# EFFICACY OF MANCOZEB AND CARBENDAZIM IN THE MANAGEMENT OF LATE LEAF SPOT ON GROUNDNUT (*ARACHIS HYPOGAEA* L.) IN THE NIGERIAN SAVANNA

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## *ABSTRACT*

***In 2015 cropping season, SAMNUT – 14, a variety of groundnut susceptible to late leaf spot was subjected to five different frequencies (0, 1, 2, 3, and 4 weeks) of fungicide application. The experiment was in a Randomized Complete Block Design (RCBD) with three replications established at the Institute for Agricultural Research (IAR) Farm Samaru, Zaria. Natural infection in the field was relied upon as the source of inoculums. Stand count at emergence, and at harvest, disease severity at 60, 80 and 90 Days After Sowing (DAS) based on 1 – 9 scale, Area Under Disease Progress Curve (AUDPC), percent defoliation, pod and haulm yields were recorded. The results showed that, there was no significant difference in disease severity at 60 DAS between all the treatments. The severity recorded on plants sprayed weekly ($T_1$) and biweekly ($T_2$) was significantly lower when compared with other treatments at 80 and 90 DAS. Unsprayed plants recorded the highest AUDPC while the least was observed in plants sprayed weekly. Stand count at emergence and at harvest did not differ significantly across all the treatments. Plants sprayed weekly ($T_1$), biweekly spray ($T_2$) and plants sprayed every three weeks ($T_3$) recorded lower percent defoliation while $T_0$ and $T_4$with significantly higher defoliation were statistically similar. Pod and haulm yields were highest in $T_1$ and lowest in $T_4$. Haulm yield in $T_1T_2$ and $T_3$ were statistically similar and significantly higher than $T_0$ and $T_4$. Disease severity correlated positively and was highly significant with percent defoliation at 80 DAS and 90 DAS. Application of the fungicide at two weeks interval was considered optimum having recorded yields and disease reduction that were statistically similar with weekly and fortnightly spray. This will reduce cost and labour as well as minimize environmental pollution.***

**Key words:** Groundnut, *Phaeoisariopsis personata*, Mancozeb + Carbendazim, Management

## INTRODUCTION

Groundnut (*Arachis hypogaea* L.) also known as peanut, earthnut or monkey nut is a member of the family Fabaceae is used for human food and animal feed (Sharma, 2005). It is an important food legume highly adapted to tropical and subtropical climates of the world (Janila *et al.,* 2013) and contains 48-50 % oil, 26-28 % protein, and a rich source of dietary fibre, minerals (calcium, potassium, phosphorus, magnesium) and vitamins (Brink and Belay, 2006; Schilling, 2012; Janila *et al.,* 2013). Groundnut can fix atmospheric nitrogen to the soil to help in the maintenance of soil fertility (FAO, 2012). This crop is cultivated annually on about 24.63 million hectares worldwide with annual production of 41.27 million tons in shell and productivity of about 1.85 t ha–1 (FAO, 2012). Groundnut is the 13$^{th}$ most important crop and the 5$^{th}$ most important oilseed in the world in terms of volume of oil production and is widely grown in more than 100 countries of tropical, subtropical and warm temperate regions of the globe (Vijaya, 2007; Upadhyaya *et al.,* 2012).

Major groundnut producing countries are China (45%), India (16%), USA (5%) and Nigeria (4%) (FAO, 2013). In West Africa, Nigeria is the largest producer of groundnut with annual production of 3.07 million tons on about 2.4 million hectare (FAO, 2012). Despite the economic, social and cultural importance of groundnuts, its productivity is severely constrained by several biotic and abiotic factors. Drought is the major abiotic constraint affecting groundnut production and quality worldwide (Reddy *et al.,* 2003). Groundnut yield and quality are severely constrained by a wide variety of fungi, bacteria,

viruses, and nematodes. Among the fungal diseases, early leaf spot (*Cercospora arachidicola* Hori) and late leaf spot *(Phaeiosariopsis personata* van Arx) are the most prevalent and occur in all groundnut growing regions (Liu *et al.,* 2013). In Nigeria, the leaf spots and rosette virus are the most serious damaging diseases of groundnut (Alabi *et al.,* 1993).

