Studies on the Fungicidal Control of Rice Blast

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SUMMARY

A RANGE of fungicides including organomercury, organotin and dithiocarbamate formulations were screened against rice blast by inducing severe epiphytotics of the disease in highland nurseries. The organomercury fungicide Verdasan achieved the best disease control and was outstanding in its long term effect. Antracol, a dithiocarbamate, was the most effective of the non-mercury fungicides tested and compares very favourably with Verdasan in its protective action although it lacks the long term effect of the latter. It is much superior to fermate, which is practically ineffective in severe blast epiphytotics, and could be recommended in place of the latter for use under Ceylon conditions. It should be applied at 0.2-0.3 per cent. on a 7-10 day spraying schedule depending on the nature of the epiphytotic and the prevailing conditions. With the exception of the organotin fungicide Brestan 60 which achieved a measure of control when applied at high dosages, none of the other non-mercury fungicides tested achieved satisfactory control.

INTRODUCTION

Blast is one of the most important diseases of rice and although the use of resistant varieties constitutes the most effective means of combating the disease, chemical control measures have to be adopted in certain situations.

Abeygunawardena and Peiris (1) found that ferric dimethyl dithiocarbamate inhibited the spore germination of the causal fungus, *Piricularia oryzae,* and fermate has been generally recommended for control of the disease in Ceylon although it does not achieve a high degree of control under conditions favouring severe epiphytotics. Marks and Peiris (2) found that phenyl and ethyl mercuric compounds were extremely effective in controlling the disease. However, the use of these organomercury fungicides has not been

generally advocated since they are phytotoxic to some of the *indica* varieties grown locally, and because of the possibility of toxic mercury residues from treated plant material. In studies with the antibiotics antimycin, blastmycin and blasticydin 'S', Marks and Peiris (3) found blasticydin 'S' to be highly promising for the control of blast but this again has not provided a practical control measure for use in the field.

In the studies reported here, some of the more recent fungicides including organomercury, organotin and dithiocarbamate formulations were evaluated with the object of selecting a safe and effective formulation which could be used locally. The trials were carried out at the Agricultural Research Station, Rahangala.

MATERIALS AND METHODS

The method employed in the evaluation of fungicidal efficacy was similar to the highland nursery technique of Marks and Peiris (2). Rectangular nursery beds were laid out in a block comprising four 'screening' beds and five 'infection' beds, 2½ feet and 1½ feet broad respectively. The beds were constructed parallel to one another, the screening beds alternating with the infection beds, and adjacent beds separated by a space of 1 foot. The infection beds were sown first and their function was to provide a good source of inoculum. The screening beds, used for evaluating fungicidal treatments, were sown after infection in them had been assured by a high disease incidence in the infection beds. Beds were row sown at a 4 inch spacing with the susceptible variety Pachchaiperumal 2462/11, the rows being parallel to the long axis in the infection beds and perpendicular to the long axis in the screening beds. A basal fertilizer dressing was given at the following rates :—

Cattle manure ..	.. 0.5	lb./sq. ft.
Urea ..	.. 0.1	oz./sq. ft.
or sulphate of ammonia	.. 0.2	oz./sq. ft.
Concentrated superphosphate	.. 0.05	oz./sq. ft.
Muriate of potash	.. 0.05	oz./sq. ft.

Top dressings of urea or sulphate of ammonia were applied at the same rates to stimulate foliar growth and susceptibility to blast infection.

Fungicidal spraying commenced with the appearance of the first symptoms of infection in the screening beds. Each fungicidal treatment was applied to a block of 7 rows and was replicated four times at random in the four screening beds. In each screening bed, 7-10 rows were left untreated at the ends to act as guard rows. The first spray was generally given at 2-3 weeks after planting. The development of infection was followed and assessed according to the Okamoto scale (5).

Prevailing weather conditions exert a marked influence on the development of the disease, periods of continually wet weather being highly favourable for increased disease incidence. This influence is reflected in the data given in tables 2-5 on the incidence of blast infection in the trials described.

The fungicides tested are listed in table 1.

EXPERIMENTAL RESULTS

Data relating to the following four trials are presented in tables 2-5.

