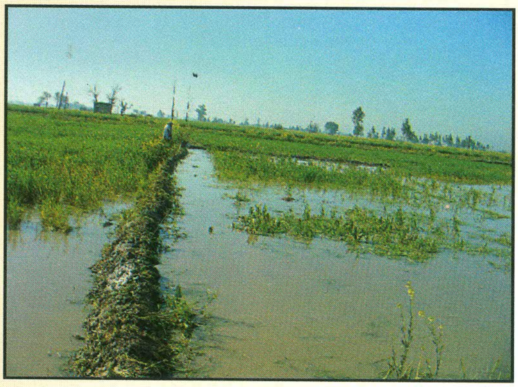
ICAR

Technical Bulletin: CSSRI/Karnal/2008/5

Farmers' Response and Strategies to Manage Rainstorms and Low Temperature during Winter



M.J. Kaledhonkar, D.P. Sharma, S.K. Gupta
D.S. Bundela & Gurbachan Singh

CENTRAL SOIL SALINITY RESEARCH INSTITUTE
KARNAL – 132 001 INDIA

Technical Bulletin: CSSRI/Karnal/2008/5

Farmers' Response and Strategies to Manage Rainstorms and Low Temperature during Winter

M.J. Kaledhonkar
D.P. Sharma
S.K. Gupta
D.S. Bundela
Gurbachan Singh

CENTRAL SOIL SALINITY RESEARCH INSTITUTE
KARNAL – 132 001 INDIA

Citation:

Kaledhonkar, M.J., Sharma, D.P., Gupta, S.K., Bundela, D.S. & Singh, Gurbachan 2008. Farmers' Response and Strategies to Manage Rainstorms and Low Temperature during Winter. Technical Bulletin No. 2008/5, Central Soil Salinity Research Institute, Karnal, India, p 14

Published by :

Director, Central Soil Salinity Research Institute
Karnal – 132 001 India
Telephone: +91-184-2290501; Fax: +91-184-2290480
E-mail: director@cssri.ernet.in
Website: www.cssri.org

Designed & Printed at:

Azad Offset Printers (P) Ltd. 144-Press Site, I.A.-I, Chandigarh
Telephone : +91-172- 2652349, 2651316, 2654411 & 5001805

INTRODUCTION

The mankind is known to the need of surface drainage probably since the beginning of agriculture. That might be a reason why rural landscape remained dotted with village ponds. These ponds provided needed space for drainage and at times provided water for domestic chores and irrigation. Of late, surface stagnation in the event of excess rain/irrigation in cropped lands has assumed a serious dimension due to inappropriate design and maintenance of surface drainage systems in irrigation projects, poor land leveling, unscientific irrigation methods and improper irrigation scheduling. Continuous rice-wheat rotation in semi-reclaimed and reclaimed sodic lands in northwest India is resulting in the development of a hard layer usually at the shallow depth because of puddling and use of heavy machinery. All these practices are worsening the problem of surface water stagnation. Drainage is essential for sustainability of agricultural production and productivity in northwest India due to flat nature of the terrain. On the contrary, importance of drainage has not received adequate attention by the farming community and the planners as damages caused by poor drainage are become significantly un-affordable in case of rain events of larger return periods. Yet, limited to above normal rainfall years although this fact has created complacency amongst various stakeholders and consequent non-adoption of surface drainage. Other reason might be farmers' reluctance to loose land for construction of surface drains, although such land losses are compensated through sustaining high yield levels upon adoption of land drainage.

A CASE STUDY

During the month of February 2007, an average rainfall of about 200 mm occurred in different parts of northern states such as Punjab, Haryana, western Uttar Pradesh and Rajasthan due to western disturbances during 3 to 10 February. Rainfall of 188 mm poured down continuously in a four days spell from 7 to 10 February. This rainfall proved beneficial for rainfed crops such as mustard, wheat, etc. grown on sandy soils in Bhiwani, Hisar, Mahendragarh and Rewari districts. However, large areas in Haryana, Punjab, western Uttar Pradesh and Rajasthan suffered from water stagnation due to impeded drainage. The excess water continued to stand in agricultural fields for more than 10 days due to poor infiltration rate and low evaporation during month of February (Fig. 1). The frequency analysis revealed that current event had return period more than 20 years as a storm of 124 mm could be expected to occur once in 20 years. Even a rainstorm of 76 mm that could occur once in 5 years, could prove detrimental to crop growth, if it happens following irrigation event to winter crops.

