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Control of Fruit-Dropping in Italian Prunes by Foliar Sprays of 2,4,5-TP

By

Walter J. Kochan, Leif Verner, Abdul Kamal, and Ronald Braun

GROWERS' SUMMARY

A spray of 20 ppm 2,4,5-TP applied 800 to 1100 degree days above 43° F. following full bloom will substantially reduce prune dropping in both the standard and Demaris early strains of Italian prune. In Idaho, Agricultural Extension agents will record the number of degree-days starting at full bloom and inform fruit growers when it is time to spray.

To be most effective 2,4,5-TP should be used every year and should never be used before 800 degree days have accumulated. If 2,4,5-TP is used too early, fruit of poor quality and limb breakage due to an excessively large crop may result.

Although spraying with 2,4,5-TP reduces the amount of fruit dropping and thereby increases the size of the crop carried to maturity, the size of the individual fruit from treated trees has been as large or larger than fruit from non-treated trees.

We do not recommend that prune growers wait until normal fruit dropping has thinned the crop to the level desired at harvest. In a large percentage of our trials, spraying with 2,4,5-TP resulted in an increased amount of fruit dropping for a short period of time following treatment, and virtually no dropping for the remainder of the growing season. Therefore, if the grower waits until the trees are carrying the desired size of crop before treating with 2,4,5-TP, a light harvest may result due to the thinning that occurs immediately after treating.

The use of 2,4,5-TP will increase the size of the crop carried to maturity even in a year when the amount of fruit has been reduced by late spring frosts.

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Control of Fruit Dropping in Italian Prunes by Foliar Sprays of 2,4,5-TP

Walter J. Kochan¹, Leif Verner¹, Abdul Kamal², and Ronald Braun²

INTRODUCTION

Late-season dropping of Italian prunes (*Prunus domestica*) has been severe in many prune-growing areas in the Pacific Northwest. This has been true particularly of the early strains of Italian prune which normally mature about 14 days before the standard strain. The dropping usually has reached a peak in July but occasionally has been severe through the harvest period in late August and September. Some southwestern Idaho growers reported losses to 50 percent of the crop in 1953, a year in which late-season dropping was heavy. Commercial growers are on record as having removed Italian prune orchards of the early strains because premature fruit dropping made their operation unprofitable.

A study of this problem was first undertaken in Idaho in 1955. A preliminary report covering the results of experiments from 1955 through 1957 has been made by Verner et al. (11). The work reported in the present bulletin covers the period 1957 to 1960, inclusive.

Review of Literature

Trials in California by Harris et al. (4) on French prunes demonstrated that 2,4,5-TP (α (2,4,5-trichlorophenoxy) propionic acid) reduced dropping but was less effective than 2,4,5-T (2,4,5-trichlorophenoxyacetic acid). Harris and Hansen (5) found that 2,4,5-T applied at 15 to 40 ppm on French prune trees 9 to 11 weeks after pit hardening (4 to 6 weeks before harvest) reduced dropping of fruit by 40 to 90 lbs. per tree. However, in spite of the spray, 50 to 100 lbs. of fruit dropped before harvest and the authors conclude that the treatment is not justified unless mechanical harvesting equipment is to be employed.

Many investigators have observed beneficial effects of 2,4,5-TP when applied to apple foliage. The effects include reduced fruit dropping (2, 3, 6), improved fruit color (6, 8, 9) and hastened fruit maturity (6, 8, 9). Crane (1) reported reduced fruit dropping, earlier maturity, increased diameter and increased fresh weight of Stewart apricots as a result of foliar sprays of growth regulators including 2,4,5-TP. Serr and Forde (7) reduced the dropping of Peerless almonds with treatments of 20 ppm 2,4,5-TP. Zielinski et al. (12) reported an acceleration of fruit maturity when 2,4,5-T was applied to Stanley and Italian prunes 16 to 20 days before maturity.

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Procedures

The trials were conducted in 3 southwestern Idaho Italian prune orchards, 1 of the Demaris early strain and the other 2 the standard strain.

Exploratory trials in 1955 and 1956 showed that 20 ppm (parts per million) 2,4,5-TP¹, as the acid equivalent, applied about the third week of June, gave the most desirable results (11). Ten ppm 2,4,5-TP was less effective and 40 ppm was but little more effective than 20 ppm; therefore, except as otherwise noted, the 20 ppm rate was used in all the treatments herein described. A comparison was made of the effectiveness of 2,4,5-TP and 2,4,5-T at equivalent concentrations. The 2,4,5-T proved inferior and was used for 1 year only.

