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Discussion Session on *Iris Yellow Spot Virus* (IYSV) of Onion:

IYSV Challenges to the Onion Industry in Washington
(modified from a paper prepared for the 2004 National Allium Research Conference)

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Abstract
Iris yellow spot virus (IYSV) has spread rapidly throughout the western US in the past 5+ years. In Washington, IYSV was first observed in 2002 in five onion seed crops in the northern Columbia Basin. In 2003, IYSV was detected in bulb and seed crops in this vicinity. In 2004, IYSV was detected in bulb and seed crops throughout the Columbia Basin, and in bulb crops in the Walla Walla region, but was most prevalent in furrow-irrigated crops in the northern Basin. A severe outbreak of IYSV in a cultivar trial demonstrated significant differences in susceptibility of 46 cultivars. The impact of IYSV on bulb yield is illustrated by the regression: $Y = 65.1 - 0.3X_1 - 0.3X_2 – 0.6X_3$ ($R^2 = 0.21$), where Y = mean bulb yield (tons/acre), and X_1, X_2, and X_3 = mean % plants with mild, moderate, and severe IYSV symptoms. The impact of IYSV on onion seed production was investigated in an open pollinated, direct-seeded onion seed crop. The incidences of IYSV and lodged scapes (from coalescing IYSV lesions) ranged from 24-81% and 7-20%, respectively, across the crop. Regression of seed yield/umbel (Y) vs. % infected plants (X) demonstrated: $Y = 1.27g – 0.008X$ ($R^2 = 0.75$), with a 41% reduction in yield from the west to east sides of the crop. A 12 acre, furrow irrigated, hybrid seed crop planted in July 2004 was abandoned in September 2004 as a result of severe IYSV infection of the male parent (estimated loss of ~$100,000). The green-bridge effect created by proximity of biennial seed crops and annual bulb crops in the Columbia Basin is discussed with respect to options and research priorities for management of IYSV.

The onion bulb and seed industry in Washington
Onion seed crops are grown on 700 to 900 acres annually in the Columbia Basin of central Washington, with a per-acre value of $2,800 to $4,000 for open pollinated seed crops and $4,000 to $6,000 for hybrid seed crops. Despite the minor acreage, onion seed crops in Washington produce up to 20% of the US and world supply of onion seed. In addition, 16-18,000 acres of storage onions are harvested annually in Washington with a farmgate value of $58-60 million. Washington ranks third in the US for acreage of storage onions. Approximately 50% of the storage onions and onion seed grown in Washington are exported.

Iris yellow spot virus (IYSV) in Washington
Iris yellow spot virus (IYSV) is an emerging disease of Allium crops. In the US, the virus was first reported in Idaho in the early 1990s, where it was limited primarily to onion seed crops. IYSV has since spread rapidly throughout the western US, and in 2004 was reported in Georgia. In Washington, symptoms of IYSV were first observed in 2002 by Pelter and du Toit, in five onion seed crops in the northern Columbia Basin at incidences ranging from <1% to approximately 20% in individual crops. However, attempts by two independent labs to use an

ELISA assay to confirm the presence of IYSV in samples from these crops were inconclusive. In 2003, Pelter and du Toit sent symptomatic samples from an onion seed crop in the northern Basin to Pappu, who used a reverse-transcriptase polymerase chain reaction (RT-PCR) assay followed by cloning and sequencing of part of the viral genome to verify the presence of IYSV in this state. Similarly, the virus was detected in samples from two onion bulb crops, each located within 2 miles of the symptomatic onion seed crop.

In 2004, IYSV was found to be widespread throughout the Columbia Basin. Symptomatic plants sampled from bulb crops in the northern, central, and southern Basin all tested positive for IYSV. In addition, the presence of IYSV was confirmed in the Walla Walla region of sweet onion production. Although symptoms were observed in every bulb crop examined, the incidence and severity of infection was greatest in furrow-irrigated crops located in the northern Columbia Basin. The disease was observed primarily along the edges of crops growing under overhead irrigation systems, reflecting more effective management of the onion thrips (*Thrips tabaci*) vector compared with drip and furrow irrigation.

