Table 2. Segregation of heat tolerance in the F_2 generation of HT × HS crosses; AVRDC, 1976.

Cross	Total plants	Observed ratio[z] HS	Observed ratio[z] HT	Chi-square[x]	Probability
B 41-1 × B 4-1	346	261	85	0.03	0.80–0.90
B 41-2 × B 4-2	366	272	94	0.09	0.70–0.80
B 41-4 × B 4-4	486	369	117	0.22	0.50–0.70
B 173-1 × B4-1	431	325	106	0.04	0.80–0.90
Total	1629	1227	402	0.38	0.98–0.99
Heterogeneity test				0.29	0.95–0.98

[z]HS = heat sensitive; HT = heat tolerant.

[x]Values obtained by fitting observed proportions to 3:1 ratio.

Table 3. Segregation of heat tolerance in the backcross generation, F_1 × HT parents; AVRDC, 1976.

Cross[w]	Total plants	Observed ratio[z] HS	Observed ratio[z] HT	Chi-square[x]	Probability
(B 41-1 × B 4-1) × B 41-1	439	227	212	0.510	0.30–0.50
(B 41-2 × B 4-2) × B 41-2	474	254	220	2.440	0.10–0.20
(B 41-4 × B 4-4) × B 41-4	319	165	154	0.380	0.50–0.70
(B 173-1 × B 4-1) × B 173-1	353	177	176	0.003	0.90–0.95
Total	1585	823	762	3.330	0.50–0.70
Heterogeneity test				0.990	0.80–0.90

[z]HS = heat sensitive; HT = heat tolerant.

[x]Values obtained by fitting observed proportions to 1:1 ratio.

[w]S_1 progenies of individual plants used in HT × HS crosses served as recurrent stocks.

which produced heads of dubious firmness were observed later to determine if they would eventually attain the solidity typical of those from HT parents. The experiment was terminated 70 days after transplanting at the onset of the cool season. All plants that did not produce heads or produced heads but did not attain sufficient firmness were considered HS.

Observations on the selfed progenies of parents showed they were homozygous for either heat tolerance or heat sensitivity (Table 1). Although some F_1 plants were noted to produce the semblance of heads, they readily collapsed when firmly pressed and invariably failed to attain the compactness typical of heads produced by the HT parents. Thus, the F_1's were scored entirely as HS implying complete dominance of heat sensitivity over heat tolerance.

The above classification scheme for exceptional F_1 plants was similarly followed in scoring segregating populations, i.e., plants which produced the semblance of heads but otherwise lacked firmness were considered HS. Of 10 combinations planted, only four survived well enough to allow reliable genetic analysis. The other populations were heavily infected with soft rot and downy mildew, or drastically reduced by a severe cabbage webworm (*Hellula undalis* Fabrices) infestation. These combinations were therefore excluded from genetic analysis.

The segregation pattern of heat tolerance in the F_2 generation among the 4 crosses (Table 2) did not deviate significantly from a ratio of 3 HS : 1 HT suggesting that heat tolerance is controlled by a single recessive gene.

Further evidence for monogenic control of heat tolerance is substantiated by the backcross segregation data (Table 3). The backcrosses of the F_1 to the HT parents segregated 1:1 and among 1614 surviving plants of corresponding backcrosses to HS parents, no HT plants were recovered.

The simple inheritance of heat tolerance should allow its rapid fixation among breeding lines. Our past observations on the first inbred generation of breeding materials derived from F_2 populations of HT × HS crosses has revealed a number of lines homozygous for this character.

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Effect of Nitrogen Source and Nitrapyrin on Sweet Corn[1]

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Additional index words. nitrification inhibitor, nitrate, ammonium, urea, *Zea mays*

Abstract. **Sweet corn (*Zea mays* L.) showed no yield response for 2 years to spring applied N from $Ca(NO_3)_2$, urea, and urea plus nitrapyrin on a loam soil high in organic matter and cation exchange capacity. Ear leaf N concentration decreased with NH_4-N sources in 1 year but not both. Kernel protein and leaf levels of P, K, Ca, and Mg were unaffected by treatment. On a loamy sand soil low in cation exchange capacity the NH_4-N sources, compared with NO_3-N, raised the kernel protein concentration by 0.26% both years. On this soil of the NH_4-N sources, the addition of nitrapyrin to the urea band reduced ear leaf NO_3-N levels without reducing ear leaf total N or kernel protein. The NH_4-N sources restricted ear leaf Mg concentration but enhanced uptake of N both years and P and K in 1 year.**

