companion crops:



- Soil fertility enhancement, nutrient status improvement by intercrops like nitrogen fixation by legumes.
- Scope for additional yields and income from intercrops if the companion plants are sown.
- Increase in plant health when the companion crop is sown with main crop by the mechanism of push-pull, repelling and attracting pests.
- Crop diversity brought in by the companion crops which also act as shelter to beneficial insects or natural enemies that can help to control crop pests,
- Diversity crops always cushion the farmers from total crop failure in case of severe calamities to the main crop and provide additional income for the farmer.
- Crop diversity also supports below ground biodiversity or soil biology, which in turn

positively influences soil fertility.



Attributes of a good companion crop

- Companion crops should not compete with the main crops for growth factors such as nutrients, sunlight, water, and space both below and above ground.
- Besides compatibility between intercrops, sowing time is also important in performance of Campanian crops.
- The placement and spacing of companion crops in the cropping diversity plot is also an important factor.
- Border crops, trap crops as part of the companion cropping can reduce the pest and disease incidence.

Some suitable companion crops for cabbage

- Coriander and mint plants release a strong scent helps to repel some pests.
- Tomatoes can reduce diamondback moth damage to cabbages through repelling the moth while on the other hand, the cabbage repels the tomato bollworm.
- Chilies, when mixed with cabbages, are also known to repel the diamondback moth.
- Mustard has been shown to act as traps for the diamondback moth.
- Spinach or beans can reduce aphid infestations on cabbage.

Flower strips for promotion of natural enemies

- Flower strips on border (as also a border crop) and some flower plants as trap crops improve the food base and create a habitat for beneficial insects that are natural enemies of some pests.
- These flower strips and trap crops help to promote and increase the performance of predatory species, e.g. spiders, ladybirds, and of parasitic beneficial insects.

<u>The following crop diversity is</u> <u>recommended for Cabbage</u> <u>with Natural farming</u>

- Border crops (Flower strips): One external row of Sunflower, middle row of Marigold, inner row of Chrysanthemum.
- **Trap crops:** Mustard, Marigold, sunflower, Castor, Okra
- Inter crops: Onion/Galic, Tomato, Chillies, Leafy vegetables (Spinach, Fenugreek, Coriander, Mint) Tubers (Radish, Carrot, Beetroot), Legumes (Pea, Bush bean)

Spacing

- Bed size 60 cm x space 30-45 cm between each bed
- Spacing between two cabbage plants; 45 cm (applicable for intercrops like Tomato, Chillies, Legumes)

- Spacing between Onion / Garlic plants
- Spacing between leafy vegetables

Crop diversity models

(a) Cabbage + Onion /Garlic model:

Intercropping Cabbage with Onion/Garlic is а good combination in terms of plant protection and economics. In practice, cabbage was this transplanted in December and onion was transplanted in the 2nd week of January. The sea rate for cabbage was 150 grams/acre and for onion 800 grams/acre.

 If the farmer prepares a 60 cm bed, the cabbage should be transplanted on both sides of the bed. The Onion/Garlic may be transplanted in the central zone, in between Cabbage plants. The number



of plants and rows may be finalized based on space availability.

• If farmers is preparing a 45 cm bed, the cabbage should be transplanted into the central zone as a single row, giving space 40-45 cm. Onion/Garlic should be transplanted on both sides of bed, in between Cabbage plants. The number of plants and rows may be decided based on space availability.

(b) Cabbage + Leaf vegetables + Tubers + Onion model:

 Cabbage can be sown on the central part of the bed (2 feet). On both lateral sides of the bed, we sow leafy vegetables (Spinach, Fenugreek, Mint, Coriander). In between leafy vegetable row, on edges of the bed, sow tuber crops (Carrot, Radish, Beetroot) by maintaining proper distance. In between two Cabbage plants transplant few Onion /Garlic saplings.

• This model can be reversed with two rows of cabbage on both sides of the bed (2 feet). In the central zone of the bed, sow leafy vegetables (anyone or mix of two to three). These leafy vegetables also act as green mulch crops. In between two Cabbage plants transplant few Onion/Garlic plants. In this case it is better to avoid tuber crops.

(c) Cabbage + Tomato + Onion model

• Cabbage can be intercropped with Tomato on





central zone of the bed (tomato in between two cabbage plants). On both lateral sides of the bed, two rows of onion/garlic can be transplanted.

 In case farmer wants to prepare 45 cm bed, Cabbage, Tomato and Onion are to be transplanted in the central zone (as per diagram), leaving side space without any crops.

