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华南地区花生叶斑病的治理*

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编者按 本文系华南农学院与美国宾州州立大学农学院一项合作科研的总结。主要内容是，根据花生叶斑病预测预报的基础上进行药剂防治的试验结果，并结合美国和中国在花生的耕作制度、品种以及气候条件的不同等情况进行分析，提出了关于花生叶斑病在华南地区治理的建设性意见，提供有关门部参考。但是，研究仅是一造的试验。因此，对本病的深入治理研究显然存在一定的局限性。

提 要

花生叶斑病不论在中国还是在美国都是一种重要病害。在美国栽培的花生田，基本上都不经过轮作，而在中国的华南地区，大部分都是与水稻轮作。因此，后者田间的叶斑病初次侵染源较少。

试验结果表明，由于花生栽培品种的不同，耕作制度的不同以及气候条件的差异等，美国乔治亚州的测报花生叶斑病的发生与发展的方法，在中国华南地区是不适用的；根据其测报方法制定的喷雾历是不很理想的，而根据另一种连续定点取样调查的测报方法定出的喷雾历的防病效果，则明显比前者好。在发病率为1，3和5%时施用农药百菌清，前后共施三次（在美国南部，最多的要施药九次），防病效果明显。

虽然在有些情况下（如花生病害的防治），药剂的应用仍然是病虫害综合治理（IPM）中最重要的一环，但是，从长远的策略来看，即使在花生叶斑病的防治工作中，仍应注意抗病品种的选育，在这一方面，中美两国进行品种资源的交换，将有利于该项研究的开展。此外，轮作、田间卫生（包括杂草的防除）以及其他耕作制度等，均应加以注意，以便发挥其在综合治理中的应有作用。

从上述两国的合作科研可以看到，农业生产上存在的问题，通过两国科学工作者的共同努力，有可能在较短的时间内得到比较好的解决。这对中美两国在今后日益需要作为粮食的花生生产都将有很大的俾益。

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MANAGEMENT OF PEANUT LEAF SPOT IN SOUTH CHINA

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Specific research details are available as a Ph.D.dissertation entitled "New IPM Strategies for peanut Leaf Spot Control in South China" by Robert L. Theberge of the Department of Plant pathology, The Pennsylvania State University. Copies are available upon request.

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INTRODUCTION

The world-wide importance of peanuts is well recognized as a food, a source of oil, and for protein meal. In the many areas of the world where peanuts are grown pest problems are a significant production factor. In the United States, peanut diseases and insect problems require the constant use of pesticides in the battle to produce a crop. Of the pest problems of peanuts, one of the most commonly recognized is the peanut leaf spot complex. Early leaf spot is caused by the fungus (*Cercospora arachidicola* Hori) and is thought to be quite destructive. Late leaf spot disease [caused by *Cercosporidium personatum* (Berk.& Curt.) , Deighton] is considered by many to be even more destructive than is early leaf spot disease. In the United States of America the control of the leaf spot complex is by regularly scheduled fungicide applications for the protection of the crop from these pathogens. It is estimated by University of Georgia scientists that in 1979 the southeastern area of the United States of America applied $20 million worth of fungicides for the control of peanut leaf spot disease. Most of that fungicide was chlorothalonil (marketed as Bravo by Diamond Shamrock Corp., Cleveland, Ohio, USA) .

Peanut production in the People's Republic of China has taken on new importance in recent years. Government policy has encouraged the expansion of peanut production for both domestic consumption and export. The peanut leaf spot complex in the People's Republic of China is a recognized significant problem in need of attention. The use of regularly scheduled fungicide as used by peanut growers in the United Stated is economically inappropriate to the People's Republic of China. The cost and the unavailability of such substantial amounts of fungicides make this solution unacceptable. With this consideration in mind, collaborative research between the South China Agricultural College and The Pennsylvania State University has been pursued to develop biologically and economically valid pest management methode for peanut production in South China.

EPIDEMIOLOGY OF PEANUT LFAF SPOT COMPLEX

A comparison of the peanut production systems of South China to southeastern United States of America is revealing as partial explanation of the differences perceived to exist in the epidemiology of the peanut leaf spot complex of these two regions. Differences in the cropping seasons

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contribute greatly to the differences in epidemiology of the peanut leaf spot complex. In the United States of America a late spring sown summer crop suffers in the early season from early leaf spot disease. This is often followed by late leaf spot as the season progresses. In SouthChina, two peanut cropping seasons (an early spring sown crop and a fall crop) differ considerably from the southeastern United States for the onset of the epidemic. During the fall crop, late leaf spot is an early and destructive pathogen requiring far greater attention than in the United States. This is often followed by early leaf spot which is far less of a problem for environmental reasons. The early leaf spot pathogen appears therefore to be more acclamated to the early spring and late fall climatic conditions.