Most of the NH_4-N toxic effects on sweet corn growth are observed on seedlings in nutrient solution or in sand cultures. Using a low external NH_4–N concentration flow culture system, Blair et al. (2) observed no toxic effects on corn growth. The addition of lime or the control of soil pH near neutral will offset the acidic nature of NH_4 and stop inhibition of growth (7). Ammonimum N is not toxic to corn growth as long as other soil nutrients, particularly K, Ca, and Mg, are at a sufficiency level for NH_4 nutrition (5).

Iowa sweet corn growers apply anhydrous NH_3 or liquid N as a spring application. The liquid N usually is 2/3 NH_4–N. An NH_4–N source coupled with a nitrification inhibitor (8) may increase the available soil N at the silking period resulting in a higher

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[2]N-Serve is a commercial preparation containing nitrapyrin as its active ingredient and is a registered trademark of the Dow Chemical Company, Midland Michigan 48640.

kernel protein content. Even with no N loss, greater plant uptake of NH_4 in place of NO_3 may boost kernel protein content by utilizing a more efficient protein synthesis process (1, 6).

Sweet corn response to N sources was evaluated for 2 years on a central Iowa loam with 4.6% organic matter, pH of 7.0, and a cation exchange capacity (CEC) of 17.5 meq/100 g, and on a southeastern Iowa loamy sand with 2.3% organic matter, pH of 5.9, and a CEC of 6.3 meq/100 g. Phosphorus and K were applied to both sites according to soil test values.

'Stylepak' was planted in 1975, and 'Midway' in 1976 on the loam soil. The land was fallow the year before experimentation. Calcium nitrate and urea were applied at 112 kg N/ha, the optimum rate for sweet corn yield on this soil. Treatments were applied 10 days after plant emergence by banding the dry fertilizer 10 cm below and 48 cm to the side of the row. Nitrapyrin (N-Serve[2]), 0.56 kg/ha, was added as a solution to the urea fertilizer band. Plant population was 30,000 plants/ha with 1.07-m row spacing in 1975 and 50,000 plants/ha with 0.97-m row spacing in 1976. Each plot was 4 rows × 6.1 m, and the center 2 rows were harvested for yield, leaf, and kernel samples. Irrigation was applied by overhead sprinkler to provide 3 cm per week. Ear leaf samples were taken at 50% silk and ears were harvested when kernels showed a transition from clear to milky fluid (68-71% moisture). Kernel samples were quick frozen and freeze dried, and protein concentration was computed as N × 6.25 expressed on a fresh weight basis.

The site with loamy sand was planted with 'Midway' in 1976 and 1977. In 1977, 70 kg Mg/ha as $MgSO_4$ was plowed under to increase soil Mg availablility. The previous crop in 1976 was rye-melons and in 1977 rye-potatoes. The dry N sources at 168 kg N/ha were banded 10 cm below the soil surface in row centers 27 days after emergence in 1976. The treatments were banded 10 cm below the soil surface and 13 cm from the seed row at planting in 1977. Previous N rate studies indicated that 168 kg N/ha was optimum for yield. Plant population was 50,000 plants/ha in 0.97-m spaced rows both years. Culture, plot design, and harvest procedure were the same as that for the site with loam soil.

The N sources had no effect on yield of either cultivar on the loam soil (Table 1). The low precipitation in the falls and winters and the fallowing of the land during the preceding year resulted in a high soil residual N. The treatments were irrigated, but below normal rainfall during both seasons minimized N leaching losses. However, on the loamy sand urea plus nitrapyrin increased yield 12% in 1976 but not in 1977 (Table 2). Overall yield level was 4 MT/ha higher in 1977, in part because of Mg fertilizer application reducing a Mg deficiency situation that existed in 1976.