Impact of IYSV on onion seed production

Although IYSV has not been demonstrated to be seedborne, the virus has been reported to cause significant reductions in seed yield. In July 2004, an open pollinated, direct-seeded onion seed crop in the northern Columbia Basin was diagnosed with a severe outbreak of IYSV approximately one month prior to harvest. A distinct gradient in incidence and severity of IYSV was observed across the field, with more severe infection towards the western edge of the crop. The incidence and severity of IYSV were recorded in replicated 10' plots near the western and eastern edges of the crop on 27 July 2004. Severity of IYSV was recorded for each plant on a scale of 0 to 4, where 0 = no symptoms, 1 = 1 to 2 small lesions on the scape, 2 = >2 medium-sized lesions on the scape, 3 = lesions coalescing on the scape, and 4 = scape lodged as a result of IYSV lesions. Umbels were harvested from each plot. The seed was dried, threshed, cleaned, weighed, and germination assays completed. Results are presented in **Table 1** and **Fig. 1**. In addition, the seed company reported a final yield of ~200 lb/acre after cleaning the seed, compared to typical yields of 800-1,000 lb seed/acre recorded for this cultivar in the northern Columbia Basin under similar production practices in previous years.

Table 1. Impact of IYSV on yield of an open pollinated onion seed crop in Washington

Location of plots (severity of IYSV)	Incidence of symptomatic plants (%)	Incidence of lodged plants (%)	Mean severity of IYSV (0 to 4)	Seed yield/umbel (g)	Seed germination (%)
East (moderate)	24.0 a	6.5 a	0.53 a	1.1 a	92.9 a
West (severe)	80.8 b	20.0 b	1.98 b	0.6 b	91.1 a

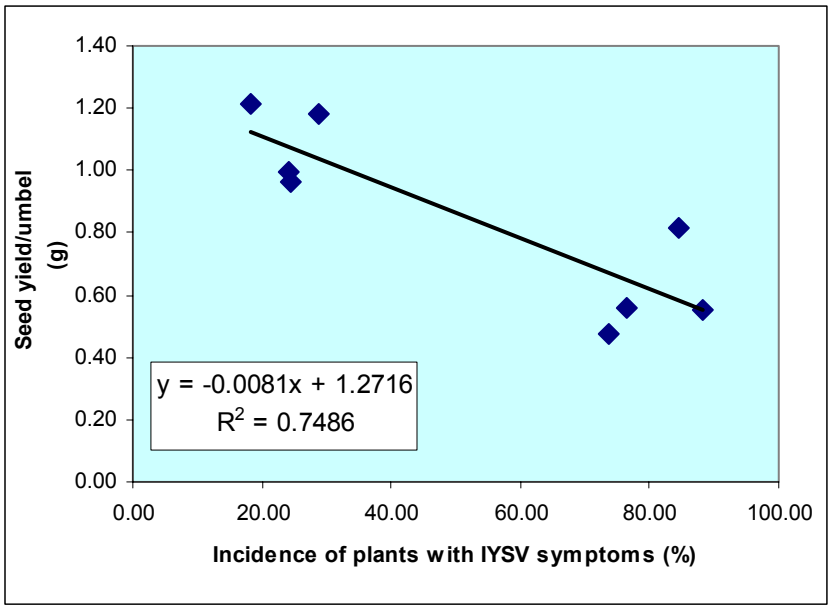


Fig. 1. Relationship between seed yield (g/umbel) and incidence of plants with IYSV in an open pollinated onion seed crop in 2004

In August 2004, Pelter and du Toit examined a 12 acre, furrow irrigated, hybrid onion seed crop that was planted in the northern Columbia Basin in July 2004. The seed crop was located <1 mile from several bulb crops infected with IYSV. Plants of the female parent had a low incidence and severity of IYSV infection, but the male parent was so severely infected with IYSV that plants were stunted and dying. The entire crop, at an estimated value of ~$100,000, was subsequently abandoned as a result of IYSV.

IYSV in the 2004 WSU Onion Cultivar Trial

The furrow-irrigated bulb crop in which the 2004 Washington State University Onion Cultivar Trial was located near Quincy, WA, succumbed to a severe outbreak of IYSV. IYSV incidence and severity ratings (latter on a scale of 0 to 3, where 0 = no symptoms, 1 = mild, 2 = moderate, and 3 = severe symptoms) were made on 11 August 2004 for each of three replicate plots of 46 cultivars. Yield measurements (total and by bulb size) were taken for replicate plots of each cultivar. All cultivars proved susceptible to IYSV with the mean incidence of IYSV ranging from 58% for 'Tioga' to 97% for 'EX 15122' (**Fig. 2**). The incidence of plants infected with IYSV was <70% for only 4 of 46 cultivars ('BGS 196', 'Golden Spike', 'T-433', and 'Tioga'), all 4 of which had no plants with severe symptoms; and was >90% for 13 of 46 cultivars (**Fig. 2**). The mean±standard deviation of the incidence of plants with mild, moderate, and severe IYSV severity ratings was 39±11, 37±12, and 7±8%, respectively.