Initiative to Assess Damage to Agriculture

The Central Soil Salinity Research Institute constituted a team of scientists to visit the affected areas in Haryana and Punjab to assess the damage caused by rainstorms during 3 to 10 February 2007 to different crops, farmers' reactions and different methods adopted by farmers to tackle this extreme event. The first hand information collected by the team has been compiled in this report.

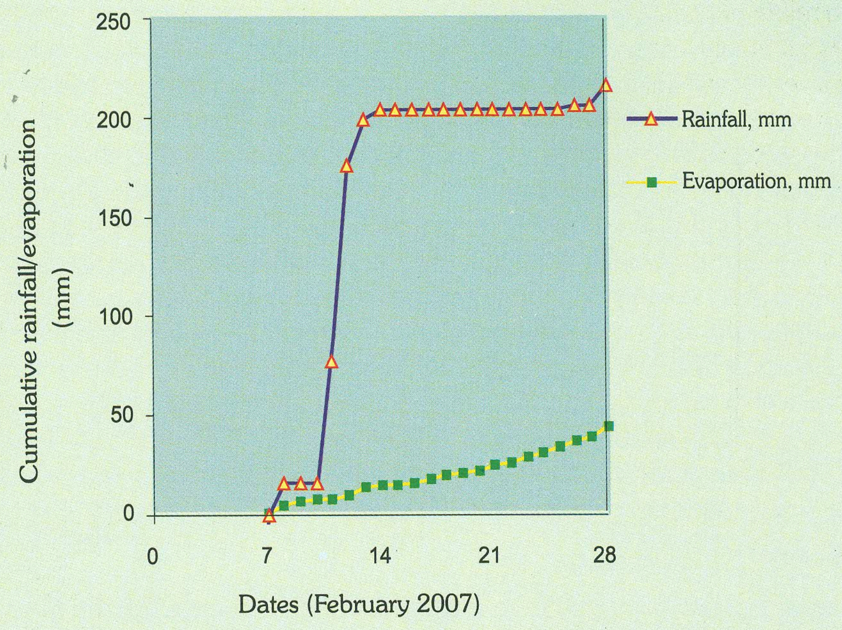


Fig. 1. Cumulative rainfall and evaporation during February 2007

PLACES SURVEYED

Haryana

Zarifa Viran, Kachhwa, Sagga, Sambali, Sitamai, Kaul, Dhand, Noch, Arnecha, Pehwa, Bakali, Mohanpur, Naya Diwana, Bhagal, Cheeka, Titana, Nou Gaja Peer, Khanpur, Ishargarh, Pilali, Samana, Raipur, Nilokheri and Taraori.

Punjab

Ramnagar, Nayagaon, Kamalpur, Mehmedpur, Bhakra Main Line Crossing, Bamana, Gajewas, Sangarur, Malerkotla, Pratap-pura (Ludhiana), Daheru, Kisangarh, Bhamadi, Monpur, KVK Fatehgarh Sahib, Sadhugarh, Brass, Khera, Hunsali, Chunnimajra, Reuna, Faggan Majara, Out skirt of Patiala, Kauli, Rajpura and Chamam.