Kernel protein concentration of either cultivar was unaffected by N source on the loam soil, but maintaining N in the NH_4 form reduced 'Midway' leaf N concentration by 10% (Table 1). The ear leaf N concentration of 2.80 to 3.14% was well within the sufficient range of 2.5-2.9% (4). Addition of nitrapyrin to the urea band did not detrimentally reduce the leaf concentration of P, K, Ca, and Mg on this inherently high exchangeable Ca-Mg loam soil. Sweet corn rotation in Iowa includes soybeans, edible dry beans, or field corn. Thus, a relatively high residual soil N level is normally present on this soil type for high sweet corn yields.

The NH_4 form of N on the loamy sand increased kernel protein by 0.26% both years when compared with $Ca(NO_3)_2$ (Table 2). The ear leaves from plants provided with urea were higher in N than those from $Ca(NO_3)_2$. The NH_4 form increased leaf P and K concentration 1 year but not in both while $Ca(NO_3)_2$ increased ear leaf Ca concentration both years. Magnesium content was reduced with the urea source with a further reduction by use

Table 1. Effect of N source at 112 kg N/ha on yield, kernel protein, and ear leaf composition of two sweet corn cultivars on loam soil.

N Source	Yield (MT/ha)	Kernel protein (% fresh wt)	Ear leaf composition (% dry wt) N	P	K	Ca	Mg
Stylepak, 1975							
$Ca(NO_3)_2$	13.8	3.88	3.31	0.30	2.19a[z]	0.94	0.37
Urea	13.4	3.88	3.27	0.30	1.92b	0.96	0.44
Urea + Np[y]	13.7	3.98	3.10	0.28	2.11a	0.92	0.40
Midway, 1976							
$Ca(NO_3)_2$	19.5	3.62	3.14a	0.31	1.82	0.88	0.40
Urea	18.6	3.58	2.80b	0.32	1.82	0.83	0.38
Urea + Np	18.4	3.46	2.86b	0.30	1.93	0.85	0.39

[z]Mean separation within column by Duncan's multiple range test, 5% level.
[y]Np = nitrapyrin added to urea fertilizer band.

Table 2. Effect of N source at 168 kg N/ha on yield, kernel protein, and ear leaf composition of 'Midway' sweet corn on loamy sand soil.

N Source	Yield (MT/ha)	Kernel protein (% fresh wt)	Ear leaf composition (% dry wt) N	P	K	Ca	Mg
1976							
$Ca(NO_3)_2$	15.4b[z]	3.20b	2.44b	0.29b	2.60a	0.70a	0.094a
Urea	15.4b	3.43a	2.62a	0.35a	2.35b	0.58b	0.080b
Urea + Np[y]	17.2a	3.48a	2.53ab	0.36a	2.48ab	0.58b	0.076b
1977							
$Ca(NO_3)_2$	19.3	2.72b	2.19	0.33	2.59b	0.67a	0.14 a
Urea	21.1	2.93a	2.31	0.32	2.69a	0.48b	0.14 a
Urea + Np	19.9	3.03a	2.26	0.33	2.66a	0.46b	0.12 b

[z]Mean separation within columns by Duncan's multiple range test, 5% level.
[y]Np = nitrapyrin added to urea fertilizer band.

Table 3. Effect of N source at 168 kg N/ha on NO_3-N concentration of ear leaf of sweet corn on loamy sand soil, 1977.

N Source	At silking NO_3–N (ppm)	At silking Total N (% dry wt)	At harvest NO_3–N (ppm)	At harvest Total N (% dry wt)
$Ca(NO_3)_2$	344b[z]	2.19	263b	1.79b
Urea	632a	2.31	403a	1.87ab
Urea + Np[y]	400b	2.26	297ab	2.05a

[z]Mean separation by Duncan's multiple range test, 5% level.
[y]Np = nitrapyrin added to urea fertilizer band.

of nitrapyrin. Ammonium N reduces plant tissue NO_3-N concentration and increases amides, amino acids, and protein (1, 6). The reduction in leaf Mg concentration with urea plus nitrapyrin suggests that the plant absorbed some NH_4 (3) possibly resulting in greater protein synthesis efficiency.

