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Antifungal Substances from Cultivated Plants in Egypt. I. Effect of some Environmental Factors on Their Production

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A number of cultivated plants which were previously recorded to have antifungal activity against *Rhizoctonia solani* were raised under various environmental conditions. Seedlings raised on light and medium soils, showed higher antifungal activities than those raised on heavy soil, especially when the soil moisture content was adjusted at 60% W.H.C. When the segments of the plant seedlings were cut from their hypocotyls, they exhibited higher inhibitory effects on the growth of the test fungus than those taken from the epicotyls of the same seedlings. Segments of lupin seedlings showed greater inhibitory effects on the test fungus than those revealed by other test plants under the various experimental conditions.

There are numerous ways by which the plant protects itself from attack by the pathogen. Some cases of resistance to attack depend upon the exudation of certain chemicals from the host. Some of these chemicals have inhibitory effects on the growth of some fungi or bacteria. Seeds and seed coats of some plants were used for isolation of the antifungal agents; thus Pearson and Parkinson (1961); Schroth and Snyder (1961); Rajagopalan and Bhuvaneswari (1964); and Cook and Snyder (1965), reported that germinating seeds exude amino acids, sugars and organic acids into surrounding environment and their exudates may play important roles in stimulating germination of quiescent propagules of fungi that cause seed decay and root rot.

Kerr (1964), showed that soil moisture affects the amount of seed exudates from germinating peas; while Schroth *et al.* (1966) reported that temperature influences the quality of exudate from germinating seeds of cotton and bean.

Sayed (1970) made a survey of the antifungal activity of some cultivated and desert plants in Egypt. She found that antifungal substances are present in a number of desert and cultivated plants in Egypt. She also found that the test plants which showed positive reactions against *Rhizoctonia solani* exuded into the medium containing rose bengal certain constituents among which are the amino acids; arginine, leucine, serine and aspartic acid.

The present investigation was planned with a view to detect the effect of some environmental factors on the amount of antifungal substances exuded from some cultivated plants which were previously demonstrated by Tolba and Sayed (1976) to contain antifungal substances against *Rhizoctonia solani*.

Materials and Methods

Seeds of the test plants were sown at the rate of 5 seeds per pot containing 300g soil. Five plants were used, namely:

1. *Triticum vulgare*, Vill.
2. *Hordeum vulgare*, L.
3. *Zea mays*, L.
4. *Lens esculentus*, Moench.
5. *Lupinus termis*, Forssk.

The different test plants were raised on light, medium, or heavy soils with water-holding capacities of 38%, 50% and 71% respectively. The moisture contents of each soil was adjusted at 40, 60 or 80% of the W.H.C. Seedlings of the test plants were raised either at 20–22 °C for 21 days or at 28–30 °C for 15 days. Segments cut from the epicotyls or hypocotyls of the seedlings prepared from each of the test plants were sterilized according to the methods described by Tolba and Sayed (1976). The sterile segments were introduced on the suface of Martin's solid medium in sterile Petri dishes, containing a fungal inoculum of *Rhizoctonia solani*. The plates were incubated at 13, 30, or 40 °C for 3 or 7 days according to the temperature of incubation.

Results

The results are presented in Tables 1 and 2 which show that:

1. Some of the test plants could inhibit the growth of the test fungus, especially, when the seedlings were raised on light and medium soils. Plants raised on heavy soil showed less cases of inhibitory effects.

2. When the moisture content of the soil was adjusted at 60% of the W.H.C., it was easy to detect inhibition of growth of the test fungus with most of the plants experimented with except lentil which showed more activity when raised on medium soil with higher moisture content, *i.e.*; 80% of the W.H.C.

3. In case of certain test plants *e.g.*, wheat, incubation at 13°C did not induce any appreciable differences in the inhibitory effect of the test plant against the test fungus. In case of other test plants, inhibition of the test fungus was more prominent when the latter was incubated at a lower (13 °C) than at a higher (30 °C) temperature level. Incubation of the fungus at 40 °C proved to be unfavourable for its growth.

4. Hypocotyl segments of most test plants showed higher inhibiting activities than corresponding epicotyl ones. This was quite clear when the soil moisture content was adjusted at 60% of the W.H.C.

5. Out of the five plants tested; lupin showed the highest activity against the test fungus followed by wheat. Barley and lentil revealed moderate activities, while maize proved to be the least active.

6. When the test plants were raised at 28 °–30 °C for 15 days, the activity decreased considerably except for lupin roots where the inhibitory effects were more or less similar under the various experimental conditions.

Discussion

The production of antifungal substances by plants is usually goverened by the prevailing conditions. Under one set of conditions the plants may produce maximum amouts of these substances, while variations in the environmental conditions around the same plant may retard its power to produce such active substances. In the present study it was found that the growth of *R. solani* was inhibited by segments from seedlings of the different test plants. Highest inhibition was observed when seedlings were raised on light and medium soils rather than on heavy soil.

The effect of soil moisture content on the antifungal activity of the seedlings of the test plants varied greatly according to the experimental conditions. However, when the soil moisture content was adjusted at 60% of its W.H.C., inhibition of growth of the test fungus by most of the test plants was clearly exhibited. The influence of soil moisture content may be an indirect one through its influence on the metabolism of the plant cells with the concomittent result of variations in the amounts and types of substances exuding from the cells of the plant segments used for testing the antifungal activity.

Kerr (1964), studied the influence of soil moisture on infection of peas by *Pythium ultimum* and stated that the importance of soil moisture is in its influence on the amount of sugar exuded from pea seeds, and this determines disease incidence.