Late leaf spot (L.L.S) induced by *Phaeiosariopsis personata* (Van Arx) is commonly present wherever groundnut is grown (Bharat *et al.,* 2013). It is economically the most important fungal disease of groundnut in Nigeria and worldwide (Pande and Rao, 2001). It causes severe defoliation and reduces pod yield by more than 50 % if the crop is not protected with chemicals (Shew *et al.,* 1988). Fungicide is the most common and effective tool for controlling disease in plants but there has been growing concern over indiscriminate use of fungicides as they are potentially hazardous to the environment, applicator and non-target organisms (Shew *et al.,* 1988). This has led to the search for innovative approach of minimizing fungicide application with the aim of controlling plant diseases effectively and safely. The objective of this study was therefore to determine the minimum rate of Mancozeb + Carbendazim spray in the management of late leaf spot in Samaru, Zaria.

## MATERIALS AND METHODS

The experiment was conducted in 2015 at the Institute for Agricultural Research (IAR) Farm Samaru, Zaria, situated at 11° 10 ˈN, 07° 38 ˈE and 685 m above sea level in the Northern Guinea Savanna zone of Nigeria. The trial was established during the rainy season. Experimental land was ploughed, harrowed and ridged at 0.75 m spacing. SAMNUT – 14, a variety of groundnut susceptible to late leaf spot was planted at an intra-row spacing of 20 cm. Five frequencies (0, 1, 2, 3, and 4 weeks) of Mancozeb + Carbendazim spray which constituted the five treatments were evaluated. The experiment was in a Randomized Complete Block Design (RCBD) with three replications. The seeds were treated with Allstar (20 % Metalaxyl and 20 % imidacloprid) at the rate 4g/10kg seeds before sowing. Weeds were controlled using Buta-force (Butachlor 50% EC) a pre-emergence herbicide. The groundnut variety was sown on four ridges of 3 m long (9 $m^2$). Two unplanted ridges between the plots and 2 m between blocks served as border to minimize spray drifts. Natural infection in the field was relied upon as the source of inoculums during the growing season. Mancozeb + Carbendazim (Mancozeb: 20 % manganese and 2.5 % Zinc and 50 % carbendazim) was applied at the rate of 6.1 g/12.2 L according to manufacturer's recommendation to manage the disease. Plants were observed for development of disease symptoms.

### Data collection

Stand Count at Emergence (SCE) was taken two weeks after sowing while Stand Count at Harvest (SCH) was taken a week to harvest. At 60, 80 and 90 Days After Sowing (DAS) disease severity was scored based on 1 – 9 scale by Subrahmanyan *et al.,* (1995) as showed in Table 1 and percent severity and Area Under Disease Progress Curve (AUDPC) were calculated using the following formula:

$$\text{Disease Severity} = \frac{\text{Sum of all disease ratings}}{\text{Total no. of plants scored X Maximum disease score}} \times 100$$

Disease severity scores were used to calculate the Area Under Disease Progress Curve (AUDPC) using the following formula adopted from Bharat *et al.* (2013):

$$AUDPC = \sum_{i=1}^{n-1} \frac{Y_i + Y_{i+1}}{2} \times (T_{i+1} - T_i)$$

Where:
Yi = Disease severity (percent) at $i^{th}$ observation
Ti = Time (days) at $i^{th}$ observation
n = Total number of observation

The ratio of leaflets lost to the total number of leaflets per plant at a week to harvest was recorded and percent defoliation was computed using the formula:

$$\text{Percent Defoliation} = \frac{\text{Number of fallen leaflet /plant}}{\text{Total number of leaflet /plant}} \times 100$$

At maturity, the groundnuts were harvested by digging of the plants with hoe. The harvested plants were allowed to dry on the field. After drying, pods were picked, the weight of the haulms and pods were recorded.

**Data Analysis:**
Data collected were subjected to Analysis of Variance (ANOVA), using SAS Software version 9, Means were separated using Least Significant Difference (LSD) at 5 % level of probability.

