

# Protection of Onion (*Allium cepa* L.) Seed Crop against Hailstorm Damage

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Seed is the vital crucial and basic foundation for agriculture, determines the yield and quality of crop production and productivity [1]. Quality seed alone contributes directly to the crop production about 15-20% of the total production depending upon the crop and it can be further raised up to 45% with efficient management of other inputs. Onion (*Allium cepa* L.) is one of the most important spices crop consumed as a vegetable imparts taste to food and have medicinal values and earn foreign currency, that is the reason the consumption pattern is increasing day by day [2]. The onion is cultivated through seeds and the demand of onion seed is increasing, but the farmers are facing the shortage of quality seeds. The unavailability of good quality seeds is partly responsible for low production and the inferior seeds may decrease even up to 15-25% of the crop production. The estimated requirement of quality onion seed is about 10400 ton, out of which 8-10% of the demand is catered by organized sectors. The National Horticultural Research and Development Foundation (NHRDF), ICAR-Directorate of Onion and Garlic Research, Rajgurunagar, Pune; National Seeds Corporations and Maharashtra State Seeds Corporation are major agencies producing quality seed in an organized manner. The private seed companies also produce around 10% of the total country requirement and rest around 80% seed is produced by farmers themselves [3]. The seed production of onion takes long time and very difficult phenomena as it is produced in two phases. In first phase, the bulb production is required, while under second phase the seed production take place from the bulb. The seed quality is influenced by a number of factors including storage of bulbs for long time, planting dates, harvesting times and environmental factors.

The quality of the seed is determined by the interaction of genetic and environmental factors, the climatic change significantly alters these factors. Lack of cool weather conditions to induce flowering is the main constraint of onion seed production in many tropical and subtropical regions. As a result, many countries have to import onion seed from sub-tropics or temperate countries where the winter season provides the chilling requirement for flowering. Hence, the onion seed production is becoming vulnerable to changing climate variability and characterized by altered frequency, timing and magnitude of precipitation and temperature in tropical and sub tropical regions. There are indications that a warming climate would favour an increase in the intensity and frequency of extreme events [4]. and we are already witnessing some of these such as heat waves and high rates of floods, drought, diseases [5, 6] and hailstorms [7, 8] increased incidences of the pests and diseases causing widespread damage and losses to onion bulb as well as seed crop. There are tough road lies ahead for India and warns the country due to extreme weather events, and estimates countrywide agricultural loss [9].

## What are hailstorms?

Hail is formed when atmospheric air heats up during the day, rising because it is lighter and then cools. The moisture within the air condenses to form clouds. Due to super cooling hailstone is formed due to heavy weight with a diameter of at least 5 mm. During vertical movement of the clouds they cannot hold these ice crystals, so they come down with great speed and falling either separately or collecting into irregular lumps moving vertically inside the cloud [10].

### Hailstorm history in India

Hot and humid afternoon hours during the summer are the most congenial for development of unseasonal hailstorm/rain and can occur at any time. It is most often associated with the larger thunderstorms of spring and summer seasons of India being situated in the tropical and subtropical regions, however causes havoc even from a few minute spell. Recently various parts of the country experienced widespread unseasonal rain and hailstorms. The freak weather event battered eight states namely Punjab, Haryana, Uttar Pradesh, Rajasthan, Madhya Pradesh, Maharashtra, Karnataka and Andhra Pradesh. Meteorological Department has analyzed hailstorms occurrence across the country between 1981 to 2015 and found that Maharashtra is most prone to hailstorms in severity. In Maharashtra, hailstorm occurring frequently during the pre-monsoon season of March, April and May has witnessed this unseasonal weather pattern for four consecutive years 2014, 2015, 2016 and 2017. The states of Himachal Pradesh, Punjab, Assam and Madhya Pradesh followed by Andhra Pradesh, Telangana, Uttar Pradesh and Haryana are in sequential positions. The least occurrence is recorded in Gujarat, Chhattisgarh, Tamil Nadu, Tripura, Meghalaya, Sikkim and Nagaland.

