# 13. AN ESTIMATION OF NITROGEN FIXATION BY ROOT NODULE

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In soybean cultivation, the fixed nitrogen plays a very important role as a nitrogen source. To evaluate the amount of nitrogen fixed by root nodule is indispensable for the improvement of soybean cultivation. Several methods have been applied for the evaluation of nitrogen fixation by root nodule. The use of nodulating and nonnodulating isolines of soybeans enables the estimation of the amount of nitrogen derived from the fixation. An attempt was made to evaluate the amount of nitrogen fixed by root nodule using nodulating and nonnodulating isolines of soybean.

## MATERIALS AND METHODS

An experiment was carried out using 3 liter pots filled with Muara soil (latosol soil). A pair of nodulating and nonnodulating isolines, A 62-1 and A 62-2, were grown in greenhouse. Var. Orba was also used for comparison.

Soybean seeds were sown at the rate of 4 seeds per pot and thinned to 2 plants per pot 7 days after sowing. Urea, TSP and KCl were applied at the rate of 0.2 g N, 0.5 g $P_2O_5$ and 0.5 g $K_2O$ per pot, respectively. One hundred g of the soil taken from soybean field where root nodule developed well were added for inoculation.

Plant samples were taken at stages of initial flowring, pod filling and harvesting, the date of sampling being 30, 60 and 71 days after sowing, respectively, except for Orba which was harvested 82 days after sowing. Total nitrogen was determined by Kjeldahl method.

## RESULTS AND DISCUSSION

The soybean plants showed very vigorous growth. Disease and insect damage was not observed throughout the growth period. The growing period of A 62-1 and A 62-2 was shorter for 11 days than Orba.

As shown in Table 1, the dry matter accumulation of soybeans at 30 days after sowing showed no difference between A 62-1 and A 62-2. The nodule development was still poor at this stage. The number of root nodules of A 62-1 and Orba was 52 and 64 and the dry matter weight was 49 and 27 mg/hill respectively. The diameter of the root nodule was less than 1 mm and the contribution of the root nodule as a nitrogen source was seemingly not significant by this stage.

At 60 days after sowing, the number and the weight of root nodules of A 62-1 and Orba were 115 and 196, and 0.79 and 1.14 g/hill, respectively, showing difference in nodule development. It was observed that the time of leaf color deterioration and defoliation of A 62-1 was later for several days than A 62-2. The weight of seeds of A 62-1 was 40 % higher as compared with A 62-2, reflecting the number of pods per plant. The growth characteristics of A 62-1 and A 62-2 differ only in their ability to nodulate. A 62-1 showed better growth than A 62-2 which was considered to be affected by the nodule development.

At 30 days after sowing, the nitrogen accumulation was almost the same among varieties. The rapid increase in nitrogen accumulation was recognized from 30 to 60 days except for nonnodulating A 62-2.

The amount of fixed nitrogen was estimated by subtracting the amount of nitrogen accumulated by A 62-2 from that accumulated by A 62-1 at 60 days after sowing, the maximum growth stage. It was estimated to be 287 mg N/hill which corresponded to 43 % of the total nitrogen accumulation by A 62-1.

The nodulating and nonnodulating isolines have been widely used for the estimation of nitrogen fixation. This method assumes that nodulating and nonnodulating isolines remove similar amounts of soil N. The root nodule development or nitrogen fixation is affected by

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environmental conditions and that of nodulating isolines is more sensitively affected. The amounts hitherto reported vary with researcher. Generally, it may be concluded that about two-thirds of the nitrogen accumulated by soybean plants derives from the fixation.

The estimated value of 43 % is considered to be rather low. As the causes of this seemingly low value, the followings may be pointed out. The amount of nitrogen fixed by nodulating isolines depends strongly on the amount of fertilizer nitrogen in the soil. As described elsewhere, the soil used in this experiment contained fairly large amount of available nitrogen which might have affected the nodule development. The growing period of A 62-1 and A 62-2 was short and the nodule development of A 62-1 was inferior to that of Orba. It is not sure whether the tropical climate was suitable for their growth and nodule development. As the use of nodulating and nonnodulating isolines of soybeans is very much helpful for the evaluation of nitrogen fixation, their screening and breeding fitted to the tropical climate are needed. Further investigation is necessary.

Data of leaf chemical analysis are useful for diagnosis. The second and the third, fully developed, leaves were collected at the flowering stage.

The growth of soybeans in Muara field was very vigorous. That in Pacet field was fairly good, however the root nodule did not develop at all. Data of leaf analysis of soybeans grown in the field of Hakkaido Natl. Agr. Expt. Sta. are added for reference.

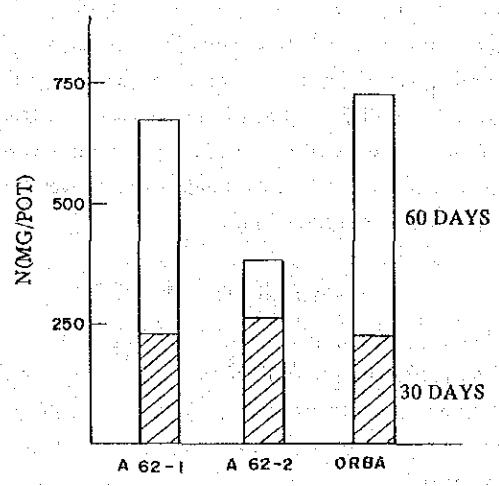


Fig. 1 NITROGEN ACCUMULATION OF SOYBEANS

Table 1. Dry matter accumulation in each plant part

(g/pot)

| Variety | 30 days | | | | 60 days | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Leaf | Stem | Root | Nodule | Leaf | Stem | Pod+Seed | Root | Nodule |
| A 62-1 | 3.68 | 3.18 | 1.06 | 0.05 | 5.95 | 5.86 | 13.90 | 2.09 | 0.79 |
| A 62-2 | 3.48 | 3.04 | 1.22 | – | 6.33 | 6.26 | 11.49 | 2.14 | – |
| Orba | 3.20 | 2.54 | 1.16 | 0.03 | 11.79 | 9.57 | 10.17 | 2.57 | 1.14 |

An attached table. Chemical composition of soybean leaves

| | | N | P | K | Ca | Mg | Fe | Mn | Zn | Cu | Fertilizer(kg/ha) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | % | % | % | % | % | ppm | ppm | ppm | ppm | N* | $P_2O_5$ | $K_2O$ |
| Muara, | A | 5.82 | 0.48 | 2.67 | 1.38 | 0.64 | 164 | 28 | 41 | 8.9 | 0+0 | 60 | 60 |
| (Var. | B | 5.80 | 0.49 | 2.63 | 1.35 | 0.61 | 134 | 23 | 40 | 13.5 | 60+0 | 60 | 60 |
| Orba) | C | 6.32 | 0.45 | 2.55 | 1.45 | 0.65 | 88 | 15 | 35 | 12.2 | 0+60 | 60 | 60 |
| | D | 6.29 | 0.47 | 2.67 | 1.53 | 0.59 | 134 | 30 | 34 | 11.7 | 30+30 | 60 | 60 |
| Pacet, | A | 5.48 | 0.32 | 2.67 | 1.50 | 0.40 | 230 | 58 | 46 | 13.6 | 0+0 | 60 | 60 |
| (Var. | B | 5.69 | 0.35 | 2.63 | 1.45 | 0.39 | 236 | 52 | 52 | 12.7 | 60+0 | 60 | 60 |
| Orba) | C | 5.91 | 0.33 | 2.93 | 1.33 | 0.36 | 206 | 96 | 52 | 12.9 | 0+60 | 60 | 60 |
| | D | 5.75 | 0.32 | 2.98 | 1.35 | 0.41 | 208 | 77 | 49 | 12.2 | 30+30 | 60 | 60 |
| Sapporo, | A | 4.48 | 0.22 | 2.38 | 1.84 | 0.53 | 184 | 52 | 32 | 3.2 | 20 | 200 | 100 |
| (Var. Kitamusume) | B | 4.68 | 0.24 | 2.40 | 1.93 | 0.59 | 184 | 51 | 28 | 3.1 | 20 | 200 | 100 |

* : Basic + top dressing

# 摘　　要

## 大豆根粒による窒素固定量の推定

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大豆栽培において，根粒固定窒素の果す役割は非常に大きい。根粒固定窒素量を推定するために，根粒着生非着生系統大豆をポット栽培し，窒素吸収量を調べた。根粒着生種A62−1，根粒非着生種A62−2の他にOrbaを供試した。

根粒着生非着生系統大豆は，生育期間が非常に短く，71日であった。播種30日後の窒素吸収量は着生，非着生種ともほゞ同じであり，根粒固定窒素の寄与は認められなかった。播種後30日から60日に至る間に，A62−1，Orbaの窒素吸収量は著しく増加したが，A62−1では窒素吸収量の増加はわずかであり，この差は，根粒固定窒素に基くものと考えられた。

固定窒素量は，A62−1の窒素吸収量の43％であった。一般に，固定窒素量は，全吸収窒素の約2／3と考えられており，本試験の結果は，一般に考えられているより低い。これは，供試品種の生育期間が非常に短期間，かつ根粒着生量がOrbaに比べ劣ったためと考えられる。

# 14. PERILAKU NITROGEN PADA TANAH KERING (BEHAVIOR OF NITROGEN IN THE SOIL)

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## RINGKASAN

Penelitian pendahuluan mengenai perilaku nitrogen pada tanah kering dilakukan melalui lima percobaan.

1). Pupuk nitrogen diberikan didalam pipa-pipa plastik yang tanam dilapangan. Setelah 10, 20 dan 30 hari diambil contohnya untuk ditetapkan $NH_4$-N dan $NO_3$-N dengan cara Conway dengan pengekstrak larutan KCl 10 %.

2). Uji perlindian dilakukan dengan melindikan akuades dari berbagai curah hujan pada tanah yang telah dipupuk dengan larutan urea dengan berbagai cara. Cairan hasil perlindian ditetapkan $NH_4$-N dan $NO_3$-N.

3). Kecepatan nitrifikasi diteliti dengan cara inkubasi aerobik tanah yang diberi pupuk nitrogen pada kelembaban 55 %. Kadar $NH_4$-N dan $NO_3$-N ditetapkan pada waktu-waktu tertentu.

4). Pola mineralisasi pada 5 jenis tanah diteliti dengan cara inkubasi aerobik pada suhu kamar dengan kelembaban 55 %. Kadar $NH_4$-N dan $NO_3$-N ditetapkan pada waktu-waktu tertentu.

5). Pengaruh kelembaban terhadap mineralisasi nitrogen diteliti dengan cara inkubasi aerobik tanah, dengan perlakuan berbagai tingkat kelembaban dan suhu. Kadar $NH_4$-N dan $NO_3$-N ditetapkan pada waktu-waktu tertentu.

Dari hasil percobaan dapat disimpulkan hal-hal sebagai berikut:

1). Pemberian pupuk urea maupun amonium sulfat menghilang dengan cepat dari lapisan atas, karena pencucian oleh air hujan. Diperkirakan pada musim penghujan N jang diberikan akan lenyap dalam waktu satu bulan. Makin dalam pupuk diaduk dengan tanah, makin besar pula nitrogen anorganik yang tercuci oleh air hujan. Perbedaan janis tanah dan macam pupuk memberikan perilaku nitrogen yang berbeda pula.

2). Nitrifikasi berlangsung satu minggu setelah pemberian pupuk nitrogen. Kecepatan nitrifikasi maksimal antara minggu kedua dan ketiga pada tanah Andosol Pacet, atau minggu pertama dan kedua pada tanah Latosol Muara.

3). Jumlah nitrogen organik yang diminerasisasikan berkisar antara 2,1-13,9 mg N/100 g tanah. Dan pada tanah-tanah yang diteliti tidak ada tanda-tanda denitrifikasi.

4). Proses nitrifikasi sangat kecil pada kelembaban 30 %, tetapi dengan makin tinggi kelembaban madin dini proses nitrifikasi berlangsung cepat. Kenaikan suhu meningkatkan dan mempercepat minaralisasi.


## PENDAHULUAN

Pupuk nitrogen yang diberikan kedalam tanah, tidak seluruhnya dapat dimanfaatkan oleh tanaman. Lebih dari setengahnya hilang oleh berbagai proses antara lain oleh : penguapan menjadi amoniak (2,7) nitrifikasi, denitrifikasi dan tercuci oleh air hujan secara vertikal maupun horizontal. (1,3,8). Proses tersebut diatas dipengaruhi oleh berbagai keadaan antara lain oleh sifat dan ciri tanah, suhu, kelembaban tanah, intensitas dan curah hujan. (1,4).

Pengkajian yang lebih mendasar mengenai perilaku nitrogen dalam proses tersebut diatas sangat penting untuk meningkatkan keefisienan penggunaan pupuk nitrogen. Informasi tersebut masih sangat terbatas di Indonesia. Ponelitian ini adalah penelitian pendahuluan yang bertujuan untuk memperoleh informasi mengenai perilaku nitrogen tanah dan nitrogen yang berasal dari pupuk pada berbagai jenis tanah, berbagai kelembaban dan hilangnya nitrogen oleh berbagai tingkat curah hujan.


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## BAHAN DAN CARA

Pengkajian perilaku nitrogen pada tanah kering dilakukan melalui lima percobaan :

Percobaan I. Perilaku nitrogen dilapang.

Percobaan ini dilakukan diladang petani, tanah Andosol Pacet (Jawa Barat) dan tanah Latosol Muara (Jawa Barat). Pipa-pipa plastik dari paralon, diameter 5 cm, panjang 20 cm ditanam di lapang.

Sebanyak masing-masing 5 ml larutan urea dan amonium sulfat setara dengan 20 mg N diaduk dengan tanah sedalam 3 cm dari permukaan tanah. Setelah 10, 20 dan 30 hari, pipa-pipa tersebut diambil, tanah dikeluarkan dari pipa-pipa dan dibagi menjadi dua bagian yakni 0 - 5 cm dan 5 - 10 cm. Pada masing-masing tanah tersebut ditetapkan kadar $NH_4$-N dan $NO_3$-N dengan cara Conway, dengan pengekstrak KC1 10 %.

Percobaan II. Pencucian nitrogen anorganik.

Untuk mengetahui nitrogen anorganik yang hilang oleh pencucian air hujan, dilakukan uji perlindian dilaboratorium terhadap tanah Latosol Muara dan Andosol Pacet. Sebanyak 70 g tanah kering udara dimasukkan kedalam tabung perkolasi. Tanah-tanah tersebut diberi larutan setara dengan 10 mg N, dengan 4 macam cara :

A. Disebar dipermukaan tanah setebal 1 cm.
B. Diaduk dengan setengah volume tanah.
C. Diaduk dengan seluruh volume tanah.
D. Tidak diberi urea.

Kadar air dari tanah dibuat sesual dengan 55 % kapasitas lapang maksimum. Setelah 7, 10, 12 dan 15 hari dari pemberian urea, tanah dilindikan dengan akuades setara dengan curah hujan100, 200, 400 dan 600 mm. Cairan ditampung, kadar $NH_4$-N and $NO_3$-N ditetapkan dengan cara yang sama seperti pada percobaan I.

Percobaan III. Kecepatan nitrifikasi.

Ditimbang tanah kering udara dari Latosol Muara dan Andosol Pacet, setara 20 g tanah kering oven didalam botol polystyrol. Tanah tersebut diaduk dengan larutan urea, amonium khlorida dan kalium nitrat, setara dengan 25 mg N/100 g tanah. Kadar air tanah dibuat sesuai dengan 55 % kapasitas lapang maksimum. Selanjutnya botol dan tanah diinkubasi peda suhu kamar ($29 \pm 3^{\circ}C$). Setelah 1, 2 dan 4 minggu dari pemberian pupuk, kadar $NH_4$-N dan $NO_3$-N ditetapkan dengan cara yang sama seperti pada percobaan I.

Percobaan IV. Pola mineralisasi nitrogen.

Pada percobaan ini digunakan 5 jenis tanah yakni : 1) Latosol Muara, 2) Podzolik Jasinga, 3) Andosol Pacet, 4) Aluvial Sukamandi, keempat tanah tersebut berasal dari Jawa Barat, dan 5) Jakenan dari Jawa Tengah. Ciri kimia dan fisika tanah tersebut disajikan pada Table 1. Sebanyak 20 g tanah diinkubasi didalam botol polystyrol pada suhu kamar. Kadar air dibuat 55 % kapasitas lapang maksimum. Setelah 2 dan 4 minggu, kadar $NH_4$-N dan $NO_3$-N ditetapkan dengan cara seperti pada percobaan I.

Percobaan V. Pangaruh kelembaban terhadap mineralisasi nitrogen.

Sebanyak 20 g tanah Latosol Muara, diinkubasi pada suhu $30^{\circ}C$ dengan perlakuan sebagai berikut :

1). Kadar air tanah dibuat setara dengan kelembaban 30 %, 55 % dan 80 % dari kapasitas lapang maksimum.
2). Tanpa dan diberi urea sebanyak 200 ppm N.
3). Satu perlakuan setara dengan kelembaban 55 % dilakukan juga inkubasi pada suhu $40^{\circ}C$.

Setelah 15, 25, 35 dan 45 hari, kadar $NH_4$-N dan $NO_3$-N ditetapkan dengan cara separti pada percobaan I.

## HASIL DAN PEMBAHASAN

I. Perilaku nitrogen di lapang. (Gambar 1).

Terdapat perbedaan mineralisasi antara plot yang diberi urea dengan plot yang diberi amonium sulfat. Sepuluh hari setelah perlakuan amonium sulfat, jumlah N anorganik mencapai 21,8 mg N/100 g tanah, dan 72 % berada pada lapisan atas, (0-5 cm). Sebanyak 28 % dari jumlah N anorganik adalah $NO_3$-N. Dua puluh hari setelah perlakuan, N anorganik turn secara tajam menjadi 11,3 mg N. Tiga puluh hari setelah perlakuan, N anorganik tinggal 3,2 mg N, berupa $NO_3$-N.

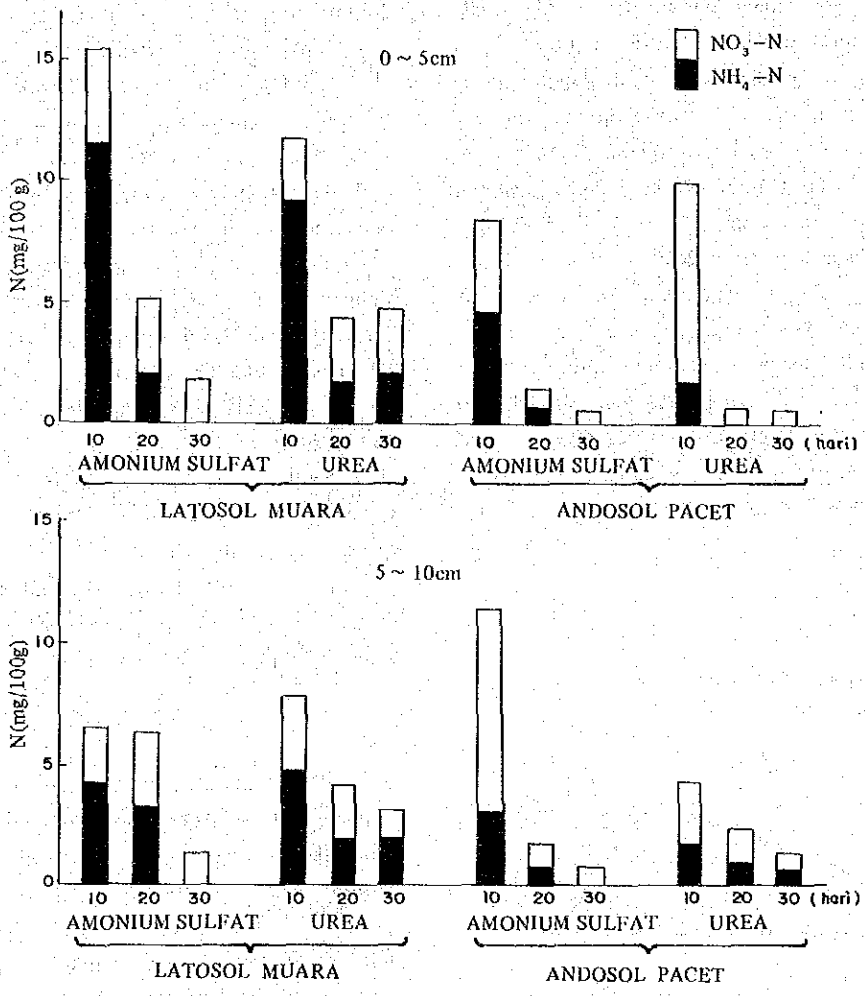
Pada plot yang diberi urea, 10 hari setelah perlakuan jumlah N anorganik adalah 19,5 mg N, 71 % berada pada lapisan atas. Dua puluh hari setelah pemberian urea, turn menjadi 8,5 mg N. Sedangkan pada 30 hari tersisa 9,8 mg N.

Didalam tanah urea mula-mula diubah oleh enzim urease menjadi $(NH_4)_2CO_3$. Proses ini terjadi hanya dalam beberapa hari pada $30^{\circ}C$. Ion hidroksil yang dibentuk karena proses disosiasi, akan meningkatkan muatan negatip tanah dan meningkatkan kapasitas adsorpsi dari tanah. Fenomena inilah yang mungkin menyebabkan perbedaan sifat mineralisasi antara amonium sulfat dengan urea. Menurut Smith (5), penggunaan kembali (recovery) nitrogen dari pupuk urea lebih tinggi daripada amonium sulfat. Hal ini mungkin karena nitrogen anorganik yang hilang dari

pupuk amonium sulfat lebih besar daripada urea.

Pada tanah andosol Pacet, 10 hari setelah pemupukan amonium sulfat, jumlah N anorganik adalah 18,9 mg N. Enam puluh persen berada pada lapisan atas. Bentuk $NO_3$-N adalah 59 % dari jumlah N anorganik. Dua puluh hari setelah pemupukan, menurun menjadi 3,2 mg N, dan 30 hari setelah pemupukan tersisa 1,3 mg N.

Pada plot yang diberi urea, 10 hari setelah pemupukan terdapat 14,3 mg N. Bentuk $NO_3$-N sebesar 76 % dari jumlah N anorganik. Setelah 20 hari menurun secara tajam.




**Gambar 1. Perilaku nitrogen pada keodaan lapng ditanah Lotosol Muara dan Andosol Pacet.**

II. Pencucian Nitrogen anorganik (Gambar 2).

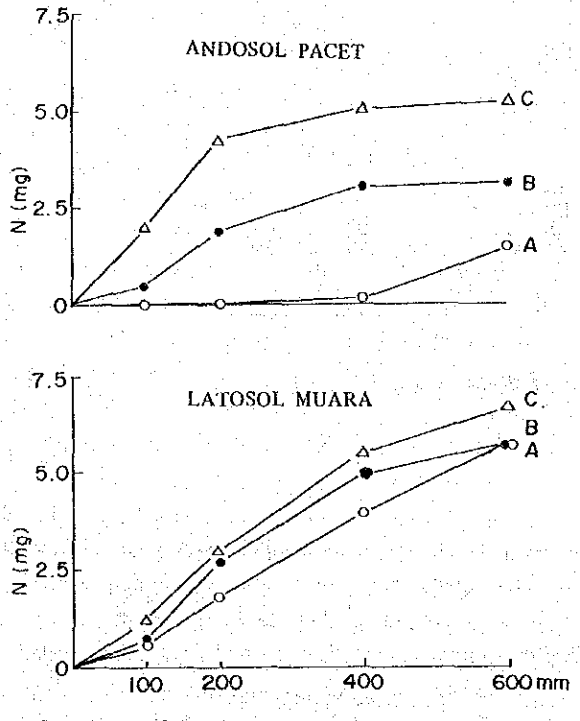
N anorganik yang hilang oleh pencucian dihitung dari pengurangan N anorganik yang tercuci dari tabung yang diberi N dengan N anorganik yang tercuci dari tabung tanpa diberi N.

N anorganik yang tercuci berbeda menurut cara pemberian urea. Pada tanah Andosol Pacet, pencucian sampai 400 mm pada perlakuan urea dengan cara disebar di permukaan, N anorganik yang hilang relatif sangat kecil. Tetapi pada perlakuan dengan cara diaduk keseluruh lapisan tanah, N anorganik yang hilang mencapai 4,3 mg N pada curah hujan 200 mm. Berarti 40 % dari pupuk yang diberikan tercuci oleh curah hujan 200 mm. Kemudian naik secara bertahap hingga mencapai 5,3 mg N pada 600 mm. Berarti 50 % dari pupuk yang diberikan hilang tercuci oleh 400 mm curah hujan.

Pada tanah Latosol Muara, perbedaan antar perlakuan lebih kecil dibandingkan dengan tanah Andosol Pacet. Pada tanah Latosol Muara jumlah anorgnik yang tercuci pada 600 mm, 6.8 mg N pada perlakuan dengan cara diaduk keseluruh tanah. Pada perlakuan disebar dipermukaan dan diaduk dengan setengah volume tanah, sama besarnya yakni 5,8 mg N. Hal ini menunjukkan

bahwa lebih dari separuh pupuk urea yang diberikan pada tanah Latosol Muara tercuci oleh curah hujan 400 mm. Dan dengan makin dalam atau makin besar volume tanah yang diaduk dengan pupuk urea, makin besar pula urea yang tercuci oleh air hujan.

