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IMPACT OF A RARE EARLY-SUMMER FROST EVENT OVER INDIANA

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1. Introduction

A number of weather extremes had potential to significantly impact corn yields in 1992 over the eastern Corn Belt. Jet stream strength and location had a major influence on growing conditions. Location of the jet stream further south than normal over the Great Lakes led to cooler than normal summer temperatures across much of Indiana. This resulted in crop development lagging normal across much of the state. Explanations for the extremes varied from El Nino to the eruption of Mount Pinatubo (Comte 1993).

Soil moisture deficits and surpluses tend to be more of a problem for corn producers than temperature extremes. The drought of 1988 will be remembered for a long time in the Corn Belt. In 1992, however, temperature extremes played a critical role in the crop's development.

Cool, wet conditions in April and early May followed by dry weather the rest of May and June slowed planting and emergence of corn and soybeans. That prompted concern in the media about another drought. Then, the wettest July of the century occurred over much of Indiana, providing ample moisture during the critical reproductive stages of development of the corn crop. There was potential for a bumper crop in 1992. Then, below normal temperatures kept development slow and autumn frosts killed the crop before it was completely mature. That left high moisture corn that was difficult to store.

The other major temperature effect on the 1992 crop was a rare early summer frost June 21-22, which produced extensive damage to crops in northern and parts of central Indiana. Damage to corn occurred on over 80,000 acres (Scheeringa 1992). Optimal air temperatures for corn growth during the daylight hours range from 77°F to 91°F depending to a certain extent on soil moisture conditions. Best air temperatures at night range from 62°F to 74°F (Neild and Newman 1986).

2. Synopsis

On June 21, circulation behind strong low pressure moving across the Great Lakes into New England advected dry Canadian air south into the Ohio Valley. North-northwest winds advected air with dew points in the low to mid 30s (°F) south from Canada. Modification of the Canadian air was limited by the rapid southward movement. The coldest air temperatures in Indiana occurred on June 22, 1992, when high pressure was centered over the state. Clear, calm conditions during the early morning hours of June 22, allowed strong radiational cooling to occur. Elsewhere, from parts of Illinois westward, radiational cooling was limited by cloud cover.

3. Temperature Extremes

The rare early summer frost occurred June 20-22, 1992 in Illinois, Indiana and Michigan. It was the second time fields were frosted in Michigan where fields of yellowed and purple plants were observed. Warm season crops have little tolerance of frost. Coldest air temperatures at shelter level, four feet above the surface, were in the mid and upper 30s (°F), primarily over west central and northern Indiana. A minimum temperature map prepared by Grant (1993) is shown in Figure 1. Cold air drainage focused some of the damage in low lying areas of fields. Zone forecast issued by the WSFO at Indianapolis, Indiana at 3:30 pm June 21, called for record or near record lows around 40°F over central Indiana. A chance of light frost was mentioned for northwest parts of the state where lows were forecast in the upper 30s and low 40s (°F).

A map of rainfall totals for the five days preceding the frost event (Grant 1993) is shown in Figure 2. It appears that increased topsoil moisture prevented, or lessened frost formation over east central and southeast Indiana. It is believed that low-level moisture was boosted in the planetary boundary layer by both evaporation from the soil and evapotranspiration from vegetation. This would result in higher dew points at the surface over east-central and southeastern parts of the state.

Another factor in determining frost occurrence was the tillage practices of farmers. No-till fields had a greater occurrence of frost than tilled fields. Apparently, crop residue on no-till fields prevented heat loss by radiation from topsoils.

Effects of the late frost were observed by Purdue University Extension Service Agents in Indiana. Earlier planted fields were at a greater risk and received more damage. The growing points

of older plants were above the surface. Extension Service Agents found damage to nodal stalk tissue in the interior of some plants. Frosted plants in some areas had dead tassels and growing points. Therefore, recommendations for management practices varied from field to field.

Management of frost damaged corn was by one of three options (Nielsen 1992):

1) One option was clipping off dead upper tissue to allow new growth to unfold from the whorl. Unfortunately, where growing points and tassels were dead, only leaf tissue could grow and clipping would do little good.
2) Replanting in these areas was a limited possibility due to lateness of the season. Growing degree day (GDD) requirements vary for different corn hybrids. Requirements for full season hybrids varies from around 2,700 to 2,800 GDD over west-central and northern Indiana. Average frost dates of around October 10 (Schaal and Newman 1981) over these parts of the state meant switching to early season hybrids (approx. 2,400 GDD), as well as risking fall frost damage.
3) Planting soybeans was a third option. Soybeans require fewer days to maturity, but replanting of fields with soybeans was only an option where corn herbicides had not been applied. Corn herbicides are detrimental to soybeans.