### Hailstorm impact on agricultural and horticultural crops

The hailstorm caused massive damage to several crops [11-13] which includes ruptured leaves, flowers and fruits depending on the stage of plant development during the damage. These injuries enhance stand reduction and defoliation. The hail damage promotes premature plant death, sterility and increases the susceptibility of crops to bacterial and fungal infection, which consequently reduces crop yield [13]. The estimated data revealed that 4.65 million ha of standing crops were ravaged in the worst-hit to Maharashtra and Madhya Pradesh alone. The frequency of hailstorm occurrence in Maharashtra is increasing, however, recently experienced in Vidarbha and Marathwada region at an interval of every 3-4 years; they were of very low intensity and short duration, hardly 2-3 minutes [14]. In Maharashtra 16 lakh ha of crops such as cotton, wheat, maize, grapes, mango, onion bulb, onion seed crop and pomegranate were damaged in Vidarbha, Marathwada and Western Maharashtra. In the year 2015, agriculture area around 17.7 lakh ha in 28 districts of Maharashtra were damaged by untimely rains and hailstorms. The maximum frequency of hailstorm

events has been recorded in districts of the northern part of Vidarbha region. Comparatively the extents of losses were less in North and Western Maharashtra regions. The hailstorm has havocked most of the Marathwada region with huge losses in Osmanabad, Latur, Parbhani, Jalna and Aurangabad districts.

### Hailstorm impact on onion seed crop

Onion seed production depends on geographical locations and seasons. Based on suitability of onion seed crop, NHRDF has identified suitable pockets for onion seed production in the country such as Vidarbha and Marathwada region in Maharashtra; Khargaon, Dhar, Indore, and Ujjain in Madhya Pradesh; Saurashtra region in Gujarat; Ranebennur in Karnataka; Kurnool in Andhra Pradesh; Sikar, Chittorgarh, Udaipur, Jhalawar and Sriganganagar in Rajasthan. Past experience revealed that every onion seed growing pockets are experienced to hailstorm is very notorious problem and occurs every year [15, 16].

Permanent or temporary losses/damage in onion seed production due to hailstorm in Maharashtra is very common. Hail can severely damage all onion plants, varies in severity depending upon the force, size, duration of the hailstorm and stage of the crop [17]. The hail can increase the chance of umbel injury, canopy damage besides uprooting and breakage of plants and crop suffer with disease, rotting and insect's infestation severely which affect the health of plant and decimate the yield. Generally earlier stages of the crop damage have greater potential for re-growth. Fixing hail damage on plants is not always possible. The extent of losses of both yield and quality varies from 10.0% to 100% depending on the crop growth stage and the amount of leaf canopy destroyed, with the greatest yield losses occurring as the crop approaches the seed maturity stage. Though in some cases the losses are irreparable, in others where the damage is less, the crop can be saved.

A field trial was conducted under shade net condition to mitigate the impact of hailstorm on onion seed crop at Regional Research Station, Nashik during *rabi* 2015-16 and 2016-17. The size of shade net structure was 10' x 10' = 100<sup>2</sup>. Shade net house was a framed structure made up of materials such as GI pipes and angle iron. Two shade nets were selected based on their shade factor along with a control plot *i.e.* Nylon cage (15 Mesh) - diffuses the light inside the net house, another one was white shade net - diffuses the highest light and without

shade net - served as control (Figure 1). During the 1<sup>st</sup> year (*rabi* 2015-16) cropping period hailstorm did not occur, while during the 2<sup>nd</sup> year (*rabi* 2016-17) at harvesting stage on dated 30<sup>th</sup> April 2017, 25.2 mm rain fall/ hail storm occurred.

