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Climates influence on the resilient neem plant

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Abstract

Climate variability, particularly extreme cold and sudden temperature drops, has stressed neem trees (*Azadirachta indica*). These trees are sensitive to frost and prolonged cold, which limits photosynthesis, reducing chlorophyll production. This leads to leaf discoloration, damage, or death of tree parts. In January and February, temperatures dropped consistently below 6°C for extended periods (IMD Chandigarh), with fewer sunny days and severe cold waves, hindering sugar production and causing dehydration in plants. Research shows that air temperature and soil moisture are key factors in regulating stem growth and carbon capture, essential for healthy growth (Clark & Clark, 1994; Banbury et al., 2021). Younger and healthier neem trees are more resilient to cold stress, while older or weakened trees are more vulnerable. Insufficient winter rainfall worsened the drying of trees. Data from Talwandi Sabo, Bathinda, Mansa, Sirsa, Sri Ganganagar, and Hanumanghar confirmed that younger trees had better survival rates compared to older ones.

Research indicates that neem trees subjected to winter pruning showed enhanced growth, with 100% of pruned trees in open areas and near buildings showing improvement. Trees near buildings or taller trees, which offered shelter from harsh conditions, were less affected by cold stress. Recovery rates were high, with 84% of trees surviving winter stress. To protect neem trees from cold stress, practices such as mulching, proper watering, pruning, microclimate management, and the use of anti-desiccant sprays can improve resilience, mitigate climate impacts, and ensure long-term vitality.

Keywords: Neem trees, Climate variability, Cold stress, Photosynthesis, Resilience strategies

Introduction

Neem (*Azadirachta indica* A. Juss.) is an indigenous tree to the Indian subcontinent and characterised by its rapid growth, significant economic worth, and wide range of applications. More than 50% of the world's countries already have neem trees growing there, and the number of neem trees worldwide is steadily rising. Neem is a multipurpose tree, also known as "wonder tree" due to its numerous uses, which have been recognised in India since the Vedic period. Neem trees has showed potential as a natural source of insecticides, pesticides, and agrochemicals, making it valuable in a variety of industries in addition to its therapeutic effects. The neem tree, also referred to as 'Indian lilac,' is notable for its rapid growth, reaching heights of up to 25 metres and living for more than 200 years (Ragit et al., 2011) [4].

Neem is adapted to subarid and subhumid areas with tropical and subtropical climates at altitudes between sea level and 700 m. Mean annual temperatures within its natural range are typically 21-32 °C (preferred temperature range of around 9.5-37 °C) (Stoney 1997) [7]. Neem can tolerate high summer temperatures (up to 50 °C) but does not tolerate frost or temperatures below 4 °C (leaf fall and death may result). Neem grows best in areas where annual rainfall is 450-1200 mm (with optimum growth where annual rainfall is around 1100 mm), but can tolerate annual rainfall as low as 150 mm if its roots can access ground water within 9-12 m of the ground surface (Stoney 1997) [7]. Once established, it is very drought tolerant and can survive 7-8 month dry seasons.

In many villages and forest protected areas, the trees are still dry. Normally, the leaves of trees turn yellow during peak winter months and then gradually begin to fall, but at the same time, new shoots start to emerge. However, during extreme winter days, the neem trees was still drying. Drying of neems was a cause of worry for the wildlife experts too, who said that many wild animals depend on neem leaves and their twigs to remain healthy in the foothills

and also inside the birds. “Not only monkeys, but also the birds depend on neem trees for health benefits, (Jaskaran Sandhu, a former member of Punjab State Board for Wildlife). “Dry trees always attract disease and fungus and it has infected neem trees of all sizes and ages. Apart from fruit rot, it causes twig blight in neem which means that fruit production falls drastically affecting birds, animals and rural communities who are economically dependent on neem seed,” (Sandhu). The drying up of twigs and leaves of neem trees has become a familiar sight in many parts of Punjab, Haryana and Rajasthan over the last 3 months.

Ironically, neem that has become synonymous with providing good health to other trees, animals and people through its twigs, leaves, flowers, bark, seeds and fruits, has been dying across the state. The experts of agriculture said that the neem already is a pesticide but, now itself a victim of pest and fungus due to the drying of leaves since the past 3 months.