 Sow two rows of cabbage on both lateral sides of the bed. In between two Cabbage plants transplant few Onion/Garlic plants. In Central zone, transplant one tomato plant positioning at centre of the four cabbage plants. Onion/Garlic may be



planted between tomato plants in the central zone.

(d) Cabbage + Chillies + Onion model

- Cabbage can be intercropped with Chillies in the central zone of bed (chili in between two cabbage plants) and on either side of the bed two rows of onion/garlic can be planted.
- Sow cabbage on both sides of bed by intercropping with onion (two onions between two cabbage plants). Sow chillies on central zone of bed, positioning between four cabbage plants.
- In case of 45 cm bed, sow Cabbage, Chillies, Onion/Garlic in the central

zone. Leave both side spaces without any crops.

(e) Cabbage + Legumes + Onion model

- Cabbage can be intercropped with peas or bush beans (or any legume) between two cabbage plants. Additionally, transplant two rows of onions or garlic on both sides of the bed.
- Sow cabbage on both sides of the bed, intercropping with onions or garlic by planting two onions or garlic bulbs between two cabbage plants. In the central zone of the bed, sow legumes, positioning them between four cabbage plants.
- For a bed size of 45 cm, sow cabbage, legumes, and



onions or garlic in the central zone, leaving the side spaces free of crops.



NURSERY MANAGEMENT



About 40 square meter nursery area is required for raising plants for one acre area.

• Seed Rate: For sowing use seed rate of 200-250 gm per acre is required.

Raised bed method

Raise the seedlings in shade net house. Cover the nursery area with 50 per cent shade net and the sides with 40/50 mesh insect proof nylon net. From the raised beds of 1m width and convenient length inside the nursery and above the beds, the portraits are placed. Construct raised beds with measurements of 10–15 cm high and 3 x 0.6 m in size. Space the beds 70 cm apart for easier watering and weeding. Apply FYM at 75 kg, with 5 kg Cocopeat, 10 kg of Neem cake and 10 kg of Ghana Jeevamrutham, add 100 grams of Pseudomonas and 100 grams of Trichoderma.

Seed treatment

Soak seeds in 50°C hot water for 30 minutes, then dry. Seed treatment should be done with Beejamruth before sowing. Sprinkling of Pseudomonas and Trichoderma powder may be advantageous for preventing disease, before sowing.

Sow the seeds at 10 cm between rows in raised seed beds after drenching it with Jeevamrutha (10% diluted).

Cover the seeds with clean, dry grass leaves, paddy straw, or thin gunny bags until the seeds germinate.

Water the beds daily in the morning and evening until they're ready to transplant.

Transplant 40 - 45 days old seedlings at a spacing of 45 cm. Avoid land infected with 'club root disease'.

Portray method



If the farmers are willing to invest in sustainable cabbage production, using portrays is recommended. Portray with 98 cells are ideal for cabbage seedling production. The following growing medium may be prepared for portrays. The sterilized cocopeat 300 kg /acre is mixed with 4 kg of neem cake Azospirillum and and Phosphobacteria each @ 400 g. About 1.25 kg of the medium is required for each tray.

Sow one seed in each portray cell. Cover the seeds with cocopeat medium and keep the tray as a layer and covered with polythene sheet for 5 days or till germination starts. After 5 days when the seeds are germinated arrange the protrays on the raised beds inside the shade net nursery. Water the tray by rose can everyday (twice / day) upto seed germination.

Nursery beds for Onion, Chillies and Tomato.

Raise the nursery beds as per protocols of Onion, Tomato, Chillies, following natural farming practices such as seed treatment, spacing, mulching, Jeevamruth etc.

Promoting seedling growth

To promote good seedling growth, application of Ghana Jeevamrutha at time of bed preparation and Drava Jeevamrutha and other liquid manures after sowing is recommended. The seeds germinate after about 4 to 7 days after sowing based on climatic conditions includina temperature. Cabbage soil seedlings are readv for transplanting within about 3.5 to 6 weeks after seed sowing. At this stage, the seedlings have 5 to 6 true leaves.

Preparing cabbage seedlings for transplanting

Similar to Tomato nursery, hardening of the cabbage seedlings is recommended before field transplanting. This can be done by minimizing watering for 1 to 2 weeks before transplantation in order to toughen and acclimatize the seedlings to the field conditions. If seedlings are grown in portrays under shade net, they should slowly be exposed to direct sunlight conditions during the hardening process and brought back into the shade net at night.