Percobaan ini sesuai dengan pernyataan Wetselaar (1962), bahwa pergerakan $NO_3$-N berkorelasi tinggi dengan jumlah curah hujan. Menurut Padre (1977), pupuk amonium yang diberikan pada tanah kering dinitrifikasi secara cepat, dan proses ini berlangsung lebih cepat pada musin penghujan dibandingkan dengan musin panas. Untuk mengurangi kehilangan nitrogen pada tanah sawah, urea diaduk dengan tanah dan dibenamkan kelapisan yang lebih dalam (lapisan reduksi). Sehingga amonium yang dihasilkan oleh urea cepat terikat oleh liat tanah dan tidak sempat tercksidasi menjadi bentuk nitrat yang mudah terbawa air. Tetapi pada tanah kering, urea yang diaduk dan dibenamkan kelapisan lebih dalam akan mempercepat nitrifikasi dan dengan makin tinggi curah hujan makin banyak nitrat yang terbawa oleh air hujan.




Gambar 2. Pengaruh berbagai curah hujan terhadap pencucian nitrogen anorganik

A. Urea disebar pada permukaan tanah setebal 1 cm
B. Urea diaduk dengan setengah volume tanah
C. Urea diaduk dengan seluruh volume tanah

III. Kecepatan nitrifikasi. (Gambar 3).

Proses nitrifikasi dimulai pada minggu pertama setelah pemupukan. Terdapat perbedaan kecepatan nitrifikasi, pada kedua jenis tanah dan pupuk nitrogen.

Pada tanah Andosol Pacet, nitrifikasi berlangsung cepat pada minggu kedua sampai minggu keempat. Pupuk urea nitrifikasi lebih cepat daripada pupuk amonium khlorida. Pada minggu keempat, setengah dari $NH_4Cl$ yang diberikan berubah menjadi $NO_3$-N, sedangkan amonium dari urea hampir seluruhnya berubah menjadi $NO_3$-N.

Pada tanah Latosol Muara, nitrifikasi lebih cepat dibandingkan dengan tanah Andosol Pacet. Nitrifikasi berlangsung cepat sejak pupuk diberikan sampai dengan minggu kedua. Perbedaan nitrifikasi kedua pupuk tersebut lebih kecil dibandingkan dengan pada tanah Andosol Pacet. Pemberian pupuk $KNO_3$ dimaksudkan untuk mengetahui kehilangan nitrogen oleh proses denitrifikasi.

Ternyata $NO_3$-N pada tanah Lotosol Muara tidak berkurang, bahkan sedikit meningkat. Pada tanah Andosol Pacet, $NO_3$-N sedikit menurun sampai minggu kedua, kemudian naik lagi. Hal ini menunjukkan bahwa pupuk nitrogen yang diberikan pada kedua tanah tersebut tidak denitrifikasi.

IV. Pola mineralisasi nitrogen. (Gambar 4).

Terdapat perbedaan pola mineralisasi diantara lima jenis tanah. Pada tanah Podzolik Jasinga nitrifikasi hampir mendekati nol, sedangkan pembentukan $NH_4$-N jauh lebih tinggi dibandingkan dengan tanah yang lainnya, yakni 8,9 mg N pada minggu pertama, dan pada minggu ke 4 mencapai 14,8 mg N.

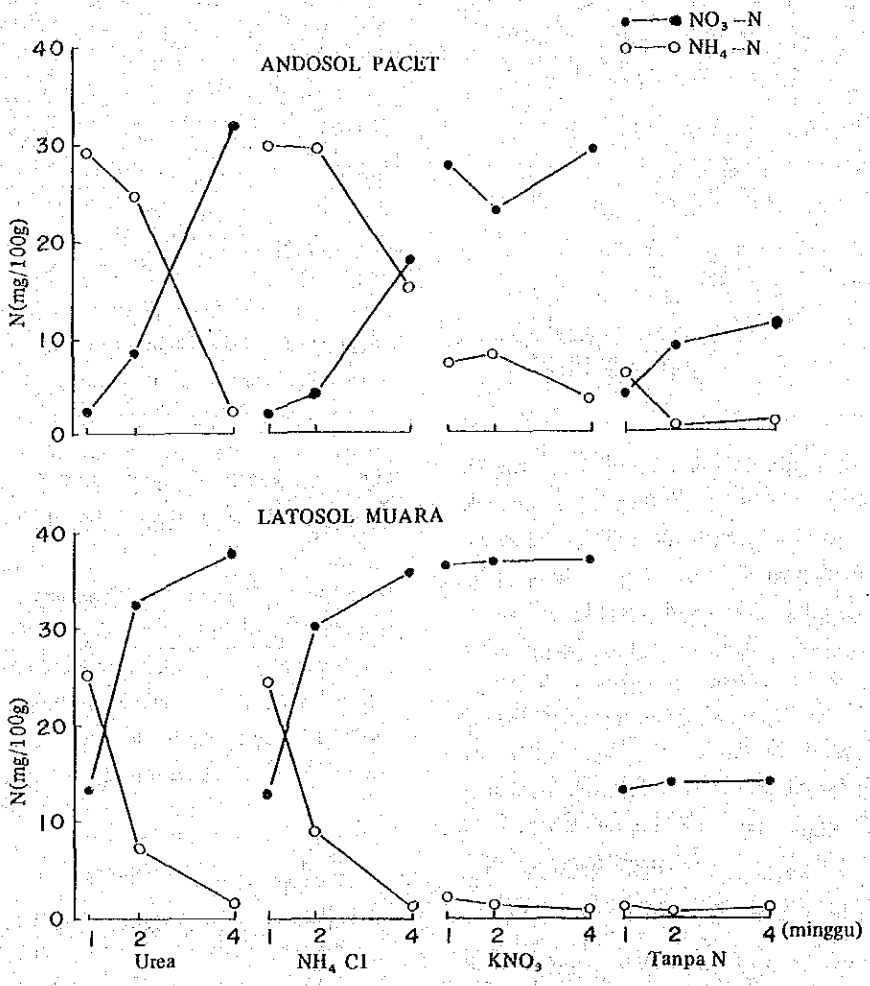
Pada tanah kering, $NH_4$-N yang berasal dari tanah maupun pupuk nitrogen dioksidasi menjadi $NO_2$-N oleh bakteri pengoksid amonium dan selanjutnya diubah menjadi $NO_3$-N oleh bakteri pengoksid nitrit.

Kegiatan jazad renik ini sangat peka terhadap kondisi linkgungannya. Diduga populasi dan kegiatan jazat renik ini sangat tertekan pada tanah Podzolik Jasinga. Pada tanah ini, penimbunan $NH_4$-N mungkin akibat dari rendahnya nisbah C/N. Penelitian Sahrawat (1978) mendapatkan hubungan negatip yang sangat nyata antara nisbah C/N dengan $NH_4$-H yang dilepaskan.

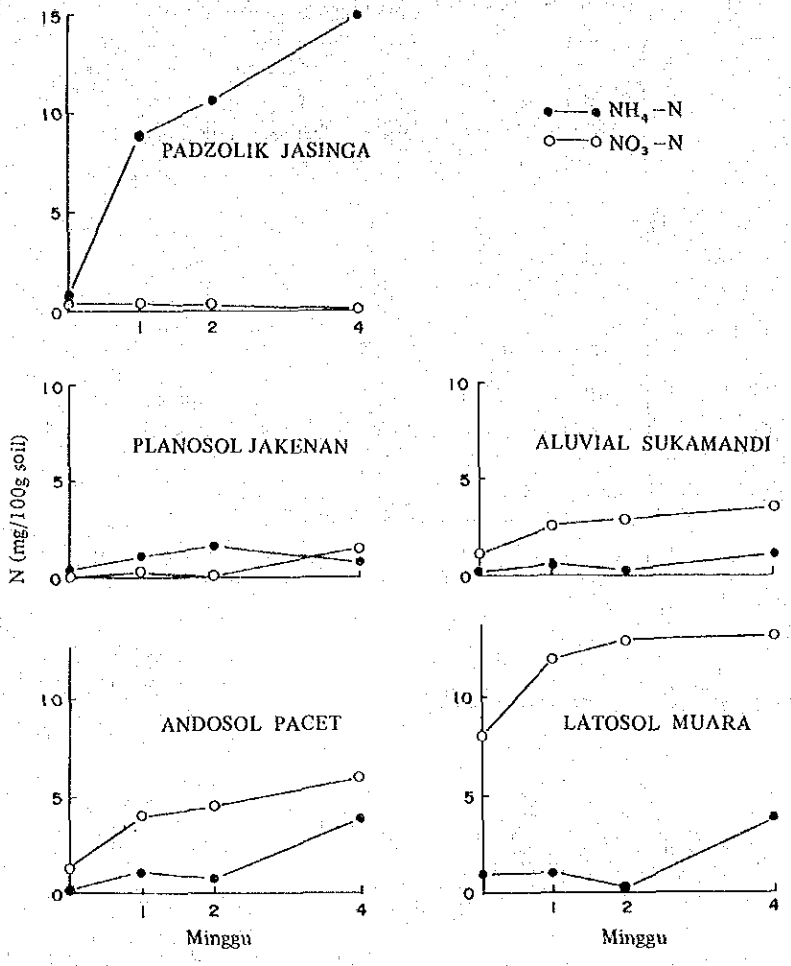
Pembentukan nitrogen anorganik yang terendah terdapat pada tanah Planosol Jakenan. Jumlah amonium naik secara lambat, demikian juga $NO_3$-N nya relatip sangat kecil sampai pada minggu kedua. Pada minggu

Table 1. Ciri Kimia dan Fisika Lima Jenis Tanah Untuk Penelitian

| Ciri | Jenis dan asal tanah | | | | |
|---|---|---|---|---|---|
| | Latosol Muara | Podzolik Jasinga | Andosol Pacet | Aluvial Sukamandi | Planosol Jakenan |
| | ..... Jawa Barat ..... | | | | Jawa Tengah |
| % Pasir | 17,1 | 16,0 | 0,5 | 13,1 | 15,6 |
| % Debu | 5,4 | 7,3 | 87,6 | 74,5 | 80,0 |
| % Liat | 77,5 | 74,7 | 11,9 | 12,4 | 4,4 |
| pH–$H_2O$ (1:2,5) | 5,94 | 5,63 | 4,88 | 4,73 | 5,70 |
| %C | 1,81 | 0,42 | 0,67 | 0,64 | 0,32 |
| %N | 0,28 | 0,13 | 0,11 | 0,10 | 0,08 |
| C/N | 6,46 | 3,23 | 6,09 | 6,4 | 4,0 |
| P-Bray II ppm | 21,0 | 1,2 | 10,1 | 10,5 | 32,0 |




Gambar 3. Perubahan jumlah $NH_4$ -N dan $NO_3$ -N pada tanah Latosol Muara dan Andosol Pacet




**Gambar 4. Pola mineralisasi nitrogen dari lima jenis tanah pada keadaan inkubasi aerobik**

ke 4 jumlah N anorganik hanya mencapai 2,5 mg N.

Pada tanah Andosol Pacet, jumlah N anorganik mencapai lebih dari 5 mg N, pada minggu pertama, setelah itu naik mencapai 9,7 mg N pada minggu ke 4. Pada tanah Aluvial Sukamandi, pembentukan N anorganik relatip rendah. Pada minggu pertama hanya mencapai 3,2 mg N, dan pada minggu ke 4 hanya mencapai 5,5 mg N. Jumlah N anorganik tertinggi terdapat pada tanah Muara dan proses nitrifikasi berlangsung sangat cepat. Jumlah N anorganik mencapai 12,0 mg N pada minggu pertama dan jumlah $NH_4$-N dan $NO_3$-N mencapai 16,8 mg N pada minggu ke 4.

V. Pengaruh kelembaban terhadap mineralisasi nitrogen (Tabel 2 dan 3).

Peningkatan kelembaban menurunkan kadar $NH_4$-N tanah, tetapi menaikkan $NO_3$-N. Kadar $NH_4$-N menurun dari 2,5 mg N menjadi 1,3 mg N, sedangkan

**Tabla 2. Pengaruh Berbagai Kelembaban Terhadap Konsentrasi $NH_4$–N Tanah Pada Kondisi Inkubasi Aerobik 30°C.**

| Lama Inkubasi | Kelembaban (% bobot) | | | |
|---|---|---|---|---|
| (hari) | 30% | 55% | 80% | 55% pada 40°C |
| | mg N/100 g tanah | | | |
| | N = 0 | | | |
| 15 | 2,5 | 1,6 | 1,1 | 1,2 |
| 25 | 3,6 | 3,7 | 2,1 | 4,6 |
| 35 | 1,2 | 1,0 | 0,7 | 1,0 |
| 45 | 2,8 | 1,0 | 1,3 | 0,9 |
| Purata | 2,5 | 1,7 | 1,3 | 1,8 |
| | N = 200 ppm | | | |
| 15 | 19,1 | 7,0 | 5,7 | 8,2 |
| 25 | 19,1 | 4,7 | 3,1 | 3,5 |
| 35 | 14,9 | 1,0 | 0,7 | 1,1 |
| 45 | 18,8 | 1,0 | 0,9 | 1,5 |
| Purata | 18,0 | 3,4 | 2,6 | 3,6 |

Table 3. Pengaruh Berbagai Kelembaban Terhadap Konsentrasi $NO_3$–N Tanah Pada Kondisi Inkubasi Aerobik 30°C.

| Lama Inkubasi (hari) | Kelembaban (% bobot) | | | |
|---|---|---|---|---|
| | 30% | 55% | 80% | 55% pada 40°C |
| | mg N/100 g tanah | | | |
| | N = 0 | | | |
| 15 | 1,8 | 4,2 | 10,1 | 7,3 |
| 25 | 3,9 | 7,1 | 3,6 | 10,0 |
| 35 | 5,7 | 7,5 | 9,4 | 9,9 |
| 45 | 3,4 | 7,0 | 6,4 | 10,2 |
| Purata | 3,7 | 6,5 | 7,4 | 9,3 |
| | N = 200 ppm | | | |
| 15 | 2,6 | 3,2 | 9,9 | 15,9 |
| 25 | 3,0 | 5,1 | 23,0 | 32,7 |
| 35 | 5,9 | 34,8 | 25,3 | 26,6 |
| 45 | 4,2 | 19,6 | 22,9 | 25,4 |
| Purata | 3,9 | 15,7 | 20,3 | 25,0 |

$NO_3$-N meningkat dari 3,7 mg N menjadi 7,4 mg N.

Kenaikan subu cenderung menaikkan kadar $NH_4$-N maupun $NO_3$-N. Hasil percobaan ini sesuai dengan penelitian Sahrawat (1978).

Pada kelembaban 30 %, urea yang diberikan tidak nitrifikasi. Tetapi pada kelembaban 55 %, urea yang diberikan diubah menjadi $NO_3$-N dan kecepatan nitrifikasi naik tajam setelah inkubasi 25 hari, yakni dari 5,1 mg N menjadi 34,8 mg N. Pada kelembaban 80 % kecepatan nitrifikasi naik tajam sejak inkubasi 15 hari, yankni dari 9,9 mg N menjadi 23,0 mg N. Setelah inkubasi 35 hari, kadar $NO_3$-N mulai menurun. Hal ini menunjukkan awal dari proses denitrifikasi relatip lebih tinggi.

Hasil percobaan ini konsisten dengan yang diteliti oleh Sahrawat (1980), bahwa mineralisasi nitrogen dipercepat dengan penggenangan dan pengeringan. Penggenangan dalan hal ini berarti peningkatan kadar air. Beberapa peniliti lain juga berpendapat bahwa pembasahan dan pengeringan tanah akan memacu dekomposisi bahan organik.

## KESIMPULAN

Dari hasil percobaan dapat disimpulkan hal-hal sebagai berikut:

1). Pemberian pupuk urea maupun amonium sulfat menghilang dengan cepat dari lapisan atas, karena pencucian oleh air hujan. Diperkirakan pada musim penghujan N jang diberikan akan lenyap dalam waktu satu bulan. Makin dalam pupuk diaduk dengan tanah, makin besar pula nitrogen anorganik yang tercuci oleh air hujan. Perbedaan jenis tanah dan macam pupuk memberikan perilaku nitrogen yang berbeda pula.

2) Nitrifikasi berlangsung satu minggu setelah pemberian pupuk nitrogen. Kecepatan nitrifikasi maksimal antara minggu kedua dan ketiga pada tanah Andosol Pacet, atau minggu pertama dan kedua pada tanah Latosol Muara.

3). Jumlah nitrogen organik yang diminerasisasikan berkisar antara 2,1 - 13,9 mg N/100 g tanah. Dan pada tanah-tanah yang diteliti tidak ada tanda-tanda denitrifikasi.

4) Proses nitrifikasi sangat kecil pada kelembaban 30 %, tetapi dengan makin tinggi kelembaban makin dini proses nitrifikasi berlangsung capat. Kenaikan suhu meningkatkau dan mempercepat mineralisasi.

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# 摘　　要

## 土壌中における施肥窒素の行動

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窒素は，作物生育に最も重要な要素であり，施肥窒素の土壌中での行動を明らかにすることは，施肥改善を図るうえで重要である。インドネシアでは，畑地に施用された窒素の行動，土壌窒素の有効化等に関する研究は，未だほとんど行われていない。施肥窒素の土壌中での行動を明らかにするために，二・三の実験を行った。

5種類の畑土壌を選び，土壌窒素の無機化の様相をビーカー培養法により調べた。土壌窒素の無機化量は，土壌によって異なり，4週間後の無機態窒素生成量は，2.1～13.9 mg／100 g 乾土であった。硝酸化成の速度は，一般に認められているより遅く，硝酸化成がほとんど進行しない土壌もみられた。

尿素，塩安を土壌に添加し，硝酸態窒素の生成状況を調べた結果，硝化作用は窒素添加1週間目頃から始まり，尿素の場合は，4週間後にはほゞ全量が硝酸態で検出されたが，塩安の硝化速度は，尿素より遅かった。

カラムを用い，尿素の施用位置を表面，表層，全層として，滲透水に伴う無機態窒素溶脱状況を調べた。無機態窒素の溶脱量は，施用位置によって異なるが，溶脱量の最も多い全層施用の場合には，降水量400 mm 相当量の滲透水により，施用量の約50％が溶脱した。

雨期に，圃場に塩ビ管を埋設し，尿素，硫安を添加して土層中の無機態窒素の推移を調べた。0～10 cmの土壌内の無機態窒素量は，施用後急速に低下し，30日後にはほゞ全量が消失した。

# 15. PENGARUH PENEMPATAN UREA TERHADAP PERILAKU NITROGEN PADA LAHAN KERING LATOSOL MUARA

# INFLUENCE OF UREA APPLICATION ON THE BEHAVIOR OF NITROGEN IN THE LATOSOL AT THE MUARA EXPERIMENT STATION

A. Hidayat,* M. Zaini, * T. Fujimoto,** and M. Ismunadji,***


## RINGKASAN

Pengaruh penempatan urea terhadap perilaku N pada lahan kering Latosol Muara yang berkenaan dengan produksi bahan kering Jagung Varitas Arjuna diteliti melalui 3 percobaan :

1). Percobaan pot di rumah kaca, menggunakan 5 kg tanah kering dengan pemupukan TSP dan ZK masing-masing 1 g. Sedangkan Urea diberikan dengan cara a) disebar dipermukaan, b) ditugal dengan kedalam 3-4 cm dibawah biji, c) diaduk dengan tanah dengan kedalaman 0-7 cm, dan d) kedalaman 0-14 cm, e) diaduk di sekitar akar tumbuh dengan ukuran luas 100 cm, dengan kedalaman 7 cm. Dua tanaman Jagung Varitas Arjuna ditanam setiap pot nya. Setelah 25, 35 dan 45 hari tanaman diambil beserta akarnya, dibersihkan ditimbang bobot keringnya dan dianalisa kadar nitrogennya dengan cara destruksi basah Kyeldahl. Tanah bekas pertanaman diambil dan dianalisa $NH_4$-N dan $NO_3$-N pada kedalaman 0-7 dan 7-14 cm, dengan cara CONWAY.

2). Pengaruh kelembaban terhadap mineralisasi N diteliti dengan cara inkubasi aerobik tanah, dengan perlakuan berbagai tingkat kelembaban dan suhu. Kadar $NH_4$-N dan $NO_3$-N ditetapkan pada waktu-waktu tertentu, dengan cara CONWAY.

3). Uji perlindian dilakukan dengan melindikan akuades dari berbagai curah hujan pada tanah yang telah dipupuk dengan larutan urea dengan berbagai cara pemupukan. Cairan hasil perlindian ditetapkan $NH_4$-N dan $NO_3$-N dengan cara CONWAY.

Dari hasil percobaan dapat disimpulkan bahwa cara penempatan urea berpengaruh nyata terhadap bobot kering tanaman pada awal pertumbuhan. Pemberian pupuk secara ditugal menyebabkan tingginya kadar N-anorganik disekitar akar dan menghambat perkembangan akar pada umur muda. Hal ini menyebabkan rendahnya penyerapan N dan efisiensi pemberian N.

Pada lapisan atas (0-7 cm), bentuk $NO_3$-N cenderung lebih banyak dari pada bentuk $NH_4$-N dan pada lapisan bawah (0-14 cm), sebaliknya.

Makin dalam pupuk urea diaduk tanah, makin besar pula N-anorganik yang tercuci oleh air hujan. Perbedaan jenis tanah memberikan perbedaan tingkat pencucian yang berbeda pula.

Peningkatan kelembaban menurunkan kadar $NH_4$-N dan menaikkan kadar $NO_3$-N. Kenaikkan suhu meningkatkan dan mempercepat mineralisasi N. Proses nitrifikasi sangat kecil pada kelembaban 30 % tetapi dengan makin tinggi kelembaban makin dini proses nitrifikasi berlangsung cepat.


## PENDAHULUAN

Pupuk nitrogen yang diberikan kedalam tanah, tidak seluruhnya dapat dimanfaatkan oleh tanaman. Lebih dari setengahnya hilang oleh berbagai proses antara lain oleh penguapan menjadi amoniak (2,7), nitrifikasi, denitrifikasi dan tercuci oleh air hujan secara vertikal maupun horizontal (1,3,8).

Berbagai cara pemupukan pada tanaman jagung telah diusahakan untuk meningkatkan hasil dan efisiensi pemupukan. Antara lain dengan cara ditugal (spot


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application), dilarik pada sisi tenaman (side dressing), disebar pada permukaan tanah setelah tanam dan diaduk dengan tanah sebelum membuat larikan.

Tetapi informasi mengenai perilaku N-anorganik yang berhubungan dengan tingkat ketersediaan N dari berbagai cara pemupukan tersebut masih sangat terbatas. Pengkajian yang lebih mendasar mengenai perilaku N-anorganik dari berbagai cara pemupukan tersebut sangat penting untuk meningkatkan efisiensi pemupukan Nitrogen.

Penelitian ini bertujuan untuk memperoleh informasi mengenai perilaku N-anorganik tanah pada berbagai cara pemupukan, pengaruhnya terhadap penyerapan N oleh tanaman dan tingkat pencucian oleh berbagai curah hujan. Pengaruh peningkatan suhu dan kelembaban terhadap perilaku N juga dipelajari.

## BAHAN DAN METODA

Penelitian dilakukan dari bulan Juli 1980 sampai dengan Desember 1980, di kamar kaca dan laboratorium Kelompok Fisiologi Balai Penelitian Tanaman Pangan Bogor. Tanah yang digunakan adalah tanah Latosol Coklat kemerahan Muara, diambil dari kedalaman 0-20 cm. Sifat kimia dari tanah tersebut disajikan pada Tabel 1.

**Tabel 1. Ciri Kimia dan Fisika Tanah Latosol Muara dan Andosol Pacet**

| Ciri | Latosol Muara | Andosol Pacet |
|---|---|---|
| Tekstur | | |
| % Pasir | 17,1 | 0,5 |
| % Debu | 5,4 | 87,6 |
| % Liat | 77,5 | 11,9 |
| pH-$H_2O$ (1:2,5) | 5,94 | 4,88 |
| % C | 1,81 | 0,67 |
| % N | 0,28 | 0,11 |
| C/N | 6,5 | 6,1 |
| P-Bray II (ppm P). | 21,0 | 10,1 |

### Percobaan di Rumah Kaca

Delapan kilogram tanah kering udara dimasukkan ke dalam pot-pot dengan ukuran 1/2000 are dan diberi pupuk TSP dan ZK sebanyak masing-masing 1 gram. Urea diberikan masing-masing sebanyak 2 gram dengan cara sebagai berikut :

A. Disebar di permukaan
B. Ditugal dengan kedalaman 3-4 cm, dibawah biji.
C. Diaduk dengan tanah dengan kedalaman 0-7 cm.
D. Diaduk dengan tanah dengan kedalaman 0-14 cm.
E. Diaduk di sekitar tempat tumbuh tanaman dengan ukuran luas 100 $cm^2$, dengan kedalaman 7 cm.
F. Tanpa diberi urea.

Empat biji jagung varietas Arjuna ditanam, seminggu kemudian disiapkan dua tanaman. Rancangan yang dipakai adalah rancangan acak kelompok dengan empat ulangan, dan tiga ulangan tambahan untuk pengambilan contoh.

Setelah berumur 25, 35 dan 45 hari setelah tanam, tanaman dipotong pada pangkal akar, dikeringkan pada 60°C dan ditetapkan bobot kering dan kadar nitrogennya dengan cara destruksi basah Kyeldahl.

Akar tanaman dicabut, dibersihkan dengan air hujan dan dikerjakan sama seperti terhadap tanaman. Tanah bekas pertanaman, diambil dengan menggunakan pipa pengambil contoh tanah, dan dipisahkan berdasarkan kedalam 0-7 cm dan 7-14 cm, kecuali perlakuan D dan F. Kadar $NH_4$-N dan $NO_3$-N ditetapkan dari kedua bagian tanah tersebut dengan cara CONWAY dengan larutan pengekstrak KC1 10 %.