**RESULTS**
Stand counts at emergence and at harvest did not differ significantly across all the treatments and were statistically similar as presented in Table 2. The result showed low disease severity at 60 DAS which did not differ significantly for all the treatments. $T_1$ (26.34%) and $T_2$ (25.72%) recorded low disease severity while $T_0$, $T_3$ and $T_4$ do not differ significantly and recorded high severity of 50.09%, 47.78% and 51.96% at 80 DAS respectively. At 90 DAS, lowest disease severity was recorded on $T_1$ (33.33%) followed by $T_2$ (56.41%). Disease severities recorded by $T_3$ (68.99%) and $T_4$ (75.99%) did not differ significantly and were higher than $T_0$ (87.04%) which had the highest severity at 90 DAS as shown in Table 3. Figure 1 shows the calculated values for Area Under Disease Progress Curve (AUDPC) over time under field condition. Unsprayed plants recorded the highest area under disease progress curve (2078.55) followed by plants sprayed every four weeks (2028.15) and those sprayed every three weeks (1964.45) which was higher compared to the plants sprayed biweekly. The least estimate of area under disease progress curve was observed in plants sprayed weekly. Percent defoliation significantly varied among the treatments with $T_0$ (41.60%) having the highest value that was statistically similar to $T_4$ (36.60%). $T_1$ recorded the lowest defoliation (2.10%), followed by $T_2$ (8.30%). Pod yield was highest in $T_1$ (1.72), lowest in $T_4$ (1.5) while $T_0$ (1.28), $T_2$ (1.33) and $T_3$ (1.43) did not differ significantly. Haulm recorded in $T_1$, $T_2$ and $T_3$ were statistically similar and significantly higher than $T_0$ and $T_4$ (Table 2). The correlation Coefficient between stand counts, disease severity, percent defoliation, pod and haulm yield are presented in Table 4. Disease severity at 80 and 90 DAS showed highly significant positive correlations (+0.87**and +0.92** respectively) with percent defoliation. Pod yield had highly significant negative correlation (-0.52*) with disease severity at 90 DAS. Pod yield had highly significant positive correlation (+0.56**) with haulm yield.

**DISCUSSION**
The results of the study show that, increase in frequency of Mancozeb + Carbendazim spray particularly at weekly and biweekly intervals resulted in a significant increase in pod and haulm yields compared to those sprayed at four weeks interval. Pande *et al.* (1998) reported that fungicide application on different groundnut varieties with different levels of resistance improved yield and biomass production about twice when compared with non – treated plots of same varieties. Waliyar *et al.* (1998) also reported significant increase in yield by one or two spray depending upon the suitable time of application. Vyas *et al.* (1986) recommended the application of Carbendazim and Mancozeb in middle of August for

control of early and late leaf spots of groundnut. Mittal (1996) reported that three sprays of Carbendazim at 10 days intervals can effectively control the late leaf spot of groundnut. The result of this study also revealed that application of mixture of Mancozeb and Carbendazim resulted in reduced disease severity. This agrees with Johnson *et al.* (1998) who studied effectiveness of different fungicide for the control of late leaf spot of groundnut under rain fed condition that spraying of fungicide mixture (Mancozeb 0.2% and Carbendazim 0.1%) effectively controlled the late leaf spot of groundnut leading to significant increase in pod and haulm yield. Singh and Singh (1977) who evaluated five fungicides against groundnut leaf spots reported Carbendazim as the most effective in controlling the disease along with the highest yield. The Area Under Disease Progress Curve (AUDPC) also varied among the five groundnut varieties and in all the spray frequencies evaluated which increases with an increase in severity. This result agrees with Fontem and Aighewi (1990) who reported that fungicide sprays significantly reduced epidemic rates and areas under disease progress curves of late blight of potato in the West Province of Cameroon. Chandra *et al.* (1998) also reported a significant reduction in disease index when Carbendazim + Mancozeb were applied at 30 to 80 DAS at 10 days interval. The pod yield correlated positively with disease severity indicating that late leaf spot caused significant yield reduction. The findings contradict David *et al*. (2015) negative correlation between pod yield and disease severity.

## CONCLUSION

The results of this study showed that, reducing the interval of spray resulted in disease reduction and increased in pod and haulm yields. Spraying at four weeks interval was not effective in reducing disease intensity. It can thus be concluded that spray interval of two weeks of Mancozeb and Carbendazim is optimum in the management of late leaf spot of groundnut. This will reduce the potential dangers of frequent use of pesticides to the environment. In line with this, therefore, use of foliar spray of fungicide at two weeks interval along with recommended agronomic practices is recommended in the management of late leaf spot of groundnut in the Nigerian savanna.