In most of the earlier trials, 2,4,5-TP was applied in mid-June. A more precise method for determining the time to treat Italian prune trees is by totaling the number of degree days, with a base of 43°F., from full bloom and treating when 800 to 1100 degree days have accumulated². If 2,4,5-TP is applied much before 800 degree days have accumulated, then limb-breakage, poor fruit quality and an increased amount of internal browning may result. The treatment becomes less effective with time and may be largely without value when applied as late as July 15 (1649 degree days after full bloom in 1957).

Sprays of 2,4,5-TP were applied to entire, mature prune trees using a power sprayer with a single-nozzle hand gun. A water solution of the plant growth regulator was applied until the solution first began to drip from the leaves. Check trees were sprayed with water only. The cover crop under the spread of the trees' branches was cleared out and all prunes that had dropped up to the time of spraying were removed. Prunes that dropped after the sprays were applied were picked up and counted at approximately weekly intervals. Ten trees per treatment were used throughout except where five standard strain prune trees per treatment were used in the annual vs. biennial application experiment.

At harvest, a random sample of 75 or 100 prunes was picked from each tree and weighed. Using this information, together with the total weight of fruit harvested, the approximate number of prunes harvested per tree was calculated. This figure, plus that of the number of prunes dropped, gave the total number of prunes on the tree at the time the treatments were applied. It was possible then to compute dropping on a percentage basis from the time the sprays were applied.

¹ A 10.6% formulation of the triethanolamine salt (Color Set), Dow Chemical Co., Midland, Michigan.

² For any given day this is determined by taking the mean temperature for that day (i.e., the average of the highest and lowest temperatures recorded) and subtracting 43° F. The resultant figures for all of the days from full bloom to the time of treatment are totaled to give the accumulated degree days.

At harvest, representative samples of prunes were taken from each tree to test effects of the treatments on the fruit's firmness, on the percent soluble solids of the juice, and on the amount of the fruit's internal browning after a period of storage. The firmness of the fruit was determined using the Idaho pressure tester (10).

The percent soluble solids was determined separately for each prune of a random sample. The procedure used in this method is as follows: With a sharp knife a small portion of flesh with its attached skin is cut from the apex of the prune. The cut is transverse, and deep enough (in the Italian variety) to leave a cut surface of an area approximating that of a 1-cent coin. With the small piece of apical tissue held between the thumb and forefinger, a single drop of juice is squeezed onto a hand refractometer and a reading is taken. The refractometer is wiped dry with a piece of soft cloth or facial tissue and is then ready for the next reading. Readings, which can be taken at a rate of about $\frac{1}{2}$ -minute each, are totaled and averaged to give a single value for the sample as a whole.

Numerous comparisons made between readings taken by the apical drop method described above and readings based on a juice sample from the macerated pulp of the whole fruit have shown a correlation coefficient of $+0.99$ between the two sets of readings. The apical drop readings usually are 1.0 to 1.5 percentage points higher on the soluble solids scale than the whole-fruit readings.

The amount of internal browning was measured by cutting the prune in half through the long axis, examining the flesh surrounding the pit, and assigning values as follows:

- 0—No internal browning.
- 1—1 to 25 percent of the flesh at the pit cavity brown.
- 2—26 to 50 percent of the flesh at the pit cavity brown.
- 4—More than 50 percent of the flesh at the pit cavity brown.

The values indicating the relative intensities of browning of the individual prunes were totaled and this figure was expressed as a percent of the total which would have been obtained if all the prunes were rated as 4.

Results and Discussion

Effects On Yield

The effects of the 2,4,5-TP sprays, as measured by the percent of the crop held to maturity and the weight of the prunes harvested, are presented in tables 1 through 5. Twenty ppm 2,4,5-TP sprayed on the foliage 800 to 1100 degree days after full bloom had a significant, positive effect on both the early and standard strains of the Italian prune, increasing the amount of the crop carried to maturity by as much as 52 percent in the Demaris early strain and 36 percent in the standard strain. This reduction of fruit dropping is best demonstrated by the percent of