### Uji inkubasi aerobik.

Pola mineralisasi daripada nitrogen tanah dipelajari melalui uji inkubasi aerobik. Sebanyak 20.0 gram tanah diinkubasikan di dalam inkubator pada suhu 30°C dengan perlakuan sebagai berikut :

1. Kadar air tanah dibuat setara dengan kelembaban 30 %, 55 % dan 80 % dari kapasitas lapang maksimum.
2. Tanpa diberi urea dan dengan pemberian urea dengan dosis 200 ppm N.
3. Untuk perlakuan setara dengan kelembaban 55 % dilakukan juga inkubasi pada suhu 40°C.

Setelah 15, 25, 35 dan 45 hari, kadar $NH_4$-N dan $NO_3$-N ditetapkan dengan cara CONWAY dengan larutan pengekstrak KC1 10 %.

### Uji perlindian

Untuk mengetahui jumlah nitrogen anorganik yang hilang karena pencucian oleh air hujan, dilakukan uji perlindian. Sebanyak 70.0 g tanah kering udara dari kebun percobaan Muara dan Pacet dimasukkan ke dalam labu perlindian. Tanah-tanah tersebut diberi larutan urea dengan dosis 10 mg N, dengan cara sebagai berikut :

Kode A. Diberikan pada permukaan setebal 1 cm.
Kode B. Diaduk dengan setengah volume tanah di dalam labu dari lapisan yang teratas.

Kode D. Diaduk dengan seluruh volume tanah di dalam labu.

Kode F. Tidak diberi Urea.

Kadar air dari tanah-tanah tersobut ditetapkan sesuai dengan 55 % kapasitas lapang maksimum. Pada 7, 10, 12 dan 15 hari setelah pemberian Urea, tanah-tanah tersebut dilindikan dengan akuades dengan jumlah setara dengan curah hujan 100, 200, 400 dan 600 mm.

Cairan hasil perlindian ditampung dan ditetapkan kadar $NH_4$-N dan $NO_3$-N ditetapkan dengan cara CONWAY dengan pelarutan pengekstrak KCL 10 %.

## HASIL DAN PEMBAHASAN

### Bobot Kering Tanaman dan Akar

Data bobot kering tanaman (batang + daun) dan akar disajikan pada Table 2 dan 3. Dari tabel tersebut di atas dapat dikemukakan bahwa perlakuan penempatan urea berpengaruh nyata terhadap bobot kering tanaman pada awal pertumbuhan sampai umur 25 hari setelah tanam, sedangkan terhadap bobot kering akar berpengaruh nyata hanya pada umur 25 hari setelah tanam. Pada 35 dan 45 hari setelah tanam penempatan urea tidak berpengaruh terhadap bobot kering tanaman dan akar. Hal ini disebabkan karena pada umur 35 hari setelah tanam dan selanjutnya akar tanaman telah dapat menggunakan seluruh N yang tercuci dan berada di dasar pot. Pengamatan visual terhadap perkembangan akar menunjukkan bahwa pada umur 25 hari setelah tanam, 60 % akar tanaman berada pada kedalaman 0 - 10 cm, sedangkan pada umur 35 hari setelah tanam akar mencapai dasar pot, sehingga dapat menyerap seluruh N yang tercuci dari lapisan atas. Pada kondisi di lapang unsur hara dapat terbawa air ke luar petakan

**Table 2. Pengaruh Penempatan Pupuk Urea Terhadap Bobot Kering Batang dan daun tanaman Jagung varietas Arjuna pada beberapa Fase. Semua perlakuan dipupuk dengan TSP dan ZK masing-masing 1 gram.**

| Hari setelah tanaman | Perlakuan | | | | | |
|---|---|---|---|---|---|---|
| | A | B | C | D | E | F |
| | gram tiap pot | | | | | |
| 15 | 1.23 ab | 0.93 d | 0.97 cd | 1.33 a | 1.19 abc | 1.03 bcd |
| 25 | 10.43 a | 8.04 b | 10.22 ab | 9.10 ab | 8.54 ab | 7.07 b |
| 35 | 27.72 a | 25.27 a | 27.65 a | 28.44 a | 26.90 a | 20.80 b |
| 45 | 61.54 a | 62.60 a | 64.23 a | 61.07 a | 58.40 a | 42.83 b |

1). Angka rata-rata dari 4 ulangan.

2). Angka-angka yang diikuti huruf yang sama tidak berbeda nyata pada taraf 0.05 menurut DMRT.

**Table 3. Pengaruh Penempatan Urea terhadap bobot kering akar tanaman Jagung Varietas Arjuna. Pada Beberapa fase. Semua perlakuan dipupuk dengan TSP dan ZK masing-masing 1 gram.**

| Hari setelah tanam. | Perlakuan | | | | | |
|---|---|---|---|---|---|---|
| | A | B | C | D | E | F |
| | gram tiap pot | | | | | |
| 15 | 0.21 a | 0.17 a | 0.23 a | 0.25 a | 0.28 a | 0.19 a |
| 25 | 1.71 ab | 1.12 ac | 2.02 a | 1.47 abc | 1.24 abc | 1.00 c |
| 35 | 6.84 a | 7.05 a | 6.96 a | 8.01 a | 6.76 a | 6.82 a |
| 45 | 10.50 a | 11.50 a | 12.05 a | 9.90 a | 11.12 a | 6.80 b |

1). Angka rata-rata dari 4 ulangan.

2). Angka yang diikuti oleh huruf yang sama tidak berbeda nyata pada taraf 0.05 menurut DMRT.

maupun merembes ke lapisan tanah yang lebih dalam sehingga tidak terjangkau oleh perakaran. Keadaan ini tidak terjadi pada percobaan pot. Oleh karenanya pencucian hara dianggap tika ada.

Pengaruh yang menonjol dari penempatan urea terhadap bobot kering tanaman pada umur 15 dan 25 hari setelah tanam terdapat pada perlakuan A, B, C dan D. Pada perlakuan B, 2 gram urea diberikan secara terkumpul pada kedalaman 5 cm, menyebabkan tekanan terhadap perkembangan tanaman. Bobot kering tanaman dan akar pada perlakuan B pada 15 dan 25 hari setelah tanam, paling rendah. Hal ini akibat dari tingginya konsentrasi N anorganik pada daerah sekitar akar, yakni mencapai 3000 ppm N. Percobaan pengaruh dosis urea yang tinggi terhadap perkembangan akar tanaman (Hasil penelitian Fujimoto, T. 1981 tidak dipublikasikan) menunjukkan bahwa konsentrasi 2300 ppm N telah menyebabkan kerusakkan akar. Bobot kering tanaman pada perlakuan B sampai 35 hari setelah tanam labih rendah dari perlakuan lainnya. Tetapi pada umur 45 hari setelah tanam bobot kering tanaman pada perlakuan B menempati urutan ke dua.

Hal ini karena akar tanaman A, C dan D secara keseluruhan berpengaruh baik terhadap bobot kering tanaman jika dibandingkan dengan perlakuan B, E dan F, walaupun pada 35 hari setelah tanam secara statistik tidak berbeda nyata. Urutan ini tergambar juga pada bobot kering akar.

## Penyerapan dan efisiensi N.

Data penyerapan dan efisiensi penggunaan pupuk N disajikan pada Tabel 4 dan 5. Pada umur 15 hst., penyerapan N yang tertinggi terdapat pada porlakuan D, berikutnya pada perlakuan A dan E dan yang paling rendah terdapat pada perlakuan B dan C.

Pada umur 25 dan 35 hst., perlakuan yang menonjol

**Table 4. Pengaruh penempatan urea terhadap jumlah Nitrogen yang diserap tanaman Jagung varietas Arjuna pada beberapa waktu pengambilan contoh (mg N).**

| Hari setelah tanam. | Perlakuan | | | | | Rata-rata |
|---|---|---|---|---|---|---|
| | A | B | C | D | E | |
| 15 | 12.7 | 2.4 | 2.1 | 20.7 | 13.4 | 10.2 |
| 25 | 157.0 | 110.0 | 144.1 | 130.6 | 100.1 | 128.4 |
| 35 | 474.0 | 382.7 | 506.5 | 486.4 | 426.0 | 455.1 |
| 45 | 548.9 | 667.7 | 545.9 | 709.2 | 671.7 | 628.7 |

1) Angka tersebut di atas didapat setelah dikurangi dengan control.

**Table 5. Pengaruh penempatan urea terhadap efisiensi pemberian Nitrogen tanaman Jagung varietas Arjuna pada berbagai waktu pengambilan Contoh.**

| Hari setelah tanam. | Perlakuan | | | | |
|---|---|---|---|---|---|
| | A | B | C | D | E |
| | ..... % ..... | | | | |
| 25 | 17.1 | 12.0 | 15.7 | 14.2 | 10.9 |
| 35 | 51.5 | 41.6 | 52.1 | 52.1 | 46.3 |
| 45 | 59.7 | 73.7 | 59,4 | 77.1 | 73.0 |

1). Efisiensi = $\frac{\text{Mg N yang diserap pada masing-masing perlakuan} - \text{mg N yang diserap pada perlakuan tanpa pemberian Urea.}}{920} \times 10$

adalah perlakuan A, C dan D yang rendah penyerapan N terdapat pada perlakuan B dan E. Tetapi pada umur 45 hst., terjadi penurunan kecepatan penyerapan nitrogen pada perlakuan A dan C, sedangkan pada perlakuan B dan E justru meningkat. Hal ini menunjukkan bahwa pada awal pertumbuhan penyerapan N pada perlakuan B dan E terhambat karena perkembangan akar tertekan akibat dari konsentrasi N-anorganik yang tinggi. Tetapi setelah konsentrasi N-anorganik tersebut menurun, perakaran mulai berkembang dan telah mencapai dasar pot, sehingga penyerapan hara khususnya nitrogen meningkat melebihi perlakuan A, C dan D.

Efisiensi pada 15 hari setelah tanam tidak dihitung karena banyaknya N yang diserap lebih kecil dari 50 mg N; sangat kecil bila dibandingkan dengan N yang diberikan (920 mg N). Sedangkan dari jumlah tersebut di atas, terdapat N yang berasal dari biji (bibit).

Dari data tersebut di atas dapat dikemukakan bahwa pada awal pertumbuhan, perlakuan A, C dan D memberikan efisiensi penyerapan yand relatif tinggi, sedangkan yang relatif rendahterdapat pada perlakuan B dan E. Tetapi pada fase berikutnya efisiensi N pada perlakuan B dan E naik melampaui perlakuan A dan C.

Kedaan ini tentunya akan berbeda jika perlakuan ini diadakan di lapang, sebab setelan satu bulan urea yang diberikan pada keadaan di lapang, akan habis tercuci. Sedangkan pada percobaan pot, kehilangan N oleh pencucian hampir tidak ada. Artinya tanaman dapat mengambil N yang tertampung di dasar pot.

N anorganik yang teritinggal pada pot-pot percobaan.

Data N-anorganik yang tertinggal pada pot-pot percobaan disajikan pada Table 6. Secara keseluruhan jumlah N-anorganik di dalam tanah menurun dengan makin bertambahnya umur tanaman.

Dari data tersebut di atas dapat dikemukakan bahwa 15 hari setelah perlakuan berbagai cara penempatan pupuk urea, jumlah N-anorganik terbesar terdapat pada perlakuan B, yakni 3020 ppm N. Berikutnya adalah perlakuan E, yakni 1521 ppm N. Terkecil terdapat pada perlakuan D, yakni 205 ppm N. Sedangkan pot tanpa pemberian urea terdapat sebesar 46 ppm N.

Pada 25 hari setelah tanam konsentrasi N pada perlakuan B dan E masih menunjukkan tingkat yang cukup tinggi yakni 1185 ppm N dan 726 ppm N. Kedaan ini jelas menggambarkan perlakuannya, yakni semakin terkumpul urea tersebut ditempatkan, konsentrasi N pada titik tumbuh semakin tinggi.

**Tabel 6. Pengaruh Penempatan Pupuk Urea Terhadap Nitrogen Anorganik Tanah Di dalam Pot Percobaan pada beberapa Fase pengambilan contoh. 1).**

| Hari setelah tanam. | Perlakuan | | | | | |
|---|---|---|---|---|---|---|
| | A | B | C | D | E | F |
| | | | | ppm | | |
| 15 | 368 | 3026 | 404 | 205 | 1521 | 46 |
| 25 | 254 | 1185 | 295 | 160 | 726 | 31 |
| 35 | 89 | 266 | 102 | 73 | 68 | 26 |
| 45 | 29 | 32 | 41 | 15 | 25 | 15 |

1). Dosis urea yang diberikan adalah 2 g/8 kg tanah kering udara (920 gram N)
Setiap pot ditanami jagung varietas Arjuna sebanyak 2 tanaman.

Kedaan ini menyebabkan tertekannya perakaran pada perlakuan B dan E, dan berpengaruh pada bobot kering pada umur 25 dan 35 hari setelah tanam.

Jika dilihat dari bentuk $NH_4$-N dan $NO_3$-N nya (Tabel 7 dan 8), komposisi dikedua kedalaman tanah berbeda. Secara keseluruhan bentuk $NH_4$-N lebih banyak berada pada larisan 7-14 cm, kecuali pada umur 25 hst., bentuk $NH_4$-N 64 % berada pada lapisan 0-7 cm. Dan pada umur 45 hst., komposisi bentuk $NH_4$-N dikedua kedalaman tersebut berimbang.

Komposisi bentuk $NO_3$-N dikedua lapisan berimbang selama fase pertumbuhannya, kecuali pada umur 35 hst.,

Table 7. Pengaruh Penempatan pupuk Urea terhadap Komposisi $NH_4$-N tanah di dua kedalaman pada beberapa waktu pengambilan contoh.

| Perlakuan/ Kedalaman. | Hari setelah tanam 15 | 25 | 35 | 45 | Rata-rata |
|---|---|---|---|---|---|
| | | | % | | |
| A 0 - 7 | 19 | 63 | 50 | 57 | 44.8 |
| 7 - 14 | 91 | 37 | 50 | 43 | 55.3 |
| B 0 - 7 | 49 | 77 | 21 | 40 | 46.8 |
| 7 - 14 | 51 | 23 | 79 | 60 | 53.3 |
| C 0 - 7 | 41 | 44 | 50 | 31 | 41.5 |
| 7 - 14 | 59 | 56 | 50 | 69 | 58.5 |
| E 0 - 7 | 11 | 73 | 32 | 57 | 43.3 |
| 7 - 14 | 89 | 27 | 68 | 43 | 56.8 |
| Purata | | | | | |
| 0 - 7 | 28 | 64 | 38 | 46 | |
| 7 - 14 | 72 | 36 | 62 | 54 | |

Table 8. Pengaruh Penempatan pupuk Urea terhadap Komposisi $NO_3$-N dua kedalaman yang berbeda pada beberapa waktu pengambilan contoh.

| Perlakuan | Hari setelah tanam 15 | 25 | 35 | 45 | Rata-rata |
|---|---|---|---|---|---|
| A 0 - 7 | 41 | 46 | 93 | 33 | 53.3 |
| 7 - 14 | 59 | 54 | 7 | 67 | 46.8 |
| B 0 - 7 | 51 | 50 | 84 | 57 | 60.5 |
| 7 - 14 | 49 | 60 | 16 | 43 | 39.5 |
| C 0 - 7 | 35 | 53 | 40 | 78 | 51.5 |
| 7 - 14 | 65 | 47 | 60 | 22 | 48.5 |
| E 0 - 7 | 40 | 64 | 59 | 50 | 53.3 |
| 7 - 14 | 60 | 36 | 41 | 50 | 46.8 |
| Rata rata | | | | | |
| 0 - 7 | 41.8 | 53.2 | 69.0 | 54.5 | 54.7 |
| 0 - 14 | 58.2 | 46.8 | 31.0 | 45.5 | 41.3 |

bentuk $NO_3$-N, 69 % berada pada lapisan 0-7 cm. Tetapi bentuk $NO_3$-N tersebut cenderung lebih tinggi pada 0-7 cm dibandingkan dengan 7-14 cm. Hal ini dapat dimengerti bahwa lebih dekat lapisan tanah dengan permukaan (terbuka terhadap udara bebas) proses oksidasi (nitrifikasi) lebih kuat daripada lapisan yang lebih dalam.

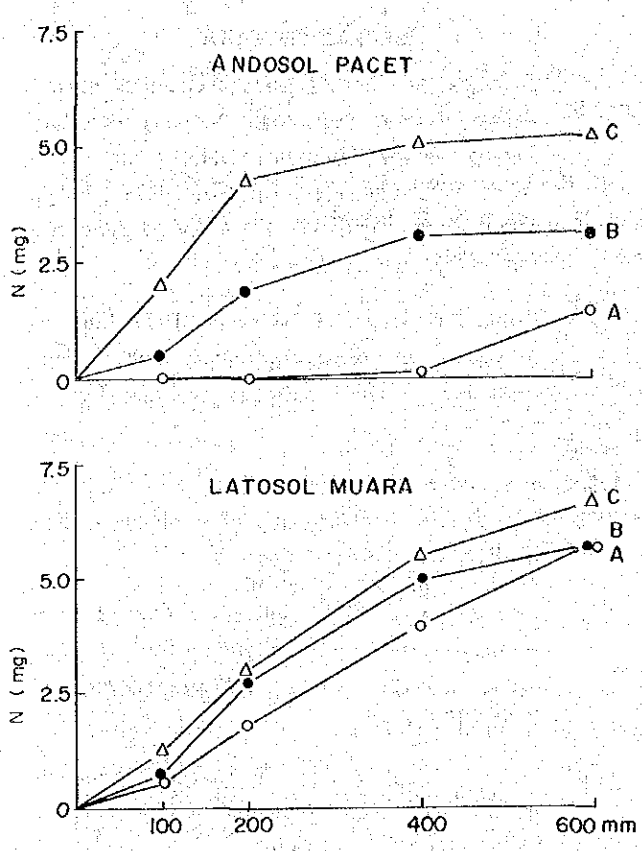
Pencucian Nitrogen anorganik (Gambar 1).

N anorganik yang tercuci berbeda menurut cara dari pengurangan N anorganik yang tercuci dari tabung yang diberi N dengan N anorganik yang tercuci dari tabung tanpa diberi N.

N anorganik yang tercuci berbeda menurut cara permberian urea. Pada tanah Andosol Pacet, pencucian sampai 400 mm pada perlakuan urea dengan cara disebar di permukaan, N anorganik yang hilang relatif sangat kecil. Tetapi pada perlakuan dengan cara diaduk keseluruh lapisan tanah, N anorganik yang hilang mencapai 4,3 mg N pada curah hujan 200 mm. Berarti 40 % dari pupuk yang diberikan tercuci oleh curah hujan 200 mm. Kemudian naik secara bertahap hingga mencapai 5,3 mg N pada 600 mm. Berarti 50 % dari pupuk yang diberikan hilang tercuci oleh 400 mm curah hujan.

Pada tanah Latosol Muara, perbedaan antar perlakuan lebih kecil dibandingkan dengan tanah Andosol Pacet. Pada tanah Latosol Muara jumlah anorganik yang tercuci pada 600 mm, 6.8 mg N pada perlakuan dengan cara diaduk keseluruh tanah. Pada perlakuan disebar dipermukaan dan diaduk dengan setengah volume tanah, sama besarnya yakni 5,8 mg N. Hal ini menunjukkan bahwa lebih dari separuh pupuk urea yang diberikan pada tanah Latosol Muara tercuci oleh curah hujan 400 mm. Dan dengan makin dalam atau makin besar volume tanah yang diaduk dengan pupuk urea, makin besar pula urea yang tercuci oleh air hujan.

Percobaan ini sesuai dengan pernyataan Wetselaar (1962), bahwa pergerakan $NO_3$-N berkorelasi tinggi dengan jumlah curah hujan. Menurut Padre (1977), pupuk amonium yang diberikan pada tanah kering dinitrifikasi secara cepat, dan proses ini berlangsung lebih cepat pada musim penghujan dibandingkan dengan musim panas. Untuk mengurangi kehilangan nitrogen pada tanah sawah, urea diaduk dengan tanah dan dibenamkan kelapisan yang lebih dalam (lapisan reduksi). Sehingga amonium yang dihasilkan oleh urea cepat terikat oleh liat tanah dan tidak sempat teroksidasi menjadi bentuk nitrat yang mudah terbawa air. Tetapi pada tanah kering, urea yang diaduk dan dibenamkan kelapisan lebih dalam akan mempercepat nitrifikasi dan dengan makin tinggi curah hujan makin banyak nitrat yang terbawa oleh air hujan.




**Gambar 1. Pengaruh berbagai curah hujan terhadap pencucian nitrogen anorganik**

A. Urea disebar pada permukaan tanah setebal 1 cm
B. Urea diaduk dengan setengah volume tanah
C. Urea diaduk dengan seluruh volume tanah

Pengaruh kelembaban terhadap mineralisasi nitrogen (Tabel 9 and 10).

Peningkatan kelembaban menurunkan kadar $NH_4$-N tanah, tetapi menaikkan $NO_3$-N. Kadar $NH_4$-N menurun dari 2,5 mg N menjadi 1,3 mg N, sedangkan $NO_3$-N meningkat dari 3,7 mg N menjadi 7,4 mg N.

Kenaikan suhu cenderung menaikkan kadar $NH_4$-N maupun $NO_3$-N. Hasil percobaan ini sesuai dengan penelitian Sahrawat (1978).

Pada kelembaban 30 %, urea yang diberikan tidak nitrifikasi. Tetapi pada kelembaban 55 %, urea yang diberikan diubah menjadi $NO_3$-N dan kecepatan *nitrifikasi naik tajam setelah inkubasi 25 hari, yakni* dari 5,1 mg N menjadi 34,8 mg N. Pada kelembaban 80 % kecepatan nitrifikasi naik tajam sejak inkubasi 15 hari, yakni dari 9,9 mg N menjadi 23,0 mg N. Setelah inkubasi 35 hari, kadar $NO_3$-N mulai menurun. Hal ini menunjukkan awal dari proses denitrifikasi relatip lebih tinggi.

Hasil percobaan ini konsisten dengan yang diteliti oleh Sahrawat (1980), bahwa mineralisasi nitrogen dipercepat dengan penggenangan dan pengeringan. *Penggenangan dalam hal ini berarti peningkatan kadar* air. Beberapa peneliti lain juga berpendapat bahwa pembasahan dan pengeringan tanah akan memacu dekomposisi bahan organik.

**Tabel 9. Pengaruh Berbagai Kelembaban Terhadap Konsentrasi $NH_4$-N Tanah Pada Kondisi Inkubasi Aerobik 30°C.**

| Lama Inkubasi (hari) | Kelembaban (% bobot) | | | |
|---|---|---|---|---|
| | 30% | 55% | 80% | 55% pada 40°C |
| | mg N/100 tanah | | | |
| | N = 0 | | | |
| 15 | 2,5 | 1,6 | 1,1 | 1,2 |
| 25 | 3,6 | 3,7 | 2,1 | 4,6 |
| 35 | 1,2 | 1,0 | 0,7 | 1,0 |
| 45 | 2,8 | 1,0 | 1,3 | 0,9 |
| Purata | 2,5 | 1,7 | 1,3 | 1,8 |
| | N = 200 ppm | | | |
| 15 | 19,1 | 7,0 | 5,7 | 8,2 |
| 25 | 19,1 | 4,7 | 3,1 | 3,5 |
| 35 | 14,9 | 1,0 | 0,7 | 1,1 |
| 45 | 18,8 | 1,0 | 0,9 | 1,5 |
| Purata | 18,0 | 3,4 | 2,6 | 3,6 |

**Tabel 10. Pengaruh Berbagai Kelembaban Terhadap Konsentrasi $NO_3$-N Tanah Pada Kondisi Inkubasi Aerobik 30°C.**

| Lama Inkubasi (hari) | Kelembaban (% bobot) | | | |
|---|---|---|---|---|
| | 30% | 55% | 80% | 55% pada 40°C |
| | mg N/100 g tanah | | | |
| | N = 0 | | | |
| 15 | 1,8 | 4,2 | 10,1 | 7,3 |
| 25 | 3,9 | 7,1 | 3,6 | 10,0 |
| 35 | 5,7 | 7,5 | 9,4 | 9,9 |
| 45 | 3,4 | 7,0 | 6,4 | 10,2 |
| Purata | 3,7 | 6,5 | 7,4 | 9,3 |
| | N = 200 ppm | | | |
| 15 | 2,6 | 3,2 | 9,9 | 15,9 |
| 25 | 3,0 | 5,1 | 23,0 | 32,7 |
| 35 | 5,9 | 34,8 | 25,3 | 26,6 |
| 45 | 4,2 | 19,6 | 22,9 | 25,4 |
| Purata | 3,9 | 15,7 | 20,3 | 25,0 |

## KESIMPULAN

Dari hasil percobaan dapat disimpulkan hal-hal sebagai berikut:

1. Cara Penempatan urea berpangaruh nyata terhadap bobot kering tanaman pada awal pertumbuhan.
2. Pemberian pupuk secara ditugal, menyebabkan tingginya kadar N-anorganik disekiter akar dan mengakibatkan rusaknya akar tanaman pada umur muda. Keadaan ini menyebabkan rendahnya penyerapan N, dan efisiensi pemberian N. Dan diduga hal ini menjadi faktor penghambat dadalam usaha memaksimalkan hasil di lapang.
3. Pada lapisan atas (0-7 cm) bentuk $NO_3$-N cenderung lebih banyak dari pada bentuk $NH_4$-N dan sebaliknya.
4. Makin dalam pupuk urea diaduk dengan tanah, makin basar pula N-anorganik yang tercuci oleh air hujan. Perbedaan jenis tanah memberikan tingkat pencucian yang berbeda pula.
5. Peningkatan kolembaban menurunkan kadar $NH_4$-N dan menaikkan kadar $NO_3$-N. Kenaikan suhu meningkatkan dan mempercepat mineralisasi N. Proses nitrifikasi sangat kecil pada kelembaban 40 %, tetapi dengan makin tinggi kelembaban makin dini proses nitrifikasi berlangsung cepat.

