Weather factor and chemical management against late leaf spot (LLB) and rust diseases under rainfed groundnut conditions

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Abstract
Groundnut (Arachis hypogaea L.) is most growing under rainfed conditions, the important disease of late leaf spot and rust reduction of yield in rainfed condition. Experiments were conducted 2012, 2013 and 2014. The temperature for three years minimum temperature 23.57 °C temperature 37.54 °C combination of weather conditions during the growing season of groundnut foliar diseases of Late leaf spot and Rust diseases for favourable severe conditions. Among the different chemicals tested for three years the combination of Carbendazim + Mancozeb (SAAF) @ 1.25Kg/ha recorded the least diseases incidence of Late leaf spot (22.36%) and rust (17.58%) with accounting of diseases reduction for late leaf spot (61.24%) and rust (70.03%) followed by carbendazim and chlorothalonil. The individual application copper hydroxide controlled the rust disease effectively when compared to other treatments also increased yield 1003.67kg/ha. The Carbendazim + Mancozeb (SAAF) @ 1.25kg/ha broad spectrum fungicide for reduced the spraying schedule and no of chemicals used and also protective and curative action with contact and systemic in nature groundnut cultivations under rainfed condition.

Keywords: Temperature, late leaf spot leaf spot, rust, chemical, management

Introduction
Groundnut is called as the ‘King’ of oilseeds. It is one of the most important food and cash crops of our country. While being a valuable source of all the nutrients, it is a low priced commodity. Groundnut is also called as wonder nut and poor men’s cashew nut. In tamilnadu, cultivated around 6.19 lakh hectares with the production of 10.98 lakh tonnes. In this 70% under rainfed cultivation and remaining 30% under irrigated condition. Peanut rust (Puccinia arachidis Speg.) reduces the yield, under disease epiphytoti reduces the yield in rainfed condition. Experiments were conducted 2012, 2013 and 2014 with the test crop groundnut (TMV 7).

Materials and Methods
The experimental trial consisting of 10 treatments was laidout at Dryland Agricultural Research Station, Chettinad during 2012-2014 with the test crop groundnut (TMV 7). Randomized Block Design was adopted with three replications. The plot size for each treatment was 20m². All normal agronomic practices were followed and the yield parameters were recorded and analyzed statistically. The disease incidence was observed at 15 days interval using the disease scoring chart 1-9 scale and also recorded the yield kg/ha.
The minimum temperature and maximum temperature, leaf wetness, Relative humidity was daily observed during the growing season of groundnut cultivation fifteen days mean of weather parameters (independent variables) were. The prediction equation was worked out through multiple regression analysis using SPSS computer software. Coefficient of determination (R2) were also calculated and tested for significance at 1% level of probability. The germination and Disease incidence observed at regular intervals. In addition, growth parameters viz., plant height, number of branches. Number of pods/plant, and seed yield kg/ha, were also recorded. Percent disease index (PDI) was calculated on 15 days interval using the following formula:

\[
PDI = \left( \frac{\text{Sun of all ratings}}{\text{Total No. of observed leaves} \times \text{maximum disease grade}} \right) \times 100
\]

For the estimation of disease incidence, leaves were seen from each plot in each replication and the disease was recorded using modified 9 point scale (Subrahmanyan et al., 1995) the spraying chemicals for individual fungicides and combination fungicides at 50th DAS and 65th DAS tested against late leaf spot and rust diseases.

**Results and Discussion**

**Weather factor**

Field trials were conducted in 2011-2014 at Dryland Agricultural Research Station, Chettinad, Tamilnadu, India. The temperature for three years minimum temperature 23.57 °C temperature 37.54 °C combination of weather conditions during the growing season of groundnut foliar diseases of Late leaf spot and Rust diseases for favourable severe conditions (fig.1).

