INFLUENCE OF SOIL MOISTURE, SEEDING DATE AND RHIZOCTONIA SOLANI ISOLATES (AG2-1 AND AG4) ON DISEASE INCIDENCE AND YIELD IN CANOLA.

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INTRODUCTION

In a semi-arid region such as Saskatchewan, an increase in soil moisture by irrigation increases yield of canola (Thomas 1984). Reports in "Irrigation on the Prairies - 1985" have shown that irrigation is increasing in the prairie provinces. Soil moisture is a potential factor affecting the incidence of diseases in canola.

Damping-off and root rot are serious diseases in the Peace River region of Alberta where some fields have been reported to contain 80-100% infected plants. Disease surveys show low incidence of these diseases in Saskatchewan (Petrie & Vanterpool 1970, P.R. Verma unpublished data) and Manitoba (Rimmer & Platford 1982). These diseases reduce the number of seedlings in a crop and also affect mature plants.

The effects of soil moisture on the development of Rhizoctonia solani has been studied by several workers in different crops. However, there has been no general agreement as to whether high or low soil moisture increases the development of the fungus. Das and Western (1959), Bateman (1961) and Pitt (1964) showed that disease incidence decreases with increasing soil moisture. Jones et. al. (1926), Wright (1957) and Anderson (1982) stated that R. solani

was favoured by relatively abundant soil moisture.

Seeding date influences several factors that affect plant growth. One of them is soil temperature. By seeding canola early or late, the effects of soil temperature on emergence, disease incidence, and yield can be studied. Controversy exits in the literature on the effect of soil temperature on the infection of plants by R. solani. Walker (1928) Dickinson (1930), Abdel-Salam (1933), Leclerg (1941) and Smith (1946) stated that high temperature favoured the development of R. solani. But Richard (1923), Pitt (1964) and Anderson (1982) showed that R. solani grew well at low temperature.

A possible explanation lies in changes in the taxonomy of the fungus. Different isolates of R. solani can be classified into anatomosis groups (AG), each of which is a genetically separate and independent unit (Anderson, 1982). Kaminski and Verma (1985) recently characterized 81 R. solani canola isolates from Saskatchewan and found that they all belong to AG2-1 or AG4, both in almost equal proportion. They also found that AG2-1 isolates grew at 2 C but not at 36 C. AG4 isolates did not grow at 2 C but did grow at 36 C. The optimum temperatures for AG2-1 and AG4 were 24 and 26 C, respectively. Work in the growth chamber by one of us (S.M. Yitbarek unpublished data) showed that the above two groups also infected canola seedlings differently at different soil temperature. At 7-8 C and 7-12 C, AG2-1 isolate induced significantly higher percent pre-emergence damping-off than AG4 isolate. At 7-8 C, AG4 isolate was very weakly pathogenic. At 26-35 C, AG4 isolate was significantly more virulent than AG2-1; AG2-1 was very weakly pathogenic at this temperature. Both isolates induced similar pre-emergence damping-off at 7-18, 12-18 and 19-25 C. The purpose of the present study was to determine whether similar results might be obtained in the field and, if so, what measures might be taken to reduce infection and yield loss from R. solani.

MATERIALS AND METHODS

The experiment was carried out at the Agriculture Canada Research Station plots at Saskatoon, in 1985 and 1986. The test design was a split-split plot design (Little and Hills, 1978) with soil moisture as main plot, seeding dates as subplot and *Rhizoctonia solani* isolates as sub-subplot. There were three soil moisture regimes. "Low" soil moisture was obtained with natural rainfall. "Medium" soil moisture was obtained by rainfall supplemented by irrigating with 5 mm of water once every four days. "High" soil moisture was obtained by irrigating 5 mm of water every day except on days with rain. In 1985, the low, medium and high soil moisture plots received 130 mm, 200 mm and 700 mm of water, respectively. In 1986, the corresponding amounts were 200mm, 300mm and 500 mm, respectively. Soil moisture was determined gravimetrically and matric potentials were derived from a desorption characteristic curve of the soil.

In 1985, the four seeding dates were May 17, 24, and 31, and June 14. In 1986, the six seeding dates were May 1, 22, and 27, and June 3, 10 and 23. The first seeding date was advanced to May 1 in 1986 with the intention of achieving low soil temperatures.

