A yield loss conversion factor for peas moderately affected by fusarium root rot [1]

P. K. Basu [2]

Losses in oven-dry seed weight from moderate root rot *(Fusarium solani* f. sp. *pisi)* in several commercial pea *(Pisum sativum)* cultivars grown in a Fusarium-infested field at Ottawa were 27.4%. 20.5% and 17.3% in 1974, 1975 and 1976, respectively. Despite variation in cultivar yield response over the three-year period, it was concluded that a yield loss conversion factor of 0.23 was reasonable for moderately affected plants which usually do not show distinct aboveground disease symptoms.

Can. Plant Dis. Surv. 58:1, 5-8. 1978

Les pertes de rendement en graines (poids sec) attribuables a une infection moderee de pourridie fusarien *(Fusarium solani* f. sp. *pisi)* sur plusieurs cultivars commerciaux de pois *(Pisum sativum),* cultives a Ottawa dans un champ infeste, se sont etablies a 27.4% en 1974, 20.5 en 1975 et 17.3 en 1976. Malgré les differences varietales observees durant ces trois annees, on peut raisonnablement proposer un facteur de conversion de 0.23 pour evaluer les pertes de rendement de plantes moderement atteintes par la maladie, mais dont les parties aeriennes ne manifestent pas de symptômes nets.

Pea (Pisum *sativum* L.) root rot caused by *Fusarium solani* (Mart.) Sacc. f. sp. *pisi* (F. R. Jones) Snyd. & Hans. is widely distributed in Canada (1). In an earlier study (2) it was found that plants had to be grouped into severe and moderate categories in order to estimate pea yield loss. The symptoms of the moderately affected plants ranged from a trace to 5 cm brown to black discoloration of the lower stem and tap root region, lateral roots were usually clean and plants apparently healthy except for normal senescence of a few lower leaves. The average yield reduction in the severe category was about 60% (2,3). However, the effects of moderate infection on pea yield remained inconclusive largely because of insufficient data. Hence further experimental work was undertaken to determine the yield loss of field-grown peas showing moderate levels of disease.

Materials and methods

In a continuation of the pea root rot study initiated earlier at Ottawa (2), several commercial pea cultivars were tested in 1975 and 1976 in the same Fusarium-infested field (0.28 ha) where root rot had developed each year since 1971.

In 1975, the infested area was planted with 29 pea cultivars (Table 1) using four replications in plots of 1.8 x 2.1 m size in a randomized block design. In 1976, 12 cultivars (Table 2) were planted using eight replications with the same size of plots. Commercially fungicide-treated pea seeds, obtained from Asgrow Seed Co., Kalamazu, Michigan, U.S.A., were sown with a grain drill at a spacing of 5 x 15 cm in early June each year. Plants were rated for disease and harvested when the majority of the pods of apparently healthy plants had filled approximately 60 to 70 days after planting. One hundred plants were dug along the diagonals of each plot, their roots were washed and classified into healthy, moderate (root rot 1-3) and severe (root rot 4) categories (2). In addition, oven-dry (48 h at 80°C) seed weights (g) were obtained from 25 healthy and 25 moderately affected plants from each plot to determine the yield loss of the latter group.

Results and discussion

The effects of moderate root rot development on pea yield loss will be discussed on the basis of data obtained in the Fusarium-infested field at Ottawa during three years (1974-1976). The average yield loss of 10 cultivars with moderate root rot was 27.4 ± 2.6% in 1974 as reported earlier (2). The loss was 20.4 ± 2.5% for 29 cultivars in 1975 (Table 1) and 17.5 ± 2.6% for 12 cultivars in 1978. (Table 2). It is noteworthy that the standard error values, 2.6, 2.5 and 2.6 were within 15% of their respective means. Such values are considered acceptable for crop-disease-loss assessmerit (4). However, the yield loss of moderately affected plants of different cultivars ranged from zero to nearly 50% (Table 3). This makes the grouping of cultivars based on the percent yield loss of the moderately affected plants inadequate. Six of the cultivars tested each year also showed large variation in yield loss from moderate root rot (Table 4). The loss values of cultivars, such as, Asgrow #4683 and Charger remained reasonably consistent, but those of Anoka, Trojan and Venus decreased while the losses in Nugget increased during the three-year period. The causes of these changes and also the presence of two negative loss

