The impact of lime and root inoculum on maize in conservation farming basins

Introduction

The purpose of the trial is to find the impact of lime and root inoculum individually and jointly on maize yields in conservation farming basins in the region IIa agro-ecological zone.

Data

Table 1 shows the summary statistics of maize yields on the trials. The mean yield from 110 treatments was 4,682 kg ha^{-1} with a standard deviation of 1,474 kg ha^{-1}. The slightly lower median of 4,550 kg ha^{-1} suggest the distribution is nearly normal. The minimum yield was 1,896kg ha^{-1} and the maximum 7,900kg ha^{-1}.

Table 1 shows the summary statistics of maize yields on the trials.

Root inoculum and lime trial						
	n	**Mean**	**Median**	**StDev**	**Minimum**	**Maximum**
Yield	110	4,682kg	4,550kg	1,475kg	1,896kg	7,900kg

Table 2 shows the maize yields from each of the four treatments. The four treatments are 1) no lime and no inoculum, 2) inoculum and no lime, 3) lime and no inoculum and 4) lime and inoculum. The mean yield without lime or inoculum is 4,697 kg ha^{-1} with a standard deviation of 1,595kg; the mean yield with inoculum but no lime is 4,746 kg ha^{-1} with a standard deviation of 1,280kg; the mean yield with lime but no inoculum is 4,339 kg ha^{-1}; and the mean yield with both lime and inoculum is 5,945 kg ha^{-1}. The difference between the treatments by one-way analysis is not significant, the F-statistic of 0.79 fails to reject the null hypothesis at 3 and 106 degrees of freedom. It is interesting to note that the lime treatment (3) is less than the no lime treatment (1).

Table 2 shows the maize yields from each of the four treatments.

```
ANALYSIS OF VARIANCE ON Yield
SOURCE     DF         SS         MS         F         p
C104        3    5168154    1722718      0.79     0.503
ERROR     106  231850096    2187265
TOTAL     109  237018256
                                      INDIVIDUAL 95% CI'S FOR MEAN
                                      BASED ON POOLED STDEV
 LEVEL      N       MEAN      STDEV  -----+---------+---------+---------+-
     1     29       4697       1595           (----------*----------)
     2     27       4746       1280            (----------*----------)
     3     27       4339       1444  (-----------*----------)
     4     27       4945       1567                (----------*----------)
                                      -----+---------+---------+---------+-
POOLED STDEV =     1479               4000      4500      5000      5500
```

Table 3 shows the distributions of maize yields with and without lime. The average yield of maize without lime is 4,721 kg ha^{-1} with a standard deviation of 1,439 kg ha^{-1} and 4,642kg ha^{-1} with

lime, with a standard deviation of 1,523kg. There is no significant difference between them; the F-statistic of 0.08 fails to reject the null hypothesis at one and 108 df.

Table 3 shows the distributions of maize yields with and without lime.

```
ANALYSIS OF VARIANCE ON Yield
SOURCE     DF        SS        MS        F        p
Lime        1    172116    172116     0.08    0.780
ERROR     108 236846144   2193020
TOTAL     109 237018256
                                    INDIVIDUAL 95% CI'S FOR MEAN
                                    BASED ON POOLED STDEV
 LEVEL      N      MEAN     STDEV  -+---------+---------+---------+-----
    -1     56      4721      1439      (---------------*---------------)
     1     54      4642      1523   (---------------*---------------)
                                    -+---------+---------+---------+-----
POOLED STDEV =     1481           4250      4500      4750      5000
```

Table 4 shows the distributions of maize yields with and without inoculum The average yield of maize without inoculum is 4,524 kg ha^{-1} with a standard deviation of 1,521kg, and with inoculum, 4,846 kg ha^{-1} with a standard deviation of 1,421kg. The difference is not significant with a F-statistic of 1.31 at one and 108 degrees of freedom.

Table 4 shows the distributions of maize yields with and without inoculum.

```
ANALYSIS OF VARIANCE ON Yield
SOURCE     DF        SS        MS        F        p
Inoculum    1   2840907   2840907     1.31    0.255
ERROR     108 234177344   2168309
TOTAL     109 237018256
                                    INDIVIDUAL 95% CI'S FOR MEAN
                                    BASED ON POOLED STDEV
 LEVEL      N      MEAN     STDEV  ---+---------+---------+---------+---
    -1     56      4524      1521   (------------*------------)
     1     54      4846      1421              (-------------*------------)
                                    ---+---------+---------+---------+---
POOLED STDEV =     1473            4200      4500      4800      5100
```

Table 5 shows the distributions of maize yields in Western, Southern and Central regions. The mean yield from all the treatments in Western region is 5,242kg ha^{-1} with a standard deviation of 1,469kg; the mean yield in Southern region is 4,620kg ha^{-1} with a standard deviation of 1,463kg; and the mean yield in Central region is 4,017kg ha^{-1} with a standard deviation of 1,224kg. With the F-statistic of 6.58 and two and 107 degrees of freedom, the null hypothesis that the means are from the same population fails to be accepted.

