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THE EVALUATION OF OCCURRENCE OF PPV SYMPTOMS IN YOUNG PEACH ORCHARD ACCORDING TO THE USED ROOTSTOCK

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Abstract

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The degree of PPV occurrence was monitored in a young peach orchard during 2010–2011. This study evaluates the percentage of infected trees in 2010 as well as the intensity of PPV symptoms in 2011 in two peach varieties „Royal Glory" and „Symphony" grafted on seven different rootstocks of *Prunus* species after the natural infection. The different intensity of PPV symptoms was proved on infected parts such as flowers, leaves, fruits and from rootstocks' point of view.
In 2010 were PPV symptoms most often detected in variety 'Royal Glory' grafted on rootstock Julior where 100% of trees were infected. No visible symptoms were observed in trees of variety 'Symphony' on Pumiselect rootstock. As for the rootstocks evaluation, PPV symptoms were most numerous in trees grafted on MRS 2/5 rootstock (94.78%), at least were monitored on Lesiberian rootstock (28.47%). The intensity of PPV symptoms on flowers, leaves and fruits in each combination was evaluated in 2011. Generally, the PPV symptoms were present mainly on flowers and less on fruits.

Peaches, *P. persica* L., intensity of PPV symptoms, flower, leaf, fruit, rootstock

Plum pox virus (PPV) represents the major threat in production of plums, peaches and apricots. Eradication of this pathogen in the infected areas seems to be impossible (Hamdorf, 1986) and thus there are only two alternatives how to eliminate the PPV occurrence – either a complete removal of the infected trees or breeding new resistant varieties (Dicenta *et al.*, 1999).

Currently, the official sources have reported the PPV spread in peach orchards through the Czech Republic (Polák, 2004) as well as in other EU countries. Moreover, PPV virus is widely spread in natural environment of the Czech Republic (Polák, 2002; Polák and Komínek, 2009) so it is unlikely to guarantee a PPV–free area (Hnízdil, 2010). Finding a source of immunity or resistance within genus *Prunus persica* L., or in the wide gene pool in various geographical groups seems impossibly, the strategy to breed PPV resistant peaches gets even more complicated.

Prunus davidiana (Carriére) Franch represents the only source of resistance from related species, and it is used in INRA Avignon breeding program (Rubio *et al.*, 2010). As Polák *et al.* (1998) reports, no immune or even resistant variety was identified from 34 naturally infected varieties. However, varieties Envoy and Favorita Morettini 3 were recommended for the conditions of the Czech Republic where PPV infection is widely spread. Other varieties such as Candor, Flamencrest, Harcrest, Harmony, Maycrest, Spring Lady, Friestina and Velvet were classified as medium resistant. In other work Polák *et al.* (2003) identified the following peach varieties as medium resistant to PPV after PPV-D inoculation (Flame Prince, Cotender, Newhaven, Ruby Prince, Sun Prince, Jefferson, Camden a Jersey Queen), and as tolerant varieties Loring, Blaze Prince, June Prince and Legend.

In the course of years 2003–2007 Pollini *et al.* (2008) carried out the research of PPV symptoms

present in 21 peach varieties after the inoculation. Varieties such as 'Morsiani 90', 'Summer Lady' and 'Maria Dolce' did not show any PPV symptoms, unlike the rest of varieties where typical PPV symptoms such as foliage discoloration and diffuse spots, colour breaking of the petals, deformed fruits with light rings on the skin were reported.

The rootstock effect on PPV spread in peach varieties has not been studied yet. The aim of this study is to assess the presence and intensity of PPV symptoms in natural environment in young peach orchards. Primarily, PPV symptoms will be evaluated visually and then will be the occurrence of pathogen in leaves confirmed by ELISA test.