Significant differences in yield were observed among cultivars (**Fig. 3**). Averaged over the 46 cultivars, the regression relationship between yield and incidence of plants infected with IYSV was:

Mean bulb yield (tons/acre) = 65.10 – 0.32 X_1 – 0.30 X_2 – 0.59 X_3 (R^2 = 0.21, CV = 24.7), where X_1, X_2, and X_3 = mean % plants with mild, moderate, and severe IYSV severity ratings, respectively.

This regression relationship was improved **(R^2 = 0.88, CV = 12.1)** by accounting for inherent differences in yield among cultivars:

Bulb yield (tons/acre) = 33.45 + $(cultivar) – 0.11 X_1 – 0.14 X_2 – 0.12 X_3, where $(cultivar) ranged from -5.83 (for 'Copra') to +33.03 (for 'Ranchero') (**Fig. 3**).

The percentage colossal (>4" diameter) and jumbo (3-4" diameter) bulbs was significantly less than that recorded in the 2003 WSU Onion Cultivar Trial, in which IYSV was not observed. Although the 2003 trial was under center pivot irrigation and did not include exactly the same set of cultivars as the 2004 trial, these results support the results of researchers in Colorado (Schwartz and Gent) who have demonstrated a reduction in bulb size resulting from IYSV infection. Significant negative correlations were demonstrated between incidence of IYSV and total yield as well as percentage jumbo bulbs (**Table 2**, **Fig. 3**). Similarly, the incidence of plants with moderate and severe IYSV infections was significantly negatively correlated with total yield and percentage jumbo bulbs, and positively correlated with small and medium bulbs (**Table 2**, **Fig. 3**).

Table 2. Correlation coefficients of mean % plants infected with IYSV with mean yield (tons/acre) for three replications of 46 cultivars in the 2004 WSU Onion Cultivar Trial.

	Mean % IYSV			
Yield	**Total**	**Mild (severity = 1)**	**Moderate (severity = 2)**	**Severe (severity = 3)**
Total (tons/acre)	-0.43 **[a]	0.31 *	-0.36 *	-0.40 **
Size (% of bulbs)				
Colossal (>4")	-0.12	0.16	-0.11	-0.20
Jumbo (3-4")	-0.41 **	0.40 **	-0.40 **	-0.44 **
Medium (2¼-3")	0.36 *	-0.28	0.33 *	0.31 *
Small (<2¼")	0.35 *	-0.43 **	0.37 *	0.47 **

[a] * and ** = significant at a probability of P = 0.05 and 0.01, respectively.

Fig. 2 Mean incidence (%) of plants infected with IYSV on 11 August 2004 in the WSU Onion Cultivar Trial (total and by severity rating, where 1 = mild, 2 = moderate, and 3 = severe symptoms).