## SARAN

Percobaan-percobaan palawija khususnya jagung, yang mempelajari pengaruh pemupukan terhadap hasil hendaknya tidak dilakukan didalam pot, karena akar tanaman pada umur 35 hari dan selanjutnya telah dapat memanfaatkan pupuk yang berada didasar pot. Sedangkan pada percobaan dilapang, pupuk tersebut tidak dapat dimanfaatkan oleh tanaman karena kercuci oleh air hujan ke lapisan yang lebih dalam atau keluar petakan.

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# 16. SURVEYS ON THE OCCURRENCE OF SOYBEAN AND MUNGBEAN DISEASES IN INDONESIA

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## ABSTRACT

The following 13 kinds of soybean diseases were found to occur in the farmers' fields and fields of experimental station of CRIFC, in Java, Sumatra and Bali islands in Indonesia: Bacterial pustule, Cercospora leaf spot, Purple stain of seed, Anthracnose, Rust, Southern blight, Witches' broom, Soybean stunt, Soybean dwarf, Bean yellow mosaic, and Root-knot nematode.

Judging from the occurrence, severity of damage or distribution, Rust, Bacterial pustule, Southern blight, Witches' broom, Soybean stunt and Soybean dwarf seem to be extremely important in Indonesia.

The occurrence of the following 12 kinds of diseases affecting mungbeans was observed in Java, Sumatra, and Bali islands in Indonesia: Scab, Powdery mildew, Cercospora leaf spot, Southern blight, Damping off, Leaf blight, Rhizoctonia rot, Anthracnose, Rust, Witches' broom, Bean yellow mosaic, and Mungbean mosaic.

On the basis of the occurrence, severity of damage and distribution, Scab, Cercospora leaf spot, Anthracnose Southern blight, Bean yellow mosaic and Mungbean mosaic seem to be very important diseases in Indonesia.

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Table 1. List of diseases of soybean in Indonesia

| | Name of Diseases | Causal agents | Importance of Occurrence |
|---|---|---|---|
| I | Bacterial diseases | | |
| | 1. Bacterial pustule | *Xanthomonas campestris* pv. *glycines* | ++ |
| | 2. Bacterial blight | *Pseudomonas glycinea* | - |
| | 3. Wildfire | *Pseudomonas syringae* pv. *tabaci* | - |
| | 4. Bacterial wilt | *Pseudomonas solanacearum* | - |
| | | *Corynebacterium flaccumfaciens* | - |
| II | Fungal diseases | | |
| | 5. Purple stain of seed | *Cercospora kikuchii* | + |
| | 6. Leaf spot | *Cercospora sojina* | + |
| | 7. Anthracnose | *Colletotrichum dematium* var. *truncata* | + |
| | | *Glomerella glycines* | + |
| | 8. Target spot | *Corynespora cassicola* | - |
| | 9. Damping off | *Fusarium* sp. | - |
| | | *Pythiun* spp. | + |
| | | *Rhizoctonia solani* | + |
| | | *Sclerotium rolfsii* | ++ |
| | 10. Rust | *Phakopsora pachyrhizi* | ++ |
| | 11. Foliage blight | *Rhizoctonia solani* | + |
| | 12. Southern blight | *Sclerotium rolfsii* | ++ |
| | 13. Brown spot | *Septoria glycines* | - |
| III | Viral diseases | | |
| | 14. Witches' broom | Mycoplasma like organism | ++ |
| | 15. Soybean stunt | Soybean stunt virus | ++ |
| | 16. Soybean dwarf | Indonesian soybean dwarf virus | ++ |
| | 17. Yellow mosaic | Bean yellow mosaic virus | + |
| | 18. Yellow mosaic | Soybean yellow mosaic virus | + |
| IV | Nematodes | | |
| | 19. Cyst nematode | *Heterodera glycines* | - |
| | 20. Root-knot nematode | *Meloidogyne arenaria, M. hapla,* | + |
| | | *M. incognita, M. javanica* | + |

Note : ++; Major or important diseases, +; Occurrence of the disease was observed during the surveys (March 1979 - August 1981), -; Disease was not observed, but had already been reported in Indonesia by other authors.

**Table 2. List of diseases of mungbean in Indonesia**

| | Name of diseases | Causal agents | Importance of Occurrence |
|---|---|---|---|
| I | Bacterial diseases | | |
| 1. | Bacterial spot | *Pseudomonas glycinea* | - |
| II | Fungal diseases | | |
| 2. | Leaf spot | *Cercospora canescens* | ++ |
| 3. | Scoty blotch | *Cercospora dolichi* | - |
| 4. | Anthracnose | *Colletotrichum lindemuthianum* | ++ |
| 5. | Scab | *Elsinoe iwatae* | ++ |
| 6. | Leaf spot | *Phyllosticta phaseolina* | - |
| 7. | Damping off | *Pythium* spp., *& Rhizoctonia solani* | + |
| 8. | Leaf blight | *Rhizoctonia solani* | + |
| 9. | Rhizoctonia rot | *Rhizoctonia solani* | + |
| 10. | Southern blight | *Sclerotium rolfsii* | + |
| 11. | Powdery mildew | *Sphaerotheca fuliginea* | + |
| 12. | Rust | *Uromyces phaseoli* | + |
| III | Viral diseases | | |
| 13. | Witches' broom | Mycoplasma like organism | + |
| 14. | Yellow mosaic | Bean yellow mosaic virus | + |
| 15. | Mosaic | Mungbean mosaic virus | + |

Note : ++, +, and -; as in Table 1.

# 摘　　要

## インドネシアにおける大豆及び緑豆の病害発生調査


1. 大豆の病害

インドネシアで発生が報告された大豆の病害は約２１種類（第1表）であり，日本植物病名目録の記載数３７種類，あるいは「Compendium of Soybean Diseases」の記載数４５種類に比べると少ない。

インドネシア国内での大豆の生産は，主として中・東部ジャワで行われており，年間生産量の約７割がこの地方で生産されている。

これらの地帯における大豆作は，主に水田跡の乾期作と言う作付様式がとられており，畑作大豆の作付はさほど多くない。近年いわゆる外領と呼ばれるスマトラ，カリマンタン，スラウェシ等に移民策がとられており，これらの地域では畑作大豆が作付されている。しかし作付面積，生産量とも低く，作付様式は，やはり陸稲跡の乾期作が主である。

このように大豆が主として乾期作として作付されてるため，発生する病害の種類も少いのではないかと思われる。

本調査では，ジャワ島，バリ島およびスマトラ島の一部の地域において，一般農家の大豆栽培圃場および中央農業研究所の地域試験地の大豆圃場を調査し，大豆さび病等１３種の病害の発生を確認した。これらの病害の内，発生が多く，かつ広く分布して重要と考えられる病害は大豆さび病，葉焼病，てんぐす病およびウィルス病であった。

2. 緑豆（マングビーン）の病害

Charles Y. Yang（1977）によれば２６種類の病害がマングビーンで報告されており，その大部分はアジアの熱帯及び亜熱帯で見られると言う。しかし，インドネシアで発生が報告されたものは約１６種類（第２表）である。

インドネシアでのマングビーンの生産は，主として東部ジャワ，南スラウェシ，ランポン，中部ジャワの各州で行われている。またマングビーン生産の主体は大豆と異なり，畑地帯でどちらかと言えば雨期に作られていると言われている。しかし今回の調査は大豆と並行して行ったため，調査対象となったマングビーンは試験地のものも含めてほとんどが水田後作のものである。

今回の調査で発生が認められた病害は，そうか病，ウドンコ病，Cercospora 斑点病，白絹病，苗立枯病，Rhizoctonia rot，さび病，てんぐす病，Virus 病（Bean yellow mosaic virus，Mungbean mosaic virus）の１０種類であった。

これらの内，発生が多く，分布も広く，かつ被害が大きいと思われるのは，そうか病，Cercospora 斑点病，炭そ病，白絹病およびVirus 病であった。

そうか病（Scab：*Elsinoe iwatae* KAJIWARA et MUKELAR）はBogor 周辺できわめて激しく発病し，罹病株は生育不良で早く枯死するため，収穫皆無になることがある。またランポン州テギネネンセンターの種子生産圃場で激発しているのを観察した。しかし中・東部ジャワでは調査対象が水田後の乾期作であったため，若干の発生は認められるが，それ程ひどいものではなかった。また大部分の罹病株は炭そ病を併発しているため，病原菌の分離が困難であった。

Cercospora 斑点病は，ほとんどすべての栽培圃場で発生が認められ，激しいものは圃場一面が褐変しており，また成熟期に近いものでは葉がほとんどなく，褐色の茎に黒色の莢がついているといった状態のものもみられた。

Virus 病及びてんぐす病は，どちらかと言えば農家圃場よりも，試験地または種子生産の圃場に発生が認められ，将来，大きな問題となると思われた。

さび病は，東部ジャワの試験地（Genteng）で激発しているのを観察したが，その他にはみられなかった。

# 17. HYPHAL ANASTOMOSIS GROUPS OF *RHIZOCTONIA SOLANI* KÜHN IN INDONESIA

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## ABSTRACT

The knowledge on the characteristics and ecology of the pathogen have enabled to develop successful control measures. In order to study the characteristics of *Rhizoctonia solani* which cause a large number of diseases on various crops in Indonesia, grouping of *R. solani* with hyphal anastomosis was carried out by using Ogoshi's method.

Almost all the isolates of *R. solani* from various crops in Indonesia belonged to the AG-1 or AG-4 groups, while isolates belonged to the AG-2-1 group could not be detected. Out of 180 isolates of *R. solani* from rice 151 belonged to the AG-1 group, 71 isolates from legumes were roughly divided into two groups: 39 isolates belonged to the AG-1 group and 30 isolates to the AG-4 group. Out of 60 isolates from weeds 50 belonged to the AG-1 group.

It seems that the isolates suited to comparatively high temperatures were distributed in Indonesia. It is suggested that weeds are one of the inoculm sources of the Rhizoctonia diseases of rice and legumes.

## INTRODUCTION

In 1858, J. Kühn described the fungus *Rhizoctonia solani*, as a pathogen of potato black scarf disease. Since then the fungus has been known as a widespread, destructive and versatile plant pathogen. Although a large number of studies on this pathogen have been carried out, there is much confusion and disagreement on the taxonomy and nomenclature of the fungus.

Recently Parmeter and Whitney (1970) reviewed the literature on the taxonomy and nomenclature of the imperfect state of the fungus. They summarized the characteristics of *R. solani* as follows:

A. Characteristics consistently present:
1. Multinucleate cells in young vegetative hyphae.
2. Prominent septal pore apparatus.
3. Branching near the distal septum of cells in young vegetative hyphae.
4. Constriction of the branch and formation of a septum in the branch near the point of origin.
5. Some shade of brown.

B. Characteristics usually present, with one or more occasionally lacking in individual isolates:
1. Monilioid cells.
2. Sclerotia (without differentiated rind and medulla).
3. Hyphae with a diameter of more than 5 $\mu$.
4. Rapid growth rate.
5. Pathogenicity.

C. Characteristics never observed:
1. Clamp connections.
2. Conidia.
3. Sclerotia differentiated into a rind and medulla.
4. Rhizomorphs.
5. Red, green, blue, bright yellow, orange or other pigments except brown.
6. Perfect state except in *Thanatephorus cucumeris* (Frank) Donk of the fungus.

Because of the wide variations in the morphology, pathogenicity and physiology the taxonomy and nomenclature of *R. solani* have been a source of confusion and controversy for many years.

Several workers have attempted subgroupings of *R. solani*. The presence of anastomosis has been used by Matsumoto et al (1932), Schultz (1936), Richter & Schneider (1953), Parmeter et al (1969), Sherwood (1969), and Ogoshi (1976), to recognize varieties or sub-specific groupings.

In the anastomosis groupings of *R. solani* by Ogoshi (1976), 242 out of the 255 isolates tested fell into one of the five groups (AG-1, AG-2, AG-3, AG-4, and AG-5). AG-2 was divided into Type-1 and Type-2 by the frequency of hyphal anastomosis. It is suggested that there may be pathological, ecological and morphological differentiations in *R. solani* and these differentiations materialize in anastomosis groups.

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Table 1. Anastomosis Groups of *Rhizoctonia solani* Kühn isolated from various crops and weeds in Indonesia.

| Hosts | Anastomosis groups (by Ogoshi 1976) | | | | | | |
|---|---|---|---|---|---|---|---|
| | AG-1 | AG-2-1 | AG2-2 | AG-3 | AG-4 | AG-5 | Total |
| Rice | 151 | 0 | 1 | 0 | 28 | 0 | 180 |
| Legumes | 39 | 0 | 1 | 0 | 30 | 1 | 71 |
| Corn & Sorghum | 9 | 0 | 0 | 0 | 4 | 0 | 13 |
| Vegetables | 5 | 0 | 0 | 0 | 7 | 0 | 12 |
| Wheat | 0 | 0 | 1 | 0 | 2 | 0 | 3 |
| Potatoes | 0 | 0 | 0 | 1 | 3 | 0 | 4 |
| Weeds | 50 | 0 | 2 | 0 | 8 | 0 | 60 |
| Soils | 1 | 0 | 0 | 0 | 1 | 0 | 2 |
| Total | 255 | 0 | 5 | 1 | 83 | 1 | 345 |

In the case of Rhizoctonia and other organisms, the implementation of control measures depends on the characteristics of the pathogen. The great variability of the pathogen and the confusion in the taxonomy must undoubtedly be ascribed to much of the disagreement in the literature.

Thus, it is necessary to determine the characteristics of *R. solani* in Indonesia. The present report describes grouping based on hyphal anastomosis of *R. solani* isolated from various crops and weeds in Indonesia.

## MATERIALS AND METHODS

*Anastomosis was tested at 25°C on 2 % water agar* media by the reaction of five pairs of isolates, one of which being a standard isolate from each anastomosis group and the other unknown. The advancing hyphae made contact, slightly overlapped and were observed under the microscope.

When anastomosis occurred between an unknown isolate and a standard isolate from one of the five groups, it was decided that the unknown isolate belonged to the same group as that of the standard.

## RESULTS

The results of groupings of *R. solani* isolates are shown in Table 1. A total of 345 isolates were tested, and 255 of these fell into the AG-1 group, 83 isolates into AG-4 group, and the other 5, as well as one isolate each into the AG-2-2, AG-3 and AG-5 groups, respectively. Isolates belonging to the AG-2-1 group were not detected.

The 180 isolates of *R. solani* from rice were divided into three groups: 151 isolates fell into the AG-1 group, 28 into the AG-4 group, and one into the AG-2-2 group. The 71 isolates from legumes were divided into four groups: AG-1 (39), AG-2-2 (1), AG-4 (30), and AG-5 (1). The 60 isolates from weeds were divided into three groups: AG-1 (50), AG-2-2 (2), and AG-4 (8).

Thus almost all the isolates from rice, legumes and weeds in Indonesia belonged to the AG-1 or AG-4 groups.

## DISCUSSION

Ogoshi (1976) reported that in Japan, 18 isolates from *Gramineae* (mostly from rice plants) belonged to the AG-1, AG-2-1 and AG-2-2 groups, and 25 isolates from *Leguminosae* to the AG-1, AG-4, and AG-5 groups. Most of the isolates belonging to the AG-1 or AG-4 groups were more thermophylic than the isolates from the other groups.

In the present investigations, almost all the isolates from rice and legumes in Indonesia belonged to the AG-1 or AG-4 groups as in Japan. Furthermore, most isolates from other crops also fell into the AG-1 or AG-4 groups. It seems that the isolates suited to comparatively high temperature were distributed in Indonesia.

On the basis of the results obtained, it was show that *R. solani* isolates from weeds belonged to the AG-1 or AG-4 groups. It is also suggested that weeds are one of the inoculum sources of the Rhizoctonia diseases of rice and legumes plants.

In the present investigations, almost all the isolates of *R. solani* tested originated from diseased plants, and did not include isolates from soil. It seems that further studies on the groupings of *R. solani* isolates from soil should be carried out in order to draw a distribution map of *R. solani* in Indonesia.

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# 摘　　要

## インドネシアにおいて各種作物及び雑草より分離される *Rhizoctonia solani* Kühn 菌株の菌糸融合による類別

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インドネシアで各種の作物（稲，大豆，緑豆，落花生，とうもろこし，じゃがいも，麦及び野菜類）及び各種の雑草などから分離された *R. solani*，345菌株を生越（1976）の方法に従って，菌糸融合による類別を行った。

供試した *R. solani* 345菌株は，AG−1に属するもの255，AG−4に83，AG−2−2に5，AG−3とAG−5にそれぞれ1菌株と類別され，AG−2−1に属する菌株は認められなかった。

稲より分離された180菌株では，151菌株（83.9%）がAG−1に，28菌株（15.6%）がAG−4に類別された。このことからインドネシアにおける稲紋枯病は，日本と同様に，*R. solani* の主としてAG−1の菌によって生じ，AG−4の菌によっても生じることが明らかとなった。

豆類（大豆，緑豆，落花生）から分離された71菌株（*R. solani*）では，39菌株（54.9%）がAG−1に，30菌株（42.3%）がAG−4に属した。この結果は日本と比べるとAG−1の割合が多い点及びAG−5が少ない点で若干異なる傾向を示した。インドネシアで豆類の作付は主として水稲跡の乾期作として行われているためAG−1が多く分離されるものと考えられる。

各種の雑草から分離された60菌株の *R. solani* の内，83%に当る50菌株がAG−1に属するものであり，これら雑草は稲紋枯病の感染源となり得ることが示唆された。

生越（1976）が *R. solani* の各菌糸融合群について報告した中で，AG−4は他群に比べて好高温性であり，AG−1にも好高温性のものが多く含まれるとした。本試験の結果，インドネシアで罹病植物から分離された *R. solani* のほとんどの菌株がAG−1又はAG−4に属するものであったことは，この両菌群の好高温性にその一因があると考えられる。

本試験では稲及び豆類以外の作物並びに土壌からの分離菌株が少なかったので，今後より広範に *R. solani* 菌株を収集し，インドネシアにおける *R. solani* の分布を明らかにする必要があろう。

# 18. RHIZOCTONIA ROT ON MUNGBEANS

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## ABSTRACT

In 1980, leaf blight, foot rot and stem rot symptoms were observed on mungbean plants at the Tegineneng Center in Lampung, and at the Muara and Citayam Stations of CRIFC, in West Java.

*Rhizoctonia solani* Kühn was predominantly isolated from diseased leaf and stem of mungbean. But some other fungi, such as *Sclerotium rolfsii, Fusarium* spp., *Trichoderma* sp., *Pythium* sp., and *Setodochium* sp. were also isolated.

Isolates of *R. solani* recovered from diseased plants fell into two groups, namely AG-1 and AG-4 groups.

However, the results obtained from inoculation tests, indicated that *R. solani* was the pathogen of this disease. Pathogenicity tests on mungbeans were carried out and the results showed that leaf blight symptoms caused by *R. solani* isolates belonged to AG-1 group, and were not induced by isolates belonging to AG-4 group. Foot rot or stem rot symptoms were caused by both isolates (AG-1 and AG-4 groups) of *R. solani.*

Leaf blight, stem rot and foot rot symptoms were observed on soybeans, by inoculation of all the isolates of *R. solani* tested.

*Sclerotium rolfsii* caused typical southern blight symptoms on mungbeans and soybeans, and *Pythium* sp. caused damping off. But they did not cause the same symptoms as those observed in the fields. *Fusarium* sp., *Trichoderma* sp., and *Setodochium* sp. did not inhibit any pathogenicity to mungbeans or soybeans.

## INTRODUCTION

In March 1980, it was observed in the mungbean fields of the Tegineneng Center (Lampung Tani Makmur Project), in Lampung, that leaf blight and stem rot symptoms severely affected mungbean plants. Also in June 1980, at the Citayam Station and in July 1980, at the Muara Station, the same symptoms were observed on mungbean plants.

The present report describes the results of isolation, identification and pathogenicity tests carried out at the Plant Pathology Sub-Division of BORIF, CRIFC, Bogor, from March 1980 to August 1981.

## MATERIALS AND METHODS

Isolation of the pathogen:

Diseased leaves or stems were cut to small pieces near the margin of the lesion, and these small pieces were placed on 2 % plain agar medium in petri dishes after usual surface sterilization. Then mycelia grown from these samples were transferred to slightly acid Potato Dextrose Agar medium (PDA). Mycelial transfers were repeated until a pure culture of the fungus was obtained.

Identification and grouping of *R. solani*:

The fungi isolated from diseased plants were identified by their morphological characteristics under the microscope. The isolates of *R. solani* were divided into anastomosis groups according to Ogoshi's method.

Inoculation tests:

15 - 20 seeds of mungbean, variety No. 129 or soybean, variety Ringgit were planted in pots (1/5000 a) containing sterilized soil. Inoculation using the mycelial suspension as inoculum was made 1 month after planting.

## RESULTS

Symptoms of diseased plants:

Leaf blight; the lesions were irregular in size, with a light brown color, and in the later period of infection, some leaves became black or dark brown and died.

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On the portion of the stem where such infected leaves were attached, a lesion with a light or dark brown color was observed.

Stem rot or foot rot; the lesions which were light brown in the center, with a dark brown discoloration at the margin were slightly depressed. Afterwards, the lesions progressed along the stem, and sometimes, the part of stem which was infected became folded down.

Isolation and identification:

The results of isolation are shown in Tables 1 and 2.

*R. solani* was predominantly isolated from diseased leaves and stems of mungbeans although some other fungi such as *Sclerotium rolfsii, Fusarium* spp., *Trichoderma* sp., *Pythium* sp., and *Setodochium* sp. were also present.

**Table 1. Fungi isolated from diseased leaves of mungbean. Showing leaf blight symptoms.**

| Fungi | Tegineneng, 10 March, | Citayam, 3 July, | Muara, 23 August |
|---|---|---|---|
| *Rhizoctonia solani* | 11 | 7 | 7 |
| *Setodochium* sp. | 0 | 0 | 1 |
| Others | 3 | 1 | 0 |

**Table 2. Fungi isolated from stems of mungbean. Showing stem rot and foot rot symptoms.**

| Fungi | Tegineneng, 10 March, | Citayam, 3 July, | Muara, 20 August, | Muara, 23 August, |
|---|---|---|---|---|
| *Rhizoctonia solani* | 10 | 5 | 17 | 9 |
| *Sclerotium rolfsii* | 1 | 0 | 5 | 0 |
| *Fusarium* spp. | 0 | 2 | 0 | 0 |
| *Setodochium* sp. | 0 | 0 | 0 | 1 |
| *Trichoderma* sp. | 0 | 1 | 8 | 0 |
| *Pythium* sp. | 0 | 6 | 0 | 0 |
| Others | 1 | 4 | 2 | 2 |

Grouping of *R. solani* isolates:

The results are shown in Table 3.

The 23 isolates recovered from diseased leaves were divided into three groups. Of these 11 isolates fell into the AG-1 group, 8 isolates into the AG-4 group, and 4 isolates into other groups. The 32 isolates isolated from the stems were also divided into three groups and 15 isolates fell into the AG-1 group, 13 isolates into the AG-4 group, 4 isolates into other groups.

**Table 3. Grouping of *R.solani* isolates recovered from diseased leaves and stems of mungbean.**

| Place | Portion | AG-1 | AG-4 | others |
|---|---|---|---|---|
| Tegineneng | Leaves | 4 | 5 | 2 |
| –ditto– | Stems | 9 | 1 | 0 |
| Citayam | Leaves | 3 | 1 | 1 |
| –ditto– | Stems | 1 | 2 | 1 |
| Muara | Leaves | 4 | 2 | 1 |
| –ditto– | Stems | 5 | 10 | 3 |
| Total | Leaves | 11 | 8 | 4 |
| | Stems | 15 | 13 | 4 |

Inoculation tests:

The results of inoculation tests are shown in Tables 4 and 5.

Leaf blight symptoms of mungbean were only caused by isolates of *R. solani* belonging to the AG-1 group and were not induced by isolates belonging to the AG-4 group. Foot rot or stem rot symptoms of mungbean were caused by both isolates (AG-1 and AG-4 groups).

On soybeans, leaf blight, stem rot and foot fot symptoms were caused by all the isolates of *R. solani* tested.

**Table 4. Results of inoculation tests of *R. solani* isolated from diseased mungbeans.**

| Isolates of *R. solani* | No. of inoculated plants | No. of infected plants (foot rot) | No. of infected plants (leaf blight) | Reisolation from infected stems | Group of isolates |
|---|---|---|---|---|---|
| 1. Control | 11 | 0 | 0 | – | |
| 2. Rs12-7904 | 24 | 0 | 0 | – | AG–1 |
| 3. Rs2-8015 | 20 | 13 | 0 | 5/5* | AG–4 |
| 4. Rs12-8027 | 21 | 19 | 8 | 19/19 | AG–1 |
| 5. Rs12-8038 | 28 | 15 | 10 | 17/17 | AG–1 |
| 6. Rs2-80116 | 18 | 11 | 5 | 5/5 | AG–1 |
| 7. Rs2-80124 | 19 | 10 | 3 | 9/9 | AG–1 |
| 8. Rs2-80138 | 18 | 14 | 0 | 16/16 | AG–4 |
| 9. Rs2-80142 | 19 | 11 | 3 | 5/5 | AG–1 |

Note: * denominator; the number of plants used in the reisolation tests, numerator; number of plants from which *R. solani* was reisolated.