Method of Planting

Transplanting should be done. preferably in the morning or late evening. Before transplanting, the roots of the seedlings are Beejamrutha. dipped in Irrigation should be given immediately after transplanting. seedlings should The be transplanted within 4-6 weeks of sowing. Older seedlings when transplanted result in poor growth and yield.

Season of sowing

- Hills: January February, July
 August, September-October
- Plains: August November

Spacing of Cabbage:

- Early season crop: 45 x 45 cm or 60 x 30 cm
- *Mid maturing crop:* 60 x 45 cm

- *Late maturing crop:* 60 x 60 cm or 75 x 60 cm
- Hills: 40 x 40 cm
- Plains: 45 x 30 cm
- *Hybrid:* 60 x 45 x 45 cm in paired row system

The spacing of intercrops is to be done as per crop standard spacing recommendations. However, farmers should follow design principles, height, canopy, root zone, competition for light etc.

CABBAGE CROP GROWTH STAGES



Cabbage crop period is broadly divided into; 1) Transplantation to head initiation stage which lasts for 10 days, 2) head initiation stage which lasts for 30 days, 3) head initiation to development stage which lasts for 30 days, 4) maturation to harvest stage which lasts for 35 days.

Further, in detail, the crop period can be classified into seven stages:

- Seed sowing stage: Seed treatment and sowing till before germination.
- Early seedling stages: Starting with seed



germination to two leaves stage.

- Late seedling stage: During this stage the cabbage plant is fully established by producing root system and fewer leaves.
- **Transplant stage:** Starting with 5-6 leaf stage and remaining till 6-8 leaf stage. Plants grow in size and new leaves begin to form a horizontal rosette type of growth.
- **Cupping stage:** Plant attain a basic structure that will support growth of the head. Leaves start to enlarge and head wrapper leaves are produced.
- Early heading stage: Plant grow further with initiation of head and maturation of leaves.

[Image courtesy: Soha Sabry]

• Maturation stage: Leaves around head become more

enlarged. The head begins to develop from the inside out and the outer leaves curve over to cover the head. This is the stage with more biomass accumulation.

heading

WATER MANAGEMENT





Like other vegetable crops water is one of the most important inputs to cabbage and intercrops production considering the high-water demand and shallow root systems. The soil must be given periodically, but care should be taken not to wet too much as this causes rotting of the plants. Dry soil conditions during crop may stimulate the period cabbage to go into flowering and prevent them from forming heads or cause them to develop a bitter or tart flavour. So, it is important to maintain а consistent water supply to the cabbages to prevent water stress.

- Suitable irrigation systems: Furrow irrigation, sprinkler irrigation, drip irrigation systems suitable for are cabbage production. If the farmer can afford drip irrigation is considered the most efficient type of irrigation. Compared to sprinkler. drip has the advantage of conserving moisture and reducing incidences of leaf diseases. Alternaria leaf spot, e.q. which spreads rapidly in moist conditions.
- Reduction of water evaporation: In case of cabbage cultivated as mono crop, it is recommended to apply a thin layer of mulch to the cabbage field to reduce water evaporation from the soil. This also prevents weed growth. lf farmers are practicing poly cropping with

other vegetables, growing of leafy vegetables as green mulch crop is highly recommended.

- Suitable water quality: The water used for irrigation should be suitable for natural farming. It should be free from biological and chemical pollutants. The salt content of the water should be within acceptable levels to avoid the build-up of soil salinity.
- Irrigation schedule: First irrigation should be given immediately after transplanting. Based on soil moisture and climatic conditions, provide irrigation at every 10-15 days interval. Give adequate water during vegetative stage and limit after head formation as excess soil moisture cause cracking of heads.

INTER-CULTIVATION AND WEEDING



Since cabbages are generally growing slowly, they take time to cover the ground and this gives space for weeds to grow, hence a good control strategy is required.

In the case of monoculture of cabbage, it is important to keep

the fields without weeds by 2 to 3 hand weeding. In case of poly cropping models, there is no scope for hoeing, however farmers may continue hand taking weeding care of intercrops. As cabbage and other intercrops normally develop a shallow root system, care must be taken to avoid damage to the roots while hand weeding.

If farmers are not following bed systems, it is necessary to take up earthing up operation after 30 days after transplanting.

Growing leafy vegetables as intercrops, act as green mulch which also prevents weed growth. Wherever cabbage is grown as mono crop, straw mulching is strongly recommended.

PLANT PROTECTION

In plant protection there is 3 steps approach to managing pests and diseases.

- Good crop management and field hygiene practices:
 - Use of tolerant or resistant varieties.
 - Maintain soil health that provides adequate and balanced nutrient supply.