Trial 1.—(Planted on 20.4.63, table 2). Conditions during the period of this trial were favourable for the development of blast. The first spray was given at 2 weeks after planting and the subsequent sprays at weekly intervals. Infection set in at a very early stage and increased steadily, almost 80 per cent. of the foliage in the controls being destroyed in 5 weeks. Verdasan and Brestan 60 achieved the best disease control. Both these fungicides were tested at high dosages in this trial ; phytotoxic effects were observed with Verdasan at the higher dosages.

Trial 2.—(Planted on 25.1.64, table 3). Conditions extremely favourable for disease development were encountered in this trial. Sprays were applied at weekly intervals, the first being given at 3 weeks after planting. A rapid development of the disease occurred during the fourth week and the controls were dead in just over five weeks. The Verdasan treatments achieved the best control of blast followed by the Antracol and Brestan 60 treatments. Spraying was discontinued after the third application and the progress of the disease observed. Infection increased rapidly in the Antracol and Brestan 60 treatments in sharp contrast to the Verdasan treatments indicating the ability of the latter to check disease development for a considerably longer period.

Trial 3.—(Planted on 4.4.64, table 4). Conditions were similar to trial 2 with a rapid development of blast during the fourth week. The first spray was applied at 2½ weeks after planting. With the exception of three treatments where a fortnightly spraying schedule was investigated, all other treatments were given as weekly sprays. The same trends as in trial 2 were observed, Verdasan achieving the best control followed by Antracol and Brestan 60.

Trial 4.—(Planted on 2.2.65, table 5). The development of the disease was somewhat delayed but infection steadily increased from the sixth week. 80 per cent. of the foliage in the controls was destroyed by the nineth week and complete destruction had occurred in just over 10 weeks. The first spray was given at 3½ weeks after planting and subsequent sprays at weekly intervals. Differences in the efficacy of the various fungicidal treatments were very conspicuous by the nineth week. Excellent control of blast had been achieved by Verdasan and Antracol and to a lesser extent by Brestan 60 while more than 80 per cent. destruction of foliage had occurred in practically all the other treatments. Spraying was discontinued after these treatments had received a total of seven weekly sprays and the progress of infection observed in an environment extremely favourable for the spread of the disease. Within three weeks infection in the Antracol and Brestan 60 treatments had increased to the 80 per cent. level. Verdasan alone held infection in check at the 5 per cent. level once again demonstrating its ability to afford a high degree of protection for a considerably long period.

DISCUSSION AND CONCLUSIONS

In the method adopted in this series of trials for the evaluation of fungicidal efficacy, plants are heavily predisposed to blast and the foliar phase is subjected to an epiphytotic of a much higher intensity than would be obtained under mudland conditions. Thus the fungicides are tested under extremely rigorous conditions.

On the basis of the percentage leaf area destroyed, Peiris and Marks (4) recognized seven grades of resistance to blast as follows :—

% Leaf area attacked	*Degree of resistance*
0.2 or less	Very highly resistant
0.3- 1.0	Highly resistant
1.1- 5.0	Very resistant
6.0-25.0	Moderately resistant
26.0-55.0	Moderately susceptible
56.0-80.0	Fairly susceptible
80.0 and above	Very susceptible

A fungicidal treatment may be considered as conferring a degree of resistance comparable with one of these seven grades depending on the percentage leaf area destroyed by blast. Further, successive assessments of percentage foliar destruction will reflect the interaction of the influence of the prevailing conditions and the effect of a fungicidal treatment in the interveining period on blast development of the influence of the prevailing conditions and the effect of a fungicidal treatment in the interveining period on blast development A reference to tables 2-5 will indicate the comparative efficacy of the fungicidal treatments evaluated in each of the four trials. The formulations Verdasan (organomercury), Antracol (dithiocarbamate) and Brestan 60 (organotin) were superior to fermate, generally recommended at present, for controlling blast. Verdasan has outstanding fungitoxic properties and holds the disease in check for a long period, a dosage of 0.2 per cent. and a spraying schedule of 2-3 weeks being adequate even under rigorous conditions. However, the use of organomercury fungicides must be considered with some caution under Ceylon conditions. Antracol, a non-mercury fungicide also achieved good control of blast although not as effective as Verdasan in its long term action. It was the only dithiocarbamate among the maneb, zineb and fermate formulations tested which achieved a high degree of control of the disease under rigorous conditions. It has no draw backs from the point of view of phytotoxicity or residual effects, and could be recommended at a dosage of 0.2-0.3 per cent. on a 7-10 day schedule, depending on the nature of the epiphytotic, as a safe effective fungicide under local conditions. Brestan 60 was inferior to Antracol and must be applied at a relatively high dosage to achieve a reasonable degree of control. It does not therefore offer a competitive alternative to Antracol as a non-mercury fungicide.