**Correlation weather factor**

Herein analysis was carried out to identify whether there is significant relationship between weather factors and leaf spot and rust

| Correlations          | Leaf Spot | Leaf Rust |
|-----------------------|-----------|-----------|
| **Maximum Temp**      | Pearson Correlation | .447     | .534     |
|                       | Sig. (2-tailed)    | .450     | .354     |
|                       | N              | 5        | 5        |
| **Minimum Temp**      | Pearson Correlation | .720     | 1.000*   |
|                       | Sig. (2-tailed)    | .170     | .000     |
|                       | N              | 5        | 5        |
| **Rainfall**          | Pearson Correlation | -.571    | -.023    |
|                       | Sig. (2-tailed)    | .315     | .971     |
|                       | N              | 5        | 5        |
| **Leaf wetness**      | Pearson Correlation | -.465    | -.262    |
|                       | Sig. (2-tailed)    | .430     | .670     |
|                       | N              | 5        | 5        |

Null Hypothesis – There is no significant relationship between the weather factors and leaf spot and leaf rust.

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Fig 1: Temperature variation in late leaf spot and rust severity at DARS, chettinad.
The Kurtosis value was estimated to be 24.51 on an average for the past three years weather factor. The skewness value is calculated to be 1.077, meaning the dataset is highly positively skewed. Further, it was found that the maximum temperature from weather factor was lowest [23.79 °C] during average 3 years of 90 days and highest [24.94 °C] during average 3 years of 60 days.

### Relative Humidity

Three year Relative humidity is can interpreted that the relative humidity for average 3 year 74.16 per cent with an standard deviation 4.22%. The Kurtosis value was estimated to be -0.963 [Std. Value: -1 to +1] therefore the dataset has neither flatness nor peaks over the past average 3 years RH. The skewness value is calculated to be 0.478% [Std. Value: (-0.5 to +0.5)-Symmetrical, (-1 to -0.5 or 0.5 to 1)-Moderately Skewed (>1 or <1)- Highly skewed] meaning the dataset is highly positively skewed. Further, it was found that the RH from weather factor was lowest [70.0%] during average 3 years of 90 days and highest [80.18%] during average 3 years of 105 days.

## Weather Factor – Maximum Temperature

From the descriptive statistics using weather factor in three years, it can interpreted that the maximum temperature of weather factor for average 3 years is on an average 32.16 °C with an standard deviation 1.839 °C. The Kurtosis value was estimated to be -0.528 [Std. Value: -1 to +1] therefore the dataset has neither flatness nor peaks over the past average 3 year’s maximum temperature. The skewness value is calculated to be 1.077 °C [Std. Value: (-0.5 to +0.5)-Symmetrical, (-1 to -0.5 or 0.5 to 1)-Moderately Skewed (>1 or <1)- Highly skewed] meaning the dataset is highly positively skewed (Table 1a). Further, it was found that the maximum temperature from weather factor was lowest [30.79 °C] during average 3 years of 75 days and highest [34.94 °C] during average 3 years of 45 days.

### Minimum Temperature

Three year minimum temperature, it can interpret that the minimum temperature of weather factor for average 3 years is on an average 24.51 °C with an standard deviation 0.59 °C. The Kurtosis value was estimated to be -3.09 [Std. Value: -1 to +1] therefore the dataset has neither flatness nor peaks over the past average 3 years minimum temperature. The skewness value is calculated to be -0.625 °C [Std. Value: (-0.5 to +0.5)-Symmetrical, (-1 to -0.5 or 0.5 to 1)-Moderately Skewed (>1 or <1)- Highly skewed] meaning the dataset is highly positively skewed. Further, it was found that the RH from weather factor was lowest [70.0%] during average 3 years of 90 days and highest [80.18%] during average 3 years of 105 days.

### Table 1a: Average three years weather factors

| Weather Factors | Days | max temp | mini temp | Leaf wetness | wind speed | RH |
|-----------------|------|----------|-----------|--------------|------------|----|
|                 | 45   | 34.94    | 24.89     | 4.51         | 4.94       | 74.4 |
|                 | 60   | 33.17    | 24.94     | 3.29         | 4.69       | 76.05 |
|                 | 75   | 30.79    | 25.00     | 3.91         | 1.84       | 70.18 |
|                 | 90   | 30.80    | 23.94     | 3.71         | 7.93       | 70   |
|                 | 105  | 31.13    | 23.79     | 4.46         | 7.34       | 80.18 |

### Descriptive Statistics

|                | Mean    | Standard Error | Standard Deviation | Sample Variance | Kurtosis  | Skewness  | Range  | Minimum | Maximum | Sum     | Count |
|----------------|---------|----------------|--------------------|-----------------|------------|-----------|--------|---------|---------|---------|-------|
|                | 32.16   | 0.265          | 0.594              | 0.016           | -0.528     | -0.231    | 1.22   | 30.79   | 34.94   | 160.83  | 5     |

