I. INTRODUCTION

The cycle of events, in recent past, leading to epiphytotics in Krishna and Godavari delta during 1918-19 (Sundararaman, 1922), in Indo-China (Barat, 1931), in Ceylon during 1943 (Abeygunawardena, 1967) and the great Bengal famine in 1943, remind us that the brown spot disease can come unexpectedly and almost a total destruction of the crop might be expected (Padmanabhan, 1973). Since Padwick's (1950) remarks, reliable estimates of grain yield losses in the range between 19.2-41.2% or 14.2-40.6% on the basis of paddy or rice has been substantiated by Vidhyasekaran et al. (1973). Observing blast in 10% and brown spot in 35% of the 205 rice field surveyed in Nigeria, the latter causing yield losses of 30-43% under severe and 12% under moderate infection, a shift of emphasis from blast to brown spot investigations is considered necessary by Aluko (1969, 1975) in regions where upland rice is grown. In fact, much of the future expansion of the world's rice land will probably be in upland (pluvial rice land or pluvial anthraquic as per Boermann and Van Breeman's, 1973, terminology) rice growing areas because most of the land suitable for lowland (rainfed or irrigated) rice culture is already under cultivation (De Datta, 1981).

The great volume of literature on host-parasite interaction suggests that it is possible to manipulate the mechanisms by which plants resist parasites and we can successfully protect them to our advantage from debilitating and devastating diseases, either by fixing the defending power genetically into the plants or by
inducing resistance through cultural treatments (Sridhar and
Mahadevan, 1979). However, they contend that despite numerous
studies made in India, Japan and Philippines our present day
knowledge remains fragmentary and confusing.

Very little is known concerning the inheritance of resistance
to brown spot (Cu, 1972) and breeding for its resistance seems to
be handicapped as Adair (1941) considered several genes to be
operative or recessive for resistance to Helminthosporium oryzae.
Since field resistance is based upon the capacity of plants to
limit infections owing to polygenic inheritance of physiological
and/or structural components, control of the disease can be
effected by growing field resistant varieties under conditions
less favourable for infection or to say by following practices
which can create conditions to build up field resistance. Since
the advantages of many resistant varieties are short lived,
tolerance (endurance) would act as safeguard against heavy losses
from a disease; and would be particularly valuable where a
'breakdown' of other forms of resistance is likely (Russell, 1978).

Unbalanced fertilization (application of NPK only) is
reported to increase disease incidence not only in the susceptible
vars. but also in moderately susceptible and resistant ones
(Ayotade and Salako, 1980). Usages of high levels of nitrogen
fertilizers to boost up yield predisposes the leaf tissues to
greater infection by the fungus and consequently disease epidemics
build up more rapidly in fields with dwarf varieties than in the
field with tall indicas (Cu, 1972; Dhamal and Prasad, 1977).
According to Matsushima (1980) the disease is most apt to occur
when the nutritional conditions of the plant change suddenly from
an excess to a deficit or from a deficit to an excess, a contention
ably demonstrated in the bimodal behaviour of the pathogen in
response to nitrogen (Chattopadhyay and Dickson, 1960; Gangopadhyay
and Chattopadhyay, 1975; Kauser and Kauser, 1978) and NP (Vargas,
1963) fertilization. Intensive cropping, particularly under the
double cropping system, seems to have encouraged the spread of
both blast and brown spot diseases (Siddiqui, 1980). The disease
usually occurs in problem soils with nutritional deficiencies or
in poorly drained soils where uptake of nutrients is hindered
(Baba, Inada and Tajima, 1967; Tanaka and Yoshida, 1970; Ou, 1973;
Yoshida, 1981). Attempts to improve upon such soil conditions,
evidently can benefit the farmers.

Various cultural practices such as avoidance of late planting
in kharif, early planting in rabi, close spacing and monoculture
(Chattopadhyay and Chakrabarti, 1965; Grummer and Roy, 1966) are
helpful in reducing the incidence of the disease.