4. Conclusion

Rare early summer frosts can occur well into the month of June over the eastern Corn Belt. In these cases, frost will tend to occur where topsoils are driest. Evapotranspiration by vegetation may increase the low level moisture and dew points enough to prevent frost occurrence where topsoil moisture is greater.

Early summer frosts, though rare, can cause significant damage to spring seeded crops. Due to shortness of season, options are limited for managing frosted corn fields. The options include:

1) Clipping to allow unrestricted leaf development and harvesting what matures,
2) Replanting with early hybrids and risking an early fall frost occurrence,
3) Switching to soybeans.

Irrigation, where available during the few days before the event, might have saved corn in some areas. Additionally, tillage practices may have been a factor, with crop residue preventing heat radiation from the ground.

5. Acknowledgements

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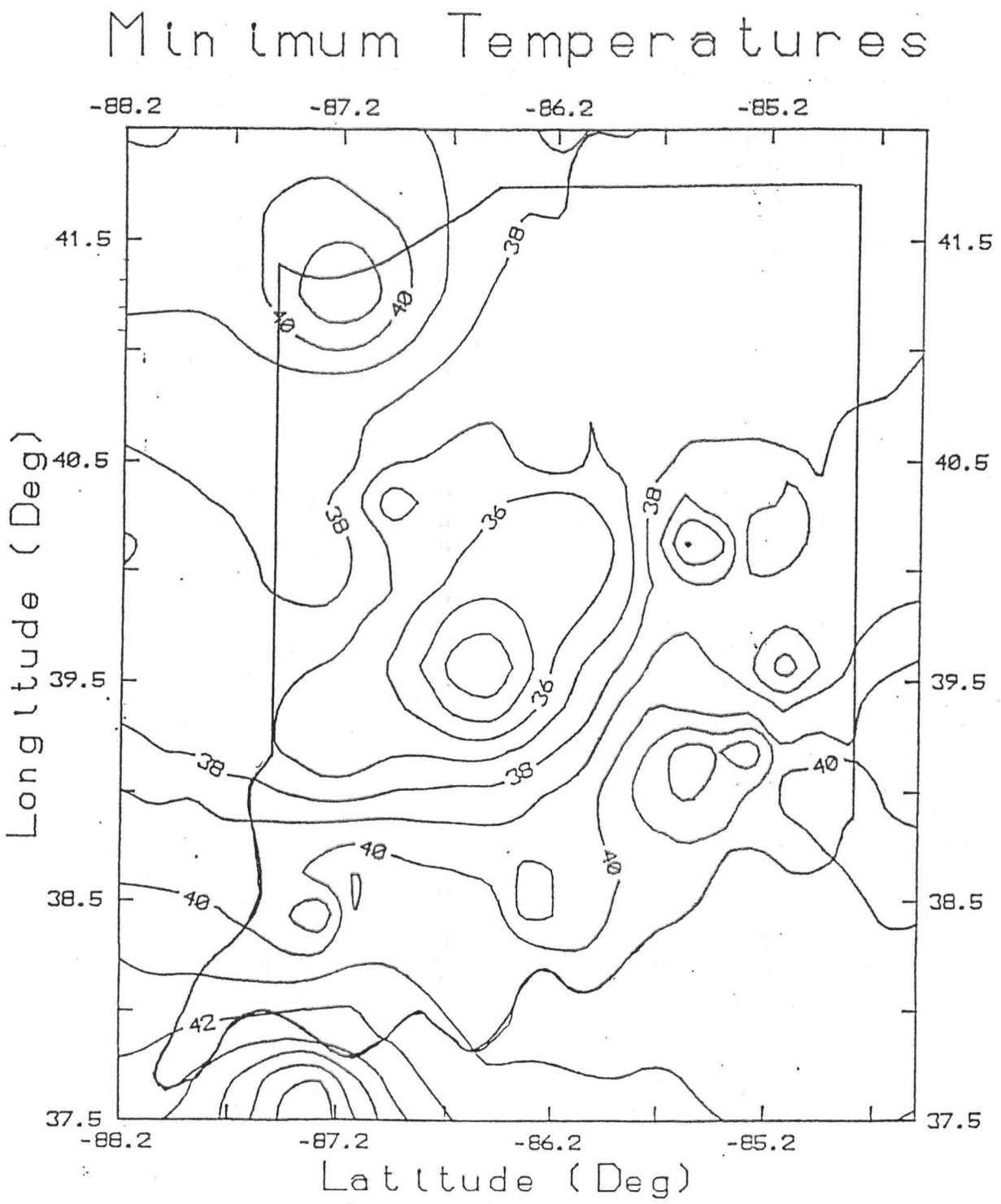

Figure 1. Indiana minimum temperature map for June 22, 1992. Temperature in degrees Fahrenheit (°F) and isolines in one degree increments.

