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EFFECT OF CROP ROTATION ON THE POPULATION AND VIABILITY OF SCLEROTIA OF *SCLEROTIUM ORYZAE*, THE CAUSE OF STEM ROT OF RICE

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Abstract

The effect of various cropping pattern on the population and viability of sclerotia of *Sclerotium oryzae* was examined. Reduction in population and viability of sclerotia was observed in soil cropped under rice-lucerne-rice (91 and 97%), rice-wheat-mung-rice(94 and 87%), followed by rice-wet-fallow-rice (88 and 97%), rice-mustard-rice (89 and 76%), and rice-wheat-rice(82 and 73%) rotations with 50 and 60% reduction in continuous dry fallow treatment.

Introduction

Sclerotium oryzae Catt., the cause of stem rot of rice occurs in almost all the rice producing countries of the world (Ou, 1972) . Loss in yield as high as 72-78% have been recorded in certain rice growing areas of the Punjab in Pakistan (Shafi, 1970) . The fungus survives in the form of sclerotia for upto 6 years either in the soil or on the rice stubbles (Park &Bertus, 1932). In the present paper the effect of different crop rotations on the population and viability of sclerotia of *S. oryzae* is presented .

Materials and Methods

S. oryzae Catt., (K.U.M.H.Cult. No. 158) isolated from infected culms of rice collected from Kala Shah Kaku, Lahore was used. Three month old sclerotia with 100% viability produced on autoclaved rice stem pieces (Icm) in Erlenmeyer flasks at $30 \pm 2°C$ were separated by dry sieving and used for artificial infestation of soil @ 5 scl. /g of soil.

Cemented rings, 40cm diam., and 15cm height were laid in a field at Karachi University experimental plot where the soil was sandy loam, pH 8.2. The effect of different cropping sequences viz., i) rice-wheat-rice, ii) rice-mustard-rice, iii) rice-lucerne-rice, iv) rice-wheat-mung-rice, v) rice-wet fallow-rice and vi) rice-dry fallow-rice rotations were tested on population and viability of sclerotia of *S. oryzae*. Wheat *(Triticum aestivum* L.*)*, mustard *(Brassica rapa* L.*)* and lucerne *(Medicago sativa* L.*)* were sown in December, 1984 and 1985, mung *(Vigna radiata* (L) Wilczek was sown in April, 1985 and 1986 at recommended rates and rice was transplanted @ 10 seedlings per ring, 2 seedlings per hole in July, 1985 and 1986. Plants were irrigated at 3 day interval. Wheat, mustard and lucerne were harvested in the month of March, 1985 and 1986, mung in June and rice in

October, 1985 and 1986. The treatments were replicated 3 times in a randomized block design. Soil samples were collected at monthly interval for 23 months beginning December 1984. Sclerotia from soil were separated by wet sieving and floatation technique and viability of sclerotia tested by transferring them on water Agar at 30±2°C (Usmani & Ghaffar, 1974).

Results

From a two years data (December 1984 – October 1986), maximum reduction in population and viability of sclerotia was observed in cropped soil rather than dry fallow plots. Upto 64% reduction in population of sclerotia was observed within 3 months in fields rotated with lucerne followed by 28% reduction in wheat and 39% in mustard. In plots where mung was planted, 71% reduction in number of sclerotia was observed. After 23 months interval reduction in population of sclerotia was in 91% in rice-lucerne-rice, 94% in rice-wheat-mung-rice, 88% in rice-wet-fallow-rice, 89% in rice-mustard-rice and 82% in rice-wheat-rice as compared to 50% in dry fallow (Fig. 1).