Two virulent *R. solani* isolates, one from each of AG2-1 and AG4, were used. The *Rhizoctonia* isolates were cultured separately on autoclaved rye grains. Two hundred *R. solani* infested rye grains were seeded with 200 seeds of canola (cv. Westar)/4.6 m row. In 1985, four rows were sown in each sub-subplot. In 1986, the number of rows per plot was increased to six.

Seedling emergence counts were taken on the two outermost rows 28 days after seeding. The plants in two inside rows were used to assess disease incidence at maturity, and yield. Based on severity of lesions, plants were

classified into six disease categories. The percent disease rating (=disease intensity) was obtained using the following formula:

$= [(X_0*0 + X_1*1 + X_2*2 + X_3*3 + X_4*4\ X_5*5)/(\text{total plants}*5)] \text{ X } 100$

where

X_0 = number of healthy plants;

X_1 = number of plants each one with small, light brown lesion(s) on tap root;

X_2 = number of plants each one with concentric brown lesion(s) on one side of tap root above main lateral roots;

X_3 = number of plants each one with tap root girdled by large, sunken, dark brown lesions, no constriction on tap root;

X_4 = number of plants each one with extensive girdling of tap root above main lateral roots, lateral roots still present;

X_5 = number of plants each one with tap root rotted above main lateral roots.

* = multiplying by

0, 1, 2, 3, 4, and 5 are the integers.

RESULTS AND DISCUSSION

Soil moisture

Fig. 1 shows the soil moisture contents in the summers of 1985 and 1986. Except at the beginning of the experiment in 1985 and on days of heavy rain, we were able to vary the soil moisture fairly well. Attempts were made to maintain an average high soil moisture at about -0.3 bar, medium soil moisture at about - 7 bars and low soil moisture at about -15 bars.

Analysis of soil (Table 1) shows that most of the soil chemicals were not affected by the addition of irrigated water except sodium. This could be a serious problem by applying large amount of irrigation (300 mm) per crop.

Table 1. The effect of additional moisture has on soil chemicals.

Moisture regime	NO_3-N	NH_4-N	Ca	Mg	K	Na
	ppm					
Low	25.0[a*]	3.5[a]	6455[a]	745[a]	725[a]	17.5 [b]
Medium	22.9[a]	3.3[a]	6503[a]	748[a]	700[a]	22.5 [b]
High	17.0[a]	3.4[a]	6525[a]	755[a]	710[a]	37.5[a]

* Means in a column followed by the same letter are not significantly different at p=0.05 level as determined by Duncan's multiple range test.

Soil moisture influenced disease ratings significantly both in 198 and 1986. Percent disease ratings were significantly higher in high soil moisture than medium and low soil moisture as shown in table 2.