VISIBLE EFFECTS OF WATER STAGNATION ON CROPS

The areas surrounding Karnal, within a circle of approximately 25-30 km radius, was the worst affected as water stagnation occurred over vast areas (Fig. 2a & b). In fact, this was the area of alkali soils and was reclaimed over the last 3 decades or so. The vertical movement of water in these lands gets adversely affected because the lower layers generally have high ESP even at this time. The area near Fatehgarh Sahib in Punjab with relatively heavy soils was also affected severely. In other areas of Punjab, damage was relatively less as compared to Fatehgarh Sahib area. During the survey, it was observed that the area affected varied from 0-30% approximately. The damage also varied from 0-30% for wheat and almost 100% for the vegetable crops. Vegetable crops such as tomato, cabbage, potato, chilly, etc. suffered the most in Sagga, Sambli and other villages around Karnal (Fig. 3a). Yellowing effect in wheat was observed in vast area indicating yield loss (Fig. 3b). According to the results of a special *Girdawàri* carried out by Haryana state, crop losses were 25-100% in an area of 2.24 lakh hectares (ha). Nearly 50% of area in Karnal district suffered loss between 25 and 50% while 33% area suffered loss of about 75-100%.

(a)

(b)

Fig. 2. Water stagnation in fields at the time of survey

Causes of Yield Decline due to Heavy Rainfall

Excessive rainfall, hailstorm and surface stagnation caused severe changes in the physico-chemical environment of root zone and resulted in:

- Physical injury to the crops by hailstorm and consequent crop lodging
- Poor aeration resulting in depletion of oxygen and excess of carbondioxide in the root zone generally known as hypoxia
- Post-stagnation ill effects due to sub optimal oxygen diffusion rate (ODR)

A CSSRI study revealed that ODR remained below the optimum level for an additional period of 5.5 days after removal water stagnating in the cropland for 6 days (Fig. 4)

- Leaching of essential plant nutrients resulting in lower uptake
- Decrease in redox potential resulting in reduced uptake of certain elements and release of toxic elements in the root zone

(a) (b)

Fig. 3. (a) Complete failure of tomato crop and (b) yellowing of wheat crop due to waterlogging stress in the field

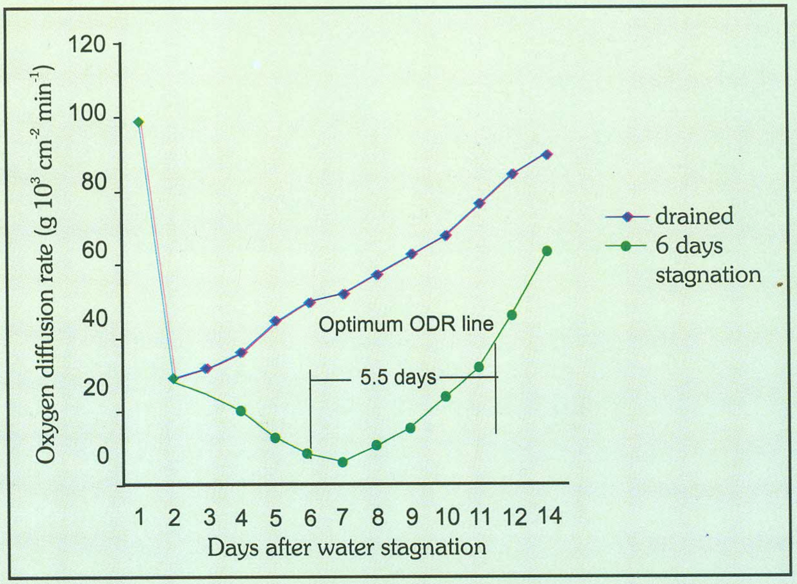


Fig. 4. ODR in drained and un-drained lands showing adverse effects even after removal of water stagnation

Other experimental studies at CSSRI, Karnal revealed that yield decline was more than 20-30% for the three *kharif* crops, while it varied from 25-50% for the four *rabi* crops when the water stagnation continued for 6 days (Tables 1 & 2). In this particular extreme rainstorm in February 2007, yield losses would be more because the water stagnation at many places continued for 10 days while soil saturated conditions prevailed for even longer duration.