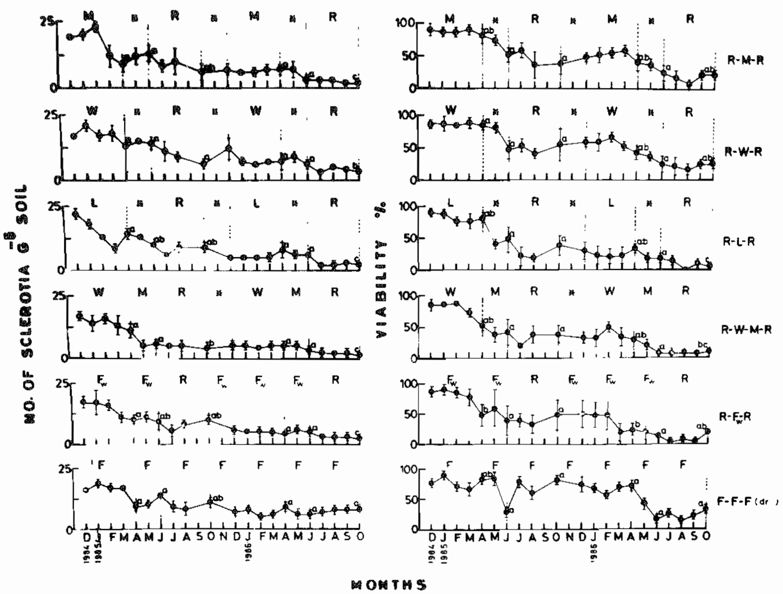

Fig. 1. Effect of crop rotation on the reduction in population and viability of sclerotia of *Sclerotium oryzae.*, (Data is for the period December, 1984-October, 1986). Means followed by same letters are not significantly different at P<0.05 using Duncan's Multiple Range test.

R-M-R = Rice-mustard-rice, R-W-R = Rice-wheat-rice, R-L-R = Rice-lucerne-rice., R-W-M-R = Rice-wheat-mung-rice, R-Fw-R = Rice-fallow (wet)-rice, F-F-F- = Fallow-fallow-fallow (Dry).

* = uncropped.

Table 1. ANOVA for the population and viability of sclerotia of *Sclerotium oryzae*.

		Population		Viability	
Source	d.f	SS	MS	SS	MS
1984 – 1986					
Treatment (T)	5	655.04	131.00 n.s.	23647.99	4729.59 n.s.
Month (M)	20	8070.29	403.51**	215841.29	10792.06**
TxM	100	980.36	9.80 n.s.	31940.09	319.40
Error	252	29281.31	116.19	879847.63	3491.45
1984 – 1985					
Treatment (T)	5	420.70	84.14 n.s.	6982.15	1396.43 n.s.
Month (M)	09	2767.87	307.54 n.s.	60165.75	6685.08 n.s.
TxM	45	763.20	16.96 n.s.	20572.04	457.15 n.s.
Error	120	28540.23	237.83	781083.06	6509.02
1985 – 1986					
Treatment (T)	5	314.21	62.84 n.s.	18181.54	3636.30*
Month (M)	10	388.56	38.85 n.s.	45608.31	4560.83**
TxM	50	245.29	4.90 n.s.	9844.35	196.88
Error	132	5546.94	42.02	208839.80	1582.11

*$P < 0.05$, ** $P < 0.01$, n.s. = non-significant.

Upto 50% reduction in viability of sclerotia was observed after 6 months interval. After 23 months interval, significant reduction in viability of sclerotia noticed was in rice-lucerne-rice (97%), rice-wheat-mung-rice (87%), rice-wet fallow-rice (77%), rice-mustard-rice (76%) and rice-wheat-rice (73%) as compared to 60% in dry fallow (Fig. 1).

The ANOVA of the data showed that reduction in population and viability of sclerotia were significant with time intervals, whereas there was no significant difference in population and viability in different cropping patterns. The ANOVA of both these parameters were different when analysed on yearly basis. In the second year the viability was significant at $P<0.05$ and $P<0.01$, respectively, in the cropping pattern and time interval. Interaction between cropping pattern and time interval was non-significant (Table 1).

Discussion

Reduction in the population and viability of sclerotia of *S. oryzae* in all the cropping patterns could be due to antifungal compounds secreted from roots of various crops used

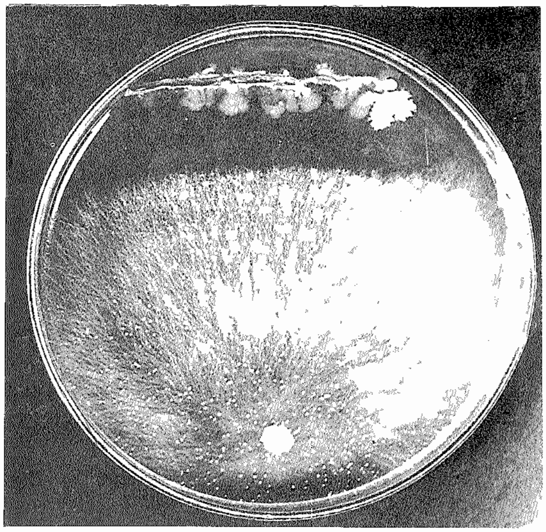

Fig. 2. *In vitro* inhibition of growth of *Sclerotium oryzae* by *Rhizobium meliloti* (lucerne isolate) on potato dextrose agar after 5-day at 27°C. *R. meliloti* on top and *S. oryzae* in bottom of plate.