Impact of climate on neem

Unusual weather patterns, such as extreme cold or sudden temperature drops, might have stressed the neem trees. Neem trees are sensitive to frost and prolonged cold conditions, which can cause reduction in Photosynthesis that depend on sunlight can be a big factor, this change leads to the reduction of chlorophyll and changes the overall colour of the leaf, which may damage or death to parts of the tree. This is noted that the temperature range in the months of January to February was recorded less than 6°C for the

prolonged period (IMD Chandigarh). The sunny days also was very less and severe cold waves were noticed, so, that the plants can't prepare sugars due to less photosynthesis and ultimately turned dry. Multiple studies have identified that air temperature and soil humidity significantly regulate the stem growth rate (Clark, D.A.; Clark, D.B, 1994) [3]. Each species is considered to have a range of temperature and water availability for optimal growth, in which photosynthetic processes allow for sufficient carbon (C) capture to cover the maintenance and growth activities of the individual, which is reflected in an increase in secondary growth (Banbury Morgan, *et al.*, 2021) [1]. Additionally, marginal resistance ranges are available, where the individual regulates photosynthesis and respiration; i.e., growth is suspended and the focus is on surviving (Brüggemann, N., 2011) [2]. If environmental conditions exceed resistance ranges, the individual will not survive.

That we recorded data from the areas of Talwandi Sabo, Bathinda, Mansa, Sirsa, Sri Ganganagar and Hanumanghar and found that the younger and stronger neem trees have survived the attack. Older or previously weakened neem trees is more susceptible to adverse conditions and less likely to recover. Healthier trees are more resilient and capable of regrowth; this is noticed from the data recorded. It is also noticed that the insufficient water during winter caused neem trees to dry out. This Winter period was of reduced rainfall and if the trees did not receive adequate water, they might have desiccated.

Inclement weather for next 4 days: IMD

NEW DELHI, DECEMBER 22
Weather over large parts of the country, especially in Punjab, Haryana and NCR, will remain inclement for the next four days, prompting the India Meteorological Department (IMD) to warn against outings and of difficult driving conditions.

In fact, the IMD has asked commuters to be careful while using any kind of transport. “Fog lights should be used during driving while mass transport users should be in touch with airlines, Railways and state transport for any revision in the schedule,” it said.

There would be deterioration in weather conditions for four days beginning Friday, said the department, while forecasting “very dense fog” in isolated pockets over Punjab, Odisha and the North-East. Some parts of western India will also witness thunderstorms accompanied with lightning at isolated places.

On Saturday, “dense to very dense fog” is very likely in isolated pockets over Punjab, Haryana, west Rajasthan and eastern part of India that could affect some airports, highways and railway routes in the affected areas. There could also be tripping of power lines in areas having dense fog, it said. — TNS

Fig 1: News coverage from IMD regarding dense fog

MERCURY DIPPING

CHANDIGARH	8°C
HISAR	8.2°C
FARIDKOT	8.6°C
PATHANKOT	8.8°C
AMBALA	9.8°C
DELHI	10.7°C

Minimum temperature



A blanket of thick fog engulfs Hisar on Friday. TRIBUNE PHOTO: ASHOK KUNDU

Brace for two more days of dense fog, showers likely in parts of region

TRIBUNE NEWS SERVICE

NEW DELHI, DECEMBER 29
The India Meteorological Department (IMD) on Friday said ‘dense to very dense fog’ is likely to continue at many parts over North-West India during the next two days and gradually decrease thereafter while light isolated rainfall is likely over some parts in the North-West and Central India on Saturday.

The weather agency further said the minimum temperatures were in the range of 7-11°C over most parts of Punjab, Haryana, Chandigarh and

HISAR COLDER THAN SHIMLA DURING DAY
Hisar recorded maximum temperature of 14.5°C on Friday. It was 6°C below normal. Even Shimla recorded a higher maximum temperature of 15.2°C on Friday.

TRAIN SCHEDULE HIT
Amid dense fog, scores of trains ran behind schedule on Friday in Punjab and Haryana, causing inconvenience to passengers.

Delhi. The weather office has predicted that cold wave conditions would prevail from December 29-31. In Punjab,

Amritsar recorded a minimum temperature of 9.9°C. Ludhiana 9°C and Patiala 9.5°C. Pathankot recorded a low of 8.8°C and Faridkot 8.6°C. In Haryana, the mercury settled at a low of 9.8°C in Ambala and at 8.2°C in Hisar. Karnal recorded a minimum temperature of 9.4°C, Rohtak 9.6°C and Sirsa 9.8°C.

Delhi's Palam station recorded 150m and Safdarjung 200m visibility, according to IMD. Flight and train schedules were also affected, with many flights experiencing delays and some facing cancellations.

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Fig 2: News coverage report dated 29th December from IMD, Regarding dense fog.

Extended dry spell, cold conditions may hit crops

No rainfall in state after Nov leaves farmers worried

MANAV MANDER
TRIBUNE NEWS SERVICE

LUDHIANA, JANUARY 18
The extended dry spell in Punjab can have an adverse effect on crops and this has made the farmers anxious. The state has not received rainfall in December and half of January. On the other side, agrometeorology experts see no sign of rain in the coming week, which has only mounted their concern.

