Abnormalities in Tomato Fruits

effects of fruit-setting plant hormones and nitrogen level in relation to quality and storage life of tomatoes studied

Randolph T. Wedding, Bernarr J. Hall, Morris J. Garber, and Frank H. Takatori

Spray applications of plant growth regulators, particularly 4-chlorophenoxyacetic acid—4-CPA—are widely used in some parts of California as an aid in obtaining set of tomato fruit during periods when the environment is unfavorable for natural fruit production. This practice is followed to a considerable extent in the tomato producing areas of San Diego County during the spring and fall months when night temperatures drop below the level favorable for the growth of pollen tubes and normal fertilization of the ovary.

Under some conditions the application of hormone sprays results in very large increases in yield as compared with untreated plants, but in some cases the quality of the fruit is appreciably lowered as a result of the treatment. The more common abnormalities are pointed fruit with an elongated blossom end or puffy fruit in which air spaces have developed within the locules. In addition, some growers and shippers believe that parthenocarpic—unpollinated—fruit produced by hormones tend to mature more rapidly and break down under storage after harvest.

Several years of field and greenhouse studies of the factors involved in the appearance of fruit abnormalities were conducted under conditions found in San Diego County. As a part of the studies, fruit from plants treated with hormones and grown with different levels of nitrogen application were harvested and stored. Storage conditions simulated the usual handling practices to permit determination of the effects of the different treatments on the performance of the fruit under storage or transit conditions.

The field plots were in commercial fields and consisted of replicated blocks in split-plot design. Plants were grown with two or more levels of nitrogen—as ammonium sulfate—applied usually in three side-dressed applications prior to, and during, the period when hormones were applied. Each nitrogen level was split into two plots, one untreated. The treated plot received hormone sprays, usually three applications of 50 ppm—parts per million—of 4-CPA spaced at 10-day to two-week intervals. In one experiment an additional material, the sodium salt of gibberellic acid—Gibrel—was included. In this case the application was as a whole plant spray of 50 ppm applied on the same schedule as the 4-CPA.

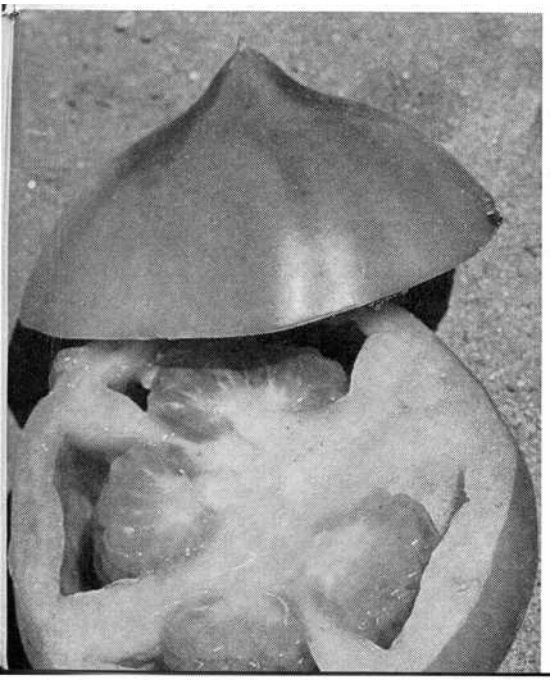
In one greenhouse experiment tomato plants were grown in three-gallon crocks of soil and watered with nutrient solution to maintain a differential nitrogen supply. These plants were treated with hormone in the same manner as those grown in the field.

Variety Early Pak was used in most of the studies because it tends to be susceptible to the fruit abnormalities under investigation even when set under natural conditions and—usually—the percentage of abnormal Early Pak fruit is increased markedly by hormone application.

Harvest records were obtained only over that portion of the season when hormone-set fruits were present. Declin-

Concluded on page 14

Parthenocarpic tomato fruit from plant sprayed with fruit-setting hormone. The seedless, pointed and puffy conditions are all shown. Puffiness may be detected externally by the flattened faces of the locules.



Relation of Pointed and Puffy Tomato Fruits to Application of Fruit-Setting Hormone Sprays and Levels of Nitrogen Used in Fertilization. 1957

Treatment	Puffy fruit %	Pointed fruit %
South Coastal, San Diego County, Spring. Variety, Early Pak.		
No hormone applied	20	11
4-CPA, 50 ppm, applied 3 times	59**	45**
Gibrel 50 ppm applied 3 times as full coverage spray	15	8
4-CPA sprayed Nitrogen at 200 lbs/acre	46	42
4-CPA sprayed Nitrogen at 600 lbs/acre	44	35#
South Coastal, San Diego County, Spring. Variety, Early Pak.		
No hormone applied	35	16
4-CPA, 50 ppm, applied 3 times	53**	31**
4-CPA sprayed— Nitrogen at 200 lbs/acre	43	37
4-CPA sprayed— Nitrogen at 400 lbs/acre	43	35
4-CPA sprayed— Nitrogen at 600 lbs/acre	43	35

** Significantly different from no hormone at 1% level.

Significantly different from lowest nitrogen application at 5% level.