- Remove and destroy highly or heavily pest infested and disease infected plants from the field.
- Rotate crops with recommended intervals between crops of the same family to avoid build-up of pests and diseases.
- Plant crops on a spot that provides adequate conditions (sun/shade; soil type; water supply, etc.).

Habitat management

- Ensure timely and effective weed management during the weed-sensitive periods of the crops.
- Companion cropping using plants that can deter pest insects.
- Others can act as pest traps and rather attract pests and reduce pest populations on the crop.
- Direct control
 - Biological control where organisms like fungi are used to kill insects, or to antagonise pathogenic fungal strains.
 - Predation/parasitism where natural enemies (e.g. Trichoderma) are used to feed on or antagonise the insects.
 - Botanicals: use of plant extracts to kill pests.

 Sticky traps which attract insects by an attractive colour and pheromone traps attract disrupt mating and for monitoring.

• Regular monitoring skills

o In natural farming besides looking at the general aspects of crop growth like nutrition and water requirements, regular attention needs to be given to pest and disease appearances. Natural farming farmers should be able to identify natural enemies and differentiate them from pests and also identifv diseases and distinguish them from nutritional deficiencies or physiological disorders. Regular monitoring for pest and disease occurrences allows for early detection of pests and diseases, and thus it will become easier to control them in initial stages

CABBAGE DISEASES AND THEIR CONTROL

Some important diseases are black rot, early blight, and downy mildew. Preventive measures can help farmers to control diseases and reduce damage and loss. These are,

- Use of disease-free planting material (seed and seedlings).
- Seed treatment with Beejamrith and Pseudomonas, Trichoderma, etc.
- Practicing proper rotation with vegetables that are not members of the Brassicacea.
- If brassicas are inevitably recurrently grown in the crop rotation, it is better to switch between cultivars (e.g. cauliflower, broccoli).
- Ensuring proper field sanitation by removing diseased plants.
- Controlling for insect vectors of disease pathogens – for example aphids transmit various plant viral diseases.
- Direct control measures are possible when diseases occur, but these are not always totally effective.
- Use sour Buttermilk and Hing solution at initial stages of infection.
- Drench Pseudomonas and Trichoderma in case of severe infection.

- Causative organism: Pythium species, Rhizoctonia species, Alternaria species
- Type of damage or symptoms:
 - o The affected plants become wilted, turn purple and die
 - Often, these plants have no lateral roots as a result of the damage caused by the diseases.
 - Damage to the roots prevents them from their key function of absorbing and transporting water and nutrients.
- Suggested control measures:
 - o Using healthy seeds and seedlings.
 - o Covering sown seeds with good quality compost or mulch materials instead of which using soil may contain pathogens.

- Provide good ventilation and air circulation to the growing seedlings. including thinning the seedlings to reduce overcrowding where necessary.
- Avoiding overwatering this is even more important during prolonged cloudy periods when evaporation is low as this keeps the seedlings wet.
- Applying botanicals and solutions such as extracts or teas of garlic, seaweed, chamomile. and sour buttermilk and hingi solution.
- Rogueing off and infected destroying cabbages and other host plants (like volunteer crops or weeds) to the damping off diseases.

Clubroot or the slime mold



Damping off disease

- Causative organism:
 Plasmodiophora brassicae
- Type of damage or symptoms:
 - The disease causes stunting and wilting.
 - Infected plants turn purplish and the roots form swellings which produce a foul smell when rotting.
 - The disease is aggravated by acidic soils and poor drainage.
- Suggested control measures:
 - Select disease free seeds / seedlings.
 - Seed treatment with Beejamruth and Trichoderma and Pseudomonas
 - Using well drained sites or sowing media.
 - Treating the seed with Beejamruth and 5 % Trichoderma and pseudomonas solution followed by drying under shade before sowing.
 - Good irrigation management – avoid waterlogging or poorly drained conditions.
 - Good soil pH management (liming of acidic soils to increase pH to recommended levels).

- Practicing a good crop rotation with non-host crops or plants.
- Removing and destroying infected plants.

Fusarium wilt



- Causative Organism: Fusarium oxysporum
- Type of damage or symptoms:
 - The disease causes leaf yellowing or manifests in discoloured veins.
 - The symptoms can be on one side of the plant.
 - Eventually, the leaves become brown and drop off.
 - The plants are stunted and may wilt.
 - The disease is more common during summer periods.

Suggested control measures:

- Selecting resistant varieties.
- Observing effective crop rotations and other good hygiene practices.
- Where possible, producing during winter when conditions are less favourable for the pathogen.