Dr Makhan Singh Bhullar, Director, Extension Education, Punjab Agricultural University (PAU), said the dry spell had got extended way too much this year.

"Rainfall at this time helps in proper irrigation of the wheat crop as there are less chances of spread of diseases and hence decreased the use of pesticides. Rainfall has nitrate, which is good for the crop growth. Rainfall saves both time and cost of irrigation and is helpful for farmers who have fewer irrigation options," said Dr Bhullar.

HS Lakhowal, general secretary of the Bharatiya Kisan Union, said with no rainfall farmers would have to irrigate the crop with limited irrigation. In addition to this, the affected yield of the crop also becomes worrisome. Rainfall irrigates the crop equivalently, which leads to increased yield," he said.

"There has been an extended dry spell. The state did not receive rainfall in December and half the January is already gone. The cold and foggy conditions are expected to continue this week and there seems to be no chance of rainfall," said Dr Pavneet Kaur Kingra, Professor and head, Department of Climate Change and Agricultural Meteorology, PAU.

Dr Kingra said that dry winter increases the instance of frost on the crops, which may have a harmful effect on some varieties. However, vegetables and newly planted orchards are more vulnerable to such incidence of frost, she warned.

Harbhajan Singh, a farmer from a village near Samrala, said in absence of rainfall, the wheat and potato crop will be hit. "I have also heard that mustard crop suffered frost attack in some regions due to lack of rain and extreme cold.



Commuters make their way amid fog in Amritsar. VISHAL KUMAR

PRECIPITATION WILL HELP CROP

“Rainfall at this time helps in proper irrigation of the wheat crop as there are less chances of spread of diseases, thus leading to decrease in use of pesticides. Rainfall has nitrate, which is good for the crop growth. Dr Makhan Singh Bhullar, DIRECTOR, EXTENSION EDUCATION, PAU

Fig 3: New coverage report from Meterology department- PAU regarding no rainfall

Results

Research has shown that 100% neem plants which underwent pruning at the onset of winter exhibited enhanced growth compared to those left unpruned (84% in open areas & 90% near Building). This practice, conducted during the dormant season, not only eliminates dead or diseased branches but also promotes better airflow within the plant, fostering healthier growth. By redirecting the plant's energy towards new growth rather than repairing damaged tissue, winter pruning encourages vigorous development, ultimately resulting in more robust neem plants.

Observations indicate that 90% neem trees situated near buildings and surrounded by taller trees were less affected compared to those in open areas (84%) (Figure 4 & 7). The presence of nearby structures and taller trees likely provided protection against adverse environmental conditions such as strong winds, cold waves, frost and excessive sunlight. As a result, these sheltered neem trees experienced fewer stressors and exhibited healthier growth patterns.



Fig 4: Neem image showing less affected because surrounded by building and trees

Based on the available data, it was further observed that younger neem trees exhibited better health and resilience against cold stress (Figure 5). The 96% younger plants remained unaffected by the adverse effects of low temperatures compared to their older counterparts. This finding suggests that age plays a significant role in the susceptibility of neem trees to cold stress, with younger specimens displaying greater vitality and resistance to environmental challenges.



Fig 5: Healthy plant



Fig 6: Severely affected due to winter stress

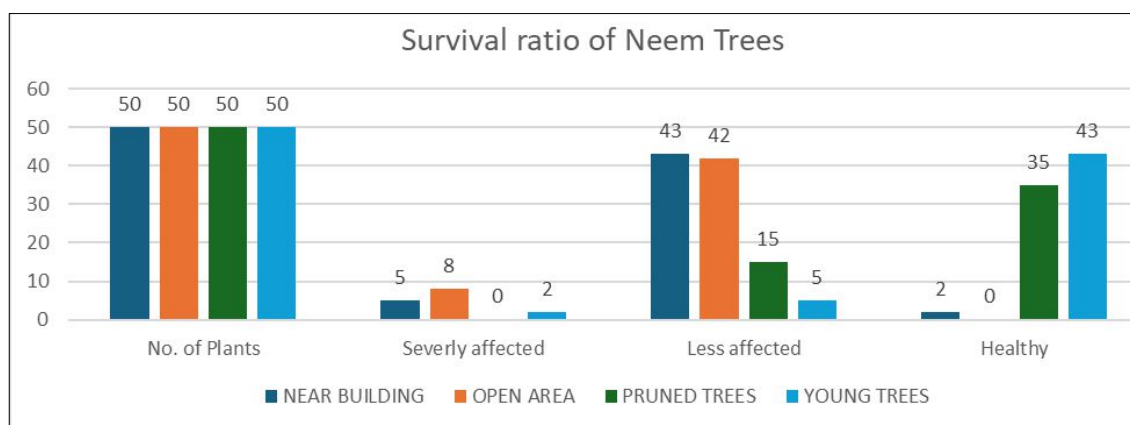


Fig 7: Graphical representation (Survival rate of neem trees)