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TABLE 1.—FUNGICIDES EVALUATED

Fungicide	*Active ingredients*
Verdasan	Phenyl mercuric acetate (equivalent of 2.5 per cent. Hg.)
Brestan 60	60 per cent. Triphenyltin acetate plus 20 per cent. Manganese ethylene bisdithiocarbamate
Du-Ter	20 per cent. Triphenyltin hydroxide
Niagara carbamate	76 per cent. Ferric dimethyl dithiocarbamate
Antracol	70 per cent. Zinc propylene bisdithiocarbamate
Lonacol	72 per cent. Zinc ethylene bisdithiocarbamate
Dithane M-22	80 per cent. Manganese ethylene bisdithiocarbamate
Dithane M-45	80 per cent. Coordination product of zinc ion and magnasene ethylene bisdithiocarbamate
Cupravit (Ob 21)	Copper oxychloride containing 50 per cent. copper
Fungicide 328	75 per cent. 3,3'-ethylenebis (tetrahydro-4, 6-dimethyl-2H-1, 3, 5-thiadiazine-2-thione)
Nitrit conc.	45 per cent. Dinitrophenyl thiocyanate.

TABLE 2.—Effect of fungicidal treatments on the development of blast in trial 1

Planted on : 20.4.63.

Sprayed on : 3.5, 10.5, 17.5 and 24.5.

Fungicide	*Dosage*	*Spraying interval in days*	*Percentage leaf area destroyed Age in days*		
			23 (13.5)	*30 (20.5)*	*37 (27.5)*
Verdasan	0·5 %	7	5·00	6·50	5·00
Verdasan	1·0 %	7	5·00	*	*
Verdasan	1·5 %	7	5·00	*	*
Brestan 60	0·2 %	7	9·50	29·00	32·50
Brestan 60	0·3 %	7	6·50	18.00	18·00
Brestan 60	0·4 %	7	5·00	11·00	5·00
Du-Ter	0·2 %	7	13·00	44·00	44·00
Du-Ter	0·3 %	7	13·00	32·50	61·25
Du-Ter	0·4 %	7	8·00	27·50	36·50
Niagara carbamate	0·06 %	7	15·00	42·75	65·00
Niagara carbamate	0·08 %	7	21·50	55·00	73·75
Niagara carbamate	0·1 %	7	16·50	48·75	65·00
Lonacol	0·3 %	7	8·00	32·50	61·25
Lonacol	0·6 %	7	8·00	29·00	35·25
Control	—	—	37 63	63·75	79·38

* Indicates phytotoxic injury.

TABLE 3.—Effect of fungicidal treatments on the development of blast in trial 2

Planted on : 25.1.64.

Sprayed on : 13.2, 21.2 and 28.2.

Fungicide	*Dosage*	*Spraying interval in days*	*Percentage leaf area destroyed Age in days*			
			28 (*22·2*)	*34* (*28·2*)	*40* (*5·3*)	*54* (*19·3*)
Verdasan	0·3 %	7	0·35	11·00	11·50	24·00
Verdasan	0·4 %	7	0·43	8·00	6·50	25·00
Verdasan	0·5 %	7	0·43	9·50	6·50	31·25
Brestan 60	0·3 %	7	1·10	21·50	42·50	87·50
Brestan 60	0·4 %	7	0·28	11·00	35·25	90·00
Du-Ter	0·3 %	7	21·50	47·50	90·00	100·00
Du-Ter	0·4 %	7	14·50	53·75	100·00	100·00
Niagara carbamate	0·075%	7	24·25	53·75	100·00	100·00
Niagara carbamate	0·1 %	7	18·00	67·50	100·00	100·00
Antracol	0·2 %	7	0·28	11·50	35·00	73·70
Antracol	0·3 %	7	0·35	6·50	25·00	65·05
Dithane M-22	0·3 %	7	12·25	61·25	95·00	100·00
Dithane M-45	0·3 %	7	7·68	40·00	80·00	100·00
Cupravit (Ob 21)	0·3 %	7	27·75	67·50	100·00	100·00
Cupravit (Ob 21)	0·5 %	7	25·00	67·50	100·00	100·00
Control	—	—	21·50	67,50	100·00	100·00