Black leg or Phoma stem canker



- Causative organism: Plenodomus lingam / Phoma linga; Plenodomus biglobosus)
- Type of damage or symptoms:
 - This seed-borne disease can be devastating.
 - A whole seedbed can become infected from just a single plant.
 - Its name derives from the characteristic black

cankers that form on the stem.

- It can also spread from infected transplants and be transmitted by insects.
- The disease often causes tap root rot and lesions on the stems and leaves.
- These lesions have small black dots in the center.
- Complete plant wilting and yellowing can occur, and ultimate death of seedlings is not uncommon.

Suggested control measures:

- Using clean healthy seeds which is disease-free.
- Seed treatment with Beejamruth and Trichoderma, Pseudomonas solution.
- If the soil is infested, then seedlings can be raised in containers in a disease-free medium.
- Transplanting of only healthy seedlings with no black spots on stems or practicing good crop rotations and field hygiene including removal of all old cabbage plants and related crops.

Downy mildew



- Causative organism:
 Peronospora parasitica
- Type of damage or symptoms:
 - This airborne disease is more prevalent in humid cool weather and can survive on plants and residues in the field.
 - Infected leaves have yellow spots on the affected areas and the yellow lesions can enlarge.
 - During humid conditions, a fluffy fine white mold appears on affected parts on the underside of the leaf.
- Suggested control measures:
 - Planting seedlings into a clean bed or field.
 - Destroying cabbage and other susceptible plant remnants at the end of the season to prevent

pathogen carry-over to the next crop.

- Using appropriate plant spacing and row orientation to allow good air circulation and avoid pockets where high humidity can build up.
- Spraying with sour buttermilk and hingi solution.

Alternaria leaf spot or Alternaria leaf blight



- Causative organism: Alternaria brassicicola
- Type of damage or symptoms:
 - This fungal disease is common during cool, rainy weather.
 - The disease starts as small, dark spots on older leaves.
 - These spots may rapidly enlarge to form large circular lesions with concentric rings.

- The lesion centers can drop off resulting in holes on the leaves.
- In wet conditions the lesions may become infested with a brown or black velvety mass of mold spores.
- The damaged parts can provide an entry for other types of diseases which may cause rotting during storage.

Suggested control measures:

- Using only healthy seeds that is disease-free as the disease is easily transmitted through seeds.
- Treating seeds with Beejamruth and Trichoderma,

pseudomonas solution.

- Practicing good field hygiene, removing and destroying all plant residues that might harbour the disease and perpetuate it.
- Diseased plant material should not be buried or ploughed into the soil as it can be a source of infection.
- Practicing good rotations with non-host plants or crops.

- Foliar spray of 3% Panchagavya or Dasagavya at 15 days interval from 30 days after planting
- Foliar spray of Sour butter milk and hingi solution.

BACTERIAL DISEASES

Black rot



• Causative organism: Xanthomonas campestris pv. campestris

- Type of damage or symptoms:
 - This is a seed-borne disease.
 - The disease can survive for up to 5 years in stems of host plants or in the field and can also be spread by infected plants or insects.
 - The disease manifests as large V-shaped yellow to light brown patches starting at the leaf margins.
 - The veins turn black, later turning to brown dry

patches ultimately causing leaf drop and stunting and death of whole seedlings.

- Suggested control measures:
- Choosing to grow tolerant varieties.
- Using healthy seeds or seedlings.
- Treating seed with Beejamruth.
- Practicing good hygiene and destroying all affected plants and cruciferous weeds before sowing and/or transplanting.
- Where possible, avoiding sprinkler irrigation as this causes the leaves to become wet and conducive to infection.
- Increasing irrigation intervals but taking care to not stress the plants.

Bacterial soft rot

- Causative organism: Erwinia carotovora var. carotovora
- Type of damage or symptoms:
 - This disease affects cabbage and other crucifers in the field but is most severe during storage.
 - The bacteria is spread in the field by water splashes



or contact with contaminated tools such as hoes or knives during field operations and harvesting. If contaminated knives are used to harvest cabbages, the stored crop may rot quickly.

- On cabbages, an initial infection occurs on the outer petiole (leafstalk) which is in contact with the soil, and then progresses to its head.
- The affected area becomes soft and mushy and generally turns dark in colour. Infected heads become watery and often the entire head rots.
- The rotting head emits a foul odour. Eventually the leaves, stems and roots are entirely decayed by the bacteria.
- Suggested control measures:
 - Planting on ridges or raised beds to prevent

waterlogging around the plants.