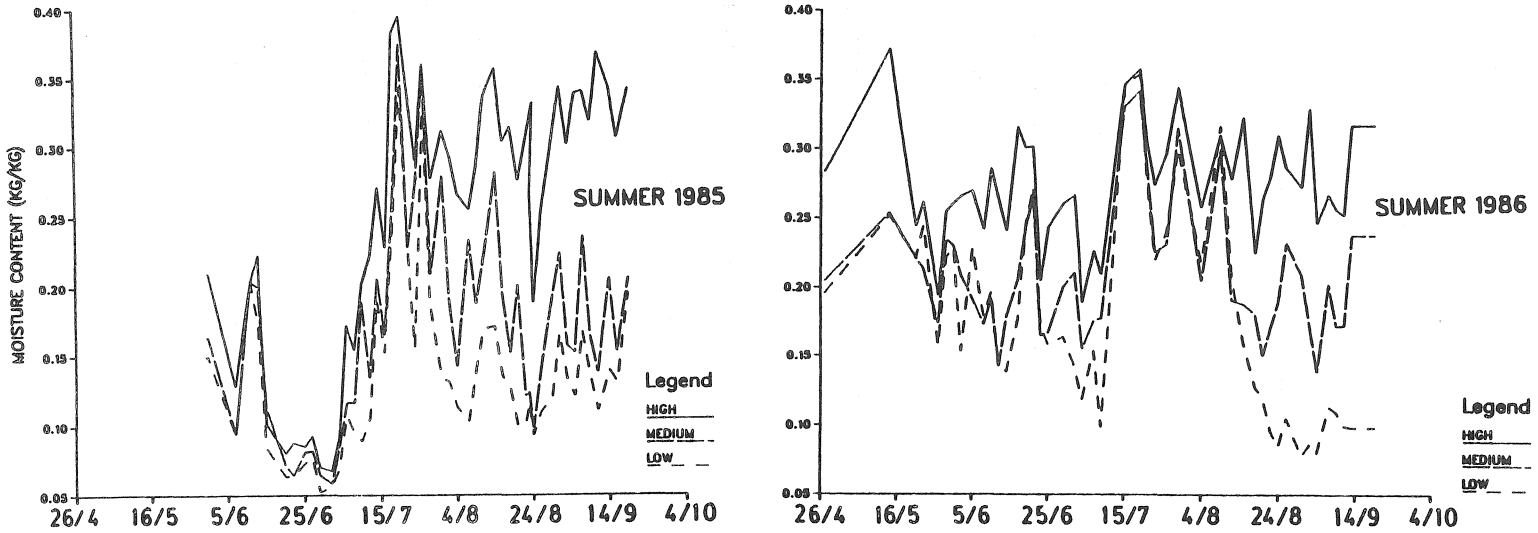

FIG.1 SOIL MOISTURE CONTENT BETWEEN 0 AND 5 CM DEPTH AND UNDER THE CANOPY OF CANOLA PLANTS (CV. WESTAR)

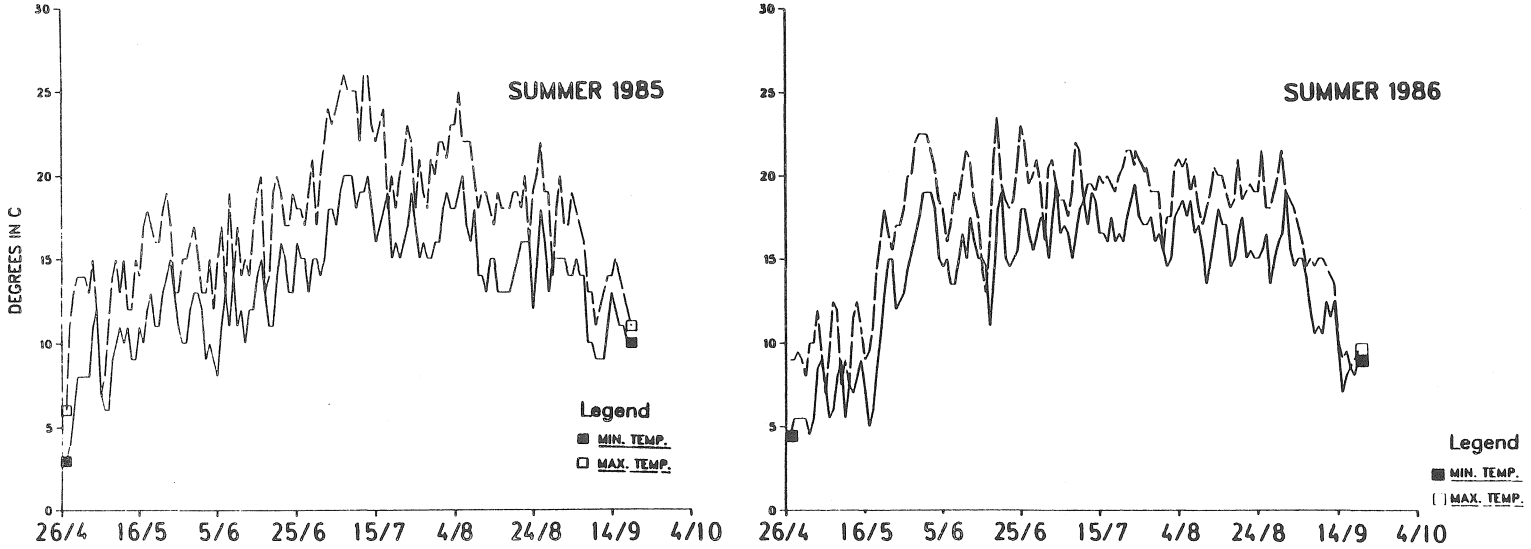

FIG.2 SOIL TEMPERATURE AT 5 CM DEPTH

Table 2. The influence of soil moisture on the percentages of disease rating on canola plants.

