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Bean Seed Treatment with Pesticides: An Adoptable Technology for Rwandan Farmers

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BEAN SEED TREATMENT WITH PESTICIDES: AN ADOPTABLE TECHNOLOGY FOR RWANDAN FARMERS

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INTRODUCTION

Beans (Phaseolus vulgaris) are a major component in the Rwandan diet, providing 23% of total caloric intake and up to 25% of protein intake. In Rwanda, beans occupy about 25% of the harvested hectarage: in 1984, there were about 348,000 ha under beans. Despite the importance of this crop, the yield of beans has declined over the years because of declining soil fertility and expansion of cultivation into more marginal land (ISNAR; 1982) The present estimated yield is only about 700 kg/ha. The total dry bean production in the country is about 200,000 tons, and green bean production is about 57,000 tons, of which 75% is produced in season A (planting time September-October) (MINAGRI, 1985).

In the project area, all three types of beans, i.e. dwarf, semi-climbing and climbing, are grown. Climbing types are generally planted pure and in monoculture except when grown in banana groves. When planted in mixtures, the number of varieties rarely exceeds five or six. The dwarf and the semi-climbing types are planted together in mixture, and a typical mixture contains about 12 to 14 different varieties (Delepierre, 1975). In the Buberuka Highlands (BH) area in season A, about 80% of the dwarf beans are grown in association with maize although beans are by far the dominant culture. In season B (planting time April), dwarf beans are generally planted without association.

Previous on-farm trials by this author (Paul; 1986) and the trials conducted by the International Center for Tropical Agriculture (CIAT) have adequately demonstrated that bean disease is a major factor that limits production in the Buberuka Highlands area. Results show that 20 to 40% of the emerged seedlings do not attain maturity and that seedling diseases, and to a lesser extent common bean flies (Ophiomyia spp.) and cutworms (Spodoptera spp.), are the major causes of this mortality. Diseased plants that survive do not produce to their full potential because of reduced photosynthetic surface, damaged roots and seed pods and the overall loss of plant vigor. The quality of the harvested product is also lowered. The importance of disease control in bean production cannot be overemphasized.

The control of bean disease and insect pests by employing sound cultural practices along with planting disease-resistant/tolerant varieties is presently under investigation (Paul; 1987a). Although the control of bean diseases by foliar application of fungicides would not be a viable option for the small Rwandan farmers at this time, preplant treatment of seeds with fungicides/insecticides is an area that deserves attention. This is a one-time application, using a simple procedure and a small quantity of chemicals and requiring no special equipment. If one or more low-cost, low-toxicity chemicals that are effective against root-rot and/or other seed-transmitted diseases and against bean flies could be identified, this knowledge could be extended to the subsistence farmers without difficulty.

OBJECTIVES

1. To test the effectiveness of certain fungicides and fungicide-insecticide mixtures as seed treatments against bean root-rot and other diseases and against bean flies under farmer conditions.
2. To make an economic assessment and a farmer assessment of this technology.

MATERIALS AND METHODS

These trials were conducted on farmers' fields and on the fields of a few area schools (CERAIs) over two seasons (87 A & 87 B). The primary reason for putting these trials on the farmers' fields was that the types and extent of various root diseases found on the research station and on the farmers' fields are not the same, probably because of different management practices. As dwarf beans are much more susceptible to diseases than are climbing types, farmers' own dwarf bean mixtures were used in this study. The plot size for each treatment was 2 m x 5 m, and only one to two replications per farm were used, using a randomized block design. Precautions were taken to avoid cross contamination at sowing by allowing a 50-cm spacing between the plots. Body parts exposed to the chemicals during seed treatment and sowing were thoroughly washed afterwards. Farmers and the school students prepared the land, helped to install the trials and took responsibility for their maintenance, while the researchers did the monitoring and evaluation. The methodology and the treatments differed somewhat in the two seasons, and were as follows:

Season 87 A: 350 bean seeds were used for each of the following treatments. The rates mentioned below were for treating 1 kg of bean seeds.

1. Thiram (80% a.i.): 3g + Benomyl (50% a.i.): 30g
2. Thiram: 3g + Lindane (20% a.i.): 3ml
3. Thiram: 3g + Endosulfan (35% a.i.): 3ml
4. Diasaat (Captan + Endosulfan + Diazinon): 5g
5. Control (no treatment).

Season 87 B: 450 seeds were used for each of the following treatments. The rates mentioned below were for treating one kilogram of bean seeds.

1. Thiram: 2g + Benomyl: 4g
2. Thiram: 2g + Benomyl: 4g + Endosulfan: 3ml
3. Endosulfan: 5ml
4. Diasaat: 4g
5. Derosal: 4g + Ridomil: 4g
6. Control (no treatment).