in the rotations which stimulated a richer and more variable microflora unfavourable to the pathogen (William & Schmilthenner, 1962). Amongst the cropping sequence, maximum reduction in viability was observed in rotation where mung and lucerne were used. This could be due to increase in the root bacteria in soil inhibiting *S. oryzae*. It is interesting to note that in dual culture plate assays *S. oryzae* was inhibited by *Rhizobium meliloti* isolated from nodules of lucerne obtained from Karachi University experimental plots (Fig. 2). There is evidence that nitrate accumulation is greater in cropped soil than in non-cropped soil especially where leguminous crops are grown than grasses and nitrogen is utilized by microorganisms in the form of nitrate (Mannan, 1962).

Rice tissues parasitically infected by *S. oryzae* remained the most important source for sclerotial inoculum. Since sclerotial population of *S. oryzae* did not increase under rice cultivation it could be due to poor colonization of the rice sheaths in non-sterile soil which is probably due to fungistasis of sclerotia of *S. oryzae* and its competition with other microorganisms (Keim & Webster, 1975).

In the present study soil kept fallow, wet or dry, also reduced the population and viability of sclerotia. According to Keim & Webster (1974) sclerotia of *S. oryzae* should be expected to germinate in moist soil but they do not since they are under the influence of soil fungistatis (Dobbs & Hinson 1953; Lockwood, 1964; Watson & Ford, 1972). Moist soil when incubated at 24±2°C contained a factor of biological origin which leached from soil and was capable of almost completely inhibiting sclerotial germination (Kein & Webster, 1975). Total loss in viability of sclerotia of *S. oryzae* in dry soil after

12-weeks suggested water stress conditions and temperature as factors involved (Usmani & Ghaffar, 1981). In dry fallow soil, reduction in population and viability of sclerotia could presumably also be due to metabolically inactive or inhibitory fungistatic factors being produced within the sclerotia which took greater time to overcome the stress of dry condition for germination (Usmani & Ghaffar, 1984). The results of the present study would indicate that the population and viability of sclerotia of *S. oryzae* can be considerably reduced from rice fields especially by rotating rice with leguminous crops.

References

Dobbs, C.G. and W.H. Hinson. 1953. A widespread fungistasis in soils. *Nature*, 172: 197-199.

Keim, R. and R.K. Webster 1974. Effect of soil moisture and temperature on viability of sclerotia of *Sclerotium oryzae*. *Phytopath.*, 65: 1499-1502.

Keim, R. and R.K. Webster. 1975. Fungistasis of sclerotia of *Sclerotium oryzae*. *Phytopath.*, 65: 283-287.

Lockwood, J.L. 1964. Fungistasis. *Ann Rev. Phytopath.*, 10: 372-398.

Mannan, M. 1962. Organic matter, nitrogen and carbon: nitrogen ratio of soil, as affected by crops in cropping system, *Soil Sci.*, 93: 83-86.

Ou, S.H., 1972. *Rice Diseases*. CMI, Kew, Surrey, England.

Park, M. and L.S. Bertus. 1932. Sclerotial diseases of rice in Ceylon. 2. *Sclerotium oryzae* Catt. *Ceylon J. Sci.* Sect. A., 11: 343-359.

Shafi, M., 1970. *Ten years of rice findings*. Kala Shah Kaku, Rice Research Station, Lahore. p. 2-4.

Usmani, S.M.H. and A. Ghaffar. 1974. Biological control of *Sclerotium oryzae* Catt., the cause of stem rot of rice. 1. Population and viability of sclerotia in soil. *Pak. J. Bot.*, 6: 157-162.

Usmani, S.M.H. and A. Ghaffar. 1981. Survival of sclerotia of rice stem rot fungus. *Int. Rice Newsletter*, 6: 13.

Usmani, S.M.H. and A. Ghaffar. 1984. Effect of water stress and temperature on the viability and germination of sclerotia of *Sclerotium oryzae*, the cause of stem rot of rice. In: *Environment, stress, plant and growth* (Eds.) S.M. Naqvi and R. Ansari, PAEC, Tandojam, pp. 105-114.

Watson, A.S. and E.J. Ford. 1972. Soil fungistasis. *Ann. Rev. Phytopath.*, 10: 327-334.

William, L.E. and A.F. Schmilthenner. 1962. Effect of crop rotation on soil fungus population. *Phytopath.*, 52: 241-247.

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