When seedlings of the test plants experimented with were raised at lower temperature levels (20–22 °C), their power to produce antifungal substances was higher than when raised at higher levels of temperature (28–30 °C). The effect of temperature is probably through promoting or inhibiting some metabolic reactions that take place inside the plant

Table 1. **Inhibition of growth of *Rhizoctonia solani* - incubated at different temperatures - by some Egyptian cultivated plants raised at 20–22°C, on light, medium or heavy soils at different moisture contents.**

	Soil texture																	
	Light (W.H.C. 38 %)						Medium (W.H.C. 50 %)						Heavy (W.H.C. 71 %)					
Soil moisture content % of W.H.C.	40			60			80			40			60			80		
Test Plant \ Temperature of incubation	13°C	30°C	40°C	13°C	30°C	40°C	13°C	30°C	40°C	13°C	30°C	40°C	13°C	30°C	40°C	13°C	30°C	40°C	13°C	30°C	40°C	13°C	30°C	40°C
Wheat (*Triticum vulgare*) Epicotyl	–	–	Nogr.	–	–	Nogr.	–	+	Nogr.	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–
Wheat (*Triticum vulgare*) Hypocotyl	+	+	Nogr.	+	+	Nogr.	+	–	Nogr.	–	–	–	–	–	–	+	–	+	–	–	–	–	–	–
Barley (*Hordeum vulgare*) Epicotyl	–	–	Nogr.	–	–	Nogr.	–	–	Nogr.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Barley (*Hordeum vulgare*) Hypocotyl	+	+	Nogr.	+	+	Nogr.	+	–	Nogr.	+	–	–	–	–	–	–	–	–	–	+	–	–	–	–
Maize (*Zea mays*) Epicotyl	–	–	Nogr.	–	–	Nogr.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Nogr.	–	–	–
Maize (*Zea mays*) Hypocotyl	–	–	Nogr.	–	–	Nogr.	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	+	–	–	–	Nogr.
Lupin (*Lupinus termis*) Epicotyl	–	–	Nogr.	–	–	Nogr.	+	–	Nogr.	–	–	–	+	–	–	+	–	–	–	–	–	+	–	–	+	–	–
Lupin (*Lupinus termis*) Hypocotyl	–	–	Nogr.	–	–	Nogr.	–	–	Nogr.	+	+	–	+	+	–	–	+	–	–	–	–	+	–	–	–	+	–
Lentil (*Lens esculentus*) Epicotyl	–	–	Nogr.	–	–	Nogr.	–	–	Nogr.	–	+	–	–	–	–	–	–	–	–	–	–	–	–	Nogr.	–	–	–
Lentil (*Lens esculentus*) Hypocotyl	–	–	Nogr.	+	+	Nogr.	+	+	Nogr.	–	–	–	–	+	–	–	–	–	–	–	–	–	–	Nogr.	–	–	–

Nogr. = No growth for the fungus.

Table 2. Inhibition of growth of *Rhizoctonia solani* - incubated at different temperatures - by some Egyptian cultivated plants raised at 28–30°C, on light, medium or heavy soils at different moisture contents.

		Soil Texture											
		Light (W.H.C. 38 %)			Medium (W.H.C. 50 %)			Heavy (W.H.C. 71 %)					
Soil moisture content % of W.H.C.		40	60	80	40	60	80	40	60	80			
Test Plant \ Temperature of incubation		13°C 30°C 40°C	13°C 30°C 40°C	13°C 30°C 40°C	13°C 30°C 40°C	13°C 30°C 40°C	13°C 30°C 40°C	13°C 30°C 40°C	13°C 30°C 40°C	13°C 30°C 40°C			
Wheat (*Triticum vulgare*)	Epicotyl	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –			
	Hypocotyl	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –			
Barley (*Hordeum vulgare*)	Epicotyl	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –			
	Hypocotyl	+ – –	+ – –	+ – +	– – –	– – –	– – –	– – –	– – –	– – –			
Maize (*Zea mays*)	Epicotyl	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –			
	Hypocotyl	– – –	+ – –	+ – –	– – –	– – –	+ – –	– – –	– – –	– – –			
Lupin (*Lupinus termis*)	Epicotyl	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –			
	Hypocotyl	+ – –	+ – –	+ – –	– – –	– – –	– – –	– – –	– – –	– – –			
Lentil (*Lens esculentus*)	Epicotyl	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –			
	Hypocotyl	– – –	+ – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –			

cell leading to the production or increased activity of the already existing antifungal substances.

The effect of temperature on the amount of antifungal substances was studied by Scroth *et al.* (1966) who reported that temperature influences the quality of exudate from germinating seeds of cotton and beans.

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المواد المضادة للفطريات فى بعض النباتات المزروعة فى مصر
١ ـ تأثير بعض العوامل البيئية على إنتاجها

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أستخدم في هذا البحث عدد من النباتات المزروعة المعروفة بقدرتها على إنتاج مواد مضادة لنمو فطرة **الرايزوكتونيا سولاني** *Rhizoctonia solani* ولقد أثبتت هذه الدراسة أن زرع بذور النباتات المستخدمة من أجل إنتاج البادرات في تربة خفيفة أو متوسطة أدى إلى زيادة فاعلية هذه البادرات في مقاومتها لنمو الفطر وخاصة إذا نظمت رطوبة التربة بحيث تكون على مستوى ٦٠٪ من قدرتها على الاحتفاظ بالماء(W.H.C.) وعندما حضرت الأجزاء النباتية المستخدمة في هذه التجارب من السويقات تحت الفلقية لبادرات النباتات المستخدمة أظهرت نشاطا في التأثير على نمو الفطر أكبر مما لو أخذت من السويقات فوق الفلقية . كما أن الأجزاء المأخوذة من بادرات نبات الترمس أظهرت نشاطا أكبر من تلك المأخوذة من بادرات النباتات الأخرى المستخدمة في هذه الدراسة .