Other comparisons are enlightening. Crop management practices in South China greatly contribute to reducing the amount of inoculnm available for initiating epidemics. Peanuts commonly follow paddy rice, which undoubtedly contributes to lessening the amount of inoculum and delaying the onset of epidemics. In the United States, given land control of peanut production, peanut farmers commonly neglect crop rotation. This is thought to contribute greatly to high levels of initial inoculum and early epidemic onset. This difference may cause greater amounts of disease in the United States and hence, a heavier dependence on fungicides. The regular use of crop rotation, common now in China, could contribute to lessening the leaf spot disease problem in the United States if practiced by American farmers.

Conversely, irrigation schemes in China may well contribute to greater amounts of disease as the methods appear to be patterned after traditional paddy rice flooding practices. In the United States over-head irrigation of peanuts is just now becoming more common. Over-head irrigation may further contribute to the epidemic development of peanut leaf spot diseases but in a way that would be expected to be quite different from flood irrigation as practiced in South China.

Plant spacing is another factor that contributes to differences observed between the two production regions. Plant stands in South China are substantially less than the United States. This may give better aeration of the plant canopy. This factor would reduce the likelihood of infection and could contribute to less disease. Moreover, the observed absence of seed treatment in South China is thought to allow significant amounts of Aspergillus crown rot (A. *nliger* van Tieghem) and, as a result, poor

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plant stands. Although the direct consequence may by on lessened leaf spot in South China the greater cousequence may be seen as reduced yields through lower plant stands and planting skips. Alternatively, the poor weed control observed in South China, relative to the United States,may also contribute to modifying the microclimate of the peanut crop canopy. Weeds that shade the crop extend both dew periods and periods of high relative humidity. This would be expected to contribute to more disease. Better weed control would then not only reduce the competition from weeds, as directly affecting peanut production, but would also lessen opportunities for leaf spot infection and development.

PESTICIDE TECHNOLOGY

The philosophy of integrated pest management attempts to combine tactics and strategies for an ecologically and economically sound system for the management of pests and the production of crops. Pesticides remain one important component of most IPM strategies. It is recognized that pesticides are costly and sometimes environmentally undesirable, but they can play an important and sometimes vital role in the production of crops.

IPM for many crops is an evolving strategy which attempts, through a dynamic process, to reduce pesticide dependency to a point where pesticides are used only as needed. Other tactics, such as host plant resistance, sanitation, etc. evolve to play more important roles in an overall strategy. However, until new varieties can be bred and the importance of other tactics evaluated, pesticides will often play a dominant role in IPM. This is very much the case for peanut leaf spot management strategies and it will continue until a greater understanding of peanut leaf spot epidemiology can be developed.

It is generally recognized that the People's Republic of China is behind in the development of pesticide technology for several historical reasons. Discussions with scientists in the People's Republic of China confirm this generally held view. The chemicals available for the control of peanut leaf spot diseases are extremely limited in the People's Republic of China. Most research emphasis has been placed on a complex of sulfur based compounds as a mix of colloidal sulfur, copper sulfate and sodium sulfanilate. Sodium sulfanilate, although effective against foliar pathogens of peanut is known to be phytotoxic and for that reason has never been commercially developed in the United States of America. Research

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has continued in the People's Republic of China with the hope that the phytotoxicity could be reduced or avoided by either crop management or application timing or other methods.

In the United States of America the most common, and indeed the predominant chemical for the control of peanut leaf spot diseases is chlorothalonil (Bravo). Chlorothalonil is considered expensive and perhaps prohibitive in some peanut production regions of the world. One portion of this research project took a look at the costs and benefits, on a foreign exchange basis, of the use of chlorothalonil (Bravo) versus the sulfur complex as protectant fungicides for the control of the peanut leaf spot complex.

One axiom of fungicide technology is that better protection is afforded when applications are made more uniformly on the leaf surface. To this point, application technology using conventional backpack sprayers (as now used in the South China peanut production region) was compared to ultra-low volume applicators that apply pesticides as a uniform droplet size that decreases drift and improves leaf area coverage. Control droplet applicators or ultra-low volume sprayers (Mini-Ulva) are manufactured by Micron Corporation, Houston, Texas. These sprayers produce droplets of uniform size (75-100 microns) and are highly efficient in the maximum penetration of the crop and by covering both upper and lower leaf surfaces. Coverage of the lower leaf surface is crucial in the control of late leaf spot which produces far more lesions on the lower surface and subsequently large numbers of spores.