- o Using clean mulches.
- Preventing other diseases (e.g. black rot; damping-off) or damage that may provide opportunities for soft rot to infest and develop.
- Avoiding harvesting when conditions are warm and moist. These conditions favour the development of soft rot.
- Harvesting healthy cabbage heads first and storing them in a cool, dry, and airy place.
- Washing hands, field tools and harvesting knives – observing good hygiene at all times.
- Removing and destroying diseased crop residues or left-over stems in the field after the crop has been harvested. Also removing and destroying other host plants such as volunteer brassicas.
- Applying good crop rotation, including avoiding growing brassica crops in the same field for a period of at least three seasons.

Bacterial leaf spot



- Causative organism:
 Pseudomonas syringae pv.
 maculicola
- Type of damage or symptoms:
 - Bacterial leaf spots are more severe in cool, moist weather.
 - The symptoms initially appear as small, faint, water-soaked areas on the underside of leaves. The affected areas develop into brownish to purplish grey necrotic spots that are fairly irregular after a few days.
 - They may coalesce or join to form large irregularly shaped spots as the disease progresses. Leaves become wrinkled and the tissue may tear when the lesions are many.
- Suggested control measures:
 - Planting tolerant or resistant cultivars.

- Using disease-free seed or seed treated with hot water before sowing.
- Using disease-free seedlings.
- Practicing suitable crop rotation.
- Avoiding sprinkler irrigation.
- Increasing the interval between irrigation, but without detriment to plants.
- Controlling cruciferous volunteer crops and weeds which can harbour the disease.
- Ploughing infected plant material deep into the soil to bury them.

CABBAGE PESTS AND THEIR CONTROL

Cabbage is frequently attacked by pests like diamondback moth, aphids, cabbage moth or cabbage worm, cutworm, leaf miner and many others.

The first line of defense by natural farmers is to apply preventive measures to reduce pest infestation.

Planting tolerant varieties, planting in pest or disease-free fields, ensuring good crop husbandry and good field hygiene, scouting for pests and diseases, etc. are some preventive strategies which organic farmers can use.

Crop rotation and crop diversification with noncruciferous crops is best model for natural farming.

Since varieties can change over time and their availability differs from place to place, farmers are encouraged to consult their extension agents and/or agro dealers regarding varieties that are tolerant of the prevailing main diseases and pests in their area.

Under heavy infestation by pests, spraying with natural repellent sprays such as *Neemstarm, Dashaparni, Agneyastram, Brahmastram* and other natural remedies will help to protect the crops and reduce yield loss.

CABBAGE PESTS AND THEIR CONTROL

Cutworms (Agrotis species)



Type of damage or symptoms:

- The pest manifests as cut or damaged stems close to the ground level (about 1 to 3 cm above ground) particularly in young succulent plants.
- The damage occurs mostly during the night as cutworms are nocturnal.
- The caterpillars can chew the stems and leaves of the young seedlings.
- The caterpillars can be found curled at the base of the young plants or inside the soil near the seedlings.
- Suggested control measures:
 - Using pheromone traps to catch the male adult moths and stop them from mating with females. This causes the females to lay sterile

eggs and hence fewer resultant larvae.

- Use light traps to attract adults.
- Practicing good pest scouting and applying direct control methods early enough when the pest populations reach critical threshold levels.
- If the plot is small and the risk of cutworms is high, producers can use seedling collars that prevent the cutworms or caterpillars from reaching the bottom part of the plant.
- Spray with chilli-garlic concoction to deter the cutworms.
- Searching for and removing the cutworm next to damaged plants to prevent further attacks on remaining plants.



Aphids

Aphids (Brevicoryne brassicae, Myzus persicae, Lipaphis erysimi)

- Type of damage or symptoms:
 - Sap sucking pests result in malformed leaves which may become chlorotic.
 - They deprive the plant of the much-needed nutrients and cause growth deformations
 - Feeding by aphids can distort leaves of older cabbages and causes leaf curl.
 - Besides, the cabbage aphid and the false cabbage aphid can transmit different viral diseases which can cause serious problems in cabbage production.
 - Cool, dry weather is most favourable for aphid development.
- Suggested control measures:
 - Removing and destroying infested plant residues, host weeds and volunteer host crops are of utmost importance before planting a new crop.
 - Ensuring rapid plant growth, favourable soil fertility and sufficient supply of nutrients, especially potassium,

strengthens the plants and makes them less vulnerable to aphid attack.