From the Correlation table the estimated significance value is 0.000 for minimum temperature and leaf rust, meaning the null hypothesis is rejected. Therefore there is significant relationship. Further the R value calculated to be 1, meaning there is 100.00% strong positive relationship between minimum temperature and leaf rust.
Table 2: Fungicides application against late leaf spot diseases conducted field experiment in the year of 2011-2012

| S. No | Treatments | Dose ml/ha | Pre Treatment Disease incidence* (%) | I* spraying* at 45 DAS | II* spraying* at 60 DAS | Mean Disease incidence (%) |
|-------|------------|------------|-------------------------------------|-----------------------|-------------------------|-----------------------------|
|       |            |            | 45 DAS | 60 DAS | 75 DAS | 90 DAS | 105 DAS |
| T1    | Chlorothalonil 75% WP | 1kg | 24.65 | 24.15 | 23.68 | 22.19 | 21.55 |
| T2    | Carbendazim 50% WP | 500g | 26.18 | 25.61 | 26.18 | 21.98 | 23.35 |
| T3    | Mancozeb | 1kg | 24.36 | 22.18 | 20.68 | 18.64 | 17.98 |
| T4    | Tridemorph 75 EC | 500ml | 25.14 | 21.89 | 19.82 | 16.37 | 15.75 |
| T5    | Copper hydroxide 77% WP | 400gm | 23.27 | 22.15 | 22.56 | 23.16 | 25.18 |
| T6    | Carbendazim+ Mancozeb | 1.25kg | 26.15 | 20.19 | 16.97 | 14.58 | 13.05 |
| T7    | Iprodione+ Carbendazim | 1kg | 24.35 | 23.64 | 22.38 | 20.19 | 20.19 |
| T8    | Cymoxanil + mancozeb | 1kg | 26.18 | 24.18 | 23.67 | 23.67 | 23.67 |
| T9    | Carbendazim & Tridemorph | (1:1) | 24.15 | 21.38 | 19.68 | 17.35 | 15.19 |
| T10   | Mancozeb & Chlorothalonil | (1:1) | 25.36 | 21.97 | 20.17 | 18.35 | 17.98 |
| T11   | Carbendazim & Copper hydroxide | (1:1) | 22.17 | 22.56 | 20.67 | 20.67 | 21.69 |
| T12   | Control |        | 23.18 | 48.95 | 67.95 | 79.62 | 86.98 |

CD (P=0.05) 1.5

Table 2a: Fungicides application against Rust diseases conducted field experiment in the year of 2011-2012

| S. No | Treatments | Dose ml/ha | Pre Treatment Disease incidence* (%) | I* spraying* at 45 DAS | II* spraying* at 60 DAS | Mean Disease incidence (%) |
|-------|------------|------------|-------------------------------------|-----------------------|-------------------------|-----------------------------|
|       |            |            | 45 DAS | 60 DAS | 75 DAS | 90 DAS | 105 DAS |
| T1    | Chlorothalonil 75% WP | 1kg | 24.65 | 24.15 | 23.68 | 22.19 | 21.55 |
| T2    | Carbendazim 50% WP | 500g | 26.18 | 25.61 | 26.18 | 21.98 | 23.35 |
| T3    | Mancozeb | 1kg | 24.36 | 22.18 | 20.68 | 18.64 | 17.98 |
| T4    | Tridemorph 75 EC | 500ml | 25.14 | 21.89 | 19.82 | 16.37 | 15.75 |
| T5    | Copper hydroxide 77% WP | 400gm | 23.27 | 22.15 | 22.56 | 23.16 | 25.18 |
| T6    | Carbendazim+ Mancozeb | 1.25kg | 26.15 | 20.19 | 16.97 | 14.58 | 13.05 |
| T7    | Iprodione+ Carbendazim | 1kg | 24.35 | 23.64 | 22.38 | 20.19 | 20.19 |
| T8    | Cymoxanil + mancozeb | 1kg | 26.18 | 24.18 | 23.67 | 23.67 | 23.67 |
| T9    | Carbendazim & Tridemorph | (1:1) | 24.15 | 21.38 | 19.68 | 17.35 | 15.19 |
| T10   | Mancozeb & Chlorothalonil | (1:1) | 25.36 | 21.97 | 20.17 | 18.35 | 17.98 |
| T11   | Carbendazim & Copper hydroxide | (1:1) | 22.17 | 22.56 | 20.67 | 20.67 | 21.69 |
| T12   | Control |        | 23.18 | 48.95 | 67.95 | 79.62 | 86.98 |

