

Advisory for care of hail storm affected horticulture crops:

In view of the permanent or temporary losses/damage occurred due to hail storm, high wind velocity and rainfall incidence in Maharashtra, Karnataka, M.P., in horticultural crops viz. pomegranate, grapes, citrus, mango, banana, papaya, onion and vegetable crops which experienced fruit injury, canopy damage besides uprooting and breakage of trees/plants advisory required to farmers for restoration based on short and long term measures is issued here. The extent of losses varies from mild to high. Though in some cases the losses are irreparable, in others where the damage is less the crop can be saved.

Hail storm damage: symptoms and diagnosis in horticultural crops

1. Hailstorms can vary in intensity, duration and when they occur during the growing season. Hail can severely damage all plants. The hail damage to plants/trees, varies in severity depending upon the type of tree and the force and size of hail that falls.
2. This damage can include tattered leaves, broken or damaged shoots, and wounds on scaffold branches, fruit damage and even fruit being knocked to the ground.
3. Sensitive leaves of plants become shredded, pock marked or ripped by hail. Hail crop damage can severely affect the health of plant and decimate the harvest.
4. The new plants which are sprouting and growing tender new leaves and stems, hail crop damage can completely kill seedlings. Hail later in the season will reduce harvests by knocking fruit off plants.
5. Hail damage to trees shows up as split and broken stems. The tips and tops of trees become scarred and pitted by the hail. This can increase the chance of disease, rotting and insect's infestation.
6. On annuals and perennials leaves, stems and flowers may be shredded, torn and knocked off. On trees and shrubs leaves, twigs and branches may be tattered, split and broken. Fruit may be pitted and knocked to the ground. The scars from hail damage to trees occur on the upper side of branches and on the side of the trunk facing the storm. The tree may take a very long time to recover. The damage increases the vulnerability of the tree to decay causing fungi and insect activity.
7. After a hard hail, we will need to know how to care for hail damaged plants and making efforts to restore them to production.

Care and advisory for management of hail affected crops:

1. Fixing hail damage on plants is not always possible. The best approach is to clean up the debris and trim off broken stems and leaves. The hail damage to trees may require pruning away of the most affected branches.
2. This time hail has occurred in spring and if crop has not been fertilized, an application of fertilizer to the impacted plants can help them to re grow and develop new foliage. Remove damaged fruits, which will attract insects.
3. Depending on the extent of damage, a fruit grower may decide to thin off damaged fruit and manage the rest.
4. Injuries to trees that are minor will heal but benefit from an application of fungicide to prevent rot from entering before the wounds are able to seal.
5. Open wounds on the growing shoots, branches and scaffolds present entry points for bacterial and fungal pathogens and also insects.
6. Plants damaged in the spring season benefit from a layer of mulch around the base of the plant to help it survive summer.
7. Some plants are too heavily affected and fixing hail damage is not possible. These plants should be removed and replaced.

Integrated Management Strategies

1. **Assess losses:** Assess the damage to the plants and estimate how quickly we can respond for measures.
2. **Cleanup:** Severely damaged trees and shrubs with broken branches should have them removed promptly. Less severe wounds may slowly heal naturally over a period of time. Damaged fruit should be removed. Do not fertilize hail damaged trees immediately.
3. **Fertilize:** If the damage is early in the growing season i.e. spring-summer, annuals and perennials may benefit from a light application of fertilizer. Immediately remove any hail damaged leaves from these plants.
4. **Replanting:** Annuals and perennials that do not show signs of recovery within a week should be replaced with new plants.
5. **Irrigation:** Water the damaged plants during the growing season giving them at least one 10-15 cm of irrigation each week depending of soil conditions and moisture.
6. **Mulch:** Applying 5-8 cm of mulch around the base of damaged plants may help them survive during the summer.

- 7. Plant protection:** The grower should maintain a minimal disease and pest management program that will protect plants/trees during the wound healing process and not predispose plants to further damage, otherwise long-term health, productivity and longevity of the orchard may be severely compromised.