Comparisons of these application technologies pointed out the effectiveness of the two chemicals being tested and the benefits of a controlled droplet ultra low volume applicator over conventional back-pack sprays. The amounts of disease on replicated peanut plots is given in Figure 1 which indicates the relative benefits of the two chemicals and the two application methods.

The consequence of the phytotoxicity of sodium sulfanilate could be seen in the mean yields of the plots from which the results shown in Figure 1 were obtained. Figure 2 presents the yield of dried pods from those plots. The better coverage from the ultra-low volume controlled droplet applicator appear to have contributed to greater phytotoxicity through better coverage.

Experimental samples of some chemicals known or thought to have

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action against peanut leaf spot diseases were tested as a complement to these trials. One chemical, Baycor(manufactured by Mobay Chemical Corporation, Kansas City, MO) proved very effective and offers promise equal to or better than the results obtained with chlorothalonil. Baycor has some measure of systemic activity and further research attention for its appropriateness for use in the People's Republic of China is indicated.

PESTICIDE SCHEDULING

The economics of the regular use of any fungicide for the control of peanut leaf spot disease in South China are not favorable. The peanut yields obtained and the cost of fungicides preclude the 9 or more applica tions common in Southeastern United Statet. For this reason, research was undertaken in South China to test peanut leaf spot forecasting methods that could schedule fungicide applications as needed. The peanut leaf spot forecasting system of the University of Georgia (Department of Agricultural Economics, Athens, GA 32602, USA) was tested in South China as part of this research project. Its performance was unacceptable for complex reasons. We understand that the Georgia system accommdates both early and late leaf spot and schedules fungicides when we independently judged them to be not necessary. By its conservative nature, the University of Georgia forecasting system calls for too many sprays. This makes it economically unacceptable for South China. The alternative, which is to limit the number of sprays to an economically acceptable number (such as 3 or 4), permits the University of Georgia peanut leaf spot forecasting system to schedule those limited sprays far too early in the growing season leaving no protection during the bulking period of the peanut crop(see Figure 3).

It is our judgement that modification of the University of Georgia peanut leaf spot forecasting system would not lead to acceptable fungicide scheduling methods as the epidemiology, economics, and production of peanuts in southeastern United States is far too different from South China.

A second fungicide scheduling method, called sequential sampling, relies on scouts to observe and record the incidence of peanut leaf spot disease in production fields. This method, which evolved from entomological studies on scheduling insecticides, proved very effective for scheduling fungicides on peanuts in South China. Three scouts, each

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recording the incidence of disease on 200 plants per field (for a total of 600 plants observed) tested for critical disease incidence levels of 1,3, and 5% leaf spot. At these critical points fungicides were applied for the management of peanut leaf spot. The entire effort took less than 15 minutes and was observed to be easily taught as a scouting procedure. The disease incidence levels of 1, 3, and 5% were set arbitrarily but proved very effective (Figure 3). The yield of plots sprayed with chorothalonil at these critical spray levels showed significant yield increases (Figure 4). Benefit/cost analysis of yield value of peannts to imported fungicide value gave a best case return ratio of 30∶1. That is for every foreign exchange dollar spent on fungicides one would gain 30 dollars in increased peanut yield. Conventional spraying methods showed little or no benefit in applying fungicides. In some cases an economic loss was indicated as the cost of fungicide exceeded the increased yleld of peanuts. The University of Georgia forecasting system was unable to obtain benefits from spraying when the number of sprays was limited to a maximum of three. Apparently, the sprays were applied too early to do much good.

Sequential sampling appears to offer great opportunities for the management of leaf spot diseases of peanuts in South China. However, more research activities are needed to strengthen any IPM program designed to permit the economic management of these important diseases of peanuts in South China.

RECOMMENDATIONS

The long-range solution to the leaf spot diseases of peanut in the People's Republic of China should come through a plant breeding program stressing, along with other characteristics, the improvement of resistance to leaf spot. The exchange of germ plasm between the People's Republic of China and the United States of America could contribute greatly to accelerating this effort. Research is needed on how resistance to leaf spot spot disease can be used to complement, reduce, and better schedule fungicides.