CD (P=0.05) 1.5

Chemicals against late leaf spot
The experiment result revealed that, late leaf spot infection ranged from 33.18 to 37.89 per cent before imposing treatments (Table 2). The three applications of fungicides in 15 days interval the Mean data revealed that late leaf spot damage on leaves ranged from 23.18 to 60.17 Decrease disease incidences. Among the treatment the combination chemicals Carbendazim + mancozeb (SAAF) @ 1.25kg/ha which recorded 23.18% Chlorothalonil @ 1kg/ha recorded (28.84%), Carbendazim @ 500gm/ha recorded 28.73% contributed significant reduction to 61.47, 53.73 and 52.25 per cent reduction over control respectively similar observation (Gadiya Kavita, Kanubhai, et al., 2018) [3], recorded Minimum per cent disease index of early (30.76%) and late (59.38%) leaf spot recorded in foliar application of carbendazim 12% + mancozeb 63% WP (0.15%) only control for leaf spot.

Chemicals against Rust in rainfed groundnut
The experiment result revealed that, rust infection ranged from 22.17- to 26.18 per cent before imposing treatments (Table 2a). The three applications of fungicides in 15 days interval the Mean data revealed that rust damage on leaves ranged from 18.19 to 61.34 Decrease disease incidences. Among the treatment the combination chemicals Carbendazim + Mancozeb (SAAF) @ 1.25kg/ha which recorded 18.19% Carbendazim and tridemorph (1:1)(v/v) recorded (19.55%), Tridemorph @ 500gm/ha recorded 19.61%, mancozeb 20.77% and Mancozeb and Chlorothalonil (1:1) 20.77% were on par and which contributed significant reduction to 70.34, 68.12, 68.03 and 66.13 per cent reduction over control respectively.

Three year pooled data analysis
The experiment result revealed that, the three year pooled data analysis the fungicides application two time spraying 50 DAS and 65DAS, observation of disease incidence in 15 days interval the Mean data revealed that late leaf spot damage on leaves ranged from 22.36 to 57.62 Decrease disease incidences (Table3). Among the treatment the combination chemicals Carbendazim + mancozeb (SAAF) @ 1.25kg/ha which recorded 22.36% Carbendazim @ 500gm/ha (26.90%) Chlorothalonil @ 1kg/ha recorded (26.90%), recorded percent disease incidence comparing to control (57.62%). The three year pooled Mean data revealed that rust damage on leaves ranged from 17.58-58.66 Decrease disease incidences (Table3). Among the treatment the combination chemicals Carbendazim + Mancozeb (SAAF) @ 1.25kg/ha which recorded 17.58% followed by mancozeb 21.61% Carbendazim 22.50 and Chlorothalonil 22.51% were on par each other. The unsprayed control severe diseases (58.66%) in control respectively premixture of Azoxyostribin 7.5% & Propiconazole 12.5% SE @ (65.62+109.38 g a.i./ha a nd 75+125 g a.i. ha) significantly reduced both the diseases (8.75% & 8.70% for tikka and 9.16% & 9.20% for rust) and incr ease yield 20.75 and 21.25 qha-1 (Sunita Mahapatra, 2016) [10].
Among three year data the Carbendazim + Mancozeb (SAAF)@1.25kg/ha for Highest Diseases reduction for late leaf spot (61.24%) and rust (70.03%) followed by copper hydroxide (50.16% and 60.22%) carbendazim and Chlorothalonil for late leaf spot and, carbendazim and chlorothalonil for rust diseases (61.62 and 61.64% per cent control) and was on par with each other, comparing to Control and other chemicals (Table 4.). The tebuconazole (0.1 per cent) was found to be the best fungicide to control tikka disease of ground nut and the second best fungicide was carbendazim (0.1 per cent) (Mushrif et al., 2017) [b]