MATERIAL AND METHODS

Between the years 2010 and 2011 the PPV (*Plum pox virus*) symptoms were evaluated in peach rootstock orchard on flowers, leaves and fruits of peach trees (*Prunus persica* L.). The symptoms were evaluated in two varieties grafted on different rootstocks – variety Royal Glory on 7 rootstocks: GF 677 (148 pcs), Lesiberian (62 pcs), Ishtara (68 pcs), Pumiselect (47 pcs), St. Julien A (13 pcs), MRS 2/5 (72 pcs) and Julior (92 pcs) and variety Symphony on 6 rootstocks: GF 677 (120 pcs), Lesiberian (82 pcs), Ishtara (61 pcs), Pumiselect (31 pcs), MRS 2/5 (43 pcs) a Julior (75 pcs). A total of 13 variety/rootstock combinations were included in the study (altogether 914 trees). The planting was set up in 2004 on the premises of Faculty of Horticulture, Department of Fruit Growing in Lednice. Trees were planted with 5 x 1.5 m spacing. The training system of the trees was maintained by long american pruning to form the modified leader (one half of the evaluated collection) and the open centre (second half of the evaluated trees). As for agro-technical measures, common treatment and spraying methods were applied, especially against leaf curl (treatment by Champion), aphids (treatment by Pirimor), powdery mildew (treatment by Kumulus), infection of Monilinia laxa (treatment by Horizon).

Monitoring of PPV virus occurrence on fruits was carried out for the first time in 2010. The trees with distinct symptoms of the pathogen were marked and the percentage of infected trees showing PPV symptoms was calculated accordingly.

The occurrence of symptoms of the pathogen was graded by points 0–3 in the year 2011, where 0 stands for no symptoms, 1 for mild symptoms, 2 for medium symptoms and 3 for severe symptoms. ELISA test confirmed the presence of the pathogen in leaves in combination 'Symphony'/ Julior and in combination 'Royal Glory'/Julior in 2010–2011. Source of infection can not be unambiguously specified, but the first symptoms (already in the third year after plantation) were observed in small quantities (5%) in both varieties on rootstock MRS 2/5. These lines were planted on the border, closed to the old very infected peach plantation from 1988 with varieties 'Redhaven' and 'Sunhaven'.

The obtained data were subjected to statistical analysis using the software Statistica, ANOVA multi-factor analysis. Scheffé test was applied to evaluate significance of differences among multiple combinations. Compared combinations were divided into two groups: a – with no significant differences, b – with significant differences or highly significant differences.

RESULTS

A) The evaluation of the occurrence of PPV symptoms in fruits in year 2010

The occurrence of PPV on fruits was observed in peach orchard during the year 2010. The variety 'Royal Glory' showed the most frequent occurrence of PPV pathogen in 342 out of 502 trees (68.13%). Few number of fruits with PPV symptoms was observed in variety 'Symphony' with the 229 infected trees out of 412 (55.58%). As for the combination variety/ rootstock the PPV symptoms were most often detected in variety 'Royal Glory' grafted on rootstock Julior and nearly every tree out of 92 was infected (100%). On the other hand no visible symptoms were

I: *Overview of the pathogen occurrence in terms of the individual combinations and varieties in 2010*

	'Royal Glory'			'Symphony'			
	PPV occurrence (pcs)	**Assessed trees (pcs)**	**PPV occurrence (%)**	**PPV occurrence (pcs)**	**Assessed trees (pcs)**	**PPV occurrence (%)**	**overall PPV (%)**
Julior	92	92	100.00	38	75	40.00	77.84
MRS 2/5	69	72	95.83	40	43	93.02	94.78
Ishtara	60	68	88.24	36	61	59.02	74.42
St. Julien A	10	13	76.92	-	-	-	76.92*
Pumiselect	28	47	59.57	0	31	0.00	35.90
GF 677	72	148	48.65	85	120	70.83	58.58
Lesiberian	11	62	17.74	30	82	36.59	28.47
overall	342	502	68.13	229	412	55.58	62.47

*this value represents the average valuation only for 'Royal Glory'

observed in 2010 in the collection of 31 trees (0.00%) of variety 'Symphony' on Pumiselect rootstock. PPV symptoms were most often observed in trees grafted on MRS 2/5 rootstock and were visible in 109 trees out of total collection of 115 trees (94.78%), while the symptoms were least observed in trees grafted on Lesiberian rootstock – 41 out of total 144 trees (28.47%). Overall number of evaluated trees was 914 in both varieties, out of which 571 trees proved PPV symptoms (62.47%).