The addition of nitrapyrin to the urea band reduced ear leaf NO_3-N concentration from 632 to 400 ppm at silking (Table 3), indicating that soil nitrification was slowed. The ear leaf N concentration at harvest was 10% higher with urea plus nitrapyrin than with the $Ca(NO_3)_2$ source. Interestingly, urea plus nitrapyrin compared with urea, reduced leaf NO_3-N without reducing the total leaf N concentration. If absorption of NH_4 occurred, the K level was adequate to promote NH_4 assimilation into protein (1) (Table 2).

The application of nitrapyrin to a spring-applied NH_4 source on a high organic matter, high basic-cation exchangeable soil, such as in central Iowa, did not result in reduction of sweet corn growth or yields; but it should be used with caution on the sandy, leachable soils to avoid reduction in Mg concentration which may cause poor growth and low yields. As a tool for manipulating the form of N available to the plant, nitrapyrin may enhance the protein concentration of grain, particularly when sweet corn is grown on soils with low residual N.

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Effect of Trickle Irrigation on Peach Trees[1]

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Abstract. **Peach trees (*Prunus persica* (L.) Batsch cv. Redglobe) were trickle-irrigated at 3 rates using open pan evaporation as a basis for calculating theoretical irrigation needs from 1973-1976 beginning when trees were 6-years-old. Although above average rainfall was received about 65% of the time, trickle irrigation (1½ times theoretical needs) increased yield per tree, fruit size, number of fruit buds per tree, and trunk diameter over non-irrigated trees. Trickle irrigation at 1½ the calculated rate increased average yield per tree, fruit size, and trunk diameters over trees sprinkle-irrigated once before harvest.**

Insufficient water has been a major limiting factor in the commercial production of fruit and other crops (1). Low well yields in North Central Texas limit the use of sprinkle or flood irrigation on a large scale. Favorable reports by Isareli researchers (2, 6, 7) focused attention on 'trickle irrigation' several years ago. When used on crops with a low plant density such as peaches, trickle irrigation conserved irrigation water (4). Increases in yield have also been reported on different crops with trickle irrigation when compared to conventional systems (2, 6, 7).

Several methods of determining irrigation needs have been proposed (2, 3, 5). Kenworthy (5) proposed the use of open pan evaporation measurements as a basis for determining irrigation needs.

The purpose of this study was to determine trickle irrigation rates necessary to maximize production and growth on established orchards.

A trickle irrigation system was installed in 1973 in a bearing 6-year-old 'Redglobe' peach orchard at the Texas Agricultural Experiment Station, Montague. Microtube emitters (0.9 mm I.D.) were installed about 1.8 m from the base of the tree on 1 or 2 sides of the tree, depending upon the number specified per tree. Trees were spaced 9 by 9 m. Each plot consisted of 3 trees, with each treatment replicated 3 times in a randomized block design.

Treatments were:

1. Dryland – control.
2. Sprinkle irrigated – one 6 cm irrigation 7-10 days before harvest.
3. Trickle irrigated with water applied at ½ the calculated rate. One emitter per tree, with trees receiving 18-160 1/tree/day 2-7 days/week.
4. Trickle irrigated with water applied at the calculated rate. Two emitters per tree, with trees receiving 36-320 1/tree/day 2-7 days/week.
5. Trickle irrigated with water applied at 1½ times the calculated rate. Three emitters per tree, with trees receiving 54-480 1/tree/day 2-7 days/week.

The calculated rate is the amount of water evaporating per day from a class A open pan, times the land area occupied by the plant canopy, times the replacement rate (60%). This was an estimation of water loss in the orchard and was the basis for calculating theoretical irrigation needs.

Annual precipitation from January 1 to July 31 during the test period at the Texas Agricultural Experiment Station, Montague, is shown in Fig. 1. Trickle irrigation was initiated in the spring when net water loss exceeded 8-10 cm after January 1 each year. Soil moisture levels were monitored on a semiweekly basis with tensiometers. Instruments were located 30, 60 and 120 cm from emitters at depths of 30 and 60 cm on trickle-irrigated trees and approximately the same locations on sprinkle-irrigated and dryland trees.

No production data were collected in 1974 because of severe spring freeze damage to the fruit crop.

Trunk diameters were measured with a caliper at marked locations on each tree. Length of shoot and number of buds were determined by measuring

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