### Table 3: Efficacy of chemicals against Late leaf spot and rust leaf spot of rainfed groundnut (Three years pooled data)

| S. No | Treatments                        | Dose (ha) | Late leaf spot Disease incidence (%) | Rust Diseases Incidence (%) |
|------|-----------------------------------|-----------|--------------------------------------|----------------------------|
|      |                                    |           | 2012 | 2013 | 2014 | Mean diseases incidence (%) | 2012 | 2013 | 2014 | Mean diseases incidence (%) |
| T1   | Chlorothalonil 75% WP             | 1Kg       | 27.84 | 28.99 | 23.86 | 26.90 | 23.37 | 23.86 | 22.35 | 22.51 |
| T2   | Carbendazim 50WP                  | 250gm     | 28.73 | 29.00 | 21.00 | 26.24 | 24.16 | 21.01 | 22.32 | 22.50 |
| T3   | Mancozeb                         | 1kg       | 31.75 | 29.55 | 23.40 | 28.24 | 20.77 | 21.15 | 22.91 | 21.61 |
| T4   | Copper hydroxide 77% WP           | 400gm     | 28.94 | 29.34 | 27.97 | 28.75 | 23.26 | 20.43 | 26.29 | 23.33 |
| T5   | Carbendazim+ Mancozeb (SAAF)     | 1.25kg    | 23.18 | 24.64 | 19.25 | 22.36 | 18.19 | 16.26 | 18.30 | 17.58 |
| T6   | Iprodione+ Carbendazim           | 1kg       | 29.93 | 32.53 | 34.16 | 32.21 | 22.15 | 23.08 | 31.32 | 25.52 |
| T7   | Cymanoxanil + mancozeb           | 1kg       | 30.19 | 32.63 | 31.88 | 31.44 | 24.34 | 23.75 | 33.23 | 27.11 |
| T8   | Mancozeb & Chlorothalonil (1:1(v/v)) | 29.74 | 31.44 | 31.24 | 30.68 | 20.77 | 19.94 | 31.69 | 24.13 |
| T9   | Carbendazim & Copper hydroxide   | 1:1(v/v)  | 29.32 | 30.73 | 33.04 | 31.03 | 21.55 | 22.56 | 34.45 | 26.19 |
| T10  | Control                           | 60.17 | 60.19 | 52.72 | 57.69 | 61.34 | 61.45 | 53.18 | 58.86 |

### Table 4: Effect of chemicals against groundnut Late leaf spot and Rust reduction

| S. No | Treatments                        | Dose (ha) | Late leaf spot Disease incidence (%) | Rust Disease Incidence (%) |
|------|-----------------------------------|-----------|--------------------------------------|----------------------------|
|      |                                    |           | Mean diseases incidence (%) | Percent reduction over control | Mean diseases incidence (%) | Percent reduction over control |
| T1   | Chlorothalonil 75% WP             | 1Kg       | 26.90 | 53.17 | 22.51 | 61.62 |
| T2   | Carbendazim 50WP                  | 250gm     | 26.24 | 54.51 | 22.50 | 61.64 |
| T3   | Mancozeb                         | 1kg       | 28.24 | 51.04 | 21.61 | 63.16 |
| T4   | Copper hydroxide 77% WP           | 400gm     | 28.75 | 50.16 | 23.33 | 60.22 |
| T5   | Carbendazim+ Mancozeb (SAAF)     | 1.25kg    | 22.36 | 61.24 | 17.58 | 70.03 |
| T6   | Iprodione+ Carbendazim           | 1kg       | 32.21 | 44.16 | 25.52 | 56.49 |
| T7   | Cymanoxanil + mancozeb           | 1kg       | 31.44 | 45.50 | 27.11 | 53.78 |
| T8   | Mancozeb & Chlorothalonil (1:1(v/v)) | 30.68 | 46.81 | 24.13 | 58.86 |
| T9   | Carbendazim & Copper hydroxide   | 1:1(v/v)  | 31.03 | 46.21 | 26.19 | 55.35 |
| T10  | Control                           |           | 57.69 | - | 58.66 | - |