B) Point grading of the intensity of PPV symptoms on flowers, leaves and fruits in year 2011

The intensity of symptoms on flowers

The intensity of symptoms on flowers was highest in variety Symphony grafted on rootstock Ishtara (2.48 points), while the lowest intensity was observed in variety Symphony grafted on rootstock MRS 2/5 (1.28 points). As for varieties, the highest intensity of PPV symptoms was present on flowers in variety Royal Glory (2.04 points), the lowest intensity in variety Symphony (1.84 points). Significant statistical differences were proved between both varieties ($p = 0.00$) concerning intensity of PPV symptoms on flowers. As regards the evaluation of rootstocks the highest intensity of PPV symptoms was observed in trees grafted on rootstock Julior (2.16 points) while the lowest level on rootstock Pumiselect (1.72 points). Statistical differences were proved among the rootstock Pumiselect and rootstocks GF 677 ($p = 0.01$), Julior ($p = 0.01$), Ishtara ($p = 0.02$) in the intensity of pathogen symptoms (as for Ishtara the difference was significant). Furthermore, the significant differences were proved between rootstock Lesiberian and rootstocks GF 677 ($p = 0.00$), Ishtara ($p = 0.01$), Julior ($p = 0.00$).

Intensity of symptoms on leaves

The highest intensity of symptoms was observed in variety Symphony grafted on rootstock Julior (2.07 points) but the least intensity was described in variety Royal Glory grafted on St. Julien A (0.83 points). As for both evaluated varieties, the symptoms were present in highest intensity in variety Symphony (1.77 points) unlike Royal Glory with the lowest intensity (1.44 points). Significant statistical differences between the varieties were proved ($p = 0.01$) concerning the intensity of PPV symptoms in leaves. As regards rootstocks the highest intensity of PPV symptoms was observed in Julior (2.03 points) and the lowest in St. Julien A (0.83 points). Highly significant statistical differences were proved between rootstock Julior and rootstocks GF 677 ($p = 0.00$), Lesiberian ($p = 0.00$), Pumiselect ($p = 0.00$), St. Julien A ($p = 0.00$), MRS 2/5 ($p = 0.02$; significant differences). Moreover, these differences were also proved between rootstocks St. Julien and Ishtara ($p = 0.03$). ELISA test confirmed that the symptoms present in leaves during years 2011 and 2012 in both varieties grafted on Julior rootstock were caused by PPV, as the results proved positive.

Intensity of symptoms on fruits

The intensity of PPV symptoms on fruits was highest in variety Symphony grafted on Pumiselect (1.74 points) while Royal Glory grafted on GF 677 showed the lowest level (0.51 points). Comparing the varieties, Symphony showed most frequent symptoms (1.27 points) while Royal Glory the least frequent symptoms (0.83 points) and also highly significant differences were proved between the varieties ($p = 0.00$) in grading the intensity of PPV symptoms. As for the rootstocks, Julior showed most symptoms (1.33 points) unlike Lesiberian with the lowest intensity (0.66 points). Highly significant differences concerning the intensity of pathogen were identified on fruits from the observed peach trees between rootstock GF 677 and rootstocks Julior ($p = 0.00$), MRS 2/5 ($p = 0.00$), Ishtara ($p = 0.04$; significant differences). Furthermore, highly significant differences were identified between rootstock Lesiberian and rootstocks Ishtara ($p = 0.01$), Julior ($p = 0.00$), MRS 2/5 ($p = 0.00$).

II: *The average intensity of PPV symptoms (flowers, leaves, fruits) between the varieties 'Royal Glory' and 'Symphony' on different rootstocks in 2011, graded by points*

	'Royal Glory'	'Symphony'
MRS 2/5	1.81	1.40
Julior	1.75	1.92
Ishtara	1.53	1.88
GF 677	1.47	1.50
Lesiberian	1.33	1.29
Pumiselect	1.16	1.86
St. Julien A	1.11	-
average	1.45	1.64
	1.55	

Overall evaluation of the intensity of PPV symptoms observed on flowers, leaves and fruits.