Relation of Pointed and Puffy Tomato Fruits to Application of Fruit-setting Hormone Sprays and Levels of Nitrogen Used in Fertilization. 1956

Treatment	Puffy fruit %	Pointed fruit %
Greenhouse grown plants, Riverside, Spring. Variety, Early Pak.		
No hormone applied	53	37
4-CPA, 50 ppm, applied 3 times	68	64
Hormone sprayed Nitrogen at 20 lbs/acre	100	76
Hormone sprayed Nitrogen at 200 lbs/acre	36	60
North Interior, San Diego County, Spring. Variety, Early Pak.		
No hormone applied	14	14
4-CPA, 50 ppm applied 3 times	47**	42**
Hormone sprayed Nitrogen at 50 lbs/acre	57	45
Hormone sprayed Nitrogen at 200 lbs/acre	37##	45
South Coastal, San Diego County, Spring. Variety, Early Pak.		
No hormone applied	12	28
4-CPA, 50 ppm, applied 3 times	30**	44**
Hormone sprayed Nitrogen at 100 lbs/acre	32	44
Hormone sprayed Nitrogen at 200 lbs/acre	28#	44
South Coastal, San Diego County, Fall. Variety, Early Pak.		
No hormone applied	39	41
4-CPA, 50 ppm, applied 3 times	40	43
Hormone sprayed Nitrogen at 200 lbs/acre	40	44
Hormone sprayed Nitrogen at 600 lbs/acre	41	43
North Coastal, San Diego County, Fall. Variety, Pearson.		
No hormone applied	34	25
4-CPA, 50 ppm, applied 3 times	35	29
Hormone sprayed Nitrogen at 200 lbs/acre	35	28
Hormone sprayed Nitrogen at 400 lbs/acre	35	29
Hormone sprayed Nitrogen at 600 lbs/acre	35	28

** Significantly different from no hormone at 1% level.

#, ## Significantly different from lowest nitrogen application at 5% and 1% levels.

TOMATOES

Continued from page 5

ing yields in the hormone treated plots and the absence of seedless fruit were indicators of the dissipation of the hormone effect.

Data were obtained on total and marketable yield, fruit size and numbers of abnormal fruit, but only the information relating to pointed and puffy fruit is presented in this report. The tables on page 5 show that neither hormone applications nor level of nitrogen fertilization have a significant effect on production of puffy or pointed fruit in all seasons or all locations. During the fall 4-CPA failed to increase significantly the percentage of abnormal fruit. In the fall experiments no significant increase in yield was obtained through the use of hormone, which may indicate that natural-set fruit were predominating in these plots. In all other experiments 4-CPA resulted in significant increases in both pointed and puffy fruit, as well as increases in early yield.

Gibrel, in the one experiment where it was used, had no effect on pointed or puffy fruit, but did result in a decrease in early yield, mainly due to a decrease in average fruit size. In addition, fruits from these plots were largely unmarketable due to a brown, corky surface.

The effect of nitrogen on production of abnormal fruit by hormone treated plants is not so clear cut as the effect of hormone itself. In a few cases significant decreases in either pointed or puffy fruit were related to an increase in nitrogen level, particularly where the low rate of nitrogen application was 100 pounds per acre or less. In the remainder of the experiments the differences, if any existed, were too small to be statistically significant.

Storage

In some cases storage experiments were carried out on samples consisting of 50 fruit from each plot. These fruit were picked at the green-mature stage, selected for uniformity of size and color, and placed in storage at Riverside in a refrigerated room maintained at 63°F. After 10 days storage, sorting of the fruit commenced and continued at three- to five-day intervals until all fruit had reached the red, or table-ripe, condition. The fruit were rated as to two qualities, ripeness and condition at maturity. The Ripeness Index was obtained by rating each individual fruit as to color, on a scale ranging *1* for green-mature, to *5* for table-ripe. Means of these values constituted the average condition of ripeness at each sorting date. The Table-ripe Condition Index was obtained by rating each fruit as to its quality, at the time it reached the table-ripe stage, on a scale of *1* for rotted culls, *2* for other culls, *3* for poor quality, *4* for fair quality and *5* for good quality.