**Table 5. Results of inoculation tests of *R. solani*.**

| Isolates of *R. solani* | Mungbeans | | | | | Soybeans | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number of inoculated plants | Number of infected plants (stem rot) | Number of infected plants (leaf blight) | Reisolation from infected stems leaves | | Number of inoculated plants | Number of infected plants (stem rot) | Number of infected plants (leaf blight) | Reisolation from infected stems leaves | |
| 1. Rs12-7904 | 19 | 7 | 9 | 6/7* | 4/9* | 29 | 16 | 18 | 11/15* | 6/17* |
| 2. Rs12-8027 | 20 | 20 | 10 | 8/9 | 10/10 | 26 | 21 | 4 | 12/19 | 3/4 |
| 3. Rs12-8038 | 22 | 19 | 4 | 5/5 | 0/4 | 28 | 25 | 12 | 23/25 | 4/12 |
| 4. Rs2-80116 | 21 | 21 | 14 | 14/14 | 14/14 | 28 | 23 | 6 | 23/23 | 6/6 |
| 5. Rs2 80124 | 22 | 21 | 3 | 8/8 | 2/3 | 26 | 26 | 12 | 19/24 | 9/12 |
| 6. Rs2-80138 | 19 | 12 | 0 | 9/10 | – | 26 | 22 | 9 | 20/22 | 2/9 |
| 7. Rs2-80142 | 26 | 26 | 4 | 15/15 | 4/4 | 23 | 23 | 1 | 7/8 | 1/1 |

Note : *denominator; number of plants used in the reisolation tests, numerator; number of plants from which *R. solani* was reisolated.

## DISCUSSION

Wang and Yang (1976) reported that leaf blight of mungbean caused by *Rhizoctonia solani* occurred in Taiwan. Yang (1978) reviewed the diseases of mungbean in tropical and sub-tropical areas, and reported that *R. solani* affected many parts of the same plant at different stages of growth of mungbeans. Ranganathan, et al (1973) reported that *R.solani* isolated from diseased blackgram produced lesions brown in color at the hypocotyl on *Phaseolus aureus*. Ilag (1978) reported that root and stem rot of mungbean caused by *R. solani* occurred in the Philippines.

However, in Indonesia there were no reports describing mungbean diseases caused by *R. solani*. The present report is the first to describe leaf blight and stem rot of mungbean caused by *R. solani* in Indonesia.

Isolates of *R. solani* recovered from diseased leaf or stem of mungbean were divided into two groups, namely AG-1 and AG-4 groups. However, the results of inoculation tests indicated that the isolates belonging to the AG-1 group could produce leaf blight symptoms whereas the isolates of AG-4 group could not injure mungbean leaves. Symptoms of stem rot or foot rot could be induced by the inoculation of both isolates.

All isolates of *R. solani* from diseased mungbean produced light or dark brown lesions on the leaves and stems of soybean.

It was concluded that leaf blight and stem rot of mungbean are caused by isolates of *Rhizoctonia solani*, belonging to AG-1 and AG-4 groups, and that these isolates can injure leaves or stems of soybean.


## ACKNOWLEDGEMENT

We wish to express our gratitude to Dr. Rusli Hakim, Director of the Central Research Institute for Food Crops, and Dr. Setsuro Toda, Team Leader of the Japan-Indonesia Joint Research Project, and Dr. Tadahiro Nishizawa, Team Leader Lampung Tani Makmur Project, for the guidance, encouragement and the facilities provided in these studies.

We wish to thank Mr. Perry and Mr. Onoh for their assistance throughout the investigations, and to the Japan International Cooperation Agency (JICA) for the financial support for the studies.


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# 摘　　要

## 緑豆の Rhizoctonia－rot について

山口武夫[**]・Mukelar, A.[*], D.M. Tantera[*],

１９８０年，インドネシアのランポン州農業開発計画テギネネンセンター試験圃場及び中央食用作物研究所ムアラ並びにチタヤム試験地の圃場で，緑豆に葉腐れ及び茎枯症状の発生が観察された。

罹病株の葉の症状：初め周辺部濃褐色，中央部淡褐色の不正円形の病斑を生じ，それが拡大融合して葉は枯死に至る。

罹病株の茎の症状：罹病葉の付け根の部分に淡褐色～黒色の病斑を生じ，その病斑は凹陥し，茎はしばしばその部分で折れ曲がり，その上部は萎凋枯死に至る。

茎の地際部にも淡褐色～黒色水浸状の若干凹陥した病斑を生じ，その病斑は茎に沿って上部に拡大するが，かなり病勢が進展するまで萎凋，倒伏はみられない。

これらの罹病株から常法により病原菌分離を行った結果 *Rhizoctonia solani* が多数分離され，その他に *Sclerotium rolfsii*, *Fusarium* spp., *Pythium* sp., *Trichoderma* sp., 及び *Setodochium* sp. なども分離された。分離された *R. solani* 55菌株は，AG－1に属するもの２６菌株，AG－４が２１菌株，その他８菌株であった。

殺菌土壌をつめた径２０*cm*の鉢に植え，１ヶ月間生育させた緑豆及び大豆を用いて接種試験を行った。その結果 *R. solani* を接種した場合のみ圃場で観察されたものと同様の病徴が緑豆に発生した。緑豆の葉腐れ症状は *R. solani* のAG－１に属する菌株によって起きるが，AG－４では起こらなかった。茎枯れ症状は両群の菌株によって生じた。大豆に接種した場合，両群（AG－１及びAG－４）の菌株とも，葉腐れ及び茎枯れ症状を起こし病原性を示した。

罹病株より分離された *Sclerotium rolfsii* 及び *Pythium* SP. は緑豆及び大豆に病原性を示したが，圃場で観察された病徴とは明らかに異なるものであった。

その他の菌は緑豆に病原性を示さなかった。

*R. solani* による葉腐れ症状はWang & Yang（１９７６）が台湾で，茎枯症状はIlag（１９７８）がフィリピンで，それぞれ発生したことを報告している。しかしインドネシアでの発生は報告されていなかったので，ここでインドネシアにおいても発生したことを報告する。

# 19. CHEMICAL CONTROL OF RICE SHEATH BLIGHT IN INDONESIA

Herman, M.*, Wagiman*, and T. Yamaguchi,**

## ABSTRACT

Three pot experiments in greenhouse and two field experiments using artificial inoculation methods, were conducted at the Sub-Division of Plant Pathology and Experimental Station of Kuningan and Citayam, Central Research Institute for Food Crops in Indonesia, from December 1980 to August 1981, to compare the efficacy of three chemicals (Validamycin, Rovral and Folicur) for the control of rice sheath blight caused by *Rhizoctonia solani*.

Throughout these experiments, all the chemicals reduced the incidence of infection and subsequently increased the grain yield of rice. In almost all the experiments except a field experiment conducted at Citayam Station, Rovral and Folicur gave better control of the disease than Validamycin. Rovral application even at the reduced rate of 375 g active ingredient/ha with 2 sprays, afforded a good control of the disease and increased the grain yield of rice. Comparison of the timing of application showed that when one spray of Rovral was applied at a rate of 750 g a.i./ha 1-4 weeks before inoculation or at the same time as the inoculation, efficacy of the control of the disease was higher than when Rovral was applied 2 weeks after inoculation.

Folicur application at a rate of 375 g a.i./ha (2 sprays), also afforded a good control of the disease throughout all the experiments, and increased the grain yield of rice. When Folicur was applied at a rate of 375 g a.i./ha (1 spray), 1-2 weeks before inoculation or at the same time as the inoculation, effectiveness of the control of the disease was higher than when Folicur was applied 3-4 weeks before or 1-2 weeks after inoculation.

From these results, it was suggested that Rovral and Folicur were superior to Validamycin for controlling rice sheath blight. However, it will be necessary to conduct further experiments on the rates and frequency of chemical application under natural or artificial conditions of inoculation. With Rovral there was much difference in the efficacy for controlling the disease between two field experiments for unknown reasons, suggesting that further field experiments should be conducted in various areas of Indonesia.

## INTRODUCTION

Sheath blight disease caused by *Rhizoctonia solani* Kühn is one of the most important and common diseases of rice in Indonesia. The high temperature and humidity in most rice-producing areas in Indonesia are favourable for the development of sheath blight.

The occurrence of sheath blight has been increasing in recent years with the cultivation of new rice varieties which have some characters, such as shorter plant hight and higher tillering capacity, which are conducive to infection with sheath blight. Also the frequency of application of nitrogen fertilizer to rice has increased.

The cultivation of resistant varieties would be the most effective and economical method to control sheath blight. Unfortunately since we have not yet obtained a good resistant variety, chemical control is the only method available for successful management of the disease.

Thus experiments on chemical control of the desease in Indonesia were conducted in the greenhouse and fields.

According to the 'Report of Japan-Indonesia Joint Food Crop Research Program (Oct. 1970-Oct. 1975)' by Iwata, application of Validamycin effectively controlled

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the disease. Recently, the 'Annual Report of IRRI' suggested that new chemicals such as Rovral and Folicur could also control sheath blight.

The purpose of the current experiments was to compare the effectiveness of Validamycin and the new chemicals for the control of the disease, and also to define the most effective application rates, frequency and timing of the new chemicals.

The experiments consisted of three pot tests (Experiment A-C) in greenhouse at the Plant Pathology Sub-Division of Bogor Research Institute for Food Crops, CRIFC, and two fields tests at the Kuningan and Citayam Stations of CRIFC.

Experiment A. Preliminary pot test to determine the effectiveness of Rovral for the control of sheath blight.

## MATERIALS AND METHODS

This experiment was carried out with rice plants in pots (1/5000a) in a greenhouse at the Plant Pathology Sub-Division of BORIF, from December 1980 to March 1981.

In this test, five seedlings of the rice variety IR-36 were transplanted into a pot and nitrogen fertilizer was applied at the rate of 0.8 g per pot before transplanting. At the heading stage, the rice plants were inoculated by placing the pathogen with culture media (wheat bran culture) among the tillers near ground level.

The chemicals, application dosage and time are listed in Table 1. Chemicals were sprayed at the rate of 1500 liter per hectare and sticker was added at the rate of 1/2000 volume of liquid chemicals at the time of application. For the evaluation of the effectiveness of the chemicals, the degree of damage was investigated according to Yoshimura's formula as follows;

$$\text{Degree of Damage} = \frac{3n_1 + 2n_2 + 1n_3 + 0n_4}{3N} \times 100$$

$N = n_1 + n_2 + n_3 + n_4$ (Total number of tillers investigated)

$n_1$ = No. of tillers with lesions on leaf sheath or leaf blades of the flag leaf, 2nd, 3rd, and 4th leaf.

$n_2$ = No. of tillers with lesions on leaf sheath or leaf blades of the 2nd, 3rd, and 4th leaf.

$n_3$ = No. of tillers with lesions of leaf sheath or leaf blades of the 3rd and 4th leaf.

$n_4$ = No. of healthy tillers without lesions on leaf sheath or leaf blades.

*Table 1. Name, application dosage, application time and effects of chemicals for the control of rice sheath blight. Experiment A.*

| Name of chemicals and active ingredient | Dosage (Dilution) | Time of application | 16th March | | 30th March | |
|---|---|---|---|---|---|---|
| | | | Number of tillers | Degree of damage | Number of tillers | Degree of damage |
| 1. Control | | | 65 | 71.4 % | 74 | 73.0 % |
| 2. Validamycin 3% (Liquid form) | 1/1000 | 2 days before inoculation | 18 | 7.4 | 66 | 50.5 |
| 3. –ditto– | 1/1000 | 2 days after inoculation | 64 | 3.5 | 53 | 47.8 |
| 4. Rovral 50% (W.P.) | 1/2000 | 2 days before inoculation | 68 | 1.1 | 51 | 36.6 |
| 5. –ditto– | 1/2000 | 2 days after inoculation | 65 | 7.5 | 58 | 24.7 |

Note : Date of transplanting; 3rd December 1980,
Date of inoculation; 16th February 1981,
Date of application of the chemicals; 14th and 18th February 1981,
Date of disease assessment; 16th March and 30th March.

## RESULTS

Results of experiment A are shown in Table 1.

Application of Validamycin or Rovral had markedly decreased the degree of damage by 16th March 1981, compared with the control. By 30th March 1981, Rovral was seen to be more effective than Validamycin for controlling the disease.

It seemed that there was no difference in the degree of damage between the two application times of both chemicals, in term of infection. This experiment shows that Rovral was effective in controlling sheath blight.

Experiment B. Timing and frequency of chemical applications for the control of rice sheath blight.

## MATERIALS AND METHODS

A pot test to determine the most effective timing and frequency of application of chemicals (Rovral and Folicur) for controlling rice sheath blight was conducted in the greenhouse at the Plant Pathology Sub-Division of BORIF, in January - May 1981.

Five seedlings of the rice variety IR-36 were transplanted in a pot (1/5000 a) on 20th January 1981, and at the heading stage the plants were inoculated by the same method as that used in Experiment A.

The chemicals used, as well as application doses, timing and frequency of applications are listed in Table 2. Assessment of the disease was carried out according to Yoshimura's formula, on 24th April and 5th May 1981, as in Experiment A.

## RESULTS

The results are summarized in Table 2 and Figure 1.

It was evident that Rovral and Folicur were more effective than Validamycin in controlling rice sheath blight. Rovral gave good control, even at the reduced rate of 1/2000 with two sprays 1 week before and after inoculation. Folicur also gave good control, even at the reduced rate of 1/4000 with two sprays 1 week before and after inoculation. Both chemicals afforded a good control of the disease at a rate of 1/2000 with one spray 1 week before inoculation. For both chemicals, one spray at a rate of 1/2000 1 week before inoculation, was as effective as two sprays. One spray 1 week after inoculation using higher rates of Rovral and Folicur (1/1000 and 1/2000 respectively) did not substantially increase efficacy.

**Table 2. Name, active ingredient, application dosage, application time, application number and efficacy of chemicals for control of rice sheath blight. Experiment B.**

| Name of chemicals and active ingresients | Dilution | Time of application | | 24th April | | 5th May | |
|---|---|---|---|---|---|---|---|
| | | 1 week before inoculation | 1 week after inoculation | Number of tillers observed | Degree of damage | Number of tillers observed | Degree of damage |
| 1. Control | | – a) | – | 68 b) | 56.1% b) | 106 b) | 72.5% c) |
| 2. Validamycin 3% (Liquid form) | 1/1000 | + | + | 64 | 32.3 | 76 | 12.1 |
| 3. –ditto– | ditto | + | – | 77 | 39.6 | 83 | 10.0 |
| 4. –ditto– | ditto | – | + | 55 | 47.6 | 71 | 15.6 |
| 5. Rovral 50% (Wettable powder) | 1/1000 | + | + | 67 | 11.1 | 77 | 1.7 |
| 6. –ditto– | ditto | + | – | 73 | 11.9 | 70 | 2.7 |
| 7. –ditto– | ditto | – | + | 81 | 30.9 | 88 | 10.0 |
| 8. –ditto– | 1/2000 | + | + | 79 | 2.1 | 93 | 0.9 |
| 9. –ditto– | ditto | + | – | 74 | 7.7 | 92 | 6.2 |
| 10. –ditto– | ditto | – | + | 63 | 33.0 | 75 | 10.6 |
| 11. Folicur 25% (Wettable powder) | 1/2000 | + | + | 63 | 10.3 | 53 | 1.9 |
| 12. –ditto– | ditto | + | – | 68 | 15.7 | 75 | 5.3 |
| 13. –ditto– | ditto | – | + | 68 | 31.2 | 82 | 11.7 |
| 14. –ditto– | 1/4000 | + | + | 75 | 12.8 | 100 | 6.7 |
| 15. –ditto– | ditto | + | – | 63 | 15.8 | 70 | 6.1 |
| 16. –ditto– | ditto | – | + | 77 | 40.6 | 93 | 15.4 |

Note : a), – no application, + application, b), total number of tillers examined, c), average of four replications,
Date of transplanting: 20th January 1981, Date of inoculation; 2nd April 1981, Date of application of the chemicals; 27th March and 9th April 1981, Date of disease assessment; 24th April and 5th May 1981.

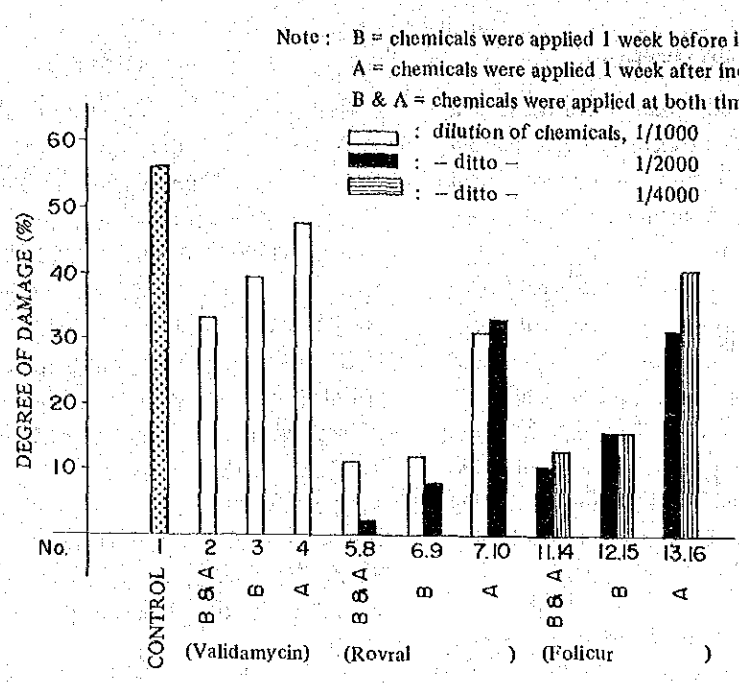


**Figure 1. Degree of damage. Chemical control of sheeth blight of rice. Experiment B. Timing and frequency of chemical application for control of rice sheath blight.**

From these results, it seems that one application of Rovral or Folicur 1 week before inoculation at the rate of 1/2000 or 1/4000 respectively, should afford effective control of rice sheath blight.

Experiment C. Timing of chemical applications for the control of rice sheath blight.

## MATERIALS AND METHODS

These pot experiments were conducted to determine how long after application to the plants the chemicals remained effective for controlling rice sheath blight and whether the chemicals had a good therapeutic effect.

Five seedlings (variety IR-36) were transplanted in a pot (1/5000 a) on 5th May 1981. Before transplanting fertilizer was added to each pot at the following rates: Urea (N) 0.8 g, Triple superphosphate 0.5 g, Potassium chloride 0.5 g per pot. Then the plants were grown in the greenhous, and the pots to which chemicals had been applied were brought outdoors. On 24th June 1981, 50 days after transplanting, all the plants were inoculated by the same method as that used in Experiment A. Chemicals were applied once a week from 4 weeks before inoculation to 2 weeks after inoculation.

The chemicals and their application dosage were as follows:

1. Validamycin 3 % liquid form 1/1000 dilution
2. Rovral 50 % wettable powder 1/2000 dilution
3. Folicur 25 % wettable powder 1/2000 dilution.

Disease assessment was carried out on 15th July 1981, by the same method as that applied in Experiment A. Protective value was estimated according to the following formula:

$$\text{Protective value} = \frac{\text{(D.D. in check plot - D.D. in treated plot)}}{\text{D.D. in check plot}} \times 100$$

D.D. = Degree of damage.

## RESULTS

The results are shown in Table 3 and Figure 2.

All the chemicals (Validamycin, Rovral and Folicur) significantly reduced the incidence of infection, even when applied 4 weeks before inoculation.

It seemed that Rovral and Folicur were more effective than Validamycin. The plot which was treated with Validamycin, at the time of inoculation showed the lowest degree of damage. Two plots which were treated 1 or 2 weeks after inoculation showed less damage than the four plots which were treated 1 - 4 weeks before inoculation.

With Rovral, three plots which were sprayed 1 or

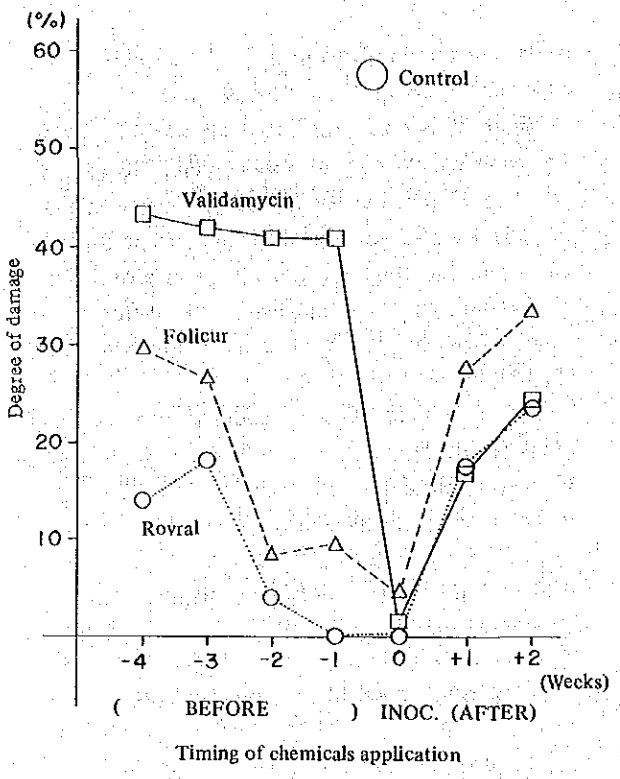


**Figure 2. Degree of damage. Experiment C. Timing of chemical application for the control of rice sheath blight.**

2 weeks before and at the time of inoculation showed the lowest degree of damage. Three plots which were treated 3, 4 weeks before and 1 week after inoculation, were less damaged than the plot which was treated 2 weeks after inoculation.

With Folicur, the three plots which were sprayed 1, 2 weeks before and at the time of inoculation, showed less damage than the other five plots which were sprayed 3, 4 weeks before inoculation and 1, 2 weeks after inoculation.

### Experiment D. Field test at Kuningan Station in the wet season, 1980/81.

On the basis of the results of several pot experiments, it appeared that Rovral and Folicur were as effective as Validamycin, and in some cases both chemicals were superior for controlling rice sheath blight. However, it is necessary to determine whether both chemicals are also effective for controlling the disease under field conditions.

**Table 3. Effect of the time of application of the chemicals on the control of rice sheath blight, Experiment C.**

| Chemicals | Active ingredients | Dosage Dilution | Time of application | Number of tillers examined | Percent of infected tillers (%) | Degree of damage (%) | Protective value (%) |
|---|---|---|---|---|---|---|---|
| 1. Control | | | | 107 | 97.2 | 64.2 | 0.0 |
| 2. Validamycin | 3% LF | 1/1000 | 4 weeks before inoculation | 119 | 80.7 | 43.3 | 32.6 |
| 3. –ditto– | –ditto– | –ditto– | 3 weeks –ditto– | 128 | 83.6 | 42.1 | 34.4 |
| 4. –ditto– | –ditto– | –ditto– | 2 weeks –ditto– | 121 | 78.5 | 41.3 | 35.7 |
| 5. –ditto– | –ditto– | –ditto– | 1 week –ditto– | 113 | 83.2 | 41.4 | 35.5 |
| 6. –ditto– | –ditto– | –ditto– | same time of inoculation | 124 | 4.0 | 1.4 | 97.8 |
| 7. –ditto– | –ditto– | –ditto– | 1 week after inoculation | 133 | 49.6 | 17.7 | 73.4 |
| 8. –ditto– | –ditto– | –ditto– | 2 weeks –ditto– | 122 | 62.3 | 24.3 | 62.1 |
| 9. Rovral | 50% WP | 1/2000 | 4 weeks before inoculation | 100 | 38.0 | 14.2 | 77.9 |
| 10. –ditto– | –ditto– | –ditto– | 3 weeks –ditto– | 140 | 45.0 | 18.2 | 71.7 |
| 11. –ditto– | –ditto– | –ditto– | 2 weeks –ditto– | 103 | 12.6 | 4.1 | 93.6 |
| 12. –ditto– | –ditto– | –ditto– | 1 week –ditto– | 130 | 0.0 | 0.0 | 100.0 |
| 13. –ditto– | –ditto– | –ditto– | same time of inoculation | 127 | 0.8 | 0.2 | 99.7 |
| 14. –ditto– | –ditto– | –ditto– | 1 week after inoculation | 109 | 52.3 | 17.5 | 72.7 |
| 15. –ditto– | –ditto– | –ditto– | 2 weeks –ditto– | 101 | 69.3 | 23.8 | 62.9 |
| 16. Folicur | 25% WP | 1/2000 | 4 weeks before inoculation | 117 | 77.8 | 29.5 | 54.0 |
| 17. –ditto– | –ditto– | –ditto– | 3 weeks –ditto– | 109 | 65.1 | 26.7 | 58.4 |
| 18. –ditto– | –ditto– | –ditto– | 2 weeks –ditto– | 104 | 26.0 | 8.3 | 87.1 |
| 19. –ditto– | –ditto– | –ditto– | 1 week –ditto– | 123 | 28.5 | 9.6 | 86.0 |
| 20. –ditto– | –ditto– | –ditto– | same time of inoculation | 114 | 14.0 | 4.5 | 93.0 |
| 21. –ditto– | –ditto– | –ditto– | 1 week after inoculation | 117 | 80.3 | 27.5 | 57.2 |
| 22. –ditto– | –ditto– | –ditto– | 2 weeks –ditto– | 112 | 84.8 | 33.3 | 48.1 |

Note: Variety; IR–36, Transplanting; 5th May, Inoculation 24th June, Disease assessment; 15th July 1981.