The overall grade average was calculated concerning the intensity of PPV symptoms on flowers, leaves and fruits in each combination. The intensity of PPV symptoms was more frequent in 'Symphony' (1.64 points) while 'Royal Glory' showed less frequent symptoms (1.45 points). On the basis of this research it was discovered that the rootstock Julior can significantly affect the peach trees susceptibility to PPV (1.84 points). Other very susceptible rootstocks are as follows: Ishtara (1.71 points), MRS 2/5 (1.61 points), Pumiselect (1.51 points), GF 677 (1.49 points). As for both varieties, rootstock Lesiberian reached on average the lowest values (1.31 points). On the other hand, St. Julien A (1.11 points) proved as the least susceptible rootstock to PPV pathogen from the evaluated

collection but only combination with variety Royal Glory was evaluated. The average grade of 1.54 was obtained in the point grading evaluation of PPV symptoms on flowers, leaves and fruits, which represents mild or medium pathogen manifestation.

Generally, the PPV symptoms were present mostly on flowers and least on fruits. Low correlation dependence was proved between symptoms on flowers and symptoms on leaves (r = 0.10515) as well as between symptoms on flowers and fruits (r = 0.10102). Low correlation was also proved in comparison of symptoms on leaves and fruits (r = 0.20878).

CONCLUSIONS

The occurrence of PPV symptoms on fruits in young peach orchard was monitored in summer 2010. The occurrence of PPV was expressed in percentage with following results:

- The most frequent occurrence of PPV showed variety 'Royal Glory' (68.13% of trees).
- As for the combination variety/rootstock were the PPV symptoms most often detected in variety 'Royal Glory' grafted on rootstock Julior (100% trees).
- In terms of the rootstocks evaluation, PPV symptoms were most often found in trees grafted on MRS 2/5 rootstock (94.78% trees).
- In overall observation, PPV symptoms were evaluated in 62.47% tree.

PPV symptoms on flowers, leaves and fruits were evaluated separately in 2011 with results:

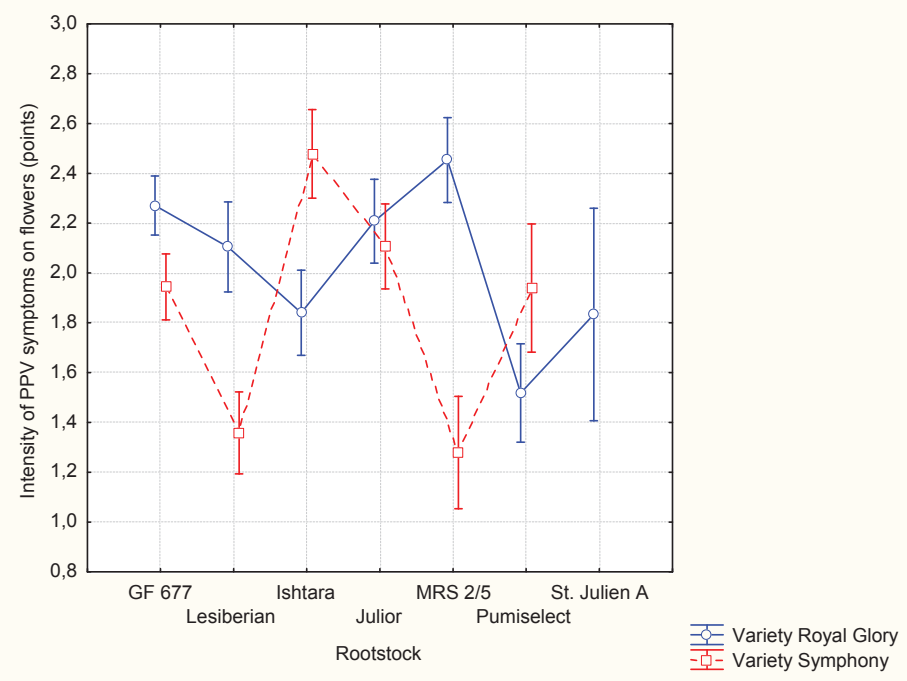
- After overall evaluation of the intensity of PPV symptoms visible on flowers, leaves and fruits was assessed that the highest intensity had variety 'Symphony' (1.64 points), as for the rootstocks the highest symptoms were detected in trees on Julior rootstock (1.84 points).
- As for varieties, the highest intensity of PPV symptoms was found on flowers in variety Royal Glory (2.04 points).
- As regards the evaluation of rootstocks the highest intensity of PPV symptoms on flowers was assessed in rootstock Julior (2.16 points).
- The highest intensity of symptoms on leaves was detected in variety 'Symphony' (1.77 points).
- In terms of rootstocks the highest intensity of PPV symptoms on leaves was observed in Julior rootstock (2.03 points).
- Variety 'Symphony' showed most frequent symptoms on fruits (1.27 points).
- As regards the rootstocks, Julior rootstock, fruits of cv. Symphony showed highest intensity of PPV symptoms (1.33 points).
- All the PPV symptoms were present mainly on flowers and less on fruits.