Fruit crops:

1. Fruit trees are amazingly resilient and many recover with proper care and time.
2. Mostly banana and papaya plants and hailstorms do not go well together. Banana and papaya crops have suffered from permanent losses which are more than 50% damage to the plants; therefore it is advised for uprooting the plants and further preparation for replacement with suitable crops as per the recommended cultural practices for the region.
3. Mango, pomegranate, grapes and citrus fruit crops do not have permanent loss. The current stage of fruit crops i.e. flowering and fruit setting at the time of hail storm is badly affected varying from case to case, location to location and crop to crop. The remedial measures are required to be followed accordingly.
4. The hail storm and unexpected rains can cause damage to grapes and pomegranate and vegetable crops. This situation may not create conducive environment for disease outbreaks as congenial temperature and humidity may not build up for such unusual short rains. However, the secondary pathogens like *Aspergillus*, *Penicillium*, *Alternaria* may enhance further rotting. To prevent secondary pathogens, farmers can be advised to spray to preventive fungicides like mancozeb (2g/l) or chlorothalonil (2g/l) or copper hydroxide (2g/l)
5. Crop insurance adjusters are trained to evaluate storm damage in many crops and should be contacted immediately for insured fruit crops.

Vegetable crops:

1. Effects of storm damage on vegetable crops and recovery of crops will depend on a number of factors such as the type of vegetable, stage of growth, weather conditions immediately after storms, and prevalence of disease organisms.
2. The loss to vegetable crops primarily includes leaf defoliation, leaf tearing and shredding, stem breakage, stem bruising and wounding, loss of flowers and small fruit, and fruit

bruising and wounding. Continued hot, wet conditions after hail storm events pose the most risk by increasing disease incidence, particularly bacterial diseases.

3. The defoliation due to storm reduces leaf area and plants will need to grow new leaves from buds. It will take several weeks to replace the leaf area lost. This will cause delays in maturity. If crops are more advanced, loss of leaf area can reduce fruit or storage organ quality (reduced sugars). Fruit or storage organ size may or may not be affected. Leaf area recovery through growth of new leaves will be encouraged by application of additional nitrogen after the storm event.
4. If leaf damage occurs in vegetative stages that cannot grow new leaves, hail damage will reduce overall marketable yield.
5. Fruit bruising or wounding often causes the most severe losses in crops such as tomatoes. Fruits may be rendered unmarketable or of reduced grade. Wounds can also increase the incidence of some fruit diseases particularly rots. In particular, bacterial rots that normally are minimal may be increased in damaged fruits. In plants such as tomatoes, it is advised to remove damaged fruits from plants. These fruits are likely to be unmarketable and will just be a drain on food resources produced by the plant. By removing damaged fruits, remaining uninjured fruits will have access to more photosynthates being produced by the plant.
6. In most of vegetable crops, losses of flowers or small fruit may limit yield potential and delay crop harvest. Beans that are flowering are particularly susceptible and flower loss due to storms may lead to split sets.
7. Bacterial and fungal diseases have been shown to be more severe after storm damage as they can readily enter through wounds. Use of copper fungicides and antibiotics limit the effect of fungal and bacterial attacks in these hail damaged vegetable crops.

General recommendations for hail storm damaged horticultural crops are to first evaluate the extent of the damage. According to the stage of the crop and extent of damage, determine if the crop can be salvaged. Crop insurance adjusters are trained to evaluate storm damage in many crops and should be contacted immediately for insured vegetable crops. For crops that will be salvaged or kept, consider applying additional nitrogen to encourage new growth where appropriate. Apply fungicides and include copper compounds where diseases are of concern.

Crop specific measures:

1. Pomegranate:

The advisory for pomegranate crop damaged to varying extents in different stages is given below based on crop stage.