The importance of crop rotation is obvious and apparent in its contribution to limiting initial disease. Efforts in the United States should begin soon to correct this oversight in crop management. Shortened crop rotations appear to be contributing to the $20 million a year that is now

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spens for leaf spot control in southeastern United States. Chinese scientists should learn from this error and not contribute to opportunities that will force shortened rotations unless absolutely necessary.

Much more research is needed on the consquences of various irrigation schemes on the epidemiology of leaf spots of peanuts. Additionally plant nutrition, relative to peanut plant health, is an area in need of more research emphasis. There are undoubtedly opportunities to amend soils, strengthen plant health, and further reduce the opportunity for peanut pathogens to cause disease.

Sprayer technology in South China could benefit from research in several other araes. Pest management strategies must be integrated into crop production practices as fully as possible. Some crop managers in South China were sometimes not cognizant of the consequences of their activities and may have contradicted the efforts of others. For instance, the previously cited example of the contribution of weeds to the epidemic development of leaf spot points to the need for an integrated crop management strategy for peanuts suitable for that production region.

Conventional back-pack spraying, as now practiced in South China for peanut disease protection, is production-scale-limiting and imprecise at best. New technology should be looked at as one method of improving the dependability and security of pest management systems for peanuts. Additionally, pesticide safety takes good common sense. The safe use of these biologically active chemicals should be stressed to the applicators in a comprehensive pesticide safety program in South China.

CONCLUSIONS

The linkage between the South China Agricultural College and The Pennsylvania State University has been rewarding and beneficial. Thses studies have demonstrated how rapidly progress can be made when scientists are given opportunities to collaborate on problems of common interests. Thare is little doubt that much can be daveloped that would contribute to lessening the destructive pests of peanuts and the dapandency on pesticides in both the People's Republic of China and the United States. By working together, scientists in both countries can help improve production of peanuts, a crop that is important and will continue to be important as both nations prepare for future food needs.

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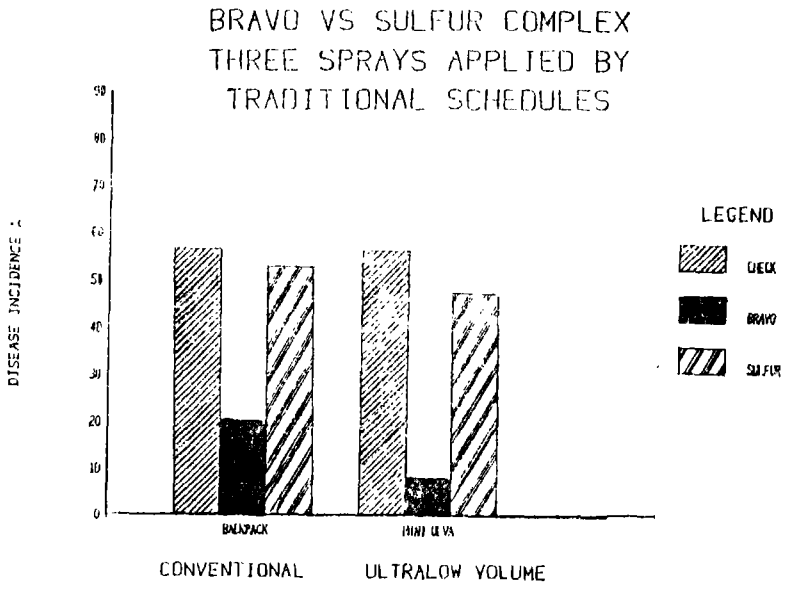

Figure 1. The incidence of peanut leaf spot disease in plots treated 1, 2, and 3 times with a sulfur complex (Sulfur) or chlorothalonil (Bravo) when applications were made by conventional back-pack sprayers or ultra low volume controlled droplet applicators. Mean of three replications.