Moisture regime	1985	1986
	%	
Low	24.0 c*	25.9 c
Medium	28.4 b	31.4 b
High	42.0 a	35.1 a

* Means in a column followed by the same letter are not significantly different at p=0.05 level as determined by Duncan's multiple range test.

In 1985, the weather was relatively dry with only 130 mm rainfall during the experiment. Yield in the high soil moisture treatment was significantly greater than in the medium soil moisture treatment which was significantly greater than the low soil moisture treatment (Table 3). However, rainfall during the experiment in 1986 was relatively high (200 mm). High soil moisture still increased yield significantly compared with medium soil moisture, but there was no significant difference in the yield between low and medium soil moisture regimes. Yield in 1986 was lower than in 1985 (Table 3) probably due to a serious infestation of blackleg (Leptosphaeria maculans).

Table 3. The influence of soil moisture on yield of canola (g per two rows of 4.6 m each)

Moisture regime	1985	1986
Low	635 c*	252 b
Medium	997 b	246 b
High	1140 a	304 a

* Means in a column followed by the same letter are not significantly different at p=0.05 level as determined by Ducan's multiple range test.

Seeding dates

Seeding date (SD) significantly influenced the total number of seedlings. The reasons of the effects are not clear. They are probably due to variation in temperatures, rainfall, and RH during the period from seeding to seedling count at 28 days old. In 1985, the percentages of seedling emergence in the noninoculated check were 46, 55, 65, and 60 on May 17, 24 and 31 and June 14, respectively. In 1986, the percentages of seedling emergence of the same treatment were 48, 40, 45, 64, 67, and 66 on May 1, 22, and 27, and june 3, 10, and 23, respectively.

The highest disease ratings occurred in both years in treatments seeded on date 2 which fell on May 24 in 1985 and on May 22 in 1986 as shown in table 4.

Table 4. The influence of seeding dates on the percentages of disease rating of canola plants

1985		1986	
Seeding date	% disease rating	Seeding date	% disease rating
		SD1 (May 1)	34.8 b*
SD1 (May 17)	35.0 b	SD2 (May 22)	46.2 a
SD2 (May 24)	37.6 a	SD3 (May 27)	43.1 a
SD3 (May 31)	33.7 b	SD4 (June 3)	26.9 c
SD4 (June 14)	19.8 c	SD5 (June 10)	22.9 d
		SD6 (June 23)	10.8 e

* Means in a column followed by the same letter are not significantly different at p=0.05 level as determined by Duncan's multiple range test.

Seeding dates showed some trend in disease ratings. Generally early seeding resulted in higher disease ratings and higher yields. Late seeded plots yielded less than early seeded plots. Plots seeded after June 10, yielded

poor quality seeds and thus marketing of such canola seeds would be a problem. There was no interaction between seeding date and soil moisture levels.

Rhizoctonia isolates

Rhizoctonia solani isolates belonging to AG4 and AG2-1 had a significant influence on percent emergence. In 1985, the non-inoculated check had a higher number of seedlings than AG4 and AG2-1 inoculated plots. In 1986, the number of seedlings in the AG4 inoculated plots was significantly greater than those in AG2-1 plots. The reverse was the case with disease ratings.

There were significant interactions between isolates and seeding dates. One obvious factor varying with seeding date was soil temperature. In 1986, as shown in Fig. 2, soil temperature was between 5 and 12 C on the first seeding date on May 1. Fig. 3 shows that the AG4 treatment had a significantly higher number of seedlings than the AG2-1, but there was no difference between AG4 and the check. When seeding was carried out three weeks later on May 22, and soil temperature was between 15 and 23 C, AG4 and AG2-1 showed about the same virulence. Both gave lower seedling numbers than the check.