S. No	Stage/Extent of Damage	Recommendation
1.	All Fruits Damaged and Branches Broken / Shredded	Remove and discard fruits, prune broken and shredded branches, apply 10% Bordeaux paste on cut ends, followed by spray of 1% Bordeaux mixture. Leave the crop on rest, follow IDIPM to prepare for next bahar.
2.	Fruits Ready for Harvest	Harvest the damaged fruits and sell if fruits do not show rotting, otherwise put in compost pit. A protective spray of boric acid (2g/l) before harvest will help avoid rotting in fruits with surface injury.
3.	Fruits to be harvested after one month	Follow spray schedule given below at i, ii & iii
4.	Fruit lemon size	If 75% fruits damaged remove all fruits, prepare for next <i>bahar</i> (August/Sep./Oct.) If 25% or less fruits damaged, remove affected fruits and protect remaining fruits with sprays mentioned at i, ii & iii followed by IDIPM Schedule
5.	Flowering/Fruit set started	Remove affected flower buds/fruits. Take sprays mentioned at i, ii & iii followed by IDIPM Schedule. Wait for more flowering and fruit set. If satisfactory flowering and fruit set is observed continue with IDIPM or otherwise leave on rest and prepare for next bahar.
6.	Non-bearing trees/in rest, with shredded leaves and Branches	Prune and remove affected branches, paste cut ends with 10% Bordeaux paste, followed by spray of 1% Bordeaux mixture. Follow IDIPM Schedule thereafter.
7.	Leaves fallen, fruits attached with some scars	If fruits received few and minor injuries take recommended sprays at i, ii & iii, irrigate adequately if rains were not sufficient, to initiate new growth. Can provide shade net to avoid scorching.

Spray Schedule:

- i. Spray Boric Acid (2 g/l) + Zinc Sulphate (2.5 g/l) + quick lime (1.25g/l gm)+Mancozeb (2.5 gl) immediately after hail storm.
- ii. After 1 week of above spray Urea(2.5-5g/l)+Carbendazim(1g/l) + (in bacterial blight affected orchards) streptocycline /Bronopol (0.5g/l)
- iii. After 10-12 days of above, a spray of chelated micronutrients @ 2-3g/l

Integrated Disease and Insect Pest Management (IDIPM) Schedule

- **For crop in rest period:** Take sprays of Bordeaux mixture (1%) altered with 2-bromo, 2-nitro propane-1, 3-diol @ 0.5g/l mixed with copper based formulations like copper oxychloride (2.5g/ l) or copper hydroxide (2.0g/ l) at 10-15 days intervals.
- **For crop in fruiting:**Spray Bordeaux mixture (0.5%), altered with streptocycline (0.5g/l) or 2-bromo, 2-nitro propane-1, 3-diol @ 0.5g/l mixed with copper based formulations like copper oxychloride or copper hydroxide (2.0-2.5g/ l) or carbendazim (1g/l) or appropriate fungicides depending on fungal problems present. In rainy days take sprays at 7 days and in winter season or dry seasons at 10-15 days interval. Mix suitable insecticides if required.
- Insecticide sprays may be taken as per requirement.
- Orchards not having bacterial blight should not take streptocycline and 2-bromo, 2-nitro propane-1, 3-diol. Only fungicide and insecticide sprays should be taken
- Recommended fertilizer application may be taken as per stage and age of crop.

2. Grapes:

Category of damage	Consequence	Recommendation
Category I Severe damage (trunk, arms, cordons)	<ul style="list-style-type: none"> • Loss for current season. • Vineyard will not yield for next two or three years depending upon injury. 	Re-planting of the vineyards

