Epidemiological Aspect of Sporulation by Blast Fungus on Rice Plants

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Infection of panicles of the rice plant by the blast fungus, *Pyricularia oryzae* Cav., causes loss in yield of grain. Grain requires 35 to 60 days in different cultivars to ripen after panicles emerge. Loss of grain depends upon when infection occurs. Therefore, it is important to know when and where inoculum is produced and how the quantity of inoculum changes with time.

As is recognized now, the outbreak of panicle blast is closely correlated with the amount of leaf blast. Lesions on leaves and on the collar auricle and ligule supply conidia for infection of panicles. Although conidia are produced on some diseased weed grasses whether they live or die, we need much more survey whether the plants function as inoculum sources for panicle infection or not.

On the other hand, some spore-trapping studies demonstrated a rapid increase in conidia after heading occurred even though levels of leaf blast were low. Although conidia are probably rapidly produced on the panicle itself, the extent to which this happens is unknown. To obtain such information, the time and level of conidium production on different organs were studied[1),2),3)].

Definition of potential for conidium formation or sporulation potential

When lesions on leaves were collected and kept in moistened containers, the fungus sporulated between 12 and 34 C with optimum 28 C. Hence, sporulation decreased sharply above 28 C. The first conidium on a conidiophore appeared from 6 to 8 hours after lesions were placed under humid condition.

The curve of conidium amount per lesion on time reached an asymptote within 12 hours at 12 or 16 C, and within 15 hours at 20 or 28 C. The fungi developed under the same circumstances produce the different number of spores at one night when placed under different surroundings.

Hence, potential for conidium formation or sporulation potential, is defined as the capacity of a fungus to produce conidia under optimum conditions per unit time. The sporulation potential must be noticed to compare the differences in isolates, effect of circumstances, disease proneness of the host, etc.

Sporulation potential of blast fungus in lesions on rice leaves

Inoculated plants had been noted under different controlled temperatures since lesions began to enlarge. Blast lesions on rice leaves expanded faster but reached a smaller final size at high temperature regimes of 32/25 C day/night or 32/20 C day/night in a 12 hr-thermoperiod than at temperatures of 25/16 C day/night. At temperature of 20/16 C day/night, the enlargement rate was slow and constant during the 25 days of observation.

The sporulation potential of *P. oryzae* in lesions increased rapidly and decreased slowly with time. The potential reached a peak value earlier at higher temperature than at medial and lower temperatures. Namely, the maximum potential for sporulation occurred from the 3rd to the 5th day of lesion enlargement in both 32/25 C and 32/20 C treatment, and on the 5th day in 25/16 C treatment. In 20/16 C treatment, no remarkable peak of sporulation potential appeared. The highest potential for accumulative spore production was found in 25/16 C treatment. Therefore, high temperatures would limit the size of the lesions and their sporulating potential.

That plants predisposed to high temperatures during early stages of leaf development display resistant to infection is well documented. High temperatures during pathogenesis and inoculum production are as equally important as high temperatures before infection to restrict the pathogen from causing epidemics of rice blast.

The maximum number of conidia varied with the combinations of host cultivars, fungus isolates and the growth stage of plants. The highest number of conidia counted was 58×10^3 per lesion. Sporulation was heavier in lesions when expanding leaves were inoculated than when inoculations were made 3 or 4 days after they became fully expanded.

The number of conidia produced in lesions was greater in leaves in tillering stage than in the stage after the panicle primordium was formed. Peak days for conidium production coincided with commencement of necrosis at the various temperatures.

Therefore, we can understand in the field that the lesions with a dark purple margin are to be a noteworthy inoculum source.

Distribution of lesions on leaves and their role of an inoculum source

According to the nature of the disease gradient, infection occurred on leaves during and soon after leaf expansion in the field, giving rise to a progressive series of lesions mentioned above.

If a leaf emerges in 5 days, as is the case during tillering, lesions on the second (n-1) or third (n-2) leaf down the culm in a descending order will have the maximum potential.

When leaves require 9 days for expansion, as occurs during the booting stage, the inoculum they produce will be the maximum in potential on the first (n) or the second (n-1) leaf.

During the incubation period, growth of leaves elevates them so that conidia are liberated from lesions at a higher position than when infection occurred. Some conidia that are liberated from an elevated position settle on young, developing tissues.

In the developing plants, lesions on the second leaf below the flag leaf play the most important role in inoculum sources against panicles because the maximum peak in sporulation coincides with the initial heading stage. Likewise, lesions on the flag leaf can supply much amount of conidia during heading. We should pay attention to spacial distribution of these lesions which are at a higher position than where panicles emerge.

Lesions on the fifth leaf (n-4) are able to supply conidia directly to the emerging panicles at the initial stage of heading. Four or five leaves are usually observed on a culm at that time. Air-flow from a surface of irrigation water to the canopy of plants was detected in paddy field. Therefore, lesions on the living leaves are possible to have a direct effect as the inoculum source for panicle infection.

Sporulation potential of blast fungus in lesions on panicles and their role of an inoculum source

In spikelets, the presporulation period was shorter than in the panicle branches and in the neck node. The incubation period for spikelet infection was from 7 to 12 days at 20 C and from 5 to 10 days at 25 and 30 C. Inoculated spikelets produced a few conidia on the night when the lesion appeared.

The peak of sporulation potential of spikelets and of neck nodes inoculated at the time of their emergence occurred from the 4th to the 8th day, and from the 8th day after appearance of lesions, respectively. The maximum number of conidia recorded were 8×10^4 per lesion in spikelets and 28×10^4 per lesion in neck nodes.

When the temperature ranged from 13.2 to 33.8 C, sporulation in lesions did not occur until 5, 10, 13 days after infection on spikelets, panicle axes and neck nodes, respectively.

Fig. 1. Mass of conidiophores and conidia by *Pyricularia oryzae* on rice spikelets

Among diseased organs in a panicle, the spikelet is a predominant source of inoculum during the ripening of grains at first because (1) the number of lesions per unit field area was greater in spikelets than in panicle branches and neck nodes during the first 2 weeks after the middle stage of heading, (2) the maximum number of conidia formed in spikelets was from 4- to 8-fold greater than that in leaves, (3) emergence from the sheath of a terminal leaf was earlier in some spikelets than in other organs and the presporulation period was of shorter duration in a spikelet, (4) spikelets had higher disease proneness, and (5) some fungus isolates having no pathogenicity to leaves were able to infect spikelets and produced conidia[2),5)].

On occasions when apical spikelets are infected immediately after emergence, they may produce conidia that infect newly emerging panicles in the same population. At that time, the infected spikelets lift up to the canopy during their incubation period and new panicles appear receiving a shower of conidia during the emerging period.

Though the ontogenetic disease proneness of rice leaf against the given fungus prominently decreases during the period following the formation of a panicle primordium, all parts of a young panicle have higher proneness.

The number of available sites of infection suddenly increases when panicles begin to appear in a rice population. As long as a small amount of mycelia survives on leaves, the produced conidia would be distributed to these sites and thereafter inoculum would increase rapidly.

When infection of a neck node or a rachis occurred by the 25th day after emergence from the flag leaf, the infection causes some losses of grain yield[4)]. A certain period of 3 to 10 days is required for heading. Hence, for loss of yield the final time of infection is 35 days after the initial heading stage in a population of rice plants.

If panicles were infected at the early stage after emergence, each organ of the panicle would supply conidia which bring about yield loss in the same rice population.

When both early and late maturing cultivars are grown in nearby fields, the source of inoculum would be on the panicle of the early-maturing cultivar. The same principle may be presumed to apply when different plantings are made in one area during the growing season.

References

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