the crop held to maturity because it tends to minimize the irregularities which might creep in due to differences in the size of the crop of different trees. The weight of prunes harvested does not take into account this difference and, therefore, may indirectly and somewhat inaccurately measure the effect of 2,4,5-TP on drop reduction. If the trees treated in June with 20 ppm 2,4,5-TP are compared with the check trees it becomes evident that: (1) The response measured as the percent of crop held to maturity in 1957, 1958, 1959 and 1960 is significant at the 1 percent level in both the early and standard strains. (2) Significance at the 1 percent level is also found in the weight of prunes of the early strain harvested in 1957, 1958, 1959 and 1960. (3) Although the weight of prunes harvested from the treated standard strain of the Italian prune is greater than the weight of the prunes harvested from the checks, the results are not statistically significant for 1957, 1958, and 1959.

Early spring frosts in 1960 reduced the average number of prunes per tree at the time of treatment to 37 percent of the number recorded for the previous year in the Demaris early strain of Italian prune. Treating with 2,4,5-TP nevertheless effected a statistically significant increase at the 1 percent level in the percent of the crop carried to maturity and the average yield per tree (table 4).

Table 1.—Reduction of prune drop following foliar sprays of 2,4,5-TP and 2,4,5-T, 1957.

Strain of Italian	Age of tree (yrs.)	Spray material	Concentration (ppm.)	Date of treatment	Accumulated degree days from full bloom	Percent of crop held to maturity	Average yield per tree (lbs.)
Standard	12	2,4,5-TP	20	June 17	936	80.9*	407
Standard	12	2,4,5-T	20	June 17	936	72.3*	376
Standard	12	2,4,5-TP	20	July 15	1649	67.4	290
Standard	12	2,4,5-TP	20	July 15	1649	69.4	340
Standard	12	Check	—	—	—	65.7	369
Early	11	2,4,5-TP	20	June 17	894	88.8*	327*
Early	11	2,4,5-TP	20	June 17	894	84.7*	301*
Early	11	2,4,5-T	20	June 17	894	71.5*	218
Early	11	Check	—	—	—	58.5	174

* Significant at the 1% level compared to check.

Table 2.—Reduction of prune drop following a foliar spray of 20 ppm 2,4,5-TP, 1958.

Strain of Italian	Age of tree (yrs.)	Date of treatment	Accumulated degree days from full bloom	Percent of crop held to maturity	Average yield per tree (lbs.)
Standard	13	May 17	283	91.4*	358
Standard	13	June 17	1056	78.9*	365
Standard	13	Check	—	66.9	310
Early	12	May 16	268	87.0*	242*
Early	12	June 16	1047	67.6*	211*
Early	12	Check	—	51.3	154

* Significant at the 1% level compared to check.

Table 3.—Reduction of prune drop following a foliar spray of 20 ppm 2,4,5-TP on June 17, 1959.

Strain of Italian	Age of tree (yrs.)	Accumulated degree days from full bloom	Percent of crop held to maturity	Average yield per tree (lbs.)
Standard	14	893	68.0*	390
Standard	14	Check	49.0	380
Early	13	845	66.9*	344*
Early	13	845	65.3*	323*
Early	13	Check	28.1	130

* Significant at the 1% level compared to check.

Table 4.—The reduction of prune drop in 14-year-old early Italian prune trees following a foliar spray of 2,4,5-TP, 1960¹.

Concentration (ppm)	Date of treatment	Accumulated degree days from full bloom	Percent of crop held to maturity	Average yield per tree (lbs.)
20	June 18	973	76*	169*
0 (Check)	—	—	51	106

¹ Late spring frosts reduced the average number of prunes per tree at the time of treatment to 37 percent of that in 1959.

* Significant at the 1% level.

Table 5.—The effect on yield of a foliar spray of 20 ppm T,4,5-TP applied 800 to 1100 degree days after full bloom on consecutive years and on alternate years.

Strain	Percent of crop held to maturity			Average yield per tree (lbs.)			Average yield per tree (lbs.)	
	1957	1958	1959	1957	1958	1959	First 2 years	3 years
	<u>82</u>	68	<u>71</u>	<u>378</u>	198	<u>366</u>	576	942
Standard Italian	<u>80</u>	<u>81</u>	<u>65</u>	<u>437</u>	<u>338</u>	<u>413</u>	775	1188
	66	67	49	369	310	380	679	1059
Demaris	<u>85</u>	53	<u>67</u>	<u>301</u>	158	<u>344</u>	459	803
Early Italian	<u>89</u>	<u>72</u>	<u>65</u>	<u>327</u>	<u>199</u>	<u>323</u>	526	849
	59	51	28	174	154	130	328	458

Underlined figures indicate that the trees were treated with 2,4,5-TP.