Table 1. Response of *kharif* (summer) crops to short-term water stagnation

Duration of water Stagnation (days)	Yield (t ha^{-1})		
	Sorghum	Pigeon pea	Sunflower
0	4.13 (100)	1.41 (100)	1.86 (100)
1	4.03 (97)	1.35 (96)	1.62 (87)
2	3.69 (89)	1.22 (86)	1.50 (81)
6	3.29 (80)	1.11 (79)	1.31 (70)
CD (p=0.05)	0.11	0.13	0.06

(Values in parenthesis in percent are of relative yield w.r.t. without water stagnation)

Table 2. Response of *rabi* crops to short-term water stagnation

Duration of water Stagnation (days)	Yield (t ha^{-1})			
	Mustard	Wheat	Barley	Berseem (Seed)
0	1.43 (100)	4.01 (100)	3.65 (100)	048 (100)
1	1.31 (92)	3.70 (92)	3.52 (96)	0.47 (98)
2	1.20 (84)	3.32 (83)	3.39 (93)	0.38 (79)
4	1.12 (78)	2.93 (73)	3.18 (87)	0.31 (65)
6	1.02 (71)	2.43 (61)	2.75 (75)	0.25 (52)
CD (p=0.05)	0.22	0.28	0.28	0.05

(Values in parenthesis in percent are of relative yield w.r.t. without water stagnation)

OBSERVATIONS ON THE STATUS OF SURFACE DRAINAGE

Most of the drainage systems were not functional because of poor maintenance, excessive weed growth and encroachments by the farmers. As such, all the major drains were choked and filled with water. In some cases, farmers used the dead storage of these drains to dispose off standing water from their fields (Fig. 5a). If these drains had been functional, water would have drained out relatively quickly, causing least damage to crops. Few farmers also used roadside plantations and the dead storage available there to drain water from their fields (Fig. 5b) besides the low-lying depressions in and around the village. Most of the farmers lamented that renovation of village ponds could have saved them from major losses that they incurred.

(a) (b)

Fig. 5. Use of dead storage (a) in drains and (b) along the roads

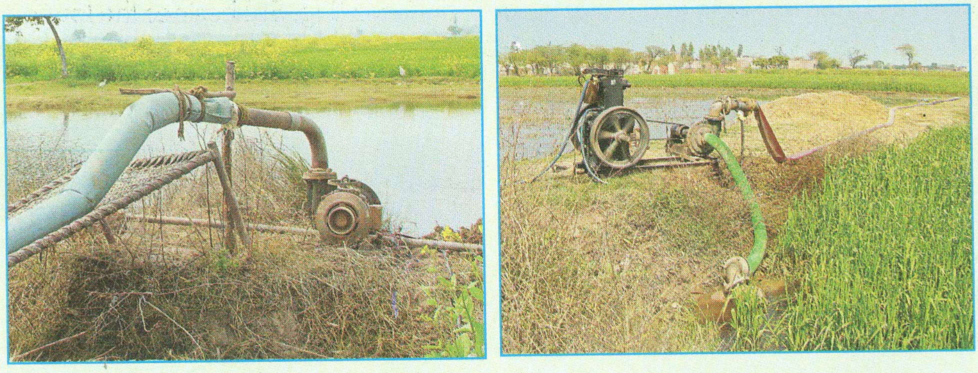
FARMERS' RESPONSE TO WATER STAGNATION

Most farmers were stationed in their fields trying to save their crops from this unexpected extreme event. The farmers adopted following dewatering methods:

- At few places in Sagga and Titana villages of Karnal district in Haryana, they manually dewatered the fields (Fig. 6). In some cases, individual farmer used bucket for dewatering, causing drudgery and health problem.
- Almost in all the villages of Haryana and Punjab, wherever possible, farmers used temporary installations of electric/diesel pumps to dispose off excess water into nearby drains or depressions (Fig. 7a & b).

Fig. 6. Manual dewatering of the mustard field

- Efforts made by the farmers could be judged from the facts that they invested for 1.5-2.0 km pipeline to drain the water. Moreover, few farmers used submersible pumps to drain the water. In the absence of electric supply, they used tractor driven alternator to generate electricity to run the submersible pumps (Fig. 8).