## MATERIALS AND METHODS

The test was carried out by split plot design in the paddy fields of Kuningan Station, with four replications.

Twelve treatments were prepared as shown in Table 4. The plot size was 5 m x 3 m (15 $m^2$). IR-36 variety was used in the test and the rice seedlings were transplanted on 7th February 1981, with 25 x 25 cm spacing. For fertilization, 120 kg Nitrogen, 60 kg Phosphate and 60 kg Potassium were applied as Urea, Triple superphosphate and Potassium chloride, respectively. Urea was applied three times, one third of the total quantity as basic dressing, one third at the tillering stage of rice and the last third at the primordia stage of rice. Both Triple superphosphate and Potassium chloride were applied as basic dressing.

Fifty one days after transplanting, rice plants were artificially inoculated using 'wheat bran culture' (28°C, 10 days incubation) to which rice husk had been added, the inoculum dosage being 3-5 g per hill.

Application dosage of chemicals was 45 g of active ingredient per hectare for Validamycin, 750 g and 375 g of actice ingredient per hectare for Rovral and 375 g and 187.5 g of active ingredient per hectare for Folicur. The chemicals were sprayed at the rate of 1500 liter per hectare, and were applied 1 week before, 1 week after inoculation and 3 weeks after inoculation, respectively.

Disease assessment was made twice, on 8-9th May and 25-26th May 1981, and degree of damage and protective value were estimated by the same formula as that used in the pot experiments. In the test, rice plants were harvested on 25-26th May 1981, and grain yields of rice with husk were estimated after dry-processing.

**Table 4 Name of chemicals, application dosage and timing of application. Experiment D and E. Field tests at Kuningan and Citayam Stations.**

| Cord | Name of chemicals and active ingredients | Dosage Dilution | Timing of application 1 week before inoculation | 1 week after inoculation | 3 weeks after inoculation |
|---|---|---|---|---|---|
| *Aa* | *Validamycin 3% Liquid form* | *1/1000* | + | + | – |
| Ab | –ditto– | –ditto– | – | + | + |
| Ba | Rovral 50% Wettable powder | 1/1000 | + | + | – |
| Bb | –ditto– | –ditto– | – | + | + |
| Ca | –ditto– | 1/2000 | + | + | – |
| Cb | –ditto– | –ditto– | – | + | + |
| Da | Folicur 25% Wettable powder | 1/1000 | + | + | – |
| *Db* | –ditto– | –ditto– | – | + | + |
| Ea | –ditto– | 1/2000 | + | + | – |
| Eb | –ditto– | –ditto– | – | + | + |
| Fa | Control, Untreated plot | | – | – | – |
| Fb | –ditto– | | – | – | – |

Split plot design : Main plots
A; Validamycin 45 g active ingredient/ha
B; Rovral 750 g a.i./ha
C; Rovral 375 g a.i./ha
D; Folicur 375 g a.i./ha
E; Folicur 187.5 g a.i./ha
F; Untreated plot

Sub plots:
a; Chemicals were applied 1 week before and after inoculation (two sprays)
b; Chemicals were applied 1 week and 3 weeks after inoculation (two sprays).

## RESULTS

The results are summarized in Table 5 and Figure 3. The results obtained from inoculated hills on 8-9th May, showed that the disease incidence of the plots to which Rovral or Folicur had been applied, was significantly different from that of the unsprayed control plot and the plot to which Validamycin had been applied. Validamycin did not decrease significantly the incidence of the infection compared with the control presumably, because it rained immediately after spraying with Validamycin.

The results obtained from inoculated hills on 25-26th May, showed that Rovral and Folicur were more effective than Validamycin in controlling the disease. In accordance with the Analysis of Variance on the degree of damage there were significant differences among the replications, chemicals, timing of applications and in the interaction between chemicals and timing of application.

The results from non-inoculated hills on 25-26th May, showed that Validamycin, Rovral and Folicur were effective for controlling the disease, although Rovral and Folicur were superior to Validamycin.

On the basis of the data obtained from inoculated hills, it was evident that all the chemicals (Validamycin, Rovral and Folicur) afforded higher grain yields of rice with husk than those recorded in the untreated control. But in the case of the non-inoculated hills yields were not significantly different among the treatments. Yields of rice from non-inoculated hills were sometimes higher than those from inoculated hills.

### Experiment E. Field test at Citayam station in the dry season, 1981.

## MATERIALS AND METHODS

The design of plots, replications, kinds of treatment, variety used, spacing of transplanting, fertilization, method and inoculum source and amount of artificial inoculation, dosage and timing of chemical application and method of disease assessment were the same as in experiment D (field experiment at Kuningan Station).

The rice seedlings were transplanted on 23rd April 1981, and 62 days after transplanting, rice plants were inoculated on 22nd June 1981. Disease assessment was made twice, on 17th July and 27th July 1981.

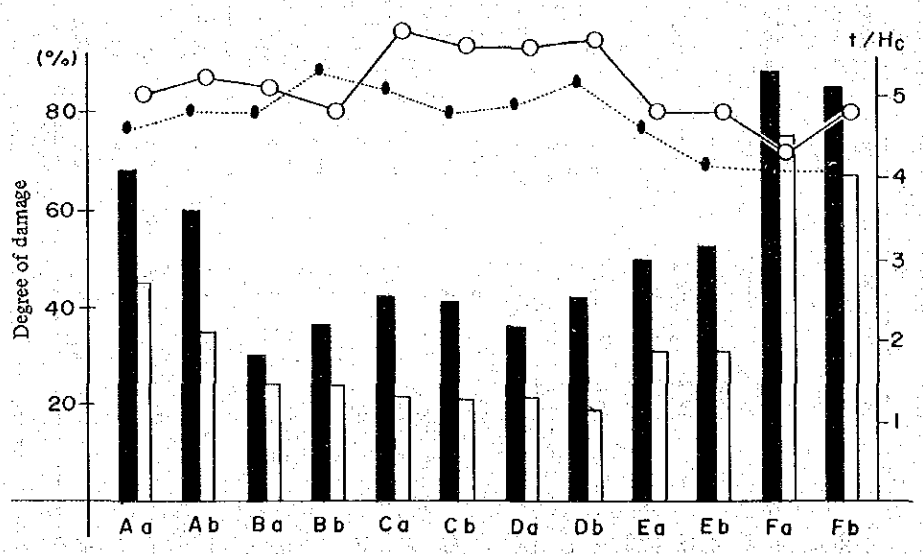


**Figure 3. Degree of damage and grain yields of rice. Experiment D. Field test at Kuningan Station in the rainy season, 1980/81.**

Table 5. Efficacy of chemicals for the control of rice sheath blight at Kuningan Station. Experiment D.

| Treat-ments | 8 May, 1981 (Inoculated hills) | | | 25 May, 1981 (Inoculated hills) | | | 25 May, 1981 (Noninoculated hills) | | | Yields | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Percent of infected tillers (%) | Degree of Damage (%) | Protective Value a)* | Percent of infected tillers (%) | Degree of Damage (%) | Protective Value a)* | Percent of infected tillers (%) | Degree of Damage (%) | Protective Value a)* | Inoculated hills t/ha | Noninoculated hills t/ha |
| Aa | 94.7 | 64.8 | 0.0 | 92.1 | 67.7 | 22.9 | 65.7 | 45.4 | 39.8 | 4.6 | 5.0 |
| Ab | 93.7 | 58.5 | 14.4 | 82.1 | 60.1 | 29.0 | 56.7 | 35.1 | 47.8 | 4.8 | 5.2 |
| (A) | 94.2 | 61.7 | 3.6 | 87.1 | 64.0 | 25.8 | 61.2 | 40.3 | 43.5 | 4.7 | 5.1 |
| Ba | 71.1 | 29.1 | 53.7 | 50.9 | 29.9 | 65.9 | 57.3 | 24.0 | 68.2 | 4.8 | 5.1 |
| Bb | 80.0 | 34.5 | 46.8 | 64.0 | 35.7 | 57.9 | 55.8 | 23.8 | 64.6 | 5.3 | 4.8 |
| (B) | 75.6 | 31.7 | 50.5 | 57.5 | 32.7 | 62.1 | 56.6 | 24.0 | 66.3 | 5.0 | 4.9 |
| Ca | 78.3 | 36.9 | 41.3 | 73.6 | 42.2 | 51.9 | 42.7 | 21.6 | 71.4 | 5.1 | 5.8 |
| Cb | 80.4 | 38.3 | 40.9 | 77.0 | 41.1 | 51.5 | 42.0 | 20.8 | 69.1 | 4.8 | 5.6 |
| (C) | 79.4 | 37.7 | 41.1 | 75.3 | 41.7 | 51.7 | 42.4 | 21.3 | 70.1 | 4.9 | 5.7 |
| Da | 83.2 | 41.3 | 34.3 | 73.2 | 35.6 | 59.5 | 38.1 | 21.7 | 71.2 | 4.9 | 5.6 |
| Db | 76.0 | 30.4 | 53.0 | 87.7 | 41.4 | 51.1 | 44.9 | 19.1 | 71.6 | 5.2 | 5.7 |
| (D) | 79.6 | 35.7 | 44.2 | 80.5 | 38.3 | 55.6 | 41.5 | 20.3 | 71.5 | 5.0 | 5.6 |
| Ea | 90.9 | 49.8 | 20.8 | 82.2 | 49.8 | 43.3 | 56.9 | 31.1 | 58.8 | 4.6 | 4.8 |
| Eb | 80.6 | 33.9 | 47.7 | 81.8 | 52.4 | 38.1 | 56.5 | 31.0 | 53.9 | 4.2 | 4.8 |
| (E) | 85.8 | 41.7 | 34.8 | 82.0 | 51.0 | 40.9 | 56.7 | 31.0 | 56.5 | 4.4 | 4.8 |
| Fa | 97.0 | 62.9 | 0.0 | 100.0 | 87.8 | 0.0 | 94.4 | 75.4 | 0.0 | 4.1 | 4.3 |
| Fb | 98.2 | 64.3 | 0.0 | 99.0 | 84.7 | 0.0 | 86.2 | 67.3 | 0.0 | 4.1 | 4.8 |
| (F) | 97.6 | 64.0 | 0.0 | 99.5 | 86.3 | 0.0 | 90.3 | 71.3 | 0.0 | 4.1 | 4.5 |

Note: a)* Protective Value was estimated according to the Formula reported by Iwata (1976)

## RESULTS

The results are shown in Table 6 and Figure 4.

The results obtained from inoculated hills on 17th July, showed that the disease incidence of the plots to which Folicur had been applied was significantly different from that of the control plot and of the plots to which Validamycin and Rovral had been applied. However application of Validamycin and Rovral decreased the incidence of infection compared with the control.

The results obtained from inoculated hills on 27th July, showed that Folicur was more effective than Validamycin or Rovral in controlling the disease. In accordance with the Analysis of Variance on the degree of damage (value exchange to Arcsin), there was a significant difference among the chemicals at 1 % level.

The results from non-inoculated hills on 27th July, showed that all the chemicals (Validamycin, Rovral and Folicur) were effective in controlling the disease. Folicur was more effective than Validamycin or Rovral.

Comparison with the results obtained from this experiment and the other four experiments (Experiment A - D), shows that the effect of Rovral in controlling the disease was different.

## DISCUSSION

Several pot experiments in greenhouse and two field experiments were conducted at the Sub-Division of Plant Pathology of BORIF, and at Kuningan and Citayam Stations, Central Research Institute for Food Crops in Indonesia, from December 1980 to August 1981, to determine of efficacy of Rovral and Folicur for controlling rice sheath blight caused by *Rhizoctonia solani*.

**Table 6. Efficacy of chemicals for the control of rice sheath blight at Citayam Station. Experiment E.**

| Treatments | 17 July, 1981 (Inoculated hills) | | | 27 July, 1981 (Inoculated hills) | | | 27 July, 1981 (Noninoculated hills) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Percent of infected tillers (%) | Degree of Damage (%) | Protective Value a)* | Percent of infected tillers (%) | Degree of Damage (%) | Protective Value a)* | Percent of infected tillers (%) | Degree of Damage (%) | Protective Value a)* |
| Aa | 88.5 | 54.9 | 20.0 | 85.8 | 52.1 | 35.2 | 34.4 | 20.8 | 33.5 |
| Ab | 96.1 | 50.8 | 37.1 | 90.0 | 46.9 | 46.6 | 24.8 | 9.5 | 74.0 |
| (A) | 92.3 | 52.9 | 28.6 | 87.9 | 49.5 | 40.9 | 29.6 | 15.2 | 53.8 |
| Ba | 92.6 | 66.1 | 3.6 | 96.7 | 78.9 | 1.9 | 35.5 | 19.2 | 38.7 |
| Bb | 86.7 | 59.7 | 26.1 | 88.5 | 58.5 | 33.4 | 17.2 | 7.9 | 78.4 |
| (B) | 89.7 | 62.9 | 14.9 | 92.6 | 68.7 | 17.7 | 26.4 | 13.6 | 58.6 |
| Ca | 72.5 | 42.5 | 38.0 | 87.3 | 60.9 | 24.3 | 36.5 | 20.8 | 33.5 |
| Cb | 92.0 | 59.5 | 26.4 | 88.0 | 62.5 | 28.8 | 32.0 | 13.8 | 62.3 |
| (C) | 82.3 | 51.0 | 32.2 | 87.7 | 61.7 | 26.6 | 34.3 | 17.3 | 47.9 |
| Da | 47.1 | 17.4 | 74.6 | 46.4 | 19.6 | 75.6 | 23.6 | 10.0 | 68.1 |
| Db | 94.1 | 46.9 | 42.0 | 84.1 | 45.4 | 48.3 | 29.0 | 10.7 | 70.8 |
| (D) | 70.6 | 32.2 | 58.3 | 65.3 | 32.5 | 62.0 | 26.3 | 10.4 | 69.5 |
| Ea | 69.9 | 44.8 | 34.7 | 71.9 | 28.9 | 64.1 | 21.3 | 7.7 | 75.4 |
| Eb | 87.0 | 43.9 | 45.7 | 88.7 | 43.7 | 50.2 | 27.8 | 9.7 | 73.5 |
| (E) | 78.5 | 44.4 | 40.2 | 80.3 | 36.3 | 57.2 | 24.6 | 8.7 | 74.5 |
| Fa | 93.0 | 68.6 | 0.0 | 91.3 | 80.4 | 0.0 | 48.7 | 31.3 | 0.0 |
| Fb | 100.0 | 80.8 | 0.0 | 100.0 | 87.8 | 0.0 | 60.1 | 36.6 | 0.0 |
| (F) | 96.5 | 74.7 | 0.0 | 95.7 | 84.1 | 0.0 | 54.4 | 34.0 | 0.0 |

Note: a)* Protective Value was estimated according to the Formula reported by Iwata (1976)

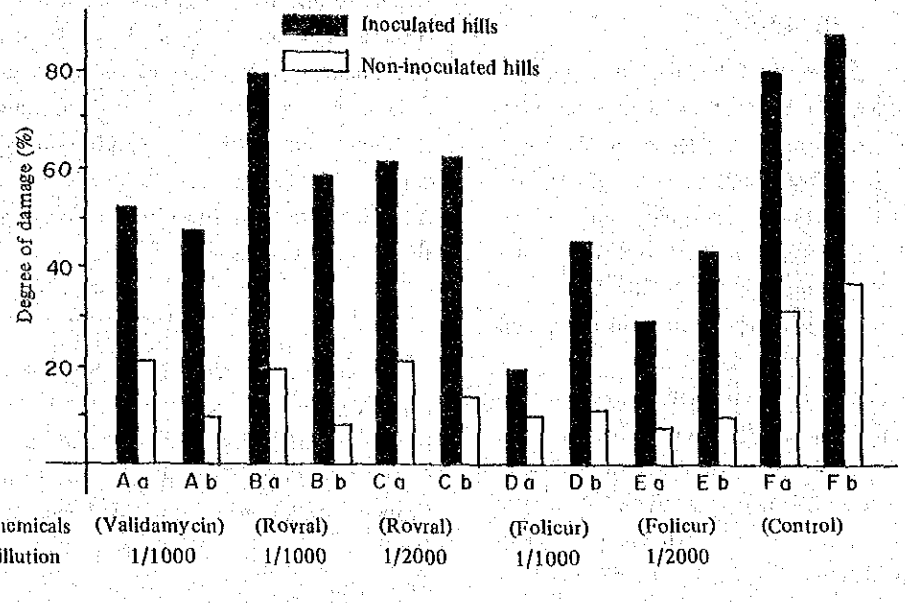


**Figure 4. Degree of damage. Experiment E. Field test at Citayam Station in the dry season, 1981.**

Throughout these experiments, all the chemicals used (Validamycin, Rovral and Folicur) reduced the incidence of infection and subsequently increased the yield of rice.

Folicur afforded a better control of the disease than Validamycin. Also Rovral was superior to Validamycin except for the field test conducted at Citayam Station.

Ou et al (1978) and 'IRRI Annual Report for 1978' reported that Iprodion, the active ingredient of Rovral, afforded a good control of the disease even at the reduced rate of 1.0 kg/ha with 3 sprays, and that Rovral and Validamycin increased the yield of rice when applied at different rates and frequency of spray.

Iwata (1976) reported that Validamycin was effective in controlling the disease in Indonesia.

In the experiments conducted in Indonesia, Rovral afforded a good control of the disease and increased the yield of rice even at the reduced rate of 375 g a.i./ha with 2 sprays. But in the field experiment conducted at Citayam Station, Rovral application could not reduced the incidence of the disease even at the higher rate of 750 g a.i./ha with 2 sprays. When Rovral was applied 1-2 weeks before inoculation (lesions has not yet appeared, booting or heading stage of rice) at a rate of 750 g a.i./ha with 1 spray, its efficacy for controlling the disease was higher than when applied 1-2 weeks after inoculation (the lesions had already appeared on rice, heading stage of rice). From the results obtained in the field experiments at Kuningan Station, Rovral significantly increased yield of rice in comparison with untreated control, when applied at the rate 750 g a.i./ha or 375 g a.i./ha with 2 sprays 1 week before and after inoculation.

The effect of Rovral for controlling the disease was different between the results obtained in Kuningan and Citayam for unknown reasons. It will thus be necessary to conduct further experiments. (Figure 4.)

According to personal information from Bayer Company which produces the Folicur (NTN 1971: N-(4-Chlorbenzyl)-N-cyclopentyl-N' -phenyl harnstoff), the results of preliminary chemical control tests on rice sheath blight using Folicur at IRRI (Philippines) showed that Folicur applied at the dosage of 1.5 liter was effective and superior to Validamycin and Rovral.

In the experiments conducted in Indonesia, Folicur applied at a rate of 375 g a.i./ha with 2 sprays 1 week before and after inoculation also afforded a better control of the disease than Validamycin or Rovral. The optimum timing for the application of Folicur was 1-2 weeks before inoculation in terms of effectiveness. Application of Folicur at a rate of 375 g a.i./ha with 2 sprays 1 week before and after inoculation also resulted in increased yield of rice.

Since in the experiments, the inoculation was carried out at the heading stage of rice plants, it was suggested that Rovral and Folicur should be applied before the heading stage.

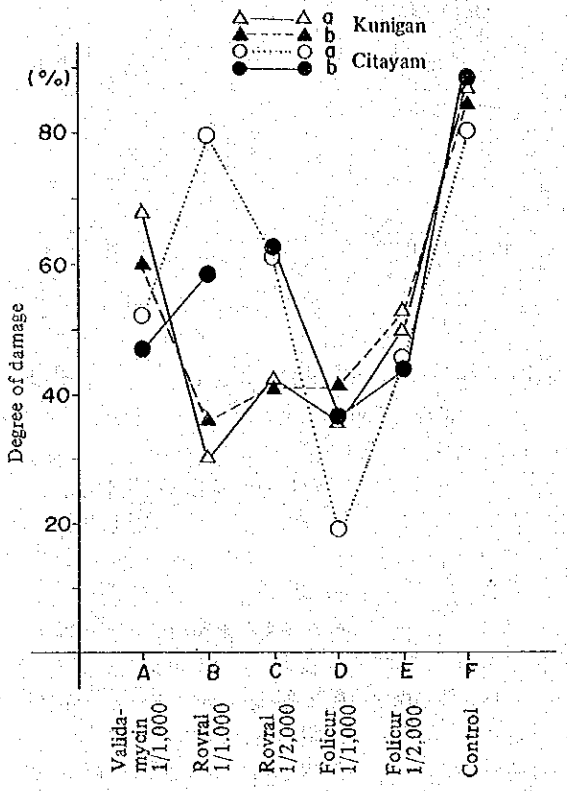


**Figure 5. Degree of damage. Comparison with the results obtained from *two field experiments at Kuningan* and Citayam.**

Note: a = chemicals were applied 1 week before and after inoculation.

b = chemicals were applied 1 week and 3 weeks after inoculation.

From the results mentioned above, it was concluded that Folicur was superior to Validamycin for controlling rice sheath blight, while Rovral was as effective as Validamycin. The rates, frequency and timing of application of Rovral and Folicur were determined as follows:

Rovral: Application rate; 750 g active ingredient/ha
Frequency; 1 or 2 sprays
Timing of application; before heading stage of rice.

Folicur: Application rate; 375 g active ingredient/ha
Frequency; 1 or 2 sprays
Timing of application; before heading stage of rice.

But it seemed that the application of both chemicals 1 week after inoculation (at the heading stage) was also effective in controlling the disease compared with the untreated control.

Although both chemicals were effective for controlling the disease at the reduced rates of 375 g a.i./ha (Rovral) and 187.5 g a.i./ha (Folicur) with 1 spray 1 or 2 weeks after inoculation, further tests on the rates and frequency of application under natural conditions of disease occurrence should be conducted.

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# 摘　　要

## 稲紋枯病の薬剤防除

Herman，M.，Wagiman，山口武夫

岩田（１９７６）はインドネシアで，Validamycinが本病に対し勝れた防除効果を示すことを報告している。その後IRRI（フィリピン）で，Rovral 及びFolicurが本病に対し勝れた防除効果を有することを示唆したので，本試験はRovral及びFolicur の防除効果をValidamycinと比較検討し，インドネシアにおける稲紋枯病の薬剤防除法を確立する目的で実施した。

試験は３つの鉢試験（試験Ａ～Ｃ）と２つの圃場試験（試験Ｄ－Kuningan及び試験Ｅ－Citayam）に分けて，１９８０年１２月から１９８１年８月の間に行った。

試験には現在インドネシアで最も多く栽培されているIR－３６を用いた。稲紋枯病罹病株から分離された*Rhizoctonia solani* Kühn の１菌株（RS2－7317，AG－1）のフスマ培養（２８℃７～１０日間）したもの１容にもみながら２容を混ぜて接種源とした。株毎に３～５$g$の接種源を地際部から５～１０$cm$の部位におく方法を用い，すべての試験を病原菌接種で行った。

薬剤は，対照としてValidamycin ３％液剤の１０００倍液を，Rovral ５０％水和剤は １０００倍～２０００倍液，Folicur ２５％水和剤は１０００倍～４０００倍液を用いた。発病調査は吉村氏の被害程度算出法に従った。

５つの試験を通じて，供試した薬剤はいずれも防除効果を示し，FolicurはValidamycinより勝れていた。RovralはCitayamでの圃場試験を除いてValidamycinより勝れた防除効果を示した。

試験Ｂの結果から，RovralとFolicurは，接種１週間前と接種１週間後の２回散布すると，そのいずれか１回散布した場合より被害程度は低く，１回の散布では接種１週間前に散布した方が接種１週間後の散布より防除効果が高かった。

試験Ｃの結果から，各薬剤とも接種４週間前あるいは接種２週間後の散布で発病を抑制した。Validamycinの発病抑制効果は接種時散布＞接種１週間後＞接種２週間後＞接種１～４週間前で，接種後散布の効果が接種前散布より高かった。Rovralの場合は接種時，接種１～２週間前＞接種３～４週間前，接種１週間後＞接種２週間後の順であった。Folicurでは，接種時，接種１～２週間前＞接種３～４週間前，接種１～２週間後であった。Rovral と Folicur はどちらかと言えば治療的効果よりも予防的効果が勝れていると考えられた。

試験Ｄの結果，供試した薬剤はいずれも発病抑制効果のみでなく，発病による減収を防止する効果を認めた。

試験Ｅにおいて，Rovralの防除効果が他の試験と著しく異なっているが，この原因は明らかに出来なかった。

本試験では出穂期に病原菌接種を行ったことから判断して，Rovral及びFolicurはその1000倍液を出穂期前後に2回散布することによって十分に本病の防除効果を認めることが出来る。Rovralは場所により効果の劣ることがあるので注意を要する。

今後，自然発病条件下の試験を行って，その効果を確認する必要があろう。

# 20. TREATMENT AND STORAGE OF SEED CORN FOR THE CONTROL OF JAVA CORN DOWNY MILDEW

Masdiar, B.,* Yusuf* and T. Yamaguchi**

## ABSTRACT

The purpose of this experiment was to determine how long after storage seeds treated with Ridomil could be protected from infection with Java corn downy mildew caused by *Peronosclerospora maydis*. Two corn varieties, Harapan (susceptible) and Harapan Baru (resistant) were used in the test. Three kinds of seed treatment plots were prepared as follows: 1. untreated seeds, 2. seeds dressed with Ridomil at a rate of 3 g formulation/kg seed, 3. seeds dressed with Ridomil at a rate of 6 g/kg seed.