TABLE 4.—Effect of fungicidal treatments on the development of blast in trial 3

Planted on : 4.4.64

Sprayed on : 21.4, 28.4, 4.5 and 11.5 (7 day interval).

21.4 and 4.5 (14 day interval).

Fungicide	*Dosage*	*Spraying interval in days*	*Percentage leaf area destroyed Age in days*			
			24 (28.4)	*30 (4.5)*	*37 (11.5)*	*44 (18.5)*
Verdasan	0·3 %	7	0·10	0·20	0·20	0·20
Verdasan	0·3 %	14	0·10	0·20	3·63	6·75
Verdasan	0·4 %	7	0·10	0·20	0·28	0·28
Verdasan	0·4 %	14	0·10	0·20	1·38	5·00
Verdasan	0·5 %	7	0·10	0·20	0·20	0·43
Verdasan	0·5 %	14	0·10	0·20	0·85	2·25
Brestan 60	0·3 %	7	0·10	5·00	29·00	61·25
Brestan 60	0·4 %	7	0·10	4·25	14·50	25·00
Brestan 60	0·5 %	7	0·10	2·75	14·50	36·50
Niagara carbamate	0·1 %	7	0·43	27·50	100·00	100·00
Antracol	0·2 %	7	0·33	1·05	8·00	25·50
Antracol	0·3 %	7	0·10	0·55	6·50	14·50
Antracol	0·4 %	7	0·13	0·28	2·25	5·75
Fungicide 328	0·1 %	7	0·13	4·25	40·00	77·50
Fungicide 328	0·15%	7	0·10	3·50	25·00	75·00
Control	—	—	0·38	29·00	100·00	100·00

TABLE 5.—Effect of fungicidal treatments on the development of blast in trial 4

Planted on : 2.2.65.

Sprayed on : 26·2, 5·3, 12·3, 19·3, 26·3 and 3·4.

The Verdasan, Brestan 60 and Antracol treatments received a further spary on 10.4.

Fungicidal	*Dosage*	*Spraying interval in days*	*Percentage leaf area destroyed* — *Age in days*								
			31 (*5·3*)	*38* (*12·3*)	*45* (*19·3*)	*52* (*26·3*)	*60* (*3·4*)	*67* (*10·4*)	*74* (*17·4*)	*81* (*24·4*)	*92* (*5·5*)
Verdasan	0·2%	7	0·00	0·00	0·20	0·00	0·20	0·83	1·17	0·50	5·00
Brestan 60	0·3%	7	0·00	0·20	0·47	1·00	7·00	0·33	45·00	45·00	80·00
Du-Ter	0·3%	7	0·03	0·73	2·00	35·00	71·67	80·00	93·33	100·00	100·00
Niagara carbamate	0·1%	7	0·00	0·83	1·67	25·00	80·00	80·00	100·00	100·00	100·00
Niagara Carbamate	0·3%	7	0·00	0·83	5·00	25·00	71·67	86·67	93·33	100·00	100·00
Antracol	0·3%	7	0·00	0·00	0·00	0·00	0·40	1·50	5·00	15·67	80·00
Nirit conc.	0·2%	7	0·00	0·73	2·67	9·00	55·00	80·00	80·00	100·00	100·00
Nirit conc.	0·3%	7	0·03	0·30	1·17	5·00	45·00	71·67	80·00	100·00	100·00
Nirit conc.	0·4%	7	0·00	0·67	1·67	7·00	45·00	80·00	86·67	100·00	100·00
Control	—	—	0·00	1·00	3·00	25·00	71·67	80·00	100·00	100·00	100·00