In 1985, when the first seeding date was late (May 17), and the soil temperature was between 10 and 20 C, there was no significant difference between AG4 and AG2-1 in the number of seedlings. However, both gave lower seedling numbers than the check. With moderate temperatures at seeding, the pattern of infection by AG2-1 and AG4 were about the same in 1985 and 1986. Thus, the results of this field experiment were in agreement with those obtained in the laboratory and growth chamber with low and moderate temperatures. AG4 and AG2-1 grow differently at low temperatures but about the same at moderate temperatures. Very high temperature did not occur in 1985 or

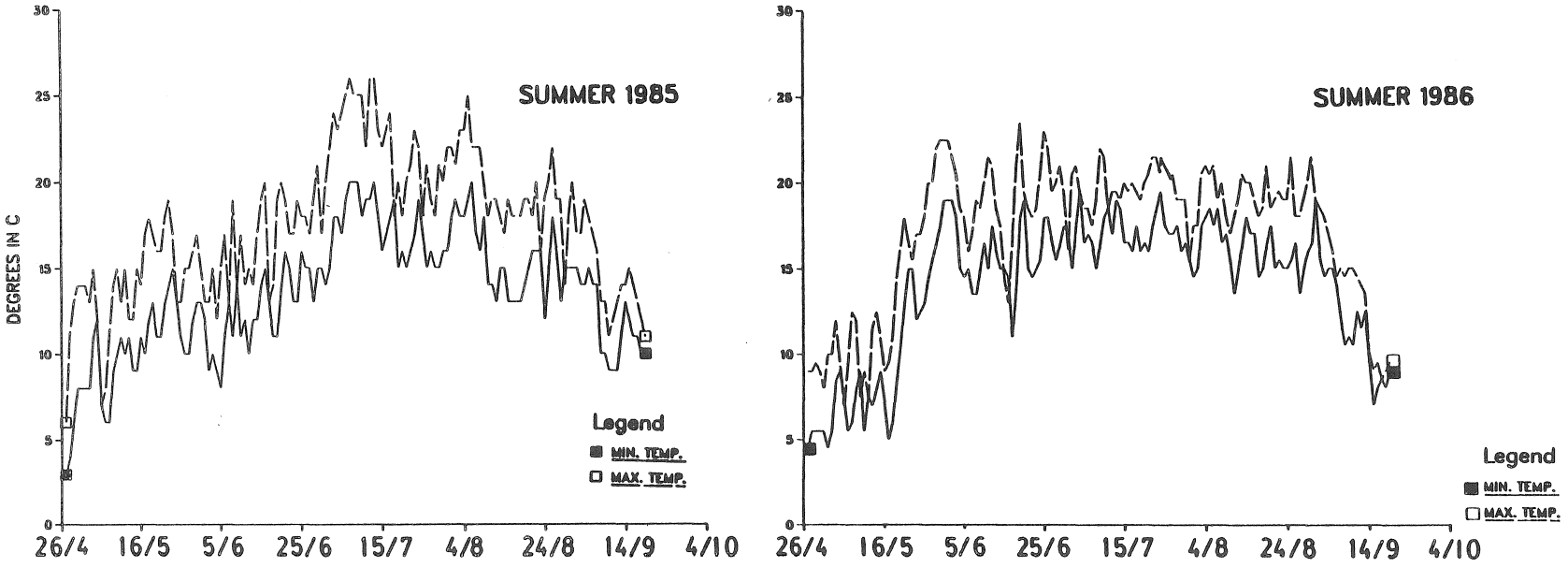

FIG. 2 SOIL TEMPERATURE AT 5 CM DEPTH

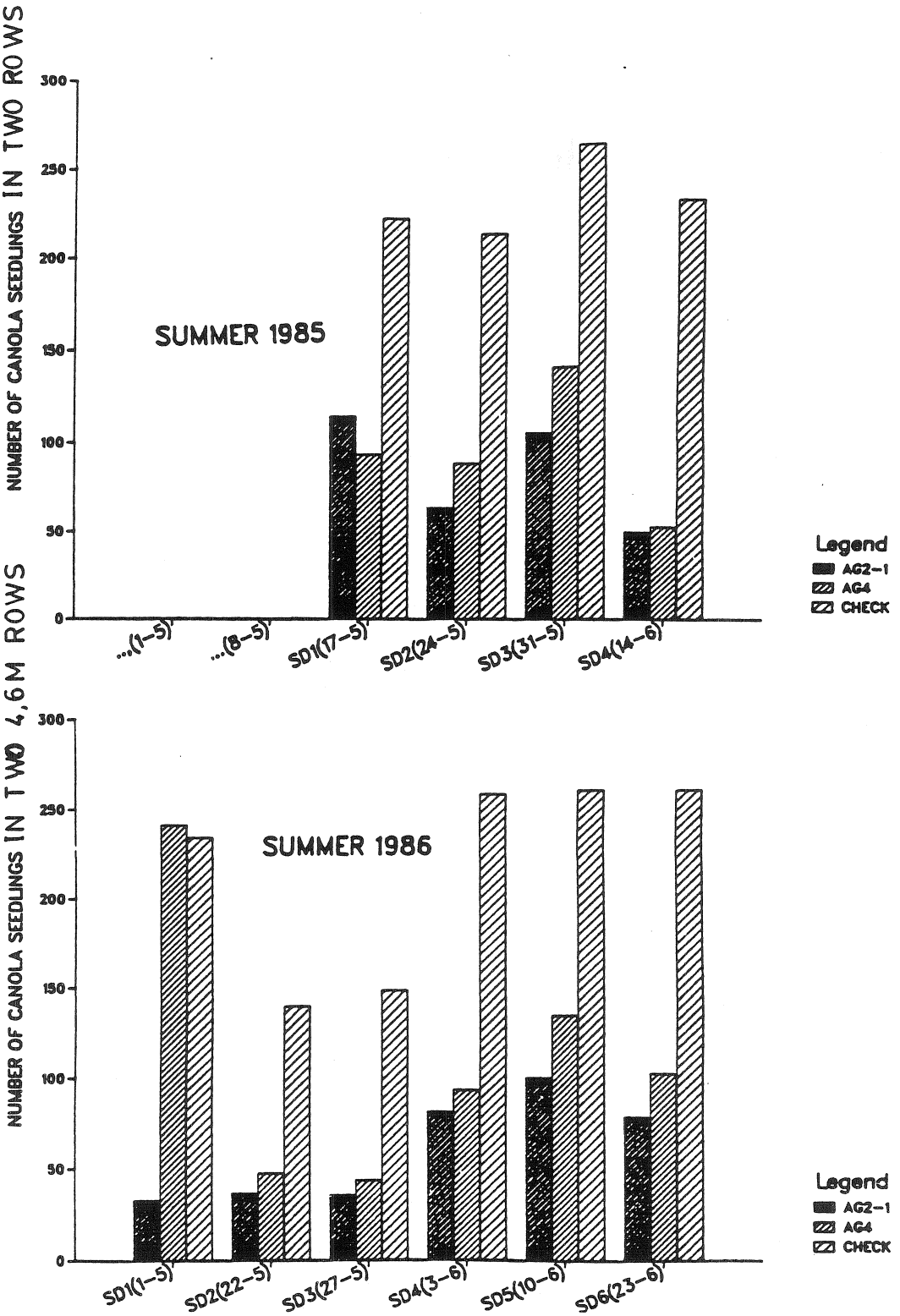

FIG. 3 THE INFLUENCE OF SEEDING DATES AND R. SOLANI ISOLATES ON THE TOTAL NUMBER OF CANOLA SEEDLINGS

1986 in the field. Therefore no comparision could be made of the virulence of AG4 and AG2-1 in the field with that of the results in the laboratory and growth chambers.

The results showed that both anastomosis groups of R. solani decreased yield significantly when the inoculum density was high. Control measures would be necessary with the levels of disease obtained in these experiments. When Rhizoctonia isolates in an area are predominantly AG2-1, they could be controlled to a certain extent by not seeding too early, when the soil temperature is low. However, if the R. solani isolates are of the AG4 type, early seeding would be beneficial. Further, unpublished data indicate that with the use of appropriate seed-treatment fungicides, reductions in the number of seedlings can be further controlled.

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