After treatment each lot of seeds was divided into four groups, and kept under four different conditions as follows: 1. laboratory room, 2. refrigerator, 3. desiccator, 4. desiccator within the refrigerator. The seeds thus treated and stored were planted on 21st March 1981 (Experiment A), and 25th May 1981 (Experiment B) in the field of Cikeumeuh Station at Bogor. The experimental fields were surrounded by infected corn plants planted two weeks before and inoculated with the pathogen.

Germination and infection were investigated weekly from two to five weeks after planting.

Infection: Plants affected by the disease were only observed in the plots which were planted with untreated seeds. The percentage of infection of the susceptible variety ranged from 0 % to 72 % (average 33 %) in experiment A, and from 0 % to 80 % (average 60 %) in experiment B, whereas that of the resistant variety ranged from 0 % to 20 % (average 5.5 %) in experiment A, and from 0 % to 19 % (average 9.2 %) in experiment B.

Seeds treated with Ridomil were not infected with downy mildew in experiment A. In experiment B, seeds were treated at a rate of 3 g/kg seeds and only two out of 2410 plants of the susceptible variety become infected.

It could be demonstrated that seed treatment with Ridomil was effective for the control of Java corn downy mildew even after nine months of storage of treated seeds.

Germination: If seeds are stored at room temperature and humidity, the germination ability decreases rapidly with time. The seeds kept at room temperature and humidity lost their germination ability after 3-5 months. However, the seeds kept at low temperature, low humidity, or under both conditions, were able to maintain their germination ability even after 6-9 months.

## INTRODUCTION

Java corn downy mildew caused by *Peronosclerospora maydis* (Butler) Shaw is one of the most important diseases of corn in Indonesia.

Kajiwara et al (1979) reported that Echromezol was able to effectively control the disease by soil treatment before planting. Exconde and Molina (1978) evaluated Ridomil (Acylalanine) in the field as seed-dressing fungicide for the control of Philippine corn downy mildew caused by *Peronosclerospora philippinensis*. Application of Ridomil at all rates tested (2, 4, 6 and 8 g active ingredient/kg seed) resulted in the absence of infection from emergence until harvest, even under high inoculum density level. Masdiar and Tantera (1979) in Indonesia reported that the application of Ridomil as seed treatment reduced the number of plants infected with Java corn downy mildew by up to 100 %.

If corn seed treated with Ridomil are delivered to corn-producing farmers, complete protection from damage by the disease can be expected. Thus, further seed treatment and storage tests were carried out in the Sub-division of Plant Pathology and Cikeumeuh Experimental Station at the Central Research Institute for Food Crops (CRIFC), from August 1980 to July 1981.

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The purpose of these experiments was to determine how long after storage seeds treated with Ridomil could be protected from infection with Java corn downy mildew.

## MATERIALS AND METHODS

Two corn varieties, Harapan (susceptible) and Harapan Baru (resistant) were used in the test. Three kinds of seed treatment plots were prepared as follows: 1. untreated seeds were used as control, 2. seeds dressed with Ridomil (35 % active ingredients) at a rate of 3 g formulation/kg seed, 3. seeds dressed with Ridomil at a rate of 6 g/kg seed.

The seeds were treated monthly from August 1980 to May 1981. After treatment each lot of seeds was divided into four groups, and kept under four different conditions, as follows: 1. laboratory room, 2. refrigerator, 3. desiccator, 4. desiccator within the refrigerator.

The seeds thus treated and stored were planted on 21st March 1981 (Experiment A), and 25th May 1981 (Experiment B) in the field of Cikeumeuh Station. The experimental fields were surrounded by infected corn plants planted two weeks before and inoculated with a conidial suspension of the pathogen.

A split plot design with two replications was used.

In Experiment A, 168 plots (2 varieties x 3 seed treatments x 4 storage conditions x 7 length of storage) were prepared, as shown in Table 1. The plot size was 5 m x 0.5 m (one row, 20 hills, 40 seeds), and two seeds were planted in each hill with 25 cm spacing. Urea (120 kg N), triple superphosphate (60 kg $P_2O_5$) and potassium chloride (60 kg $K_2O$) were applied as basic dressing.

Germination and infection were investigated weekly

**Table 1. Percentage of germination. Treatment and storage test of seed corn for control of downy mildew.**
***Experiment A, Date of planting; 21 March 1981, Date of investigation for germination; 31 March 1981.***

| Seed treatments | Length of storage (months) | Variety HARAPAN Storage conditions a* (%) | b* (%) | c* (%) | d* (%) | Average (%) | Variety HARAPAN BARU Storage conditions a* (%) | b* (%) | c* (%) | d* (%) | Average (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Control (Untreated seeds) | 0 | 76.3 | 83.8 | 78.8 | 76.3 | 78.8 | 85.0 | 86.3 | 80.0 | 88.8 | 85.0 |
| | 1 | 81.3 | 83.8 | 87.5 | 73.8 | 81.6 | 85.0 | 81.3 | 76.3 | 73.8 | 79.1 |
| | 2 | 67.5 | 68.8 | 77.5 | 81.3 | 73.8 | 71.3 | 83.8 | 95.0 | 86.3 | 84.1 |
| | 3 | 41.3 | 72.5 | 71.3 | 70.0 | 63.8 | 68.8 | 83.8 | 73.8 | 81.3 | 76.9 |
| | 4 | 26.3 | 50.0 | 75.0 | 73.8 | 56.3 | 0.0 | 41.3 | 60.0 | 66.3 | 41.9 |
| | 5 | 5.0 | 68.8 | 75.0 | 70.0 | 54.7 | 0.0 | 57.7 | 51.3 | 62.5 | 42.8 |
| | 6 | 10.0 | 77.5 | 78.8 | 72.5 | 59.7 | 0.0 | 57.5 | 62.5 | 73.8 | 48.5 |
| | Av. | 44.0 | 72.2 | 77.7 | 74.0 | 67.0 | 44.3 | 70.2 | 71.3 | 76.1 | 65.5 |
| Treated seeds (3g Ridomil/ Kg seed) | 0 | 51.3 | 88.8 | 92.5 | 91.3 | 81.0 | 71.3 | 95.0 | 82.5 | 85.0 | 83.5 |
| | 1 | 87.5 | 93.8 | 88.8 | 82.5 | 88.2 | 78.8 | 92.5 | 86.3 | 91.3 | 87.2 |
| | 2 | 87.5 | 75.0 | 86.3 | 87.5 | 84.1 | 76.3 | 80.0 | 81.3 | 80.0 | 79.4 |
| | 3 | 28.8 | 87.5 | 88.8 | 67.5 | 68.2 | 42.5 | 90.0 | 80.0 | 85.0 | 74.3 |
| | 4 | 25.0 | 78.8 | 85.0 | 85.0 | 68.5 | 0.0 | 60.0 | 66.3 | 66.3 | 48.2 |
| | 5 | 0.0 | 91.3 | 83.8 | 81.3 | 64.1 | 0.0 | 77.5 | 57.5 | 63.8 | 49.7 |
| | 6 | 1.3 | 55.0 | 86.3 | 85.0 | 56.9 | 0.0 | 57.5 | 67.5 | 63.8 | 47.2 |
| | Av. | 40.2 | 81.5 | 87.4 | 82.9 | 73.0 | 38.4 | 78.9 | 74.5 | 76.5 | 67.1 |
| Treated seeds (6g Ridomil/ Kg seed) | 0 | 62.5 | 82.5 | 80.0 | 72.5 | 74.4 | 77.5 | 80.0 | 86.3 | 87.5 | 82.8 |
| | 1 | 62.5 | 82.5 | 63.8 | 77.5 | 71.4 | 73.8 | 80.0 | 63.8 | 81.3 | 74.7 |
| | 2 | 63.8 | 76.8 | 81.3 | 78.8 | 75.2 | 65.0 | 87.5 | 55.0 | 87.5 | 73.8 |
| | 3 | 31.3 | 81.3 | 63.8 | 78.8 | 63.8 | 48.8 | 81.3 | 80.0 | 70.0 | 70.0 |
| | 4 | 13.8 | 78.8 | 68.8 | 70.0 | 57.9 | 2.5 | 62.5 | 52.5 | 60.0 | 44.4 |
| | 5 | 0.0 | 75.0 | 65.0 | 65.0 | 51.3 | 0.0 | 62.6 | 45.0 | 48.8 | 39.1 |
| | 6 | 0.0 | 46.3 | 83.8 | 91.3 | 55.4 | 0.0 | 46.3 | 32.5 | 56.3 | 33.8 |
| | Av. | 33.4 | 74.7 | 72.4 | 76.3 | 64.2 | 38.2 | 71.4 | 59.3 | 70.2 | 59.8 |

Note: * a=Laboratory room, b=Refrigerator, c=Desiccator, d=Desiccator within the refrigerator.

from 2 to 5 weeks after planting.

In Experiment B, 240 plots (2 varieties x 3 seed treatments x 4 storage conditions x 10 length of storage) were prepared, as shown in Table 3. The plot size, spacing of hill and application of fertilizers were the same as in Experiment A.

Germination and infection were investigated weekly from 2 to 6 weeks after planting.

## RESULTS

Experiment A:

The results of experiment A are shown in Tables 1 and 2, and Figures 1-8.

Germination (Table 1): There was no significant difference in the number of emerged plants among the three seed treatments. Germination was affected by the length and conditions of storage. When the seeds were kept more than three months at room temperature (24°C - 30°C) and room humidity (55 - 86 %), the percentage of germination gradually decreased. When they were kept more than five months at room temperature and humidity, the percentage of germination was practically zero.

However, when the seeds were kept at either a low temperature (about 4°C) or low humidity or both, the percentage of germination did not decrease so much even after six-month storage.

Infection (Table 2): Plants affected by the disease were only observed in the plots which were planted with untreated seeds. The percentage of infection of the susceptible variety (Harapan) ranged from 0 % to 72 % (average 33 %), and of the resistant variety (Harapan Baru) from 0 % to 20 % (average 5.5 %).

Seeds treated with Ridomil did not become infected with downy mildew from emergence until harvest, even the susceptible variety subjected to a reduced treatment rate of 3 g/kg seed.

In the plots planted with untreated seeds, there were no significant differences in the percentage of infection among different lengths of storage and storage conditions.

**Table 2. Percentage of infected plants. Treatment and storage test of seed corn for control of downy mildew. Experiment A, Date of planting; 21 March 1981, Date of investigation; 25 April 1981.**

| Seed treatments | Length of storage (months) | Variety HARAPAN Storage conditions a* (%) | b* (%) | c* (%) | d* (%) | Average (%) | Variety HARAPAN BARU Storage conditions a* (%) | b* (%) | c* (%) | d* (%) | Average (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Control (Untreated seeds) | 0 | 49.2 | 41.8 | 27.0 | 21.3 | 34.8 | 8.8 | 10.1 | 4.7 | 0.0 | 5.9 |
| | 1 | 20.0 | 25.4 | 25.7 | 28.8 | 25.0 | 1.5 | 1.5 | 3.3 | 8.5 | 3.7 |
| | 2 | 13.0 | 27.3 | 25.8 | 27.7 | 23.5 | 0.0 | 4.5 | 7.9 | 4.3 | 4.2 |
| | 3 | 3.0 | 55.2 | 43.9 | 60.7 | 40.7 | 1.8 | 3.0 | 8.5 | 1.5 | 3.7 |
| | 4 | 9.5 | 40.0 | 35.0 | 20.3 | 26.2 | – | 6.1 | 6.3 | 1.9 | 4.8 |
| | 5 | 0.0 | 47.3 | 50.0 | 41.1 | 34.6 | – | 10.9 | 0.0 | 6.0 | 5.6 |
| | 6 | 0.0 | 50.0 | 50.8 | 72.4 | 43.3 | – | 15.2 | 2.0 | 20.3 | 12.5 |
| | Av. | 13.5 | 41.0 | 36.9 | 38.9 | 32.6 | 3.0 | 7.3 | 4.7 | 6.1 | 5.5 |

Note: * a, b, c, d, same as Table 1,
All plots of treated seeds with Ridomil remained uninfected.

**Table 3. Percentage of germination. Treatment and storage test of seed corn for control of downy mildew. Experiment B, Date of planting; 25 May 1981, Date of investigation for germination; 7 July 1981.**

| Seed treatments | Length of storage (months) | Variety HARAPAN Storage conditions a* (%) | b* (%) | c* (%) | d* (%) | Average (%) | Variety HARAPAN BARU Storage conditions a* (%) | b* (%) | c* (%) | d* (%) | Average (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Control (untreated seeds) | 0 | 85.0 | 91.3 | 90.0 | 88.8 | 88.8 | 91.3 | 85.0 | 92.5 | 91.3 | 90.0 |
| | 1 | 87.5 | 85.0 | 86.3 | 87.5 | 86.6 | 81.3 | 87.5 | 85.0 | 80.0 | 83.4 |
| | 2 | 86.3 | 86.3 | 95.0 | 77.5 | 86.3 | 91.3 | 92.5 | 78.8 | 91.3 | 88.4 |
| | 3 | 93.8 | 87.5 | 88.8 | 95.0 | 91.3 | 97.5 | 93.8 | 92.5 | 91.3 | 93.8 |
| | 4 | 80.0 | 92.5 | 90.0 | 95.0 | 89.4 | 85.0 | 86.3 | 92.5 | 95.0 | 89.7 |
| | 5 | 65.0 | 95.0 | 93.8 | 87.5 | 85.3 | 90.0 | 93.8 | 96.3 | 96.3 | 94.1 |
| | 6 | 37.5 | 93.8 | 86.3 | 86.3 | 75.9 | 81.3 | 95.0 | 92.5 | 92.5 | 90.3 |
| | 7 | 22.5 | 92.5 | 96.3 | 97.5 | 77.2 | 0.0 | 95.0 | 80.0 | 95.0 | 67.5 |
| | 8 | 8.8 | 93.8 | 90.0 | 93.8 | 71.6 | 0.0 | 93.8 | 81.3 | 92.5 | 66.9 |
| | 9 | 5.0 | 87.5 | 87.5 | 90.0 | 67.5 | 1.3 | 83.8 | 82.5 | 85.0 | 63.1 |
| | Av. | 57.1 | 90.5 | 90.4 | 89.9 | 82.0 | 61.9 | 90.7 | 87.4 | 91.0 | 82.7 |
| Treated seeds (3g Ridomil/ Kg seeds) | 0 | 78.8 | 83.8 | 85.0 | 88.8 | 84.1 | 76.3 | 83.8 | 87.5 | 87.5 | 83.8 |
| | 1 | 73.8 | 86.3 | 76.3 | 91.3 | 81.9 | 86.3 | 81.3 | 80.0 | 90.0 | 84.4 |
| | 2 | 86.3 | 95.0 | 81.3 | 86.3 | 87.2 | 85.0 | 81.3 | 86.3 | 77.5 | 82.5 |
| | 3 | 78.8 | 83.8 | 83.8 | 91.3 | 84.4 | 83.8 | 87.5 | 92.5 | 87.5 | 87.8 |
| | 4 | 75.0 | 90.0 | 85.0 | 83.8 | 83.4 | 78.8 | 86.3 | 82.5 | 83.8 | 82.8 |
| | 5 | 55.0 | 86.3 | 81.3 | 86.3 | 77.2 | 75.0 | 86.3 | 81.3 | 87.5 | 82.5 |
| | 6 | 17.5 | 87.5 | 85.0 | 85.0 | 68.8 | 5.0 | 88.8 | 87.5 | 85.0 | 66.6 |
| | 7 | 15.0 | 81.3 | 90.0 | 82.5 | 67.2 | 2.5 | 83.8 | 76.3 | 76.3 | 59.7 |
| | 8 | 7.5 | 85.0 | 76.3 | 78.8 | 61.9 | 0.0 | 81.3 | 65.0 | 72.5 | 54.7 |
| | 9 | 5.0 | 63.8 | 72.5 | 87.5 | 57.2 | 1.3 | 75.0 | 70.0 | 75.0 | 55.3 |
| | Av. | 49.3 | 84.3 | 81.7 | 86.2 | 75.3 | 49.9 | 83.5 | 80.9 | 82.3 | 74.0 |
| Treated seeds (6g Ridomil/ Kg seeds) | 0 | 77.5 | 86.3 | 71.3 | 73.8 | 77.2 | 86.3 | 80.0 | 82.5 | 91.3 | 85.0 |
| | 1 | 86.3 | 90.0 | 85.0 | 75.0 | 84.1 | 80.0 | 88.8 | 91.3 | 82.5 | 85.6 |
| | 2 | 76.3 | 85.0 | 75.0 | 81.3 | 79.4 | 78.8 | 85.0 | 87.5 | 95.0 | 86.6 |
| | 3 | 63.8 | 80.0 | 80.0 | 80.0 | 75.9 | 78.8 | 93.8 | 93.8 | 73.8 | 84.4 |
| | 4 | 73.8 | 75.0 | 90.0 | 73.8 | 78.1 | 81.3 | 85.0 | 86.3 | 86.3 | 84.7 |
| | 5 | 52.5 | 96.3 | 87.5 | 88.8 | 81.3 | 65.0 | 93.8 | 86.3 | 97.5 | 85.6 |
| | 6 | 36.3 | 83.8 | 87.5 | 86.3 | 73.4 | 58.8 | 91.3 | 91.3 | 73.8 | 78.8 |
| | 7 | 5.0 | 85.0 | 87.5 | 85.0 | 65.6 | 1.3 | 81.3 | 72.5 | 85.0 | 60.0 |
| | 8 | 1.3 | 91.3 | 86.3 | 85.0 | 65.9 | 0.0 | 88.8 | 63.8 | 77.5 | 57.5 |
| | 9 | 3.8 | 71.3 | 85.0 | 75.0 | 58.8 | 0.0 | 57.5 | 63.8 | 76.5 | 49.4 |
| | Av. | 47.7 | 84.4 | 83.5 | 80.4 | 74.0 | 53.0 | 84.5 | 81.9 | 83.9 | 75.8 |

Note; *a, b, c, d, same as Table 1.

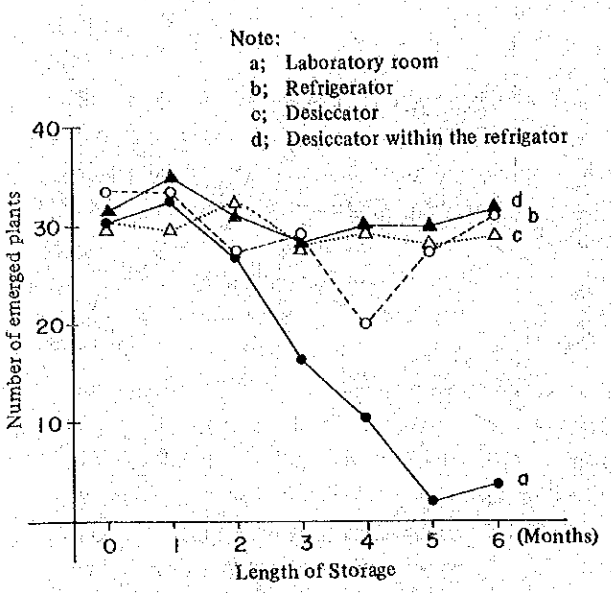


FIGURE 1 GERMINATION, (EXPERIMENT A, HARAPAN, CONTROL:UNTREATED SEEDS)

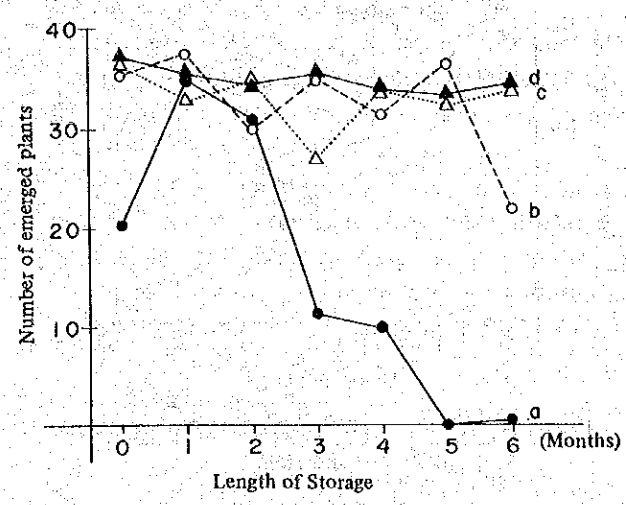


FIGURE 3. GERMINATION, (EXPERIMENT A, HARAPAN, RIDOMIL 3g/Kg seed)

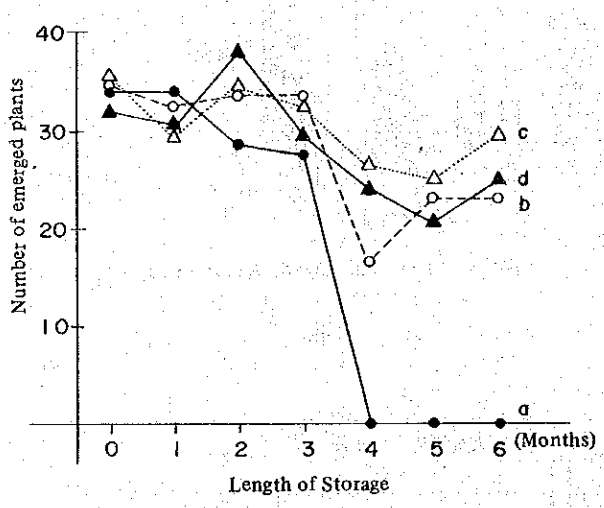


FIGURE 2. GERMINATION, (EXPERIMENT A, HARAPAN BARU, CONTROL:UNTREATED SEEDS)

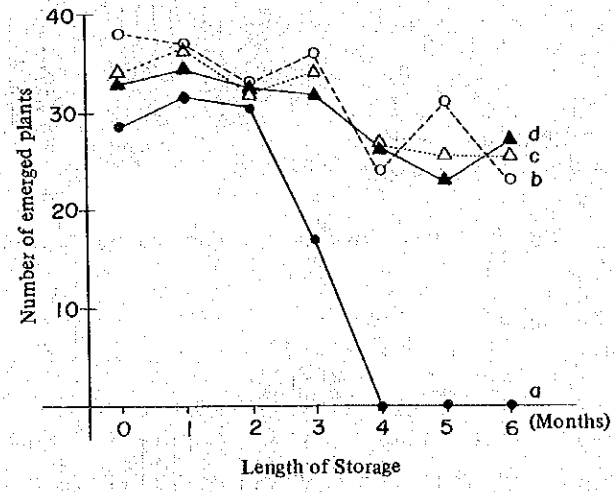


FIGURE 4. GERMINATION, (EXPERIMENT A, HARAPAN BARU, RIDOMIL 3g/Kg seed)

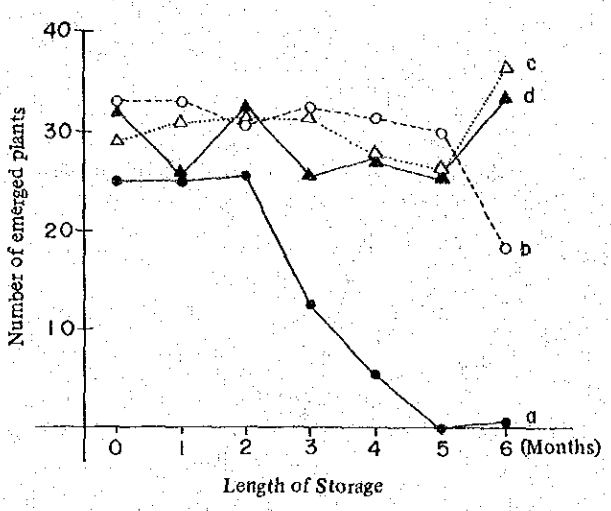


FIGURE 5. GERMINATION, (EXPERIMENT A, HARAPAN, RIDOMIL 6g/Kg seed)

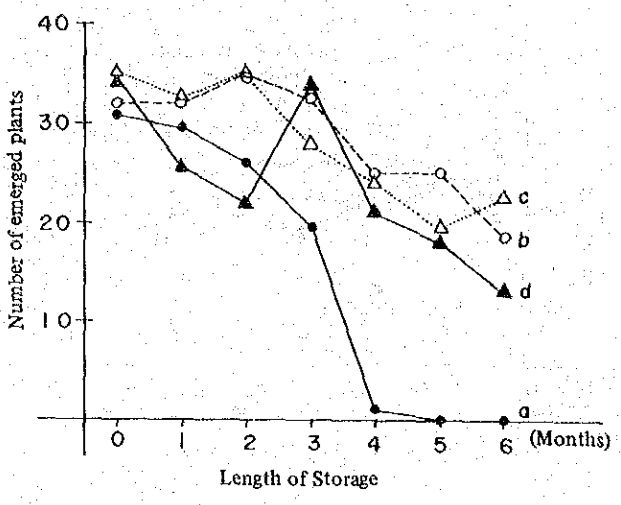


FIGURE 6. GERMINATION, (EXPERIMENT A, HARAPAN BARU, RIDOMIL 6g/Kg seed)

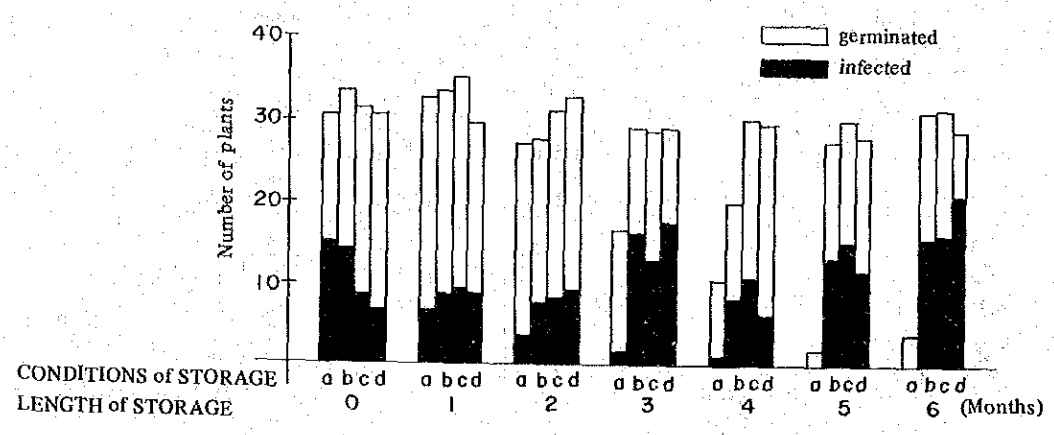


FIGURE 7. GERMINATION & INFECTION, (EXPERIMENT B, HARAPAN, CONTROL:UNTREATED SEEDS)

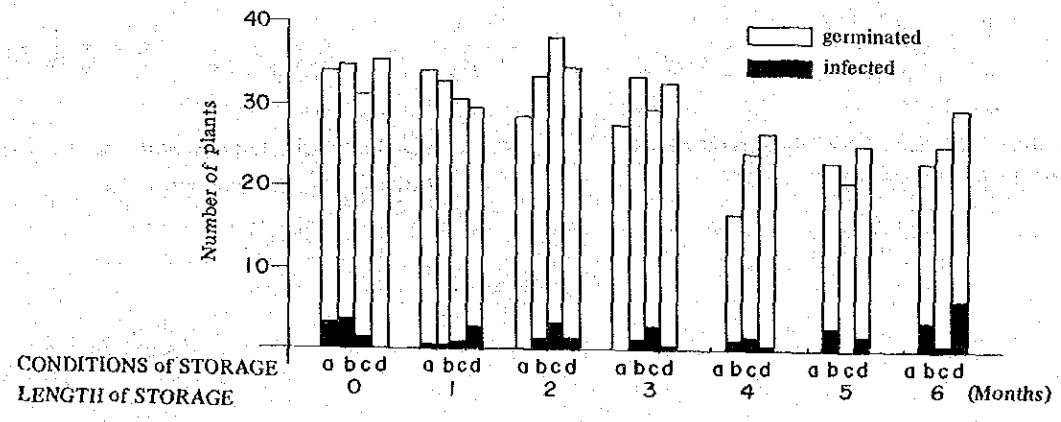


FIGURE 8. GERMINATION & INFECTION, (EXPERIMENT B, HARAPAN BARU, CONTROL:UNTREATED SEEDS)

Experiment B:

The results of experiment B are shown in Tables 3 and 4, and Figures 9-16.