Table 5 shows the distributions of maize yields in Western, Southern and Central regions.

```
ANALYSIS OF VARIANCE ON Yield
SOURCE      DF         SS         MS         F         p
Region       2   25968140   12984070      6.58     0.002
ERROR      107  211050112    1972431
TOTAL      109  237018256

                                      INDIVIDUAL 95% CI'S FOR MEAN
                                      BASED ON POOLED STDEV
 LEVEL       N       MEAN      STDEV  --+---------+---------+---------+----
     0      40       5242       1469                        (------*-------)
     1      40       4620       1463               (------*------)
     2      30       4017       1224  (--------*-------)
                                      --+---------+---------+---------+----
POOLED STDEV =      1404            3600       4200       4800       5400
```

Results

The data are combined in a general linear model that includes interaction effects between lime and the inoculum, and incorporates the site mean as a controlling variable with its associated interaction effects with lime and inoculum. Table 6 shows the results of the general linear model. The site mean, which is equivalent to the factor of the trial sites themselves, explains most of the variance and is highly significant, as expected. The impact of lime on its own is not significant with an F-statistic of 0.58, but inoculum is important with a high F-statistic of 27.69, against one and 95 degrees of freedom. The implication that inoculum increases the adjusted mean yield from 4,425kg ha^{-1} to 4,875kg ha^{-1}, an increase of 10.12 per cent. The inoculum also interacts with lime, increasing yield slightly, by 3.5 per cent.

There is no interaction between the sitemean and either lime or inoculum. Figure 1 shows maize yields with and without lime. The black line represents the cost of lime in terms of yield. The breakeven point when lime becomes viable is around 7,000kg ha^{-1}, which is very high. Figure 2 shows maize yields with and without inoculum. The black line represents the cost of inoculum in terms of yield. There is a significant increase in yield from inoculum that applies to all levels of farmer management capability.

Table 6 shows the results of the general linear model.

```
F-test with denominator: Error
Denominator MS =  180294 with  95 degrees of freedom

Numerator           DF   Seq MS      F       P
Sitemean             1 1.95E+08  1E+03   0.000
Lime                 1   104709   0.58   0.448
Inoculum             1  4993045  27.69   0.000
Lime*Inoculum        1  1153067   6.40   0.013
Lime*Sitemean        1   250255   1.39   0.242
Inoculum*Sitemean    1    34218   0.19   0.664
```

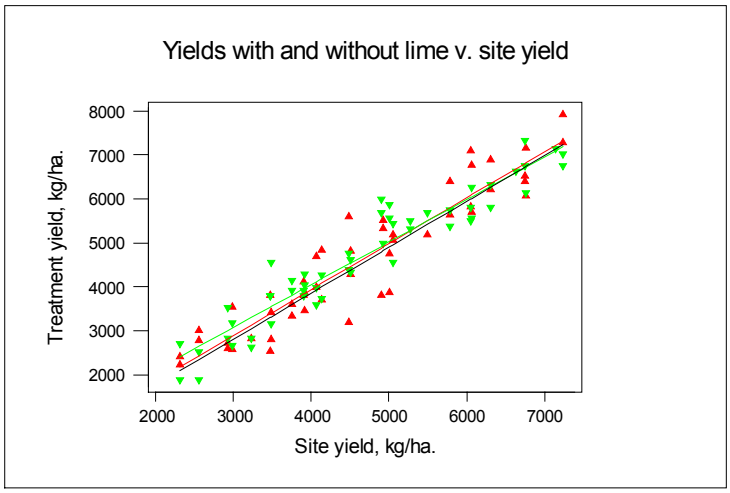

Figure 1 shows maize yields with and without lime. The black line represents the cost of lime in terms of yield.

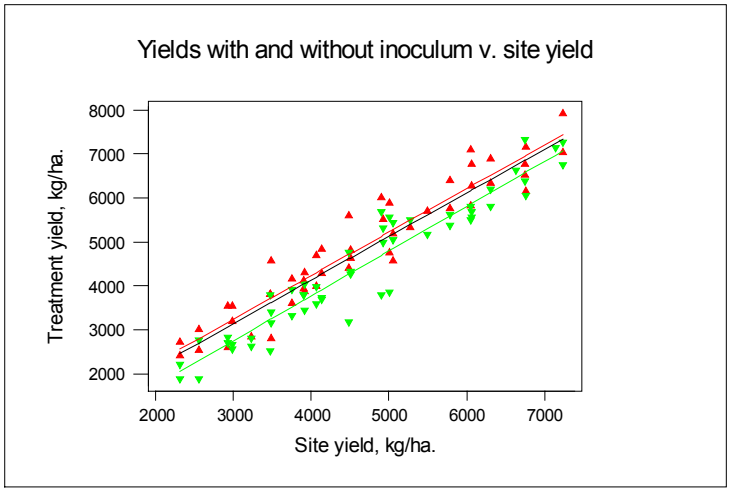

Figure 2 shows maize yields with and without inoculum. The black line represents the cost of inoculum in terms of yield.

Conclusions

1) There is no independent impact of lime on maize yields in conservation farming basins from the root inoculum and lime trials in region IIa. There is however, some interaction between lime and the inoculum that causing maize yields to be 3.5 per cent higher if lime is applied with inoculum. This interaction, however is not sufficient to cover the K50,000 (US$10) cost of lime until around 7,000kg ha^{-1}.

2) There is a 10.12 per cent increase in maize yield due to the application of root inoculum when used in conservation farming basins in the region IIa agro-ecological zone. The increase covers the K60,000 (US$12) cost of the inoculum, but importantly, the yield increase is not a function of farmer skill.