Category of damage	Consequence	Recommendation
<p>Category II</p> <p>Severe damage on current season growth and 100 % defoliation with few damaged bunches retained on vines</p>	<ul style="list-style-type: none"> • Loss for current season • Sprouting of buds after back pruning will be poor or will not be uniform • Possibility of secondary infection of fungi like <i>Botryodiplodia</i>, etc. through wounds reducing the productivity for future years • Vineyard may not yield next year. • Due to absence of leaves, sugar content in berries may not develop and there will be direct crop loss. • If such bunches are retained, depletion of reserved food material may affect the next season's crop • Due to partial injury or cracking of berries eventually there will be rotting of retained bunches. 	<ul style="list-style-type: none"> • Back pruning should be done after retaining 1 to 2 basal buds (spur pruning) on canes. • Few vines from the affected vineyard may be pruned immediately. Sprouting in these vines can be used as guideline to fix the level of back pruning • Moisture stress should be strictly avoided and vineyards should be irrigated as per the standard irrigation schedule • Spraying of copper based fungicides like Bordeaux mixture 0.5 %, or copper oxychloride (COC) 3.0 g / L or Copper hydroxide 1.5 g / L on trunk, arms and cordons to reduce secondary infection. • At five leaf stage, drenching of hexaconazole 5 EC @ 1 mL/vine in drip circle. Special nutritional and plant protection schedule is required till vineyard comes out of stress due to damage.
<p>Category III</p> <p>Leaves partially damaged but damage on individual bunches ranges from 30-100%</p>	<ul style="list-style-type: none"> • Sugar content in berries may not develop depending on extent of damage on leaves. • Damaged bunches will rot and will attract insects. Eventually bunch rots may spread to good bunches also. 	<ul style="list-style-type: none"> • Remove extensively damaged bunches before rotting sets in. • Damaged berries from partially damaged bunches should be removed with scissors. • After cleaning of bunches spray formulations of <i>Trichoderma</i> 5.0 ml or g / L alone or in combination with <i>Pseudomonas fluorescense</i> 5 g/L and Chitosan (10% solution) 2 to 3 ml /L and to protect bunches from new infection. • Spray of dichlorovos 1.0 ml / L, preferably to soil to prevent spread of insects.

Category of damage	Consequence	Recommendation
Category IV Toppling of all vines due to high intensity wind and rains or thunderstorms	<ul style="list-style-type: none"> • Vineyard may experience stress due to damage to roots and main stem. • It may affect the growth and performance of vines for next two to three years due to intense damage to roots, trunk, arms, etc. 	<ul style="list-style-type: none"> • Restructuring and re-planting of vineyards
Category V Damage in new vineyards on young shoots after re-cut	<ul style="list-style-type: none"> • The young shoot developed after re-cut eventually turns in to main stem of the vine. Any damage to such shoots will adversely affect the productivity of the vine. • Re-cut operation is taken during first year, primarily to achieve uniform growth in entire vineyard, so that all subsequent recommended package of practices can be followed at right growth stage in all the vines in vineyard conveniently. In damaged vineyards this very purpose will not be achieved. 	<ul style="list-style-type: none"> • If the majority of the vines are damaged, take re-cut in all vines above the graft union leaving one or two matured, uninjured basal buds and apply recommended fertilizers to boost the growth. • If the damage is on graft joint, re-grafting can be taken up in entire vineyard.
Category VI Damage to raisins while drying on racks due to unseasonal rains	<ul style="list-style-type: none"> • Delay in drying and physiological browning due to increase in humidity. • Rotting and heavy microbial load • Reduction in marketable quantity and quality of produce. 	<ul style="list-style-type: none"> • Spraying of ascorbic acid @ 200 ppm to control browning • Prepare yellow raisins by Sulphur fumigation @ 2-3 g / kg of grapes • Spray surface sterilants viz., Hydrogen peroxide (2 mL / L), chlorine dioxide (20-50 ppm) etc. to reduce the microbial load.
Category VII Damage to raisins on racks due to hailstorm	<ul style="list-style-type: none"> • Physical damage to sheds and rotting of berries • Unmarketable produce 	<ul style="list-style-type: none"> • To avoid further infection, dispose the produce and disinfect the raisin sheds • Restructuring of damaged raisin drying sheds

3. Citrus fruits (Nagpur mandarin, sweet orange and acid lime):

Due to hailstorms trees have been defoliated and hails have hit hard on the twigs and branches thus causing injuries. These injuries may invite secondary infection in coming days. Citrus growers are advised to take following steps immediately.