- Covering seedlings and crops with fine nylon mesh starting from transplanting stage.
- Promoting natural enemies such as ladybirds.
- Releasing the parasitoid wasp Diadegma semiclausum for biological control.
- Spraying of soaps solution against aphids may be useful.
- Spraying of Neemastram, 3% Neem oil etc. prevent build-up of large populations.
- Install yellow sticky trap 8 no/acre to monitor adults (winged adult).

Bagrada bug (Bagrada cruciferarum, Bagrada hilaris)

- The Bagrada bug is a smallish stinkbug which attacks cabbage and other crucifer plants.
- The adults lay many eggs and these hatch into nymphs after about a week.
 Damage is inflicted on host plants when adults and



nymphs insert their needlelike mouth parts and suck sap from the plant.

- Sap sucking from the leaf veins causes leaves to wilt, deform and/or die.
- Infected cabbage plants may fail to form heads and affected young seedlings may die.
- Stunted growth and leaf deformation can persist even long after an attack.
- Populations can build up quickly, reaching damaging densities that require control

Suggested control measures:

 Removing unnecessary hosts, e.g. cruciferous volunteer plants, cabbage stumps (or the remains of other crucifers) after harvest to starve off the bugs.

- Removing plant residues and planting into a clean field.
- Practicing regular scouting and controlling before damage exceeds the 10 % threshold.
- Promoting predators like wasps can feed on the Bagrada bug eggs while the hover fly is reported to feed on the adult bugs.
- Rotating host plants with non-host plants.
- Intercropping with strong smelling crops or plants such as onion, garlic, mint to deter the bugs.
- Handpicking bugs in cases where infestations are low, and plots are small.
- Spraying with soapy solutions or a mixture of chillies and garlic has been reported to be effective, especially to the nymphs.

Red spider mite (Tetranychus urticae)

- Red spider mites thrive in dry conditions.
- These tiny sucking pests weave a fine web on the underside of the leaves.



- They can be devastating, damaging plants permanently if left uncontrolled.
- Suggested control measures:
 - Raising cabbage nurseries in pest free seedbeds, and far away from the pest's host plants.
 - Applying some ashes to the leaves on seedlings in the nursery, especially when they are wet.
 - Protecting the nursery or fields by planting crops or plants which repel the pest, e.g. Onion, garlic, lemon grass, marigold, mint others known to the farmers.
 - Practicing good rotations with non-host plants.
 - Keeping a good scouting routine to identify presence of the pest and take control measures early enough.
 - Spraying with Neemastram, 3%neem oil mixed with a

soap solution and or with chilli-garlic solution.

Cabbage whitefly (Aleyrodes proletella)



- Cabbage whiteflies, like many other whitefly species, suck sap from their hosts.
- Affected leaves develop discolored patches.
- Furthermore, as the whiteflies suck out the sap, they release toxic substances into the parts of the stem responsible for transporting nutrients to growing parts.
- These toxins spread throughout the plant and inflict further damage.
- Suggested control measures:
- Promoting natural enemies such as the parasitic braconid wasps, e.g. Encarsia species.

- Promote other natural enemies include predators like thrips, ladybird beetles, lacewings and predatory mites like Amblyseius spp.
- Scouting and monitoring the populations. The damage threshold levels are 10 to 20 small or 1 to 4 young whiteflies on 10 plants (5 at the edge of the field, 5 in the middle of the field).
- When direct control becomes necessary, spraying of Dashaparni, Neemastram, Agnestram are effective against the larvae.
- Use yellow sticky traps which attract the white flies.
- If the risk of foliar diseases is low, and where possible, spraying water on the cabbage leaves can dislodge the whitefly eggs and young ones.

Thrips (various species)

- Type of damage or symptoms:
 - The feeding on cabbages by thrips causes rough bronzed blisters on leaves inside the cabbage head.
- Suggested control measures:



- Cultivating and harrowing before transplanting to destroy pupae in the soil.
- Promoting natural enemies, such as predatory bugs, predatory mites and predatory thrips.
- Planting non-host crops as part of a cabbage rotation.
- Spray the cabbages with 3% neem oil or neemastram repel thrips.
- Install 8 sticky traps per acre.

Diamondback moth (DBM) (Plutella xylostella)



- Mostly cabbage, cauliflower, broccoli, and other cruciferous crops.
- The newly hatched larvae burrow into the leaf tissues where they feed and form mines or tunnels.
- As they grow, the larvae chew and create small holes on the outer side of leaves or growing points of the young cabbage plants.