(a) (b)

Fig. 7. Dewatering of wheat fields by pumps driven by (a) electric motor and (b) diesel engine

Fig. 8. Use of alternator driven submersible pump for drainage

- In Khera, Brass and Chunnimajra villages of Fatehgarh Sahib district in Punjab, farmers pumped excess water directly into aquifer through defunct as well as operational cavity wells due to lack of natural out let (Fig. 9).

Agronomic Interventions

In Fatehgarh Sahib area of Punjab, soils are heavy with clay content more than 30%. Both surface stagnation and saturated soil conditions prevailed in agricultural fields. In both cases, most wheat fields had yellowing effect. Few farmers applied urea and sulphur to reduce the ill-effects of waterlogging. Beneficial effect of additional dose of urea following removal of stagnated water is documented at CSSRI, Karnal. However, this strategy seems to be a temporary solution considering its groundwater pollution potential. Adequate and timely drainage could be the only long-term solution to the problem. Moreover, considering severity of waterlogging and the crop stage, positive impact of additional doses of fertilizer was doubtful.

(a)

(b)

Fig. 9. Pumping of excess water into aquifer for disposal

RECOMMENDATIONS

- A properly designed surface drainage system should be implemented for command as well as non-command areas based on the topography, soil type, crops to be grown and rainfall pattern. The system should begin from farmers' fields and all fields should have a proper outlet for drainage.
- Old buried/paleo channels provide the most efficient drainage route and as such these channels should be identified using satellite remote sensing.
- Existing drains should be maintained properly. Encroachments by influential farmers should be removed. Temporary structures/dykes made to store water in the drains should be removed after fulfillment of purpose. Farmers should be educated and sensitized to the importance of surface drainage.
- With the climatic change looming large, occurrence of short duration high intensity rainfall events cannot be ignored. Farmers and the governments should be ready with contingency plans to reduce the damages.
- Groundwater recharge appears to be a practical and useful strategy to drain water particularly in groundwater declining areas. As such, government should promote recharge structures by providing subsidy to farmers. Such technological interventions could minimize the damage during extreme events without land loss for surface drainage.

- Participatory irrigation and drainage management should be encouraged.

WHAT IS THE WAY OUT?

Groundwater development through the installation of tube well by individual farmer was the key to usher in the green revolution. Now it is time for the farmers to have self-control on drainage. It is the only way that would lead to evergreen revolution propounded by the world-renowned agricultural scientist, Dr. M.S. Swaminathan. It would be ideal, if farmers could find space to dispose excess water within the field boundaries. On-farm irrigation-cum-drainage pond developed as a multi-enterprise agriculture, could be one of the possible ways out. Experience at the farm of CSSRI during the extreme event in February 2007 was quite positive as most of the excess water was diverted into two ponds existing at the farm (Fig. 10).

(a)

(b)

Fig. 10. (a) An on-farm pond for drainage cum irrigation and (b) newly developed multi-enterprise agricultural system

Water excess the storage capacity of pond, was disposed off through use of an abandoned cavity well with recharge filter at the farm. The later method did not need any extra land. More innovative scientific solutions are available and are being upgraded constantly. A low cost groundwater recharge structure (Fig. 11) could be installed to take care of extreme events as happened during February 2007.