Results of trials with 2,4,5-T, presented in table 1 and figures 1 and 2, demonstrated that this compound was not as effective as 2,4,5-TP in drop reduction. The 2,4,5-T was only 43 percent as effective as 2,4,5-TP in the standard Italian prune and only 46 percent as effective in the early Italian prune. Another unfavorable reaction associated with the use of 2,4,5-T was poor fruit

color. The deep purple color of the Italian prune is a very desirable characteristic, but prunes treated with 2,4,5-T were more red than purple. The relative effectiveness in drop reduction of 2,4,5-T as compared to 2,4,5-TP (table 1), differs with the findings of Harris et al. (4) working with French prunes in California. This may be due to varietal differences or to the fact that the problem in Idaho is of a different nature than the one encountered in California.

Effects on the fruit

Additional responses of the prune fruit to a foliar spray of 2,4,5-T and 2,4,5-TP are presented in table 6. A most important response to the 2,4,5-TP treatment was an increase in the average weight per prune. This is especially important because larger Ital-

Table 6.—The effect of a foliar spray of 20 ppm 2,4,5-T and 2,4,5-TP in 1957 and 20 ppm 2,4,5-TP in 1958 and 1959 on the percent soluble solids, firmness and weight of Italian prune fruit.

Strain	Age of tree (yrs.)	Spray material	Date of treatment	Accumulated degree days from full bloom	Percent soluble solids at harvest	Firmness at harvest (lbs.)	Average Wt. of 100 prunes at harvest (ozs.)
1957							
Standard	12	2,4,5-T	June 17	936	14.1**	15.1	104.6
Standard	12	2,4,5-TP	June 17	936	17.8	16.9	112.8**
Standard	12	2,4,5-TP	June 17	936	16.4	15.4	109.5
Standard	12	2,4,5-TP	July 15	1649	13.8**	15.6	108.1
Standard	12	Check	—	—	17.0	16.0	103.7
Early	11	2,4,5-T	June 17	894	18.2	—	114.7
Early	11	2,4,5-TP	June 17	894	17.6	—	118.3*
Early	11	2,4,5-TP	June 17	894	18.0	—	113.8
Early	11	Check	—	—	17.8	—	112.1
1958							
Standard	13	2,4,5-TP	May 17	283	18.1	—	122.0**
Standard	13	2,4,5-TP	June 17	1056	18.5	—	105.2
Standard	13	not treated	—	—	19.5**	—	100.2
Standard	13	2,4,5-TP	June 17	1056	19.3**	—	103.1
Standard	13	Check	—	—	17.8	—	99.1
Early	12	2,4,5-TP	May 16	268	18.8**	—	145.8**
Early	12	2,4,5-TP	June 16	1047	17.6	—	117.4**
Early	12	not treated	—	—	18.0	—	110.3
Early	12	2,4,5-TP	June 17	1078	18.4	—	116.3*
Early	12	Check	—	—	17.5	—	109.8
1953							
Standard	14	2,4,5-TP	June 17	893	16.4	13.2**	97.3**
Standard	14	2,4,5-TP	June 17	893	16.1	13.3**	101.0**
Standard	14	Check	—	—	16.8	13.9	88.4
Early	13	2,4,5-TP	June 17	845	16.0	12.4**	104.2
Early	13	2,4,5-TP	June 17	845	16.4	12.6**	106.0
Early	13	Check	—	—	16.2	13.4	102.2

¹ These trees treated on alternate years only; ²comparable trees treated every year.

* Significant at the 5% level compared to check.

**Significant at the 1% level compared to check.

ian prunes are commercially desirable. Treating the trees 800 to 1100 degree days after full bloom resulted in a statistically significant increase in fruit size in the Demaris strain of prunes in 1957 and 1958 and in the standard strain in 1957 and 1959. A May foliar spray also resulted in larger fruit, but undesirable responses such as an increased amount of internal browning of the fruit and poor fruit quality overshadowed any beneficial effects of treating before 800 degree days had accumulated. A most noteworthy statistic is that in no case to date has a foliar spray of 2,4,5-TP resulted in smaller fruit although all have resulted in an increased percent of crop held to maturity.