- i.** Apply copper oxy chloride / Blue copper (3 gram per litre of water) or Bordeaux mixture (1%) to thoroughly drench the trees (Approximately 10-15 litre solution per grown up tree).
- ii.** If injuries are big on stems and branches prepare a Bordeaux paste and apply on the injuries.
- iii.** After a week, apply second spray of carbendazim (1 gram per litre) + Aliette (2.5 gram per lit) to thoroughly drench the trees.
- iv.** Foliar application of gibberellic acid (GA) @ 1 gram and urea 1 kg per 100 litre of water may be given at earliest in this month i.e. March.
- v.** This is also a time to apply fertilizers to trees(200 g N + 200 g Phosphate + 100 g Potash) because new growth or flush is emerging in spring season. As per recommendations, apply fertilizers, mix in the soil and watering should be done immediately.
- vi.** Readily available mixture of micronutrients may also be applied to trees in April when new leaves almost fully develop as per prescription given on packets. Otherwise, take micronutrient powders such as zinc sulfate, manganese sulfate, ferrous sulfate (2 grams each) + borax (1 gram) + urea (10 gram) + slaked lime (5 grams) and dissolve in one litre of water. Sufficient spray should be applied to cover entire tree.
- vii.** Now summer has started, apply sufficient water to trees through irrigation.
- viii.** It is also a right time to remove dry twigs. These dry twigs harbor pathogens. Therefore, take 2-3 cm of green portion below the dry portion and prune these dry twigs and branches. Immediately after that, apply copper oxy chloride spray or Bordeaux mixture (1%) as given above. After 1 week follow spray of carbendazim + Aliette as given above.
- ix.** Remove rotten and fallen fruits and debris, twigs and leaves from the orchard floor immediately and bury them in a pit and cover with soil.
- x.** Method to prepare Bordeaux mixture (1%) : Take one kilo each of copper sulfate and lime separately. Soak in five litre of water overnight in two separate plastic containers. Stir thoroughly with a wooden stick so that copper sulfate and lime are dissolved completely. Take third separate plastic container and pour copper sulfate and lime solutions and mix thoroughly. Filter the mixture through two layers of fine muslin or any other cloth. Check copper content of the spray solution by dipping blade/knife. If copper deposit appear on blade then add little more lime solution in to Bordeaux solution. Lime is added to make Bordeaux mixture neutral. Make the total volume 100 litres by adding about 90 litres of water. This is 1% Bordeaux mixture which is used for spray.

- xi. Bordeaux paste can be prepared similarly as given above except addition of 90 litres of water. This paste is thick in consistency because there is not much water and hence applied with brush on cut/ injured surface of the trees.

4. Banana:

S. No.	Crop stage/ Extent of damage	Recommendations
1.	Early vegetative growth stage with extensive leaf damage	<ul style="list-style-type: none"> Severely damaged leaves that are broken near the petiole should be cut and removed.
2.	Vegetative stage (<5 month old plants) & breaking off of pseudostem at the top or in the middle of the plant	<ul style="list-style-type: none"> The plants can be cut just below the damaged part and allowed for emergence of new leaves.
3.	Late Vegetative stage or pre-flowering stage (>5 month old) - Toppling down of the plants	<ul style="list-style-type: none"> The pseudostem of the mother plant has to be cut and removed and one or two daughter suckers may be allowed as the followers.
4.	Flowering stage or flowered plants- breaking off of pseudostem at the top or in the middle of the plant or Toppling down of the plants	<ul style="list-style-type: none"> The mother plant has to be cut at the ground level and the pseudostem has to be cut into small pieces and mulched around the clump. One or two healthy sword suckers may be allowed as the followers and if there is severe nematode infestation of the root system, 40g of Carbofuron granules or 20g of Caldan has to be applied to all the plants and irrigated sufficiently.
5.	Post flowering or fruit maturity stage- The bunch is intact and only the leaves are partially damaged	<ul style="list-style-type: none"> Give foliar spray of 2% potassium sulphate (20g/ lit.) added with surfactant on the leaves as well as developing bunches twice at 30 days interval and cover the bunch with polypropylene or polythene sleeves.
6.	Any crop stage- Yellowing of leaves due to water stagnation	<ul style="list-style-type: none"> Draining out of stagnated water and spraying of 1.0 per cent potassium nitrate (10g /litre of water) along with good quality surfactant.