In the laboratory, the maximum temperature was 32°C (average maximum 29°C), and the minimum was 21°C (average minimum 25°C). The maximum humidity was 98 % (average maximum 80 %), and the minimum was 48 % (average minimum 61 %), from September 1980 until May 1981.

Germination (Table 3): There were significantly differences in seed germination of both susceptible and resistant varieties among the different rates of seed dressing with Ridomil. Lower percentages of germination were observed when Ridomil was administered at the higher rate of 6 g/kg seed.

When the seeds were miantained more than five months at room temperature and humidity, significantly fewer plants emerged. However, when the seeds were maintained even for nine months at low temperature or low humidity or both, seed germination did not show any appreciable decrease.

Infection (Table 4): The rate of infection with downy mildew of the susceptible variety ranged from 0 % to 80 % (average 60 %) and of the resistant variety from 0 % to 19 % (average 9.2 %).

When seeds were treated at a rate of 3 g/kg seed only two out of 2410 plants of the susceptible variety become infected, although these two plants did not show typical systemic symptoms. Seeds of the resistant variety treated at a rate of 3 g/kg seed and seeds of both varieties treated at the higher rate of 6 g/kg seeds remained uninfected.

Differences in the length and conditions of storage did not influence the percentage of infection. However, we observed that plots with poorly emerged plants had a lower percentage of infection.

**Table 4. Percentage of infected plants. Treatment and storage test of seed corn for control of downy mildew. Experiment B, Date of planting; 25 May 1981, Date of investigation for germination; 7 July 1981.**

| Seed treatments | Length of storage (months) | Variety HARAPAN Storage conditions a* (%) | b* (%) | c* (%) | d* (%) | Average (%) | Variety HARAPAN BARU Storage conditions a* (%) | b* (%) | c* (%) | d* (%) | Average (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Control | 0 | 60.3 | 64.4 | 69.4 | 73.2 | 66.8 | 6.8 | 13.2 | 9.5 | 13.7 | 10.8 |
| (Untreated | 1 | 65.7 | 70.6 | 60.9 | 80.0 | 69.3 | 7.7 | 12.9 | 7.4 | 14.1 | 10.5 |
| seeds) | 2 | 71.0 | 63.8 | 65.9 | 77.4 | 69.5 | 5.5 | 12.2 | 6.3 | 16.4 | 10.1 |
| | 3 | 61.3 | 67.8 | 78.9 | 69.7 | 69.3 | 6.4 | 8.0 | 13.5 | 19.2 | 11.8 |
| | 4 | 57.8 | 67.7 | 44.4 | 76.3 | 61.5 | 7.4 | 14.5 | 6.8 | 10.5 | 9.8 |
| | 5 | 36.5 | 76.3 | 66.7 | 67.1 | 61.7 | 1.4 | 10.7 | 13.0 | 7.8 | 8.2 |
| | 6 | 20.0 | 54.7 | 59.4 | 63.8 | 49.5 | 3.1 | 7.9 | 5.4 | 17.6 | 8.5 |
| | 7 | 11.1 | 62.2 | 55.8 | 69.2 | 49.6 | – | 6.6 | 6.3 | 9.2 | 5.5 |
| | 8 | 28.6 | 68.0 | 59.7 | 65.3 | 55.4 | – | 18.7 | 7.7 | 10.8 | 9.3 |
| | 9 | 0.0 | 68.6 | 57.1 | 69.4 | 48.8 | 0.0 | 11.9 | 7.6 | 11.8 | 7.8 |
| | Av. | 41.2 | 66.3 | 61.8 | 71.4 | 60.4 | 3.8 | 11.7 | 8.4 | 13.1 | 9.2 |
| Treated seeds | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| (3g Ridomil/ | 1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Kg seed) | 2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 5 | 0.0 | 0.0 | 1.5 | 0.0 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 8 | 0.0 | 1.5 | 0.0 | 0.0 | 0.4 | – | 0.0 | 0.0 | 0.0 | 0.0 |
| | 9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Av. | 0.0 | 0.2 | 0.2 | 0.0 | 0.08 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Note: a, b, c, d, same as Table 1, The plots of seeds treated by Ridomil at a rate of 6g/Kg seed, remained uninfected.

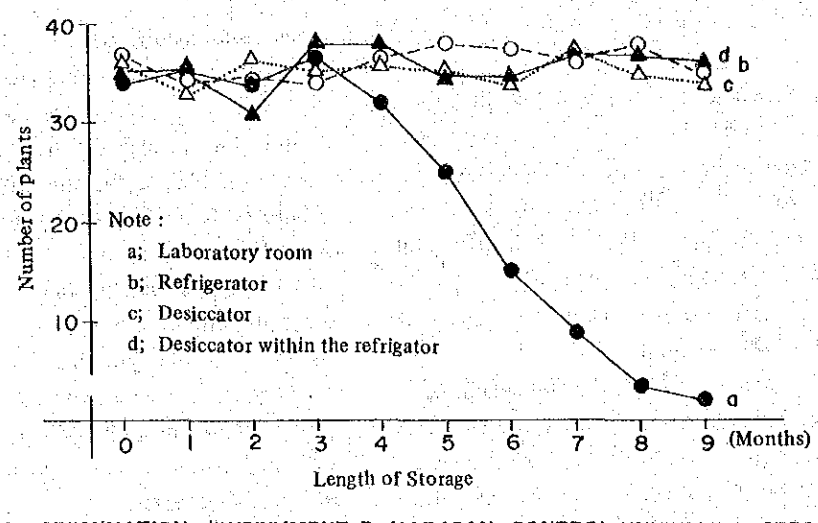


FIGURE 9. GERMINATION, (EXPERIMENT B, HARAPAN, CONTROL:UNTREATED SEEDS)

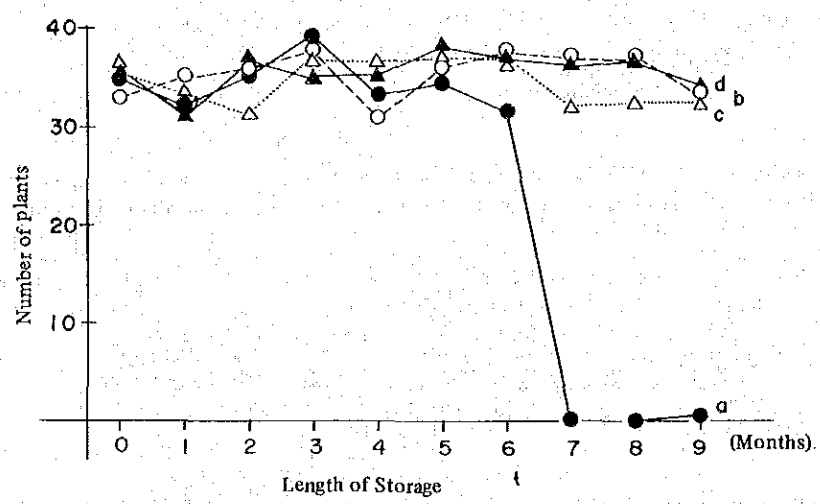


FIGURE 10. GERMINATION, (EXPERIMENT B, HARAPAN BARU, CONTROL:UNTREATED SEEDS)

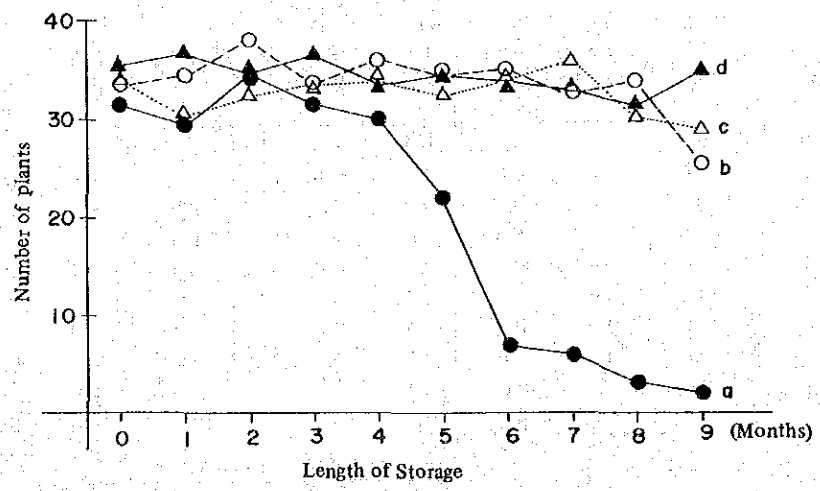


FIGURE 11 . GERMINATION, (EXPERIMENT B, HARAPAN, RIDOMIL 3g/Kg seed)

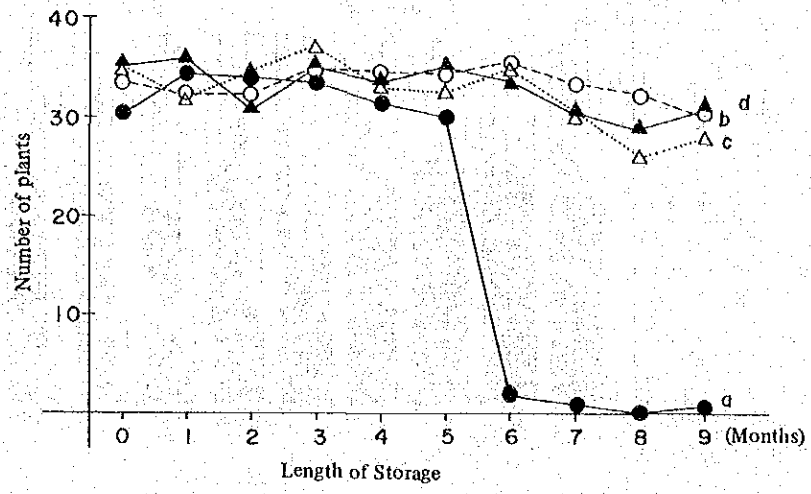


FIGURE 12. GERMINATION, (EXPERIMENT B, HARAPAN BARU, RIDOMIL 3g/Kg seed)

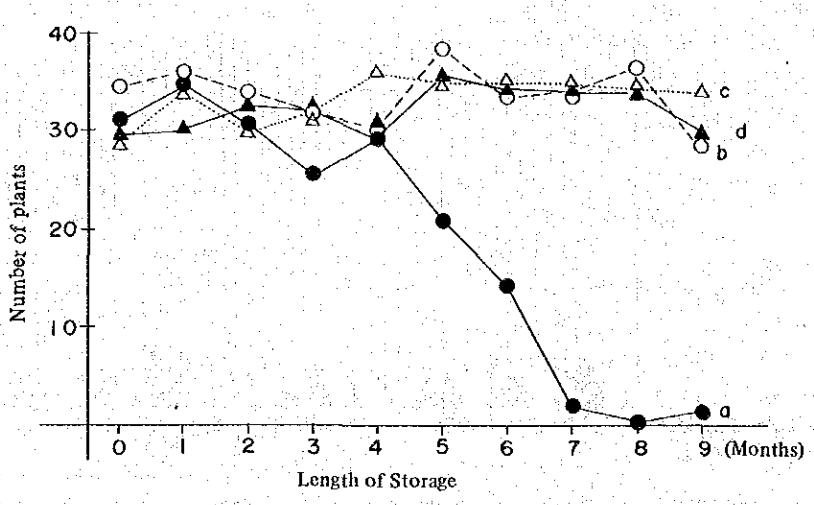


FIGURE 13. GERMINATION, (EXPERIMENT B, HARAPAN, RIDOMIL 6g/Kg seed)

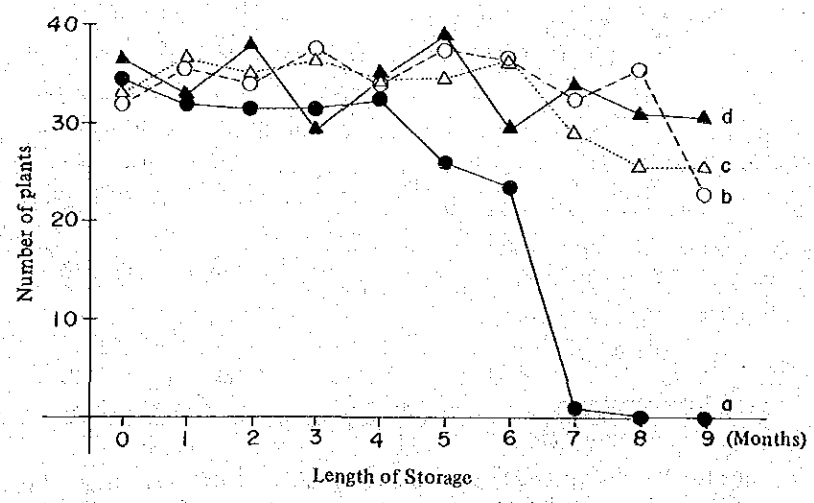


FIGURE 14. GERMINATION, & INFECTION, (EXPERIMENT B, HARAPAN BARU, RIDOMIL 6g/Kg seed)

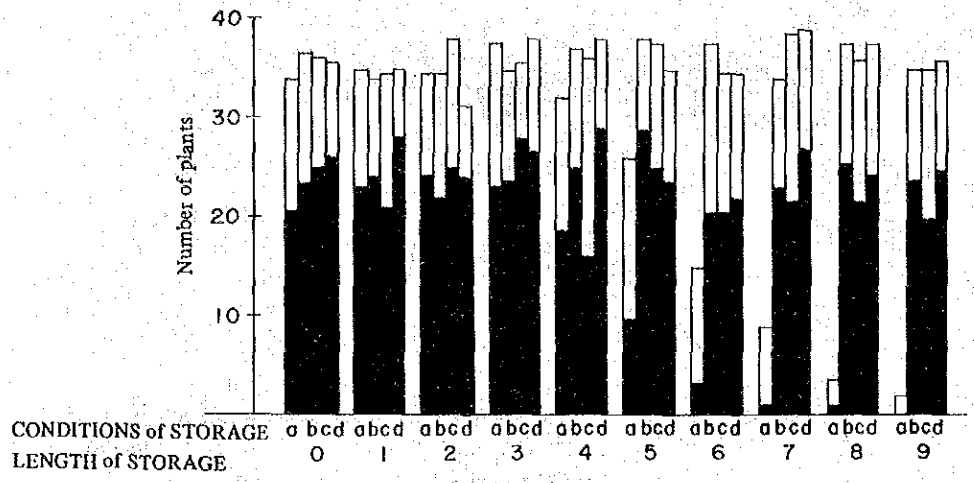


FIGURE 15. GERMINATION & INFECTION, (EXPERIMENT B, HARAPAN, CONTROL:UNTREATED SEEDS)

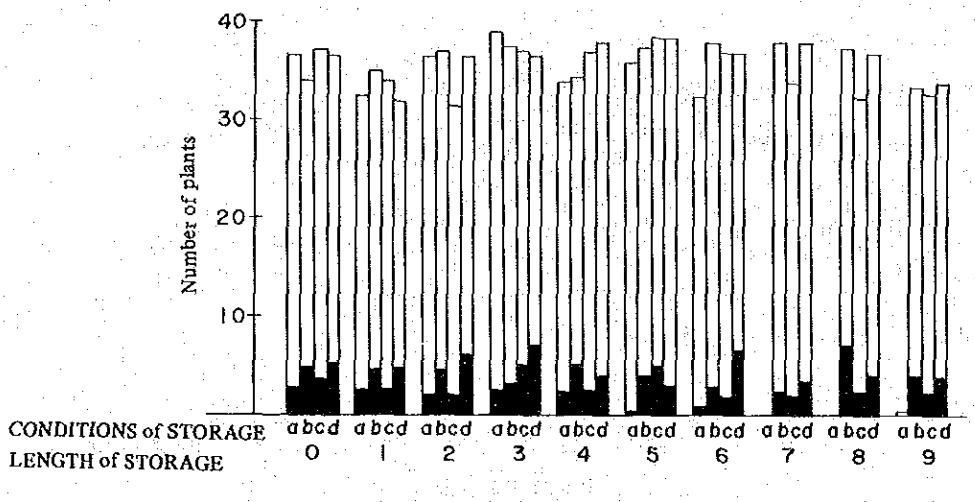


FIGURE 16. GERMINATION & INFECTION, (EXPERIMENT B, HARAPAN BRU, CONTROL:UNTREATED SEEDS)

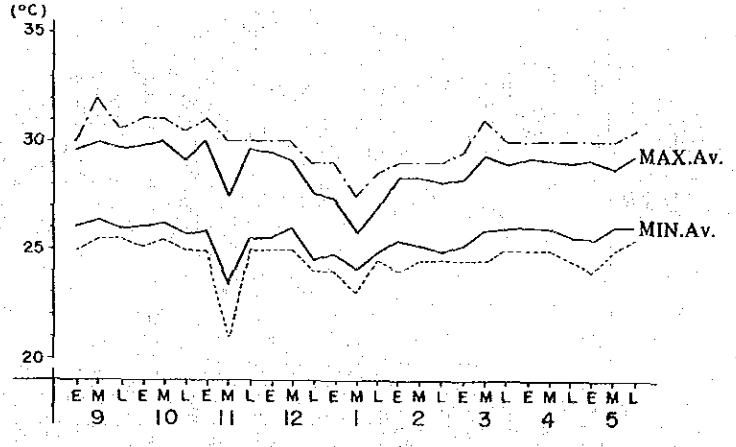


FIGURE 17. MAXIMUM and MINIMUM TEMPERATURE in the LABORATORY ROOM (E: Early, M: Middle, L: Late, MAX.Av.: Average of Maximum temperature during 10 days, from september 1980 until May 1981.

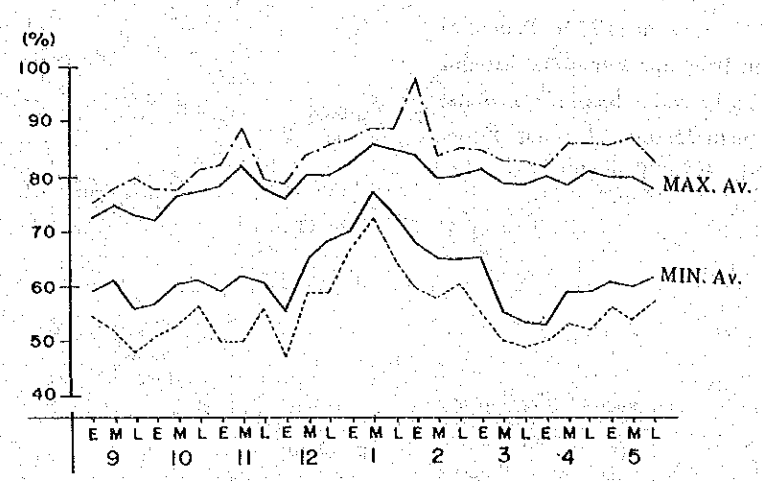


FIGURE 18. MAXIMUM and MINIMUM HUMIDITY in the LABORATORY ROOM

(E: Early, M: Middle, L: Late, same as Figure 17,)

## DISCUSSION

Exconde and Molina, Jr., (1978) reported that Ridomil as seed dressing was able to control effectively Philippine corn downy mildew caused by *Peronosclerospora philippinensis* (Weston) Shaw. Seed germination was slightly reduced with 4,6, and 8 g active ingredient/kg seed. Masdiar and Tantera (1979) reported that seed treatment with Ridomil at a rate of 1 g a.i./kg seed resulted in the absence of infection with Java corn downy mildew caused by *Peronosclerospora maydis* (Butler) Shaw in Indonesia. However these reports described only tests on seed treatment with Ridomil immediately before planting and there have been very few reports on the long-term efficacy of Ridomil as seed dressing for controlling downy mildew after storage of treated seeds.

This experiment confirmed the effectiveness of Ridomil as seed treatment to control Java corn downy mildew at the reduced rate of 1.05 g a.i./kg seed, when the seeds were treated immediately before planting.

This experiment shows that seed treatment with Ridomil for the control of Java corn downy mildew remains effective even after nine months of seed storage.

If seeds are stored under laboratory conditions, germination ability decreased rapidly with time. The seeds kept at room temperature and humidity lost their germination ability after 3-5 months. However, the seeds kept at low temperature, low humidity or both conditions, were able to maintain their germination ability even after 6-9 months of storage.

Although Exconde and Molina, Jr., reported that seed germination declined slightly at a rate of 4,6 and 8 g a.i./kg seed, we found that treatment at a rate of 2.1 g a.i./kg seed significantly reduced germination in experiment B. Such an effect was not, however, observed in experiment A. The cause of this difference remains unknown.

From the above, we may conclude that seed treatment with Ridomil remains effective for the control of Java corn downy mildew after nine-month storage of treated seeds, even at the reduced rate of 1.05 g a.i./kg seed.

However, how to maintain the germination ability of corn seeds in tropical conditions is a problem which remains to be solved. This experiment indicates that seeds should be stored under low temperature or low humidity conditions to prevent the decrease of seed germination ability.

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2). Kajawara, T., T. Kobayashi, T. Inaba, M. Sudjadi and Sumantri Otjim, (1979): Control of Java corn downy mildew caused by *Sclerospora maydis* (Rac.) Butl. by Echromezol. Journal of Pesticide Science 4 : 425-430.

3) Masdiar, B. and D.M. Tantera (1979): Penelitian Pendahuluan dengan Beberapa Fungisida Sistemik untuk Pemberantasan Penyakit Bulai *(Sclerospora maydis)* pada Tanaman Jagung. Laporan Kemajuan Penelitian seri Hama Penyakit, No. 18 : 88 - 101.

# 摘　　要

## リドミル剤で粉衣処理したトウモロコシ種子の貯蔵後におけるべと病防除効果

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リドミル剤粉衣処理種子の貯蔵後におけるトウモロコシべと病に対する防除効果を明らかにするため，2回の圃場試験を行った。すなはち，本病罹病性のHarapan及び抵抗性のHarapan Baruの2品種を用い，1980年8月より毎月末にリドミル剤（35%粉衣剤）0，3及び6 g/kg seedの割で粉衣し，それらを実験室，冷蔵庫，デシケーター及び冷蔵庫内のデシケーターに貯蔵した。これらの種子を1981年3月21日（最長で6ヶ月間貯蔵）及び1981年5月26日（最長で9ヶ月間貯蔵）に，感染源となる罹病とうもろこしで囲まれた圃場にそれぞれ播種し，発芽率及び発病率を調査した。その結果，リドミル剤粉衣処理の本病に対する防除効果は，粉衣種子を6～9ヶ月間貯蔵した後でも減少せず，処理直後のものと同等の高い防除効果を示した。しかし粉衣処理の有無に拘わらず実験室内の，温度及び湿度を制御してない自然条件下で，貯蔵された種子は，3～4ヶ月で発芽率が低下し，6ヶ月以上ではほとんど発芽率0%に近くなった。また，リドミル剤の粉衣処理は若干ではあるが発芽率を低下させる傾向にあった。