It is evidenced from the data and visual observations, the hailstorm caused severe umbel damage in the crop grown under without shade net (Figure 2 B, C & D), whereas in shade net grown crop recorded higher umbels per plant and relatively better protected due to shade net (Figure 2A) as compared with without shade grown. The damage due to rain/hail storm varied from 25% to 100% depends on severity, stage and the economic plant

parts. In unaffected umbel on an average of 562.0 seeds per umbel (Figure 3 A & B) were recorded, while in slightly affected umbel 421.0(25.09% damage) seeds (Figure 3 C), less affected umbel 386.0 (31.32% damage) seeds (Figure 3 D), moderately affected umbel 226.0 (60% damage) seeds (Figure 3 E) and severely affected umbel 100% umbel damaged, in which single seed was not recovered back (Figure 3 F). It is evidenced from the data that highest number of umbels (6.93/plant), umbel diameter (9.10cm) and seed yield (7.84q/ha) were recorded in White shade net grown crop followed by Nylon cage grown crop, whereas in without shade net conditions grown crop lowest yield (5.96q/ha) was recorded (Table



**Figure 1.** Onion seed production under shade net [A] and open field condition [B]



**Figure 2.** Heavy rain/ hailstorm damaged onion seed crop at the stage of umbels harvesting stage; umbel was healthy grown under shade net [A], under without shade net condition grown crop severely damaged [B, C & D]



**Figure 3.** Damage of umbel from a rain/hailstorm before harvest; [A] Healthy umbel at seed setting stage, [B] Healthy umbel at harvesting stage - no hail damage, [C] Mild hail damage umbel, [D] Significant damage, [E] Severe damage, and [F] Extensive damage

1). The shade net reduced the incident and intensity of hail on the onion seed crop canopy results mild damage occurred. The crop grown under without shade net open sky comparatively a higher percentage of umbel damage was recorded. The results in line with the results of [17] revealed that in central India, due to hailstorm onion crop canopy and bulb severely damaged and its leads reduction of leaf functional area in onion bulb crop. The shade nets also protected the quality of seeds, the highest 1000 seed weight, seed germination and vigour were recorded in shade nets grown crop over without shade net (Table 2). The two years pooled results revealed that shade net significantly protects the onion crop from the hailstorm/rain, both the shades *i.e.* Nylon cage (15 Mesh) and White shade net provided higher yield, which was

29.02% and 31.54%, respectively over control during 2<sup>nd</sup> year.

#### How onion seed growers should respond to hailstorm

After post-hail management option, the grower should remove the uppermost damaged parts like leaves, stems and umbel, which reduces the functional leaf area and the plant becomes very susceptible to diseases. Therefore, removal of these will helps in maintaining the sufficient number of effective leaves and umbels being produced even though 100% recovery would not possible, however specific methods would help the maximum recovery. The application of treatment thio-urea,  $\text{KNO}_3$  (1.5%), Humic acid (2 ml/L), Humic acid +  $\text{KNO}_3$  provided 40% recovery of seeds as compared with

**Table 1.** Effect of different shade nets on growth and yield in onion seed crop against rainfall/ hailstorm

Treatments	No of umbels/plant	Umbel diameter (cm)	No of seeds/umbel	Seed yield (q/ha)
Nylon cage net	6.85	8.45	456.00	7.69
White shade net	6.93	9.10	465.00	7.84
Without shade net	6.65	8.34	456.75	5.96

**Table 2.** Effect of different shade nets on onion seed test weight, germination and vigour index in onion seed crop against rainfall/ hailstorm

Treatments	1000 seed weight (g)	Seed germination (%)	Vigour index
Nylon cage net	2.968	85.13	565.04
White shade net	3.025	85.75	547.04
Without shade net	2.748	84.88	536.90

hail affected control crop. Prophylactic application of fungicide viz. Tricyclazole @1g/L or Hexaconazole @1 ml/L or Propiconazol @ 1g/L. Application of water soluble fertilizers of 19:19:19 NPK @ 10 g/L by foliar and drenching helps better plant growth. The foliar application of micronutrient boron @ 1.5g/L will help in seed setting.

The cultivation of onion seed crop under open shade net conditions is a new concept under hail storm prone areas to reduce the effect of rain and hailstorm damage. Based on results it is concluded that the onion seed production under open white shade net and nylon cage net conditions provided superior results in terms of better crop protection as compared with without shade net conditions against rain and hailstorm which results good quality seeds and better yield.

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