[1] *Contribution No. 530 from Ottawa Research Station, Research Branch, Agriculture Canada, Ottawa, Ontario K1A 0C6*

[2] *Plant Pathologist, Ottawa Research Station*
Accepted for publication February 8, 1978

Table 1. Percentage of plants in healthy and moderate root rot categories, their yield** and yield loss of moderately affected plants of 29 pea cultivars grown in a fusarium-infested field at Ottawa, 1975

Cultivar	Healthy		Moderate		Per plant yield loss of moderate (%)
	%	Yield	%	Yield	
Anoka	29.5	5.6	40.8	3.5	37.5
Beagle	14.3	2.5	54.0	2.3	8.0
Canjoy	29.3	1.0	67.8	0.9	10.0
Charger	30.0	3.1	40.5	2.4	22.6
Dark Skin Perfection	8.3	3.5	59.0	3.2	8.6
Dart	47.5	2.0	20.5	1.3	35.0
Dot	25.5	0.9	37.5	0.9	0.0
Esquire	33.0	1.5	52.0	1.2	20.0
Green Arrow	21.5	3.4	51.5	3.4	0.0
Green Bay	8.3	3.0	56.0	2.9	3.3
Hyalite	21.5	2.9	47.0	1.7	41.8
Jade	16.8	3.1	72.5	2.1	32.6
Mars	26.0	4.7	49.5	2.6	46.8
Medalist	33.3	1.8	60.7	1.6	11.1
Nugget	8.0	2.7	64.3	2.4	11.1
Pacemaker	17.8	3.8	28.8	2.8	26.3
scout	36.2	1.8	50.8	2.1	-16.6
Signet	38.3	3.9	39.3	2.4	38.5
Small Sieve Freezer	20.4	2.6	69.3	1.9	26.9
Sparkle	18.0	1.5	55.5	2.6	36.6
Target	31.0	1.5	44.0	1.2	20.0
Trojan	9.8	3.9	62.7	3.2	17.9
Trumpet	4.0	3.5	22.0	3.7	-5.7
Venus	22.3	4.4	42.4	3.3	25.0
Viking	20.2	2.2	45.0	1.6	27.8
Wyola	17.8	4.2	30.3	2.9	31.0
#4683 (Asgrow)	42.0	2.6	29.0	2.5	3.8
#A-45 (Asgrow)	38.3	1.8	53.8	1.6	11.1
#XPF3007 (Asgrow)	4.5	1.7	54.8	1.4	17.6
Mean ± SE	23.2 ± 2.2	2.9 ± 0.2	48.3 ± 2.6	2.3 ± 0.2	20.5 ± 2.5

**Yield represents oven-dry seed weight (g) per plant derived from 25 plants from each of four replications.

Table 2. Percentage of plants in healthy and moderate root rot categories, their yield** and yield loss of moderately affected plant of 12 pea cultivars grown in a fusarium-infested field at Ottawa, 19'76

Cultivar	Healthy		Moderate		Per plant yield loss of moderate (%)
	%	Yield	%	Yield	
Alaska	53.3	1.3	37.0	1.1	15.4
Anoka	10.8	2.3	73.3	2.2	4.3
Charger	34.0	1.5	57.3	1.2	20.0
Dart	25.3	1.3	55.5	1.0	23.1
Medalist	29.8	1.6	63.3	1.5	6.3
Nugget	14.8	1.7	65.8	1.1	35.3
Target	29.5	2.2	52.0	1.7	22.7
Trojan	25.3	1.7	62.5	1.5	11.8
Trumpet	39.5	2.2	48.0	1.7	22.7
Venus	24.3	2.7	64.0	2.3	14.8
Wyola	27.5	1.3	62.8	1.0	23.1
Mean ± SE	31.2 ± 4.1	1.8 ± 0.1	55.9 ± 3.6	1.5 ± 0.1	17.3 ± 2.6

*Yield represents oven-dry seed weight (g) per plant derived from 25 plants from each of eight replications.