The ripening rate of hormone treated fruit as compared with nontreated ones was significantly slower in one experiment. In two other experiments the rate was not significantly different, although in one case the hormoned fruit ripened about one day faster and, in the other case, about one day slower than the untreated fruit.

In one nitrogen level experiment, fruit from low nitrogen plots ripened significantly faster than fruit with higher rates of nitrogen application. In another experiment the difference was reversed, with high nitrogen fruit ripening as much as three days faster than those from low nitrogen plots. In the third experiment nitrogen had no effect on rate of ripening.

No significant differences in the Condition Index, related to either application of hormone or rate of nitrogen fertilization, were found in any of the experiments. Some differences did exist, but they are quite small and fall well within the accuracy of the rating methods used.

The experiments indicate that 4-CPA, used as a fruit-setting spray—under conditions found in the field in San Diego County—is capable of increasing the number of abnormal fruits on tomato plants.

Low levels of nitrogen fertilization, particularly rates lower than 100 pounds per acre, also tend to increase the appearance of pointed and puffy fruit. However, other factors are involved. Some tomato varieties seldom show these abnormalities, regardless of environmental or cultural conditions, while other varieties may show a percentage of pointed and puffy fruit under any condition. Thermograph records taken in the fields, in which the experimental plots used in these studies were located, indicate that an extreme range of day to night temperature may be involved in increasing puffiness and that low night temperatures probably increase both abnormalities. However, because the abnormal fruit can be detected as soon as the petals fall from the very young fruit, the critical period for environmental influences on fruit formation may be a very short one—during and just after flower set—so that appraisal of the influence of temperature is very difficult.

Studies of the influence of temperature under controlled conditions are being conducted and may reveal more accurately its relation to abnormal fruit development.

Ripening Rates and Condition at Maturity of Tomato Fruits Grown With Different Levels of Nitrogen Fertilization and Treated with Fruit-setting Hormone

Treatment	Days from harvest to complete maturity[1]	Condition index of fruit at table-ripe stage[2]
Fruit from South Coastal San Diego County. Harvested Dec. 13, 1956. Variety, Early Pak.		
No hormone applied	23.6	4.22
4-CPA, 50 ppm, applied 3 times	25.0*	4.02
Nitrogen applied at 200 lbs/acre	23.8	4.32
Nitrogen applied at 600 lbs/acre	25.4*	3.93
Fruit from North Coastal San Diego County. Harvested Nov. 16, 1956. Variety, Pearson.		
No hormone applied	17.6	4.64
4-CPA, 50 ppm, applied 3 times	16.9	4.24
Nitrogen applied at 200 lbs/acre	21.3	4.56
Nitrogen applied at 400 lbs/acre	17.5#	4.73
Nitrogen applied at 600 lbs/acre	17.0#	4.47
Fruit from South Coastal San Diego County. Harvested June 25, 1957. Variety, Early Pak		
No hormone applied	22.7	4.32
4-CPA, 50 ppm, applied 3 times	24.5	4.72
Nitrogen applied at 200 lbs/acre	21.4	4.59
Nitrogen applied at 400 lbs/acre	21.2	4.47
Nitrogen applied at 600 lbs/acre	21.6	4.46

[1] Days required for all fruit to reach red-ripe stage determined by sorting fruit at 3–5 day intervals during storage at 50°F.

[2] Condition index is a mean value of the rated condition of the fruit upon reaching red-ripe stage on the basis of rotted culls = 1, good quality fruit = 5.

* Significantly different from no hormone at 5% level.

\# Significantly different from lowest nitrogen application at 5% level.

Randolph T. Wedding is Associate Plant Physiologist in Plant Biochemistry, University of California, Riverside.

Bernarr J. Hall is Farm Advisor, University of California, San Diego.

Morris J. Garber is Assistant Biometrician, University of California, Riverside.

Frank H. Takatori is Assistant Specialist in Vegetable Crops, University of California, Riverside.

SILAGES

Continued from page 4

not approach the gains of those fed alfalfa hay.

By using the energy requirements for maintenance and gain, replacement values could be calculated. On a dry matter basis alfalfa silage was worth 97% of alfalfa hay, Hegari silage, 109% and Rex silage was worth 112%.

The results of these experiments indicate no difference between a sweet forage-type sorghum—Rex—and a dual purpose-type—Hegari—when made into silage and fed to beef steers.

J. H. Meyer is Associate Professor of Animal Husbandry, University of California, Davis.

G. P. Lofgreen is Associate Professor of Animal Husbandry, University of California, Davis.

The late N. R. Ittner was Specialist in Animal Husbandry, University of California, Imperial Valley Field Station, El Centro.