III: *Definition of significant differences in the intensity of PPV symptoms on flowers, leaves and fruits among the individual combinations compared to the control combination 'Royal Glory'/GF 677, graded by points*

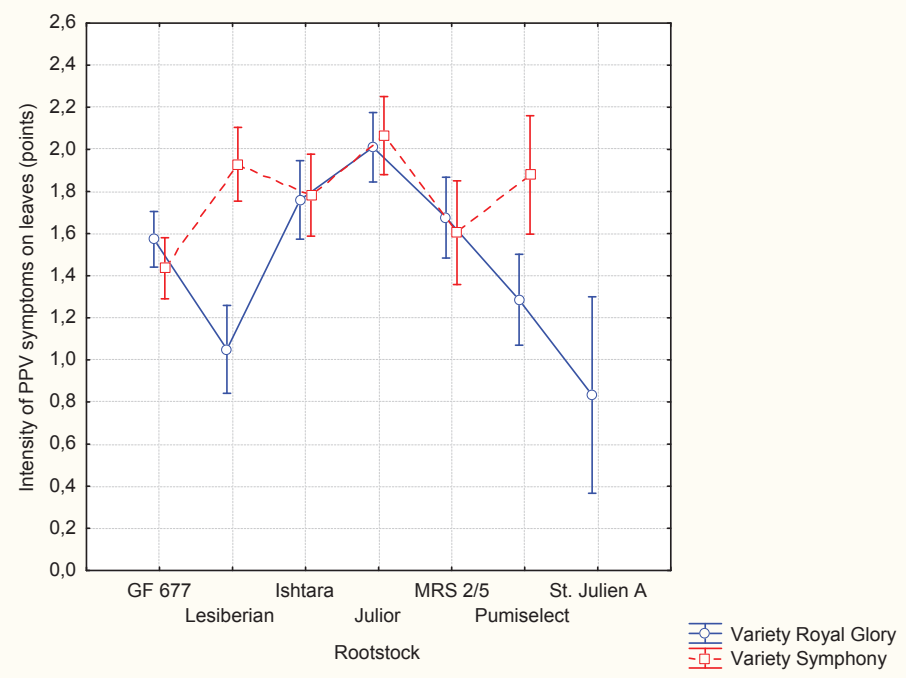
Control variety/ rootstock	Rootstock	Symptoms/flowers average +/– SD	Symptoms/leaves average +/– SD	Symptoms/fruits average +/– SD
Royal Glory/GF 677	GF 677	2.27 +/– 0.06 a	1.57 +/– 0.07 a	0.51 +/– 0.07 a
Royal Glory/GF 677	Lesiberian	2.10 +/– 0.09 a	1.05 +/– 0.11 a	0.76 +/– 0.11 a
Royal Glory/GF 677	Ishtara	1.84 +/– 0.09 a	1.76 +/– 0.10 a	0.93 +/– 0.11 a
Royal Glory/GF 677	Pumiselect	1.52 +/– 0.10 a	1.29 +/– 0.11 a	0.57 +/– 0.13 a
Royal Glory/GF 677	St. Julien A	1.83 +/– 0.22 a	0.83 +/– 0.24 a	0.69 +/– 0.24 a
Royal Glory/GF 677	Julior	2.21 +/– 0.09 b	2.01 +/– 0.08 a	1.11 +/– 0.09 b
Royal Glory/GF 677	MRS 2/5	2.45 +/– 0.09 b	1.68 +/– 0.10 a	1.28 +/– 0.10 b
average		2.03	1.46	0.84

IV: *Definition of significant differences in the intensity of PPV symptoms on flowers, leaves and fruits among the individual combinations compared to the control combination 'Symphony'/GF 677, graded by points*