Suggested control measures:

- Scouting for the build-up of DBM moth populations to monitor threshold levels.
- Covering seedlings and crops with fine nylon mesh from the beginning including nursery stage.
- Intercropping brassicas with trap plants such as Indian mustard, and repellent plants such as tomato to repel DBM.
- Promoting natural enemies like lacewings larvae, spiders, syrphid fly larvae, and some beetles to thrive.
- Where available and permitted, releasing some reared natural enemies, e.g. parasitoid wasps such as Diadegma semiclausum and the egg parasite Trichogramma pretiosum into the field.

- Some fungi, e.g. Entomophthorales can attack the larvae of DBM moths and interfere with the pest's life cycle.
- Spraying botanicals such as neemastram, 3% neem oil, 5% NSKE to control DBM larvae.
- Saying of Chilli-garlic solution at 45th, 60th and 75th day after sowing.
- Grow mustard as intercrop as 20:1 ratio to attract diamond back moths for oviposition.
- Install pheromone traps at 8 Nos/acre.

Cabbage webworm (Hellula undalis)



- The webworm larvae feed on leaves and growing points.
- They spin a web over the feeding areas.

Suggested control measures:

- Removing and destroying plant debris which might be carrying the pest.
- Planting repellent plants such as tomatoes, onions, garlic, mint which deter the larvae.
- Promoting natural predators of the pest by planting flowering plants around or near the cabbages to ensure a good habitat for them.
- Practicing good crop rotations with noncruciferous crops.
- Spraying the cabbages with neemastram, 3% neem oil and Agneyastram.

Cabbage fleas (Phyllotreta spp.)



 Type of damage or symptoms:

 The adult cabbage fleas or beetles and their larvae can cause damage to aboveground plant parts.

- Newly transplanted seedlings are most susceptible, especially in dry, warm weather.
- Suggested control measures:
 - The beetles hibernate in the soil near cruciferous plants such as weeds, green manures, and crops. Avoiding plots or fields where such plants were growing can help to control the pest.
 - Transplanting seedlings that are strong and can withstand the pest pressure.
 - Maintaining a rough tilth during cultivation as a fine tilth can make it easier for the beetles to move.
 - Covering the seedlings with netting if possible.
 - Avoiding dry conditions which promote beetle multiplication. Regular watering can help to control the pest.
 - Spraying of botanicals, Neemastram, Dashaparni, Agneyastram is useful.

Cabbage loopers (Trichoplusia ni)



- The loopers eat the cabbage leaves resulting in irregular holes or complete defoliation in heavy infestations.
- The loopers also burrow into the cabbage heads.

Suggested control measures:

- Practice suitable crop rotations and mixtures to starve off the pest.
- Promoting natural enemies like parasitic wasps and flies. Birds and bats feed on adult moths.
- Removing plant residues after harvest to prevent possible carryover of the pest to the next season, as the pest can overwinter in the residues.
- Planting clean seedlings inspect the seedlings for possible egg masses before transplanting.
- Covering the cabbages with suitable nets to prevent the moths from laying eggs.

- Checking for and removing eggs laid by moths on the cabbages.
- Checking for and removing larvae from the plants and destroying them.
- Promote predatory or beneficial organisms such as Trichogramma wasps which parasitise the looper moth eggs by laying their own eggs inside of them and hence destroying the moth eggs.
- When control is necessary, spray neemastram and other neem-based products.

HARVESTING

- Farmers should be familiar with harvesting stages. Harvest of cabbages is done based on the number of days from transplanting and also on firmness or compactness of the head. Cabbage is ready for harvest 90-120 days after planting.
- Head size is the most common indicator to determine maturity. Harvesting can start when the heads are as small as 10 cm diameter until they are 15 to 25 cm diameter.

- Farmer may follow another indicator of maturity i.e. the arrangement of the wrapper leaves. Mature cabbages have well spread wrapper leaves with the head exposed.
- Cabbage intended for storage should be harvested when they attain full maturity. Immature harvests result in poor quality.
- Farmers should initiate harvesting early in the morning when the temperature is cool. The cool conditions favour the cabbages to maintain their quality for longer periods.
- Cabbage should be harvested promptly when the heads are firm and mature. Delaying harvest, even a few days beyond maturity can result in split heads and increased incidence of field disease.
- Harvesting immature heads, however, reduces yield, and the heads are too soft to resist handling damage. Immature heads also have a shorter life than mature heads.
- The yield of cabbage varies greatly depending upon variety, maturity group and season of cultivation.

 Intercrops like leafy vegetables, tubers, chillies and tomatoes should be harvested as per maturity.





Package of Practices

Natural Farming in Cabbage

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