Nutrient Management

- 100g each of Urea and MOP and 50g of Dolomite has to be applied in a circular basin dug at 2 feet away from the plant.

- Young affected plants may be sprayed with 2.0 per cent ‘Banana Shakti’ (A NRCB Product) or ‘Banana Special’ (IIHR Product) - A banana micro nutrient mixture at 4th, 5th & 6th month after planting added with good quality surfactant.

Management of Nematodes

- Application of 40g of Carbofuron granules or 20g of Caldan to all the plants by exposing the roots in a circular basin and irrigated sufficiently.

Management of Leaf Spot diseases

- Old infected leaves should be cut and burnt
- Two sprays with mineral oil 1% (10 ml/lit.)+ 0.1% carbendazim (1 g/lit.) has to be given covering both the leaf surfaces of all the leaves at 20 days interval.

5. Onion:

The extent of losses varies from mild to severe. In case of mild or medium losses some recovery can be made by prophylactic sprays and nutrient application. In case of onion seed crop it is difficult to salvage crop. The advisory for onion and garlic crop at various stages is given below.

S. No.	Stage/extent of damage	Recommendations
	Onion bulb crop	
1.	Crop growth at 45 to 60 days after transplanting and foliage present.	Prophylactic spray of fungicide viz. Tricyclazole (@1g/l) or Hexaconazole (@1 ml/l) or Propiconazol (@ 1g/l). Spray water soluble fertilizer of 19:19:19 of NPK.
2.	Crop growth at 45 to 60 days after transplanting and foliage completely damaged.	Apply additional dose of soluble N:P:K:S @ 25:20:20:10, kg/ha in soil to boost vegetative growth. Later spray fungicides to avoid spread of disease viz. Tricyclazole (@1g/l) or Hexaconazole (@1 ml/l) or Propiconazol (@ 1g/l) along with water soluble fertilizer spray of 19:19:19 NPK on newly emerging leaves.
3.	Crop growth at 60 to 90 days after transplanting and foliage present.	Prophylactic spray of fungicide viz. Tricyclazole (@1g/l) or Hexaconazole (@1 ml/l) or Prpiconazol (@ 1g/l). Spray water soluble fertilizer of 19:19:19 NPK @ 10 g/l).
4.	Crop growth 60 to 90 day after transplanting and foliage damaged.	Prophylactic spray of fungicide viz. Tricyclazole (@1g/l) or Hexaconazole (@1 ml/l) or Propiconazol (@ 1g/l) to check further spread of diseases.
5.	Crop at maturity stage or harvested and affected by heavy rains or hail storm and bulbs are	Crop should be harvested, cured and immediately marketed.

	exposed by rains or hail storm.	
6.	Crop at neck fall stage and affected by rains and bulbs are not directly exposed.	Arrangements should be made for proper water drainage. Crop should be harvested under dry conditions and properly cured in field for 3-4 days in sun by covering the bulbs with foliage of other bulbs. After field curing foliage should be removed keeping about 2-3 cm neck length. Selected bulbs should be cured under shade for about 15 days in heap of 3-4 feet and then only it should be stored in well ventilated storage structure.
	Onion seed crop	
	Flowering and seed setting stage where crop is partially damaged.	Prophylactic spray of fungicide viz. Tricyclazole (@1g/l) or Hexaconazole (@1 ml/l) or Propiconazol (@ 1g/l). Spray water soluble fertilizer of 19:19:19 NPK @ 10 g/l). Spray of Boric acid (@ 1.5g/l) will help in seed setting.