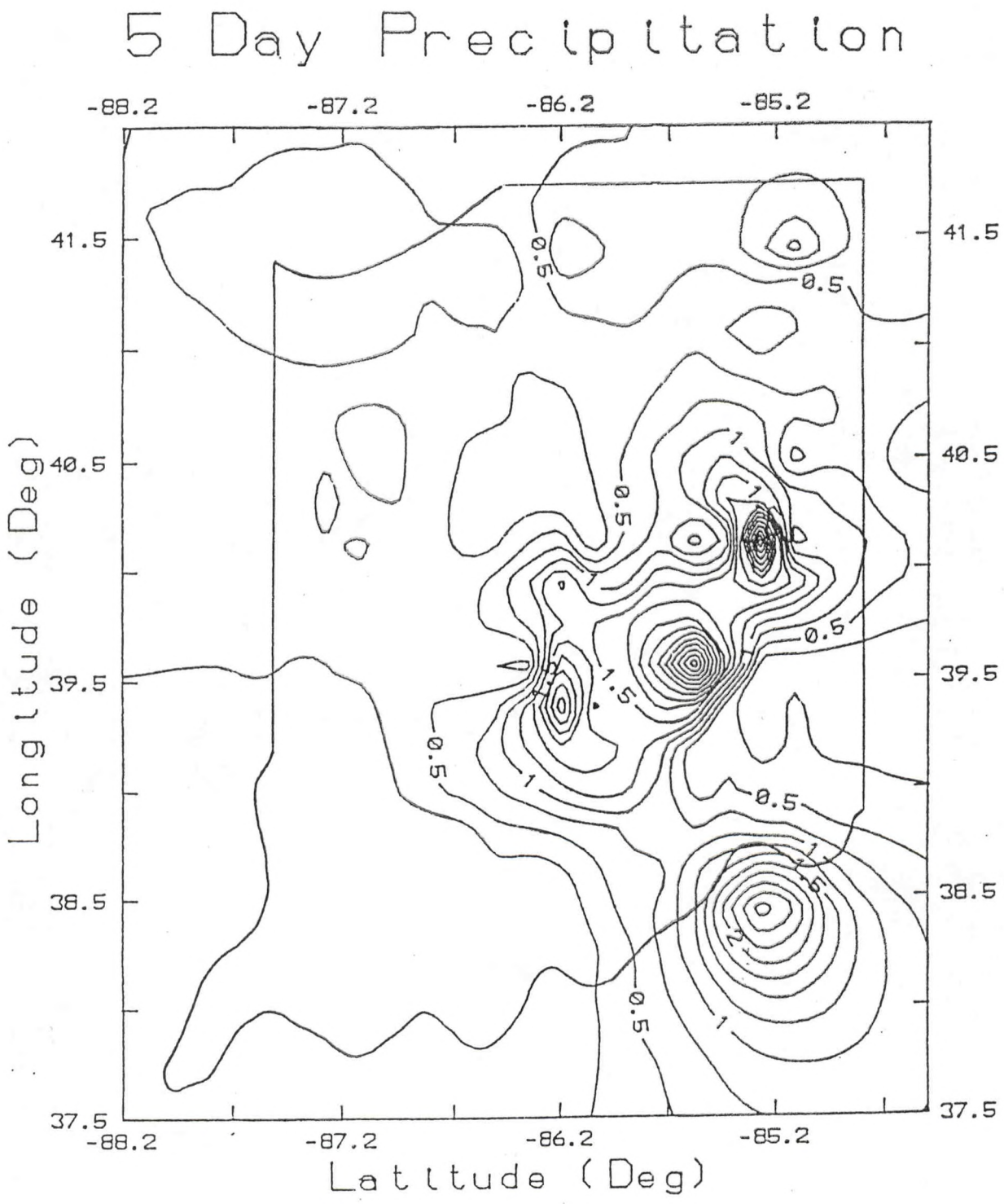

Figure 2. Rainfall totals for the five days preceding the frost event June 22, 1992. Amounts are in inches and isolines incremented every 0.25 inch.