### Table 5: Yield and cost benefit ratio for chemicals against Late leaf spot and rust leaf spot and yield and CB ratio of rainfed groundnut (Three years pooled data)

| S. No | Treatments                        | Dose (ha) | Late leaf spot Disease incidence (%) | Rust Disease Incidence (%) |
|------|-----------------------------------|-----------|--------------------------------------|----------------------------|
|      |                                    |           | Mean yield (Kg/ha) | CB Ratio | Mean yield (Kg/ha) | CB Ratio |
| T1   | Chlorothalonil 75% WP             | 1Kg       | 920 | 925 | 912 | 919.00 | 1:1.72 |
| T2   | Carbendazim 50WP                  | 250gm     | 860 | 863 | 890 | 871.00 | 1:1.65 |
| T3   | Mancozeb                         | 1kg       | 845 | 840 | 853 | 846.00 | 1:1.35 |
| T4   | Copper hydroxide 77% WP           | 400gm     | 850 | 854 | 864 | 856.00 | 1:1.50 |
| T5   | Carbendazim+ Mancozeb (SAAF)     | 1.25kg    | 995 | 988 | 1028 | 1003.67 | 1:2.0 |
| T6   | Iprodione+ Carbendazim           | 1kg       | 825 | 812 | 824 | 820.33 | 1:1 |
| T7   | Cymanoxanil + mancozeb           | 1kg       | 845 | 850 | 875 | 856.67 | 1:1.58 |
| T8   | Mancozeb & Chlorothalonil (1:1(v/v)) | 865 | 864 | 863 | 864.00 | 1:1.60 |
| T9   | Carbendazim & Copper hydroxide   | 1:1(v/v)  | 845 | 790 | 829 | 821.33 | 1:1.3 |
| T10  | Control                           | 689 | 720 | 780 | 729.67 |

### Table 5a: Effect of fungicides applications groundnut Plant parameter in field conditions.

| S. No | Treatments                        | Dose (ha) | Plant ht (cm) | Branches (No.) | No of pods/plant | Plant wet wt (gm) | Plant dry wt (gm) |
|------|-----------------------------------|-----------|---------------|----------------|-----------------|------------------|------------------|
| T1   | Chlorothalonil 75% WP             | 1Kg       | 43.47 | 9.06 | 37.08 | 195.70 | 154.5 |
| T2   | Carbendazim 50WP                  | 250gm     | 46.45 | 9.27 | 41.20 | 318.30 | 283.25 |
| T3   | Mancozeb                         | 1kg       | 44.91 | 8.45 | 36.87 | 298.70 | 270.89 |
| T4   | Copper hydroxide 77% WP           | 400gm     | 37.29 | 7.00 | 23.90 | 195.70 | 178.705 |
| T5   | Carbendazim+ Mancozeb (SAAF)     | 1.25kg    | 47.17 | 8.03 | 41.41 | 319.27 | 292.52 |
| T6   | Iprodione+ Carbendazim           | 1kg       | 46.14 | 8.45 | 39.96 | 314.15 | 289.43 |
| T7   | Cymanoxanil + mancozeb           | 1kg       | 44.08 | 7.00 | 37.90 | 267.80 | 231.75 |
The Carbanadizim + Mancozeb (SAAF)@1.25Kg/ha combination at 50 and 65 days after spraying decreased the foliar diseases of late leaf spot (61.24%) and rust (70.03%) incidence and also recorded increased the yield of 1003 kg/ha. The cost benefit analysis was also more in Carbanadizim + Mancozeb (SAAF)@1.25Kg/ha combinations as 1:2. Increased the plant height (47.17cm), branches (8.03Nos), no.of pods per plant (319 and 292.52gm/5 plant). Due to the application of the Carbanadizim + Mancozeb (SAAF) @ are broad spectrum fungicides with protective and curative action with contact and systemic in nature Similarly, Johnson et al. (1998) [6] achieved good control of leaf spot of groundnut with an increased in yield by 20% in foliar application of carbanadizim + mancozeb.

Conclusion

Concluded that among three year the weather factor maximum and minimum temperature favour at 60 days for increasing the late leaf spot and also these temperature and Relative humidity favour of rust incidence at 90th days after sowing at that spraying of Carbanadizim + Mancozeb (SAAF) at 50 and 65 days two spraying enough for groundnut cultivation under rain fed conditions, these chemicals reduced the spraying time and number of chemicals used against late leaf spot and rust disease control, these for alternating to tridemorph chemical fungicides.

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