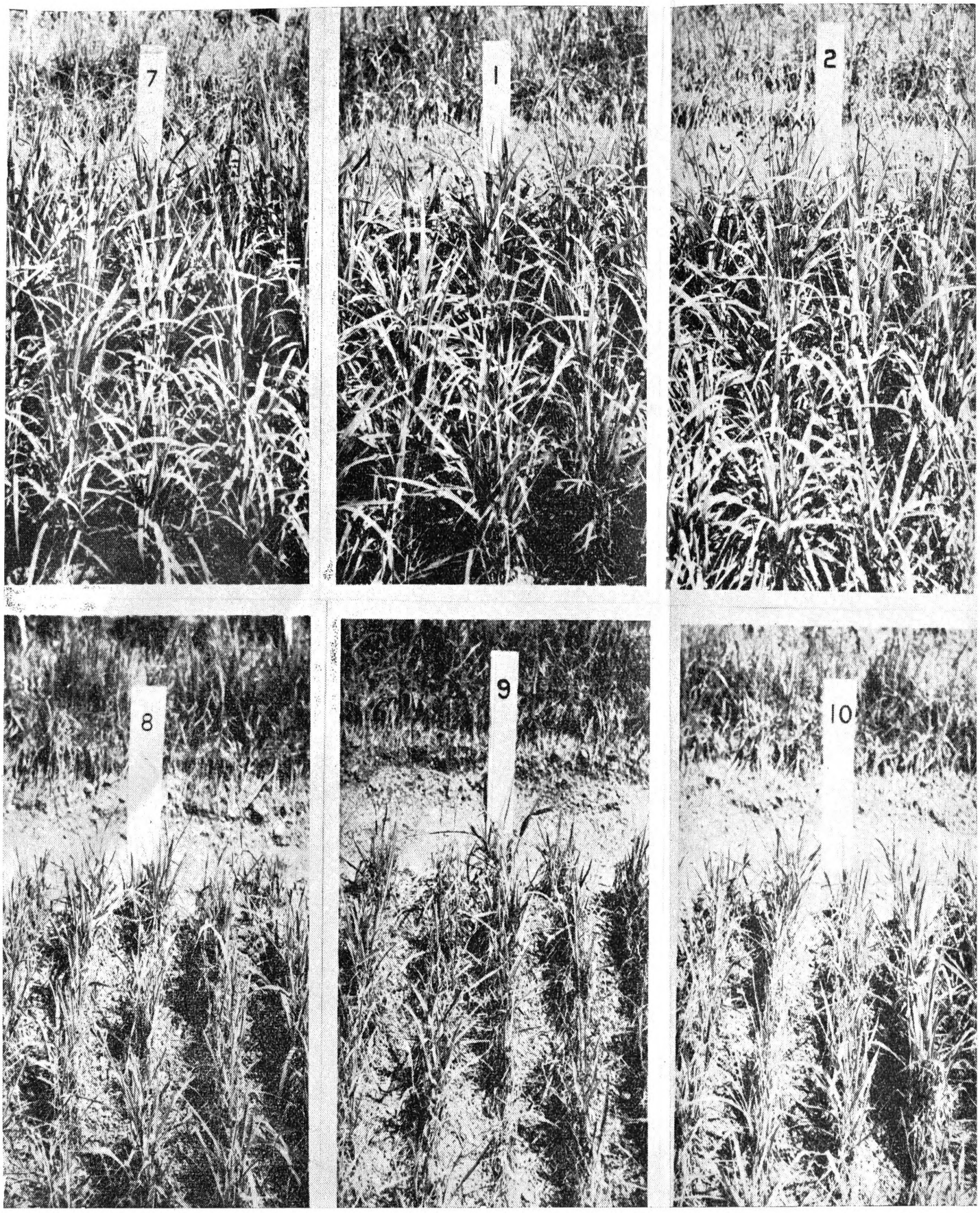

Fig. 1. Treatments from trial 4 at 62 days, 2 days after the sixth weekly spray application. Note the vigorous stand in Verdasan, 0·2% (7), Antracol, 0·3% (1) and to a lesser degree Brestan 60, 0·3% (2), in comparison with Niagara carbamate, 0·1% (8), Niagara carbamate, 0·3% (9) and the unsprayed control (10) where the foliage has been severely destroyed by blast.