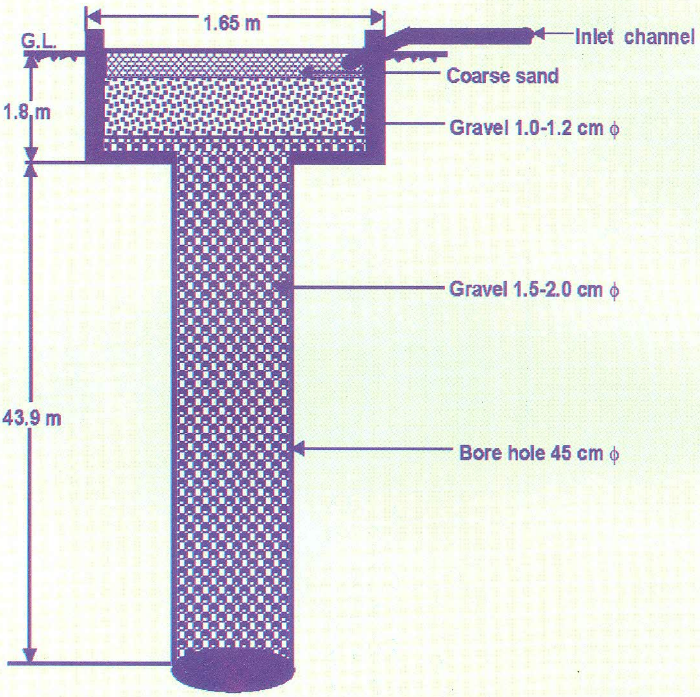


Fig. 11. A low-cost recharge shaft for groundwater recharge using excess irrigation water/rainfall (Courtesy : Dr. S.K. Kamra, CSSRI, Karnal)

ANTICIPATED BENEFITS

- Without doubt, in areas with declining water table, such events would help to recharge the groundwater. The benefits on this account can only be judged once the water table data for few years are analyzed. A proper analysis would enable us to understand the real benefits.
- Following the rain event, there was perceptible drop in the temperature. It must have benefited the wheat crop when low temperatures are required at this time for the proper growth of plants.

OTHER EXTREME EVENTS

During the winter season besides rainfall other extreme event such as minimum temperature resulting in severe cold wave conditions could prevail in Punjab, Haryana and western Uttar Pradesh. The analysis of 35 years weather data revealed that such events could occur once in 10 years, as a total of 4 events (1974, 1986, 2006 and 2008) were experienced during the last 36 years (Fig. 12). The worst event was during in the year 1974. A one-day freezing temperature could adversely affect most crops. Once it happens, many crops not only fail to survive but also find difficult to revive later. Excellent crops of potato and tomato were wiped out and the damage was almost 100% during the year 2006 when a temperature below zero degree was experienced on 9 January 2006.