There seems to be no consistent relationship between a foliar spray of 2,4,5-TP and the percent soluble solids of the fruit juice or the firmness of the fruit at harvest. The data in table 6 show that in 1957 fruit from the treated standard strain was lower in soluble solids than fruit from the check trees, but in 1958 the situation was reversed. Fruit from the trees treated with 2,4,5-TP in 1959 was softer than the fruit from the check trees. This was not true in 1957. Thus, these differences cannot be attributed to the treatment but are likely due to an error in sampling or to other unrecognized causes.

The results of a spray of 20 ppm 2,4,5-TP 800 to 1100 degree days after full bloom bore no consistent relationship to the amount of internal browning of the fruit after storage. One year, prunes from the treated trees were found to contain more internal browning than prunes from the check trees. The following year, prunes from the check trees exhibited more internal browning than prunes from the treated trees. However, treating with 20 ppm 2,4,5-TP when only 268 or 283 degree days had accumulated was responsible for a statistically significant increase in the amount of internal browning of the fruit in both the early and standard strains of Italian prune. This increase of internal browning negates any beneficial effects which were realized by a May treatment.

Mode of action of the spray

The nature of 2,4,5-TP's action as used in these experiments is not entirely clear. Drop records were obtained at intervals short enough to permit the plotting of patterns of dropping in a total of nine experiments from 1956 to 1960, inclusive. In 4 of these experiments, there was an intensification of dropping in the first 2 or 3 weeks in the sprayed plots, followed by a sharp reduction in dropping for the remainder of the season (figures 1 and 2). In 3 of the experiments, dropping was intense and essentially the same in both treated and check plots for the first 3 or 4 weeks following the treatment. After this time, dropping was much reduced in the sprayed trees. In two experiments, sprayed trees showed an immediate reduction but not elimination of dropping and a continued lower rate than the check trees to the time of harvest.

From these observations the authors are led to believe that 2,4,5-TP applied to Italian prune trees as in these experiments may

commonly, but not always, have a thinning effect shortly after the application. Sprays as described here may be expected normally to have a stop-drop effect, but this may not manifest itself for several weeks after application.

In view of the fact that dropping of fruit from treated trees has always continued for some weeks following spray application and that in most instances dropping during that period has been as great or greater than in the check trees, the assumption on the part of many growers that this spray has an immediate stop-drop action in prunes is obviously erroneous. This has led to application too early in light crop years and too late in heavy crop years. Results have been unsatisfactory in both instances.

Annual vs. biennial applications

In light of the substantial increase in production often obtained the first year 2,4,5-TP spray is used, a question arises as to the effect on the succeeding year's crop. Does the tree suffer a degree of exhaustion so that bloom or fruit set the following year is reduced or the "June drop" increased? If so, is there enough reduction in yield the second year to nullify the gain of the previous year?