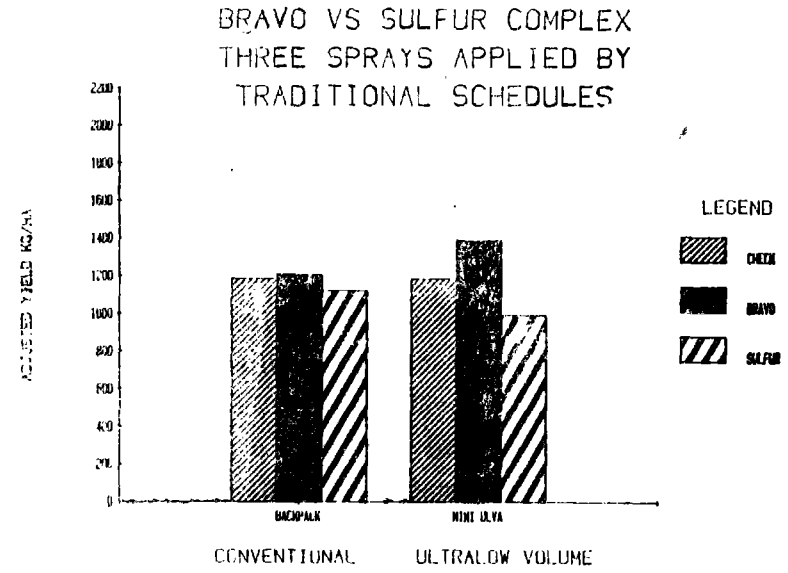

Figure 2. Yield of peanut pods from plots treated 1, 2, or 3 times with a sulfur complex (Sulfur) or chlorothalonil (Bravo) by conventional back-pack sprayer or ultra low volume controlled droplet applicator. Mean of three replications.

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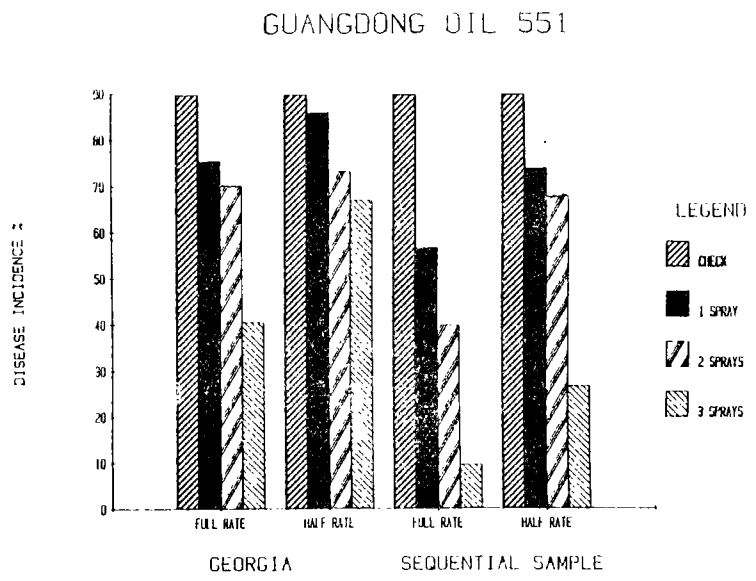

Figure 3. Incidence of peanut leaf spot in plots untreated and treated with 1, 2, or 3 sprays full or half-rate of chorothalonil (Bravo) scheduled by the University of Georgia peanut leafspot forecasting system (Georgia) or by a disease incidence sampling procedures (sequential sample). Mean of three replications.

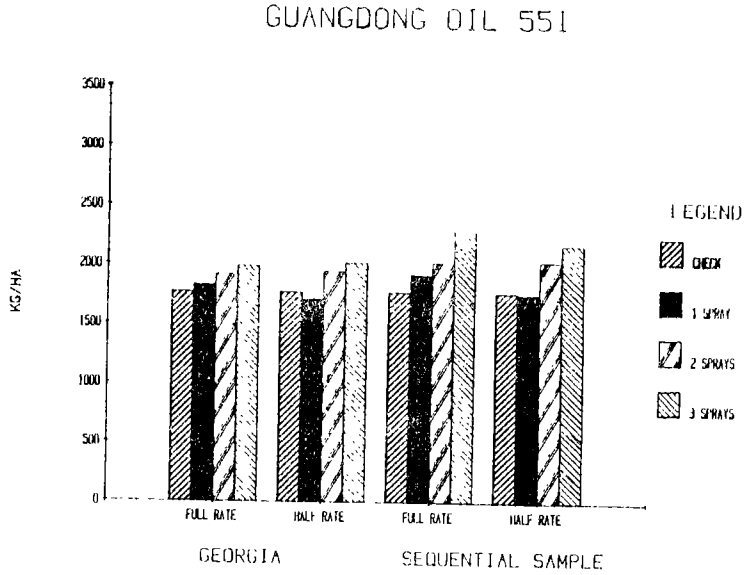

Figure 4. Yield of peanut pods from plots sprayed 0, 1, 2, or 3 times with full or half rates of chlorothalonil (Bravo) scheduled by the University of Georgia leaf spot forecasting system (Georgia) or by a diseasee incidence sampling procedure (sequential sample). Mean of three replications.

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