The required number of seeds were counted and placed in plastic bags. Pre-weighed quantities of chemicals and a few drops of water were added to the seeds, and the mixture was shaken well to provide a thorough coating of the seeds with the chemicals. After a 30-min waiting period, the treated seeds were planted separately following the traditional planting methods.

The treatments were evaluated using plant density counts, the percentage of leaf surfaces affected by diseases, the number of pods at harvest, yield and farmer evaluation. Approximately three weeks from planting time, seedling counts were taken from two 0.25 m^2 area in each plot. About six to eight weeks after planting, 10 plants per plot were carefully uprooted, and an estimation of root damage caused by diseases and insects was made (in 1987 B only). At this time, an estimation of the total foliar surfaces affected by various diseases was made. During the harvest of the crop, the number of plants and pods per plot was also counted. The farmers did the threshing and drying, and the harvest was weighed.

RESULTS AND DISCUSSION

The results as presented in Tables 1 and 2 show that between 90 and 100% of the planted bean seeds had emerged. The seeds used in these studies were the farmers' own mixtures of varieties planted after the various seed treatments by the farmers themselves in the traditional way. This shows that the quality of bean seeds used by the farmers is generally good, that they do a good job of 'cleaning' the seeds before planting and that the traditional method of land preparation and planting works well for beans. The results further show that of the seedlings that emerged, between 75 and 90% reached maturity.

These trial plots were maintained by the farmers in exactly the same way they take care of their own bean fields: the fields were not thinned but were weeded twice. There might have been some plant loss during weeding, but the majority of plants were lost due to disease and insect pests. None of the

fungicides and insecticides employed in the present study were effective in reducing plant mortality. In 1987 A, only the percentage of leaf surfaces affected by all diseases was scored (Table 1); the results indicate that Thiram+Benomyl and Diasaat provided limited control of the foliar diseases. In addition, Thiram+Benomyl increased bean yields by 40% over the untreated control.

In 1987 B, Thiram+Benomyl+Endosulfan and Derosal+Ridomil treatments significantly increased bean yields (Table 2). Except for Endosulfan, all the other treatments also had a positive effect on bean yields. This season all the predominant bean diseases in the area were scored separately (Table 3). None of the treatments were found to be effective in controlling root diseases or ascochyta. However, Thiram+Benomyl+Endosulfan and Derosal+Ridomil treatments effectively reduced the incidence of anthracnose, one of the most damaging bean diseases in the area. These same treatments and Thiram+Benomyl also significantly reduced angular leaf spot disease as compared to the control.

Although bean flies could be a serious problem in most parts of Rwanda, they are not generally considered to be a threat in the BH area. Good rainfall distribution and fertile soils are negatively correlated with bean fly infestations. In general, the rainfall distribution in the FSRP work area could be considered good. In addition, the farmers plant beans in their better fields and add manure/compost if available. These factors might explain the low incidence of bean fly infestation in the area. From the 1987 B yield data, one could consider that it was a good season in terms of bean production, yet 22% of the plants in the control plots were affected by bean flies (Table 3). When beans are planted in relatively poor soil, and have poor rainfall distribution, as was the case in 1988 B, as many as 50% of the bean plants could be lost due to bean fly attack (Burleigh, 1987). Therefore, this particular insect species could become an occasional problem for the bean farmers of this area. Endosulfan seed treatment prior to planting has been shown to be an effective way of controlling bean flies (Autrique, 1987). The present study also supports this conclusion (Table 3).

A benefit/cost analysis of bean seed treatment is presented in Table 4. Only the cost of chemicals has been taken into consideration as no equipment and hardly any additional labor were needed for treating the seeds. The results clearly show that the farmers will benefit by coating bean seeds with Thiram+Benomyl prior to planting (benefit/cost ratio of four). Addition of Endosulfan to the fungicide mixture will provide added protection against bean flies.

Potential disease and insect pest infestations later in the season cannot be predicted at planting time. Therefore, the wisdom of seed treatment may be questioned. Even in good seasons, the extra yield due to seed treatment will more than compensate for the cost of such treatment while in bad seasons the seed treatment may determine whether or not the farmer will have something to harvest. Therefore, the seed treatment should be considered as a small premium to provide coverage for a large potential loss. The yield increase from seed treatment cannot be attributed only to diseases and insect pest control. Since most of these chemicals are systemic in nature, it is possible that they also induce physiological changes in the plants,contributing to yield increase.

This seed treatment should be particularly useful for the farmers' own bean seed multiplication fields: the resultant cleaner crop with higher vigor could be expected to produce better quality seeds for the next planting. Additional research is being conducted along this line; the preliminary results obtained so far tend to support this view (Paul, 1987b).

FARMERS' OPINIONS

Although the effect of seed treatment is not spectacular, the farmers have observed that the treatment helps to reduce disease incidence. Farmers working in a bean seed multiplication program (Paul, 1987b) are beginning to appreciate the potential benefits of treating seeds with pesticides before planting. They are ready to adopt the technology and are willing to pay for the chemicals. However, chemicals will have to be available locally.