**Table 1**: Description of the 9 – point scale for late leaf spot assessment

| Description | Score | Disease Severity % |
|---|---|---|
| No disease. | 1 | 0 |
| Lesion present largely on lower leaves; no defoliation | 2 | 1- 5 |
| Lesion present largely on lower leaves; very few lesions on Middle leaves; defoliation of some leaflets evident on lower leaves. | 3 | 6 - 10 |
| Lesions are present on lower and middle leaves but severe on lower leaves; defoliation of some leaflets evident on lower leaves. | 4 | 11 - 20 |
| Lesions are present on all lower and middle; 50% defoliation of lower leaves. | 5 | 21 - 30 |
| Lesions severe on lower and middle leaves; lesions present on top leaves but less severe; extensive defoliation of lower leaves; defoliation of some leaflets evident on middle leaves. | 6 | 31 - 40 |

| | | |
|---|---|---|
| Lesions present on all lower leaves but less severe on top leaves; defoliation of all lower and some middle leaves. | 7 | 41 - 60 |
| Defoliation of all lower and middle leaves; lesions severe on top leaves and some defoliation of top leaves evident. | 8 | 61 - 80 |
| Defoliation of almost all leaves leaving bear stems; some leaflets may be present but severe leaf spots. | 9 | 81 - 100 |

Subrahmanyam *et al*. (1995).

**Table 2:** Effect of Frequency of Spray of Mancozeb + Carbendazim on Stand Count, Pod and Haulm Yield of Groundnut.

| Frequency Of spray (weeks) | Stand count at emergence | Stand count at harvest | Pod yield (kg/plot) | Pod yield (kg/ha) | Haulm yield (kg/plot) | Haulm yield (kg/ha) |
|---|---|---|---|---|---|---|
| $T_0$ | 38.33 | 36.67 | 1.28$^{ab}$ | 1444.4$^{ab}$ | 4.20$^{bc}$ | 4666.7$^{bc}$ |
| $T_1$ | 37.33 | 31.67 | 1.72$^{a}$ | 1907.4$^{a}$ | 5.23$^{ab}$ | 5814.4$^{ab}$ |
| $T_2$ | 38.33 | 30.00 | 1.33$^{ab}$ | 1481.5$^{ab}$ | 5.05$^{ab}$ | 5611.3$^{ab}$ |
| $T_3$ | 38.33 | 35.33 | 1.43$^{ab}$ | 1592.6$^{ab}$ | 6.08$^{a}$ | 6759.3$^{a}$ |
| $T_4$ | 33.33 | 27.67 | 1.15$^{b}$ | 1277.8$^{b}$ | 3.22$^{c}$ | 3574.1$^{c}$ |
| LSD | 11.011 | 9.8227 | 0.4816 | 530.63 | 1.7656 | 1961.8 |

Means within a column followed by the same letter are not significantly different at $P \leq 0.05$ by LSD.
$T_0$ = no spray; $T_1$ = spray weekly; $T_2$ = spray biweekly; $T_3$ = spray every 3 weeks; $T_4$ = spray every 4 weeks.

**Table 3:** Effect of Frequency of Spray of Mancozeb + carbendazim on Percent Defoliation and Severity of Late Leaf Spot of Groundnut

| Interval of spray (weeks) | disease severity percent at: | | | percent defoliation (%) |
|---|---|---|---|---|
| | 60 DAS | 80 DAS | 90 DAS | |
| $T_0$ | 22.30 | 50.09a | 87.04a | 41.60$^{a}$ |
| $T_1$ | 23.16 | 26.34b | 33.33d | 2.10$^{d}$ |
| $T_2$ | 21.58 | 25.72b | 56.41c | 8.30$^{c}$ |
| $T_3$ | 22.57 | 47.78a | 68.99b | 25.37$^{b}$ |
| $T_4$ | 21.72 | 51.96a | 75.99b | 36.60$^{a}$ |
| LSD | 1.9693 | 9.5436 | 8.6294 | 5.6318 |

Means within a column followed by the same letter are not significantly different at $P \leq 0.05$ by LSD.
$T_0$ = no spray; $T_1$ = spray weekly; $T_2$ = spray biweekly; $T_3$ = spray every 3 weeks; $T_4$ = spray every 4 weeks.