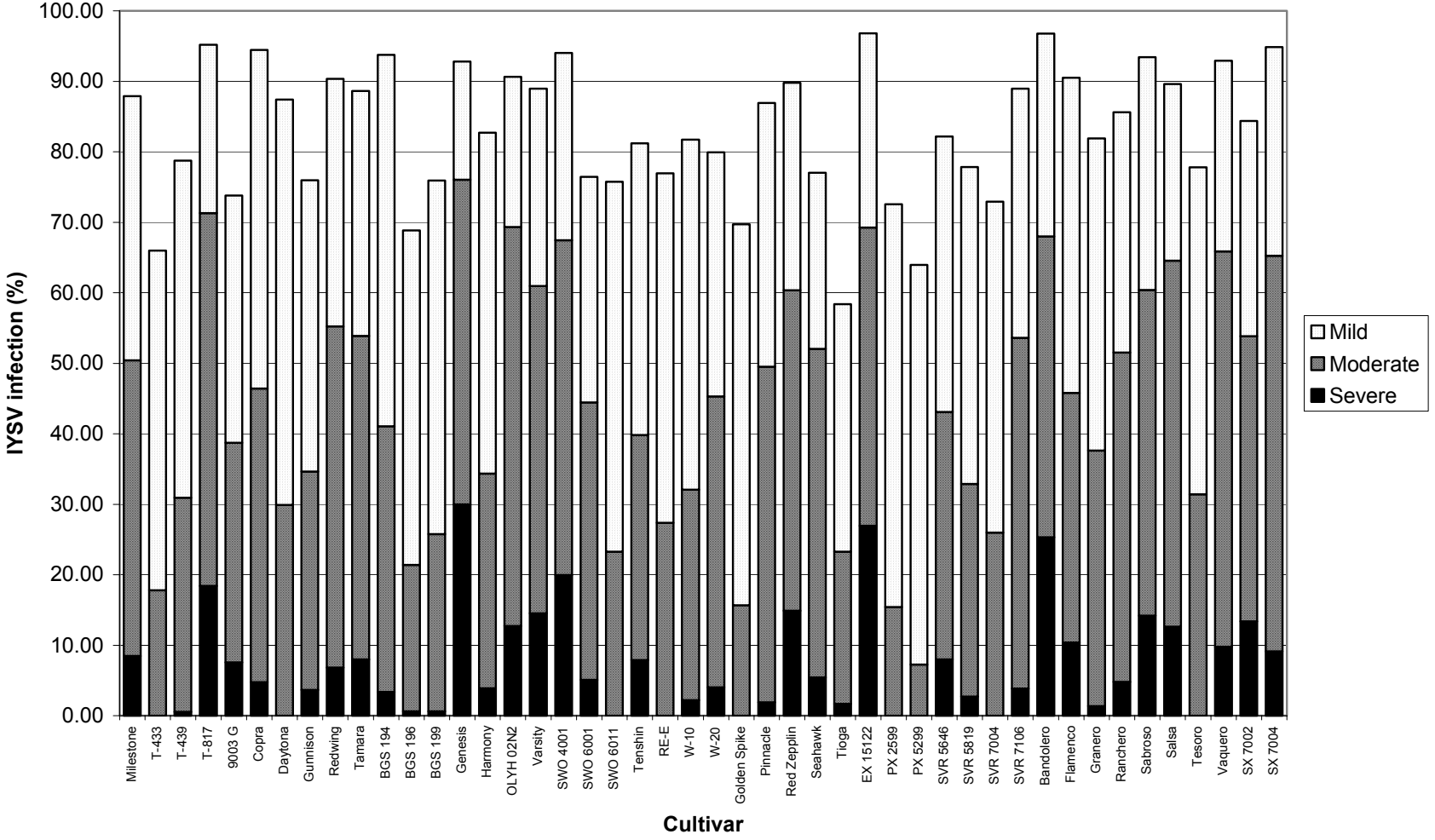
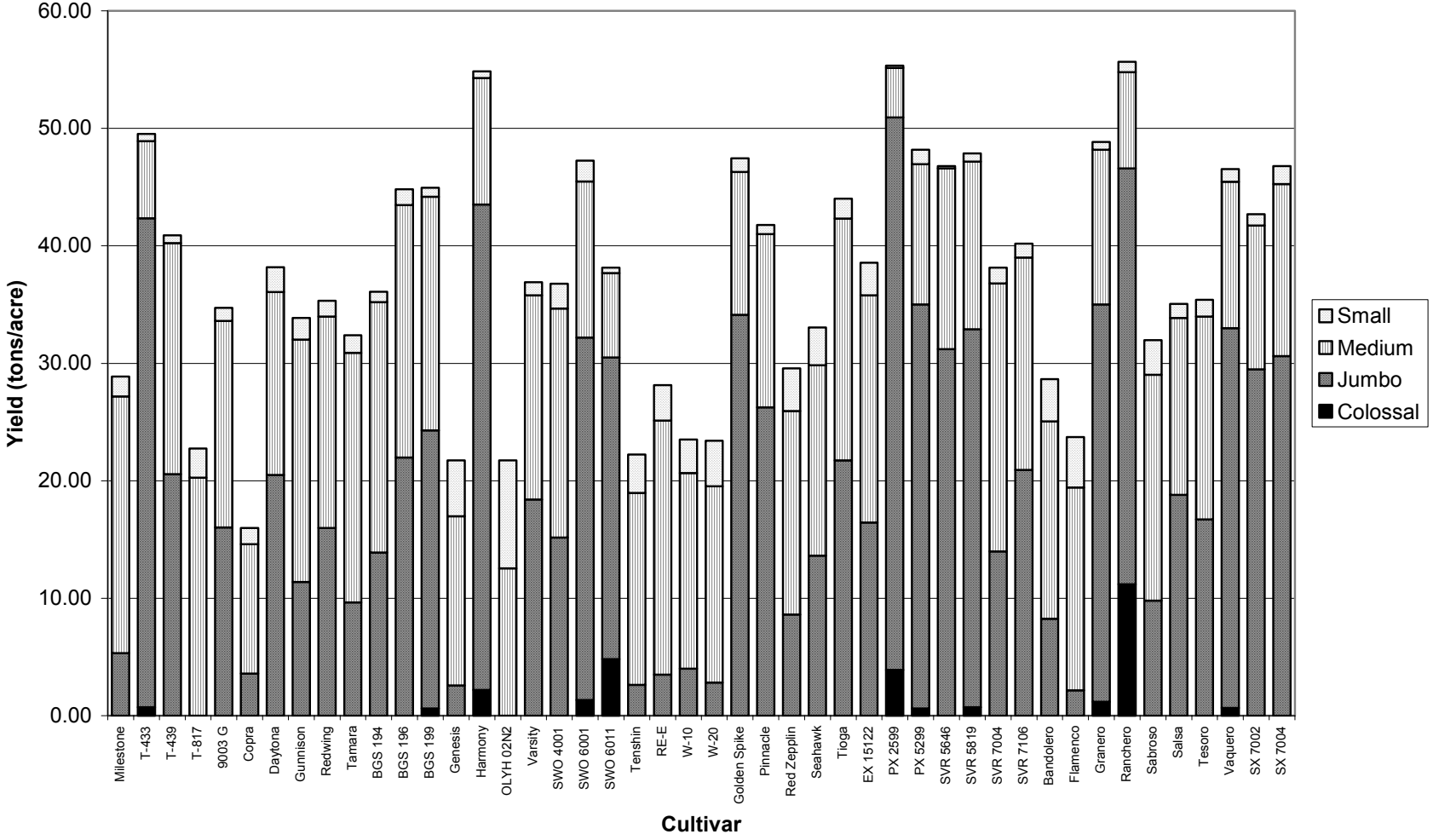