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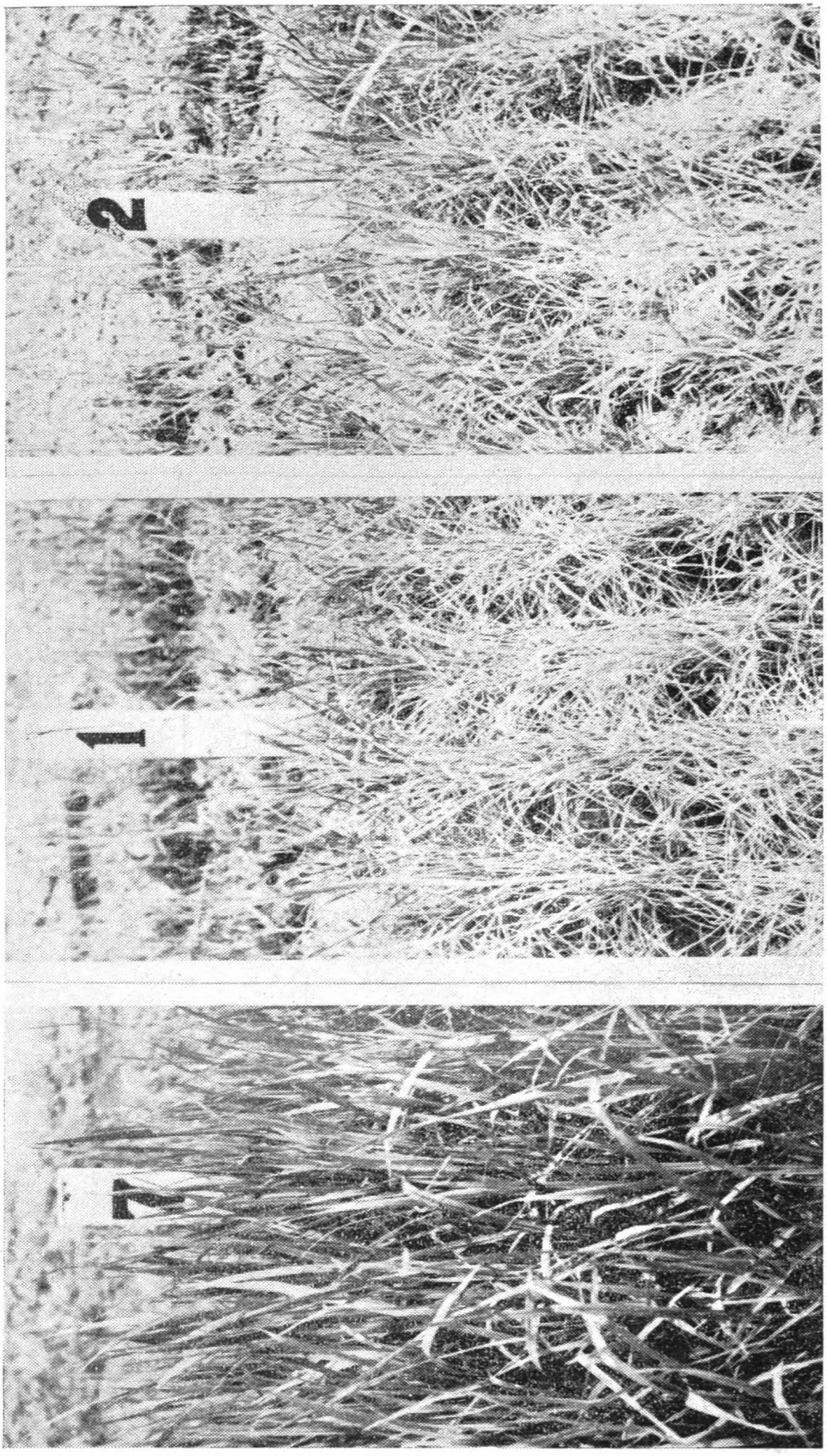

Fig. 2. Treatments from trial 4 at 95 days, 28 days after the seventh and final spray application. Note the relatively healthy foliage in Verdasan, 0·2% (7), still protected from the disease by the long term action of this fungicide, in comparison with Antracol, 0·3% (1) and Brestan 60, 0·3% (2) where the foliage has been severely affected by the rapid development of blast following the discontinuation of spraying.