NOTE:

1. Stickers should be added in all the foliar sprays @ 0.5 to 1 ml/l depending upon crop growth.
2. Wherever cloudy weather persists for more than two days, immediately fungicides should be sprayed as a prophylactic sprays even if the crop is healthy. If the thrips are present then insecticide like Prophenophos (@ 1ml/l) or carbosulphon 25 EC (2ml/l) should be sprayed along with stickers in bulb crop only.
3. There should not be water logging in the field. The water should be drained out immediately in the crop where neck fall started or crop lodged due to rains or mild hail storm.

Harvesting and Post-Harvest Management of Onion

Onion is important horticultural crop contribute significantly to the socio-economics of the country. It is grown by small and marginal farmers across the country. Prices of the onion fluctuate disproportionally putting stress both on consumers and growers. Onion is the commodity of mass consumption and used by almost all the section of the society in various ways. It is mainly grown in rabi season throughout the country, however in some part onion is grown in late kharif or early rabi and also in kharif season. About 55-60% of onion comes from *rabi* season and 40-45% from late *kharif* and *kharif* seasons. It is highly perishable and deteriorates due to desiccation, transpiration, respiration and other physiological processes even after the harvest. Care in post harvest practices and handling is thus necessary to preserve the post harvest quality of onion. Rough handling of onion at the farm directly affects the quality and shelf life of bulbs.

Pre harvest Management:

Pre-harvest chemical treatments: Pre-harvest treatments with chemicals have also found to be beneficial in reduction of post harvest losses. Spray of Streptocycline @ 0.02% and Carbendazim @ 0.1% at 10 and 20 days before harvesting, respectively, has resulted in reduced losses due to decay. Therefore onion growers should spray the above chemicals at recommended doses to avoid losses in the storage from decay.

Withholding Irrigation: As soon as neck fall starts irrigation should be withhold. Excess irrigation after maturity causes splitting of bulbs and also favors the condition for developing fungal and bacterial rot disease in field. Therefore irrigation should be stopped immediately after starting of neck fall in onion crop.

Harvesting

Rabi season onion crop is ready to harvest within 100-120 days after transplanting depending upon varieties & prevailing climate. Bulbs are considered to be mature when the neck tissues begin to soften & tops are about to abscise and decolourise. Best time to harvest *rabi* onion is one week after 50 % tops have fallen over. The onion growers should take care & harvest at proper stage as stated above to reduce the losses in storage.

Post-harvest factors

Post-harvest quality of onion is completely dependent on pre-harvest practices adopted as the quality can not be improved later, it could be maintained only.

Drying and Curing: Field curing is necessary to reduce the excess moisture from outer skin & neck region of onion bulbs in order to get good colour of bulbs & reduce infection of disease causing organisms. In *rabi* season bulbs are cured in field for 3-5 days through windrow curing method.

After neck cutting bulbs are again cured in shade for 10-15 days to remove field heat. The curing in shade improves bulb colour, helps in developing more number of skin & reduces storage losses significantly. Damaged & disease infected bulbs start rotting during shade curing which are easily sorted out before storage. It is necessary to the growers to follow the above stated drying & curing of onion bulbs to avoid storage losses & also getting good price in market.

Top-cutting / Neck-cutting: Cutting of tops close to bulbs give way to entry of moisture and micro-organism (pathogen) and thereby more losses occurs due to decay. 2 to 2.5cm tops above the bulb should be left while cutting the tops so as to have tight neck and avoid loss in storage. The onion growers should adopt the above practice to avoid further losses.