Strategies to protect neem plant from severe cold stress

By employing these techniques, neem trees can recover more effectively from winter stress and resume healthy growth:

Mulching: Apply a thick layer of organic mulch around the base of the neem tree. Mulch helps to insulate the roots, retaining soil warmth and moisture. Ensure the mulch is kept a few inches away from the trunk to prevent rot. The impact of mulching on the growth of neem plants is significant. Mulching helps conserve soil moisture, suppress weeds, and regulate soil temperature, creating optimal conditions for neem tree growth. By reducing evaporation and erosion, mulching promotes root development and nutrient absorption, leading to healthier and more robust neem trees. Additionally, mulch acts as a natural fertilizer as it decomposes, enriching the soil with essential nutrients. Overall, the practice of mulching positively influences neem plant growth by providing a conducive environment for their development, ultimately contributing to better yields and overall plant health.

Watering: Ensure adequate watering before the onset of winter. Well-hydrated trees are better equipped to handle cold stress. Water deeply during dry periods in winter if the ground is not frozen. Irrigating neem trees during winter is crucial for their health. In winter, plants tend to receive less natural moisture, making irrigation essential to prevent water stress. Adequate watering during winter ensures that neem trees stay hydrated and healthy, promoting root development and overall growth. However, it's important to avoid overwatering, as cold temperatures can slow down the absorption of water by the roots. Proper irrigation during winter helps neem trees survive the season, maintain their vitality, and prepares them for healthy growth when spring arrives.

Pruning: Properly prune the neem tree to remove any dead or weak branches, which can reduce the overall stress on the tree and improve its resilience. Pruning plays a crucial role in enhancing the growth and health of neem plants. When done correctly, pruning helps maintain the plant's shape, removes dead or diseased branches, and stimulates new

growth. By pruning, you can improve air circulation and sunlight penetration within the plant, promoting overall vigor and reducing the risk of pests and diseases. Additionally, pruning can encourage the production of more flowers and fruits in neem trees. Regular pruning not only keeps the neem plant aesthetically pleasing but also contributes to its overall well-being and productivity.

Fertilization: Apply a balanced fertilizer in the fall to provide the tree with essential nutrients before winter. Avoid high-nitrogen fertilizers late in the growing season, as they can promote tender new growth susceptible to frost damage. Fertilizers play a vital role in enhancing the growth of neem trees. They provide essential nutrients like nitrogen, phosphorus, and potassium, which are crucial for the plant's development. Proper fertilization can improve the overall health, vigor, and productivity of neem trees. By supplying the necessary nutrients, fertilizers support root growth, leaf formation, and flower and fruit production in neem plants. However, it's important to use fertilizers in the right amounts and at the appropriate times to prevent nutrient imbalances or potential harm to the trees. With the correct application, fertilizers can significantly boost the growth and yield of neem trees.

Microclimate Management: Plant neem trees in locations that benefit from microclimates, such as near buildings or other structures that provide some protection from extreme weather condition. Microclimate management can have a significant impact on the growth of neem trees. By adjusting factors like sunlight exposure, humidity levels, and temperature around the neem plants, you can create an optimal environment for their growth. Controlling these microclimatic conditions can help neem trees thrive, as they are sensitive to changes in their surroundings. Proper management can enhance nutrient absorption, reduce stress on the plants, and promote healthy development. By implementing effective microclimate management strategies, you can support the growth of neem trees, leading to stronger, more resilient plants with improved overall health.

Anti-Desiccant Sprays: Use anti-desiccant sprays to coat the leaves and reduce water loss through transpiration. This is particularly useful for evergreen neem trees that retain their leaves through winter. Anti-desiccant sprays can benefit neem tree growth by forming a protective layer on the leaves, reducing moisture loss through transpiration. These sprays are especially useful during dry or windy conditions when water loss from the leaves is high. By minimizing moisture loss, anti-desiccant sprays help neem trees retain hydration, promoting healthier foliage and overall plant vitality. Additionally, these sprays can protect the leaves from harsh environmental conditions, such as extreme temperatures or drought, thus supporting neem trees in maintaining their health and vigor. Regular application of anti-desiccant sprays can contribute to improved growth and resilience in neem plants.

Conclusion

It is concluded that the age, cultural practices and temperature plays a significant role in the susceptibility of neem trees to cold stress. However, the other 85 per cent of the trees are slowly getting back to normal and with good

sunny days and start of rain in the month of June and July and back to normal state.

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