**Table 4:** Correlation Coefficient for stand count, disease severity, percent defoliation, pod and haulm yield.

| VAR. | SCE | SCH | DS60 | DS80 | DS90 | PD | PYP | HYP | PYH | HYH |
|---|---|---|---|---|---|---|---|---|---|---|
| SCE | 1.00 | | | | | | | | | |
| SCH | 0.79** | 1.00 | | | | | | | | |
| SD60 | S0.01 | 0.04 | 1.00 | | | | | | | |
| DS80 | -0.20 | 0.09 | 0.01 | 1.00 | | | | | | |
| DS90 | -0.04 | 0.24 | -0.23 | 0.85** | 1.00 | | | | | |
| PD | -0.01 | 0.26 | -0.18 | 0.87** | 0.92** | 1.00 | | | | |
| PYP | 0.39 | 0.34 | 0.28 | -0.48 | -0.53* | -0.46 | 1.00 | | | |
| HYP | 0.33 | 0.34 | 0.04 | -0.25 | -0.28 | -0.46 | 0.56 | 1.00 | | |
| PYH | 0.38 | 0.34 | 0.28 | -0.47 | -0.51* | -0.46 | 0.09** | 0.56** | 1.00 | |
| HYH | 0.33 | 0.34 | 0.04 | -0.25 | -0.28 | -0.44 | 0.56** | 1.00** | 0.56** | 1.00 |

* = significant at P ≤ 0.05, ** = significant at p ≤ 0.01

SCE = stand count emergence; = SCH = stand count at harvest; DS = disease severity; percent defoliation; PYP = pod yield /plot; HYP = haulm yield/plot; PYH = pod yield/ha; HYH = haulm yield/ha.

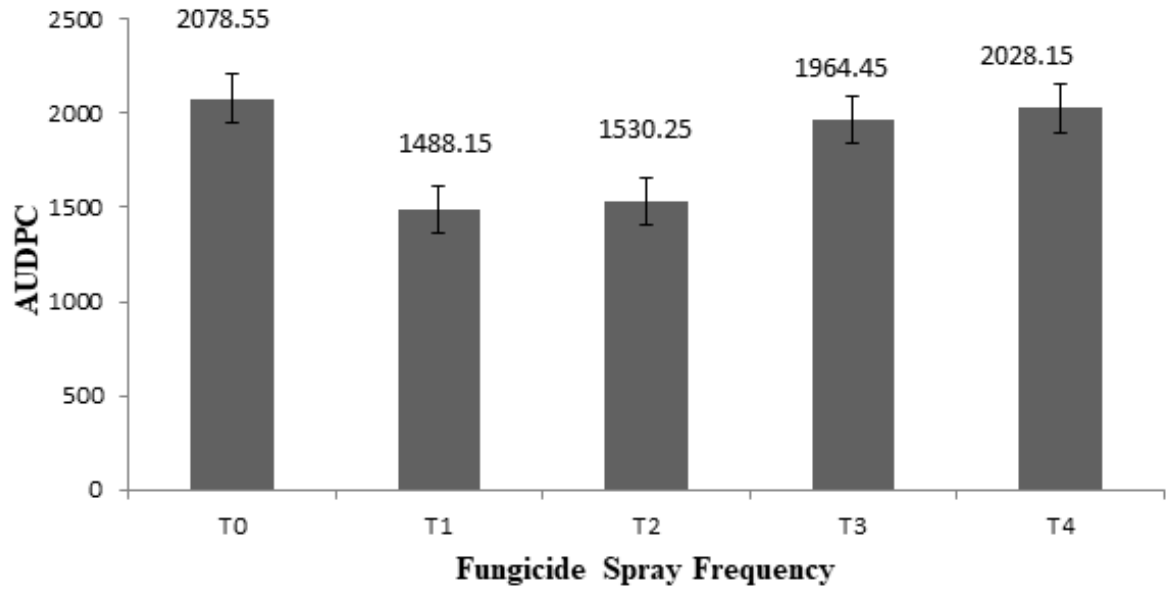


**Figure 1:** Cumulative area under disease progress curve for varying fungicide spray frequency in the field. **AUDPC** = Area under disease progress curve.
$T_0$ = Unsprayed plants; $T_1$ = Plants sprayed weekly; $T_2$ = Plants sprayed biweekly; $T_3$ = Plants sprayed every three weeks; $T_4$ = Plants sprayed every four weeks.

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