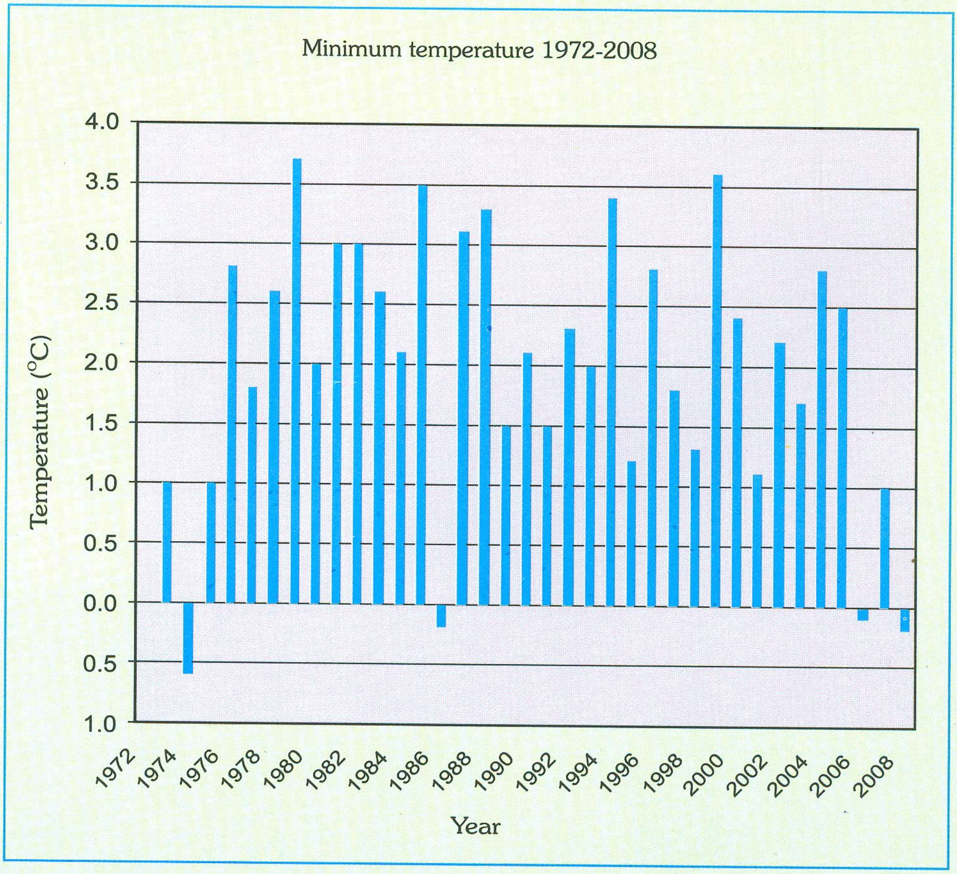


Fig. 12. Minimum temperature during the last 36 years of records at Karnal

Other crops like brinjal, peas, winter maize; Jatropha and mustard were also badly affected. Cold wave also affected fisheries and animals. Similar type of damage, although to a lesser extent, was noticed during the year 2008, another year with a minimum temperature of –0.2°C on 22 January 2008. Vegetable crops, banana and flower crops were damaged as a result of exposure to sub zero temperature of few hours. Since the cold wave and ground frost might occur in any year at any time during the winter season, farmers are advised to take following precautions to reduce/negate the adverse impacts of cold wave/frost on agricultural crops and animals:

- The frost generally occurs during 20 December to 15 January. Wherever possible, the farmers are advised to apply light and frequent irrigations to crops during December and January. High specific heat of water would help to maintain relatively warm temperature in the system and to avoid cold injury.
- Making thatches *(jhuggies)* of straw or *sarkanda* grass, etc. and keeping them open from the southeastern side for direct sunlight would help the plants to grow well. Increased absorption of radiation and provision of warmer thermal regime through covering of nursery and young fruit plants during winter by plastic mulch would also be helpful.
- Thermal insulation by the application of locally available bio-mulches would reduce the cooling rate of soil surface and would keep the soil warm. Paddy straw, generally available in plenty, could effectively be used as mulch for row crops such as wheat (Fig. 13).

Fig. 13 Mulching with locally available rice straw for wheat

- Provision of heat through fire between the rows and creating a blanket of smoke particularly in orchards by collecting and burning dried weeds/wood, etc. shall trap the outgoing long wave radiation and would be able to reduce the fall in temperature to a great extent (greenhouse effect). Locally available material can be used for creating smoke in young orchards (Fig. 14).

Fig. 14. Burning locally available waste material in orchards to save plants from cold wave

- Sprinkler irrigation could be used to release the latent heat of fusion by releasing heat into the surrounding air through condensation of water droplets. The sprinklers/ drippers may be kept in working condition and operated once a day daily for a short period during severe cold wave conditions.
- Wind breaks/shelter belts should be planted around orchards in cold wave prone areas. This will reduce the wind speed and the wind chill effect on the leeward side besides minimizing the sensible heat losses from the protected crop. The cold wave/frost damage was observed to be minimum during last year where crops were growing adjacent to shelter belts/trees.
- Other agronomic practices such as shifting of potted nursery/flower plants under shade of trees or in between trees rows and pruning of undesirable twigs/branches for in-situ use as mulch considerably negates cold injury effect on plants.

- During severe cold wave conditions animals should not be allowed to graze in the open for longer periods. Locally available straw (like paddy/maize) should be used as bedding material on the floor in animal sheds to provide warming. In case of extreme cold, animals particularly cattle should be covered with old blankets or cotton/woolen cloth during morning and evening hours.
- Proper depth of water and aeration in fish ponds should be ensured to protect fish from cold wave injury.
- Farmers have to be very careful against such events although they have no control on nature. It is believed that, to anticipate the event and apply management options could be the only way to prevent or at least minimize the damage.

Printed at : Azad Offset Printers (P) Ltd., 144, Press Site, Industrial Area-1, Chandigarh
Phones : 0172-2652349, 2654411, 2651316