Efforts on plant immunization (Ganguli and Padmanabhan, 1962;
Sinha and Trivedi, 1969, 1972, 1973; Sinha and Das, 1972), in the
light of some evidence of occurrence and induction of phytoalexin
like substances in rice in relation to infection by H. oryzae (Oku
and Nakanishi, 1962; Sinha and Diri, 1973; Sinha and Raj, 1980;
Trivedi and Sinha, 1982), though appears rewarding, the feasibility
of its application in farmers field is yet to be achieved. Studies
on host-pathogen interaction has yielded conflicting results about
the role of phenolics in resistance (Chattopadhyay and Sera, 1980;
Chattopadhyay and Samaddar, 1980). Rapid host response accompanying
stimulated synthesis and phenolic compounds (Ohata and Kubo, 1974)
or due to splitting of phenolics from its glycoside by β-glycosidase
(Shishiyama, Egawa, Mayama and Akai, 1969) and their oxidation system seems to be associated with resistance (Oku, 1952). It is, however, not yet known if there is any race-variety relationship, a host specific toxin is produced or the plants produce a phytoalexin in defense mechanism (Ohata and Kubo, 1974). Further, Chaboussou (1972) raises doubts about the claims of absolute antagonistic action of such phytoalexin like substances and emphasizes a role, in resistance, to the decline in soluble nutritional factors such as the amino acids and reducing sugars in the physiologically active tissues. However, according to Goodman, Kiraly and Zatlin (1967) in many host-parasite relationships a correlation may exist between the degree of resistance and phenol levels in healthy leaves.

The seed treatment may be beneficial if the seed is harvested from infected field and the value of leaf spray is doubtful (Ou, 1973). However, outbreaks of mercury poisoning from Hg-treated seeds involving hundreds of persons in Iraq, Pakistan and Guatemala; a pregnant mother, eating pork from slaughtered swine fed with Hg-treated wheat seeds giving birth to a baby who is blind and suffers from serious mental retardation in an area in New Mexico and deaths, reproductive failures and catastrophic decline in population of both seed-eating and raptorial predatory yellow bunting birds in middle 1950's in Sweden came as warning of growing concern about the effect of man upon his environment (Huisingh, 1974). Further, the use of agrochemicals, despite careful selection, tend to have some effects on non-target organisms or physiological processes and undesirable side-effects such as
induction of "new-diseases" or more usually the exacerbation of diseases already present are not uncommon (Giffith, 1981).

To quote Russell's (1976) viewpoint which unmistakably mirrors the lacunae in need-based research strategies: "More information is needed concerning the effects of host plant nutrition on disease control; there seem to have very few deliberate attempts to control diseases on a field scale by the addition of specific nutrients to the host plant".

Keeping with the views and the problems often discussed in national forums faced by the marginal farmers, in the rainfed areas where the disease in severe form is often associated with the crop from seed to seed; an attempt has been made in the present investigation to induce resistance through cultural practices in the rice plant, because the brown spot pathogen being homotopic (host and pathogen co-extensive, CMII distribution map 92), interestingly often appears periodically in epidemic form (which may be grouped under class I.A. of Ruddenhagen's (1977) classification of origin of basic types of epidemic diseases, being smoothly cyclical on long term host-pathogen co-evolution, as in case of cereal rusts).

Accordingly, in the present investigation, organic materials were used for amending the soil to simulate an integrated approach by way of returning to the soil the nutrients usually depleted off due to continuous cropping. The auxin like herbicides, often recommended as soil drench for weed control in uplands, formed one of the treatments to elucidate its influence on the rice plant in
relation to brown spot disease. Reference was also made to varying water regimes and nitrogen fertilization in consort with organic amelioration.

Importance of micronutrients in seed treatment or as foliar spray in control of brown spot disease was examined.

Feasibility of amelioration, towards disease resistance, with molybdenum, boron, manganese and silica, within the reported ranges of toxicity of the former three elements (Yoshida, 1981), was explored in water culture.

Chemical analyses of host nutrient status were done to establish correlation between the inorganic and biochemical parameters and the brown spot disease, with some reference to photosynthetic ($^{14}$C) efficiency of plants grown in organic amended plots and radio-autographic studies.

The leaf surface anatomy, with reference to epicuticular wax and silicification of bulliform (motor) cells was examined in relation to resistance.

Since the fungicides have their own place in disease control, tests were made to select some stand by, less hazardous candidates.

In vitro studies on conidial germinability and growth of the fungus were conducted to examine the results of the above experiments and to elucidate the importance of maintenance of osmotic equilibrium in the fungus propagule.

The role of Bacillus subtilis as an agent in soil fungistasis in relation to brown spot pathogen was exploited.
Observing the severity of seedling phase during dry (rabl) season the disease progression and conidial production ability in relation to tip burn symptomatology, were examined for the organic amendments since resistance to both facultative and obligate pathogens is often expressed as an increase in generation time of the pathogen (Russell, 1979).