Sorting and Grading: For minimizing the storage loss due to decay, drying and sprouting and also to get premium price the thick necked, bolted, doubles, injured, decayed, diseased and sprouted bulbs should be removed. The size grading is done manually or mechanically before storage. Medium size bulbs of onion (4 to 6 cm) are good for storage purpose. It has been experienced that sorting and grading helps in reduction of post-harvest losses. It is necessary to follow by onion growers for better storage & also for better price in market.

Storage of onion: Onion is stored in especially designed storage structures having proper and adequate ventilation. Disinfection of storage premises for handling and storage of onion are also required to reduce post-harvest losses particularly decay loss. To disinfect the storage structures spray Chlorpyrifos @ 2 ml/lit + Bavistin @ 1 gm/lit on roof, walls & ground of structure before storage of onion. Well sorted and graded bulbs are stored in godown /chawals. Care should be taken the height of hip is not more than 4 feet, which is recommended by NHRDF for proper storage & reduction in losses.



Improved storage structure developed by NHRDF

6. Vegetable crops:

Since vegetable crop sown /transplanted earlier during the season (January- February), may have suffered. However, losses are variable and in some cases it can be saved by adopting following recommendations. Further, the micro-climate like prevalence of warm and humid climate created due to unseasonal hailstorms and rains may extend and lead to suffering of crops from the infection of diseases.

- In vegetable crops remove all the affected plants and destroy.
- Take up fresh planting with seedling from accredited vegetable nurseries.
- Apply recommended quantity of organic manure to improve the soil fertility.
- Wherever possible integrate organic manure with *trichoderma* and *pseudomonas* so as to overcome the diseases during the seedling stage.

S. No	Extent of damage	Recommendation
1.	If more than 60% vegetable plants damaged.	<ul style="list-style-type: none"> • Harvest mature fruits if any for immediate consumption, marketing, processing etc after proper sorting. • Remove damaged plants and sowing of entire field with short duration vegetable crop viz., cowpea (bushy type like Kashi Kanchan, KashiNidhi, Kashi Unnati and others)), okra, radish and leafy vegetable crops like spinach, amaranths, coriander, etc.
2.	Less than 60% vegetable plants damaged.	<ul style="list-style-type: none"> • Remove damaged fruits, leaves, branches, etc. • Harvesting of mature fruits if any for immediate consumption, marketing, processing etc after proper sorting. • Staking and earthing-up of remaining vegetable crops like tomato, brinjal, cucurbits etc. • Spray soluble fertilizer (19:19:19 NPK @ 5 g/l of water and fungicide (carbendazine @1g/l of water). These spays may be repeated after 7 - 10 days after first spay. • The space available between the crops may be utilized by sowing short duration vegetable crop like cowpea (as stated above), okra, radish, etc.

NOTE:

Short duration vegetable crops suitable for sowing during March –April

1. One to two months duration leafy vegetable crops like : Spinach, Amaranthus, Coriander, etc.
2. Three to three and half months duration crops like Cowpea, Okra, Clusterbean

Pest management

- 1.** Follow seed treatment with Imidacloprid 48 FS/Thiomethoxam 70 WDG @ 5g/kg seed (Okra / Cowpea) to save the crop from initial infestation of sucking pests and viral diseases. After 25 DAS, one spray of Imidacloprid 17.8 SL @ 0.5 ml/l of water may be given.
- 2.** For leaf spot (*Cercospora*) and powdery mildew infection in okra and cowpea, Carbendazim 1.0g/l of water whereas in case of Solanaceous crop (tomato, brinjal ,chilli), Mancozeb 2.5g/l of water can be sprayed to control *Alternaria* leaf spot diseases.
- 3.** In cowpea for pod borer(*Maruca vitrata*) the spray of Emamectin benzoate 25WG @ 0.5 g/l of water or Indoxacab 0.75ml/l of water may be followed.
- 4.** In okra HaNPV 300LE/ha may be sprayed to save the crop from *Helicoverpa* damage.

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