Fig. 3. Mean usable yield (tons/acre) of 46 cultivars harvested on 23 September 2004 in the WSU Onion Cultivar Trial (total and by bulb size).



Conclusions

The green-bridge effect created by the proximity of biennial onion seed crops and annual bulb crops in the Columbia Basin of Washington may have exacerbated the spread of IYSV in Washington. However, similar rapid dissemination of IYSV was reported in the region of onion bulb production in Colorado, where very little (if any) onion seed is produced. Efforts to control the vector of IYSV are hampered by rapid development of onion thrips populations with resistance to insecticides. Research by Schwartz and Gent at Colorado State University has demonstrated foliar applications of Actigard (acibenzolar-S-methyl, a systemic-acquired-resistance product manufactured by Syngenta Crop Protection), significantly reduced yield losses caused by IYSV in Colorado, where the virus has caused significant losses in bulb crops. They achieved more effective management of IYSV by combining Actigard applications with neonicotinyl insecticide seed treatments and/or foliar applications. In 2004, a Section 18 registration was approved for Actigard for control of IYSV in bulb crops in Colorado. Research is needed to evaluate the potential efficacy of Actigard and/or neonicotinyl insecticides for management of IYSV in bulb and seed crops in Washington, particularly given the extended biennial season through which seed crops must be protected from the vector and virus.

Research is also needed to evaluate the efficacy of potential recommendations for management of IYSV in Washington, including:

- Isolating seed and bulb crops;
- Alternatively, planting bulb-to-seed crops instead of direct-seeded seed crops, with isolation of the bulb beds prior to transplanting the following spring;
- Fumigating bulbs used in bulb-to-seed crops prior to transplanting, to avoid moving viruliferous thrips with the bulbs;
- Implementing production practices that create less favorable conditions for the vector, e.g., overhead or drip irrigation vs. furrow irrigation, organic mulches, etc.;
- Managing alternative hosts of IYSV (e.g., weeds that prove to serve as sources of inoculum);
- Identifying IYSV resistant (or tolerant) ad thrips tolerant cultivars adapted to the Columbia Basin;
- Determining the optimal timing of insecticide and SAR applications for greater efficacy against thrips and IYSV.

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