Table 3. Tentative grouping of several pea cultivars based on the range of percent yield loss'' of moderately affected plants grown in a fusarium-infested field at Ottawa in 1974, 1975 and 1976

	Range of percent yield loss				
Year	0-10	11-20	21-30	31-40	41-50
1974	#4683 (Asgrow)	D.S.P.†	Charger	Jade	Anoka
				Trojan	#XPF 3007 (Asgrow)
	Nugget	Mars		Venus	
1975	#4683 (Asgrow)	#A-45 (Asgrow)	Charger	Anoka	Hyalite
			Pacemaker	Dart	Mars
	Beagle	#XPF 3007 (Asgrow)	Small Sieve		Jade
			Freezer		
	Canjoy			Signet	
	D.S.P.†	Esquire	Venus	Sparkle	
	Dot	Medalist	Viking	Wyola	
	Green Arrow	Nugget			
	Green Bay	Target			
		Trojan			
1976	#4683 (Asgrow)	Alaska	Dart		
		Charger	Target		
	Anoka	Trojan	Trumpet		
	Medalist	Venus	Wyola		

''Percent yield loss based on oven-dry seed weights (g) of healthy and moderately affected plants
†Dark Skin Perfection.

Table 4. Percent yield loss'' of moderately affected plants of six pea cultivars grown in a fusarium-infested field at Ottawa in 1974, 1975 and 1976

Cultivar	1974	1975	1976
#4683 (Asgrow)	6.6	3.8	7.7
Anoka	48.8	37.5	4.3
Charger	20.8	22.6	20.0
Nugget	7.7	11.1	35.3
Trojan	25.9	17.9	11.8
Venus	34.0	25.0	14.8

''Percent yield loss based on oven-dry seed weights (g) of healthy and moderately affected plants.

values have not been further investigated. Notwithstanding such (natural) variations, it seemed appropriate to derive an average loss value for the moderate root rot category with the available data. The three-year average loss for all cultivars tested was 23% which can be expressed as a yield loss conversion factor of 0.23. This factor multiplied by the percentage of plants in the moderate category (Tables 1 and 2) would provide an estimate of yield loss in field plots or in growers' fields having predominantly moderately infected plants. For example, 71.6% of the plants sampled showed moderate root rot symptoms during the 1971 pea disease survey in Ontario (1); the remaining plants were healthy. Using the factor of 0.23, the estimated pea yield loss in Ontario in that year would have been 16.5%. Similar loss estimates could also be made for other provinces where the percentage of moderately affected plants were known (1). In order to estimate an

overall loss from both moderate and severe root rot the loss conversion factors of 0.23 and 0.61 (2,3) should be used, respectively, for the two categories of diseased plants. It is noteworthy that, unlike severely affected plants, moderately affected ones do not usually show aboveground symptoms. Consequently the percentage of such plants or the area occupied by them in a field would have to be determined, from ground surveys (1). The aerial photographic methods, as employed for the determination of severe root rot or drought affected areas (3), may not be applicable for moderately affected plants.

Acknowledgement
The author wishes to thank N. J. Brown for his excellent technical assistance.

Literature cited

1 Basu, P.K., R. Crete, A.G. Donaldson, C.O. Gourley, J.H. Haas, F.R. Harper, C.H. Lawrence, W.L. Seaman, H W.N. Toms, S.J. Wong and R.C. Zimmer. 1973. Prevalence and severity of diseases of processing peas in Canada 1970-71. Can. Plant Dis. Surv. 53: 49-57.

2. Basu, P.K., N.J. Brown. R. Crete, C.O. Gourley, H.W. Johnston, H.S. Pepin, and W.L. Seaman. 1976. Yield loss conversion factors for fusarium root rot of peas. Can. Plant Dis. Surv. 56: 25-32.

3. Basu, P.K., H.R. Jackson and V.R. Wallen. 1978. Estimation of pea yield loss from severe root rot and drought stress using aerial photographs and a loss conversion factor. Can. J. Plant Sci. 58: 159-164.

4. LeClerg, E.L. 1970. Field experiments for assessments of crop losses. *In* Crop loss assessment methods. Food and Agriculture Organization of the United Nations, Rome, pp. 2.1-2.1/16.