SUMMARY AND CONCLUDING REMARKS

Coating bean seeds with a mixture of fungicides and insecticides (preferably with Benomyl+Thiram+Endosulfan) prior to planting appears to be an easy, cost-effective and practical way to provide reasonable control against anthracnose and angular leaf spot disease and against bean flies.

The farmers have few reservations about using chemical seed treatments. However, the chemi-

cals should be readily available, and initial demonstrations of the seed coating procedure would be necessary. The hazards of improper use of agricultural chemicals should be stressed to the farmers.

CIAT members in Rwanda have initiated a dialogue with the Ministry of Agriculture, Livestock and Forestry (MINAGRI), and INADES (a non-profit organization that publishes, among others, extension materials) to help bring this technology within farmers' reach. FSRP could contribute toward this goal by helping to train the local extension personnel in this respect.

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Table 1. Effect of seed treatment on plant density, diseases, and yield of beans on the farmers' fields, 1987 A.

Treatment	Plant density: Seed-ling	Plant density: At Ma-turity	Plant density: % Sur-vival	Diseases % SI[1]	No. of pods/1 plot	Yield g/plot	Yield % cont.
Thiram + Endosulfan	320	259	81	9.4	719	740 B[2]	107
Thiram + Benomyl	350	270	77	7.0	845	965 A	140
Thiram + Lindane	---	268	---	---	711	738 B	107
Diasaat	310	275	89	7.1	765	800 AB	116
Control	330	264	80	11.1	675	690 B	100

All data presented above are per $10m^2$ and should be multiplied by 1,000 to obtain corresponding data per hectare. Averages of six replications.
[1]% SI = percentages of total foliar surfaces affected by diseases.
[2]Date followed be the same letter are not significantly different at the 5% level.

Table 2. Effects of seed treatment on plant density and yields of beans under farmer conditions, 1987 B.

Treatments	Plant density: Seed-ling	Plant density: At Ma-turity	No of %Sur-vival	pods/ plot	Yield g/plot	Yield % cont.
Thiram + Benomyl	420	357	85	1355	1685 AB[1]	122
Thiram + Benomyl + Endosulfan	450	345	77	1455	1728 A	125
Endosulfan	420	319	76	1177	1326 C	96
Diasaat	410	352	86	1449	1688 AB	123
Derosal + Ridomil	450	359	80	1528	1711 A	124
Control	450	344	76	1336	1377 BC	100

All date presented above are per $10m^2$ and should be multiplied by 1,000 to obtain corresponding data per hectare. Average of nine replications. Numbers of seeds planted/plot: 450.
[1]Data followed by the same letter are not significantly different at the 5% level.

Table 3. Effects of seed treatment on the incidence of various bean diseases under farmers' conditions, 1987 B.

Treatment	Bean Flies[1]	Root Disease[1]	Anthrac-nose[2]	Asco-chyta[2]	Angular leaf spots[2]
Thiram + Benomyl	2.0 A[3]	3.8 A	4.2 AB	6.6 A	3.3 BC
Thiram + Benomyl + Endosulfan	1.0 B	3.9 A	3.3 B	6.9 A	2.9 C
Endosulfan	1.1 B	4.0 A	5.7 A	8.8 A	4.5 AB
Diasaat	1.7 AB	3.7 A	4.2 AB	4.3 A	5.3 A
Derosal + Ridomil	1.6 AB	3.7 A	3.3 B	4.9 A	3.3 BC
Control	2.2 A	3.8 A	6.1 A	8.7 A	5.4 A

Average of nine replications on six different farms.
[1]Scoring has been done on 10 plants/treatment/replication.
1 = no symptoms; 9 = very severe.
[2]Percentages of total leaf surface affected.
[3]Data in the same column followed by the same letter are not significantly different at the 5% level.

Table 4. Benefit/cost analysis of bean seed treatment with pesticides (all price estimates are in U. S. dollars).

Treatment[1]	Cost of chem/kg seed[2]	Cost of chem/ha[3]	Cost equiv. in kg beans[4]	Actual yield increase[5]	BCR[6]
Thiram: 2g + Benomyl: 4g	0.19	19.00	76.00	308	4.0
Thiram: 2g + Benomyl: 4g + Endosulfan: 3 ml	0.24	24.00	96.00	351	3.7

[1]Chemical products and the quantity employed.
[2]Price/kg: Endosulfan: $15.00
Benomyl: $40.00
Thiram: $15.00
[3]Assuming a seed rate of 100 kg/ha.
[4]Quantity of bean needed to pay for the treatment cost at the current market price of $0.25/kg.
[5]Net yield increase over untreated control (see Table 2); data converted to kg/ha.
[6]Benefit/cost ratio: column 5 divided by column 4.