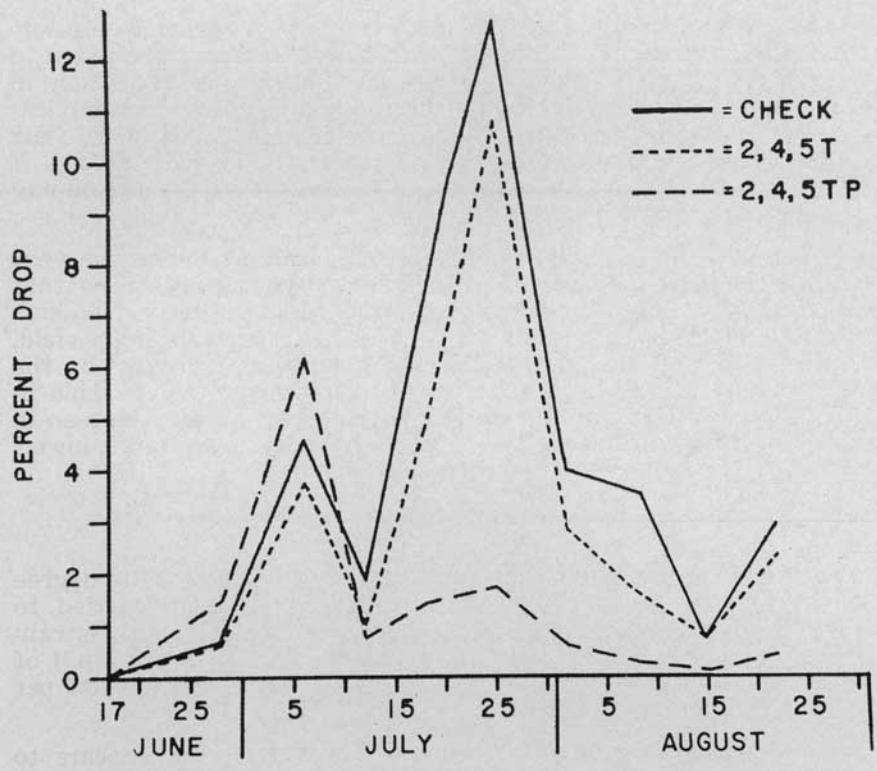
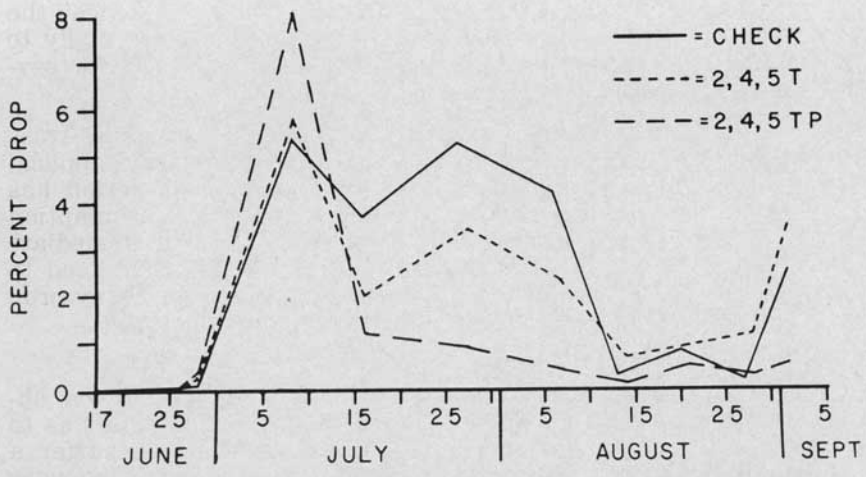
To answer these questions, some trees were sprayed on alternate years, others sprayed every year. These data are presented in table 5. Standard Italian prunes usually showed a reduction in yield the year after 2,4,5-TP had been applied, **unless** the application was repeated the second year. Those trees sprayed every year outyielded check trees over the test period. It is evident that if 2,4,5-TP is to be used as a means of reducing loss from dropping in the standard strain best results will come from annual use.

Spraying the Demaris strain of early Italian prunes one year but not the next did not reduce the second-year yield below that of the checks. This may be because of light yields that are characteristic of the early Italian prune strains. With this light yield, the tree is not overtaxed even when production is increased by the use of 2,4,5-TP. The trees of the early strain were comparable in size and age to those of the standard strain but, as may be seen in tables 1 through 5, the yields of the early strain were much lower.

Summary

A foliar spray of 20 ppm 2,4,5-TP applied 800 to 1100 degree days after full bloom increased the percent of crop carried to maturity by as much as 52 percent in the Demaris early strain and 36 percent in the standard strain of the Italian prune. In 4 of the 6 trials reported, a significant increase in the average size per prune also resulted from this treatment.

The action of 2,4,5-TP, used as described herein, appears to be essentially that of a thinning agent although under some conditions it may also have a direct or a residual stop-drop effect.



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PESTICIDE RESIDUES

These recommendations for use are based on the best information currently available for each chemical listed. If followed carefully, residues should not exceed the tolerance established for any particular chemical. To avoid excessive residues, follow recommendations carefully with respect to dosage levels, number of applications, and minimum interval between application and harvest.

THE GROWER IS RESPONSIBLE for residues on his crops as well as for problems caused by drift from his property to other properties or crops.

On the basis of the experiments reported in this bulletin, together with chemical analyses of resulting residues, the use of 2,4,5-TP as here recommended has been approved for use by the Plant Pest Control Division, U. S. Department of Agriculture, on a no-residue basis, under the following conditions:

"To reduce late summer dropping of Italian-type prunes, apply 20 ppm of 2,4,5-TP, usually during June, approximately 60 days after full bloom or 800 to 1100 degree days above 43° F. following full bloom. Do not apply less than 60 days before harvest."