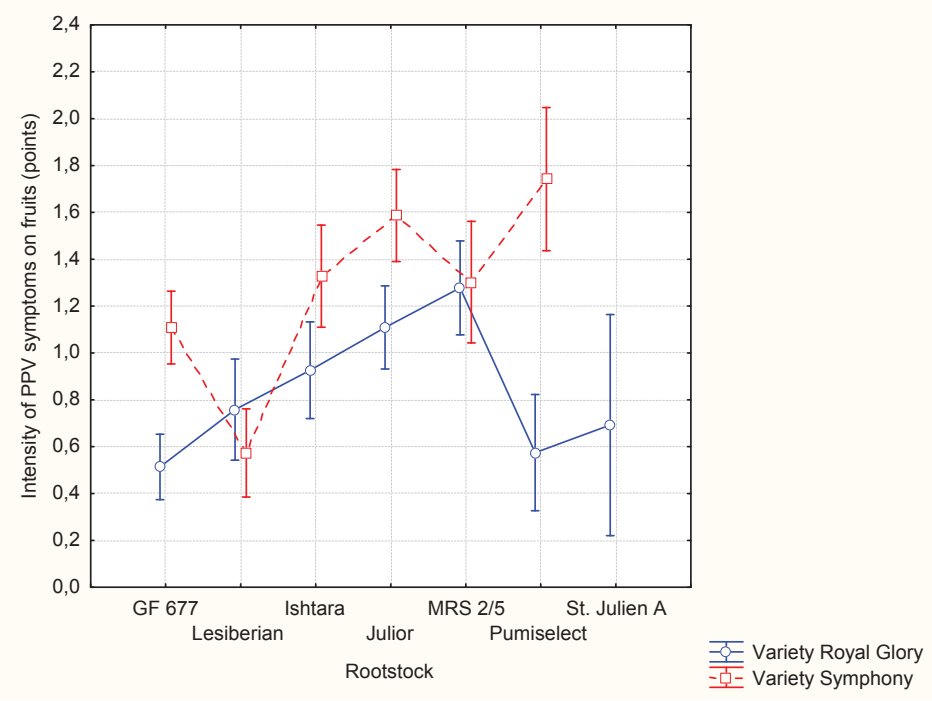
Control variety/ rootstock	Rootstock	Symptoms/flowers average +/– SD	Symptoms/leaves average +/– SD	Symptoms/fruits average +/– SD
Symphony/GF 677	GF 677	1.94 +/– 0.07 a	1.44 +/– 0.07 a	1.11 +/– 0.08 a
Symphony/GF 677	Lesiberian	1.36 +/– 0.08 a	1.93 +/– 0.09 a	0.57 +/– 0.10 a
Symphony/GF 677	Ishtara	2.48 +/– 0.09 a	1.78 +/– 0.10 a	1.33 +/– 0.11 a
Symphony/GF 677	Pumiselect	1.94 +/– 0.13 a	1.88 +/– 0.14 a	1.74 +/– 0.16 a
Symphony/GF 677	Julior	2.11 +/– 0.09 a	2.07 +/– 0.09 b	1.59 +/– 0.10 a
Symphony/GF 677	MRS 2/5	1.28 +/– 0.11 a	1.60 +/– 0.13 a	1.30 +/– 0.13 a
average		1.85	1.78	1.27



1: *Statistical evaluation of PPV symptoms intensity on flowers within individual combination of variety/ rootstock*



2: *Statistical evaluation of PPV symptoms intensity on leaves within individual combination of variety/ rootstock*



3: *Statistical evaluation of PPV symptoms intensity on fruits within individual combination of variety/rootstock*

SUMMARY

The aim of this study was to evaluate the intensity of PPV symptoms in various parts of trees (flowers, leaves, fruits) in the young peach orchard (6 years after planting) in two varieties grafted on 7 different rootstocks. The cultivars grafted on Julior and MRS 2/5 were identified as most infected by PPV pathogen. On the other hand, the lowest percentage of PPV occurrence was observed on peach cultivars grafted on rootstocks Lesiberian and GF 677. The highest values of PPV symptoms were observed on flowers, while fruits showed lowest intensity in both varieties.
Variety 'Royal Glory' grafted on rootstocks Julior and MRS 2/5 proved significantly higher intensity of symptoms on flowers as well as on fruits, while variety 'Symphony' grafted on rootstock Julior showed significantly higher intensity of symptoms only in leaves.

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