Effect of Time and Rate of Application of Bateleur Gold (S-Metolachlor + Flumetsulam) on Phytotoxicity and Weed Control Efficacy in Flue-cured Tobacco

By

U. Mazarura
Research Article

Effect of Time and Rate of Application of Bateleur Gold (S-Metolachlor + Flumetsulam) on Phytotoxicity and Weed Control Efficacy in Flue-cured Tobacco

U. Mazarura

University of Zimbabwe, Crop Science Department, P. O. Box MP 176 Mt Pleasant, Harare, Zimbabwe.

Email: umazarura@agric.uz.ac.zw

ABSTRACT

Herbicides are usually the first line of defence against weeds and form a formidable pair with mechanical control whether with machinery of hand hoeing. Due to the risk of weed resistance to herbicide control and environmental contamination, there is continuous need for new chemicals to be tested for control of weeds. In this work, the herbicide Bateleur Gold, a factory premix of s-metolachlor and flumetsulam was evaluated to establish the time and rate of application that would give efficacious weed control without causing phytotoxicity. In the first year, the herbicide was included in a screening trial comprising twelve herbicides arranged in a randomised complete block design. After good efficacy when applied immediately after planting, it was selected for further development. In the second year, in a split plot design with four blocks and four treatments, it was applied at 0.455 kg a.i ha\(^{-1}\) applied just after holing out (a.h.o) and at the same rate immediately after planting (i.a.p). A positive control Dual Magnum (s-metolachlor) at 2.2 kg a.i ha\(^{-1}\) i.a.p was used as a check and an untreated control was included. This trial showed that applied a.h.o, Bateleur Gold neither stunted Tobacco nor reduced yield but somewhat reduced weed efficacy especially overall (total weeds) nor grasses while the i.a.p. was ideal and showed no phytotoxicity and had good weed efficacy. In the third year, the i.a.p time of application was tested in a similar design but now more rates of Bateleur Gold were tested. The rates were, Bateleur Gold at 0.455, 0.92, 1.365 and 1.82 kg a.i.ha\(^{-1}\). Dual Magnum at 2.2 kg a.i.ha\(^{-1}\) i.a.p was again included as a check. This work confirmed the potential of the herbicide as a broad spectrum material and showed that the best rate that would ensure broad spectrum control was 0.92 kg a.i.ha\(^{-1}\). Further research could look at application of this material in irrigation water in order to cater for those farmers with centre pivots. In addition, although application a.h.o. does not cause stunting of Tobacco; more work may be needed to show this with greater confidence.

Keywords: Bateleur Gold, flue-cured, tobacco, s-metolachlor, flumetsulam.

INTRODUCTION

Weeds are a major threat in all farming systems and herbicides are an effective first line of defense against weeds. A Tobacco crop competes poorly against weeds during the first four weeks after transplanting, mainly because of transplanting shock. Hence there is a great need for very effective weed control during this phase of growth, after which the crop is able to smother weeds. Herbicides have been to improve yield by up to 100% over untreated controls (Dhanapal, Berg & Struik 1998) and herbicide usage is normally associated with best weed control strategy a farmer can employ (Tremola & Carotenuto 1996; Yousafzai et al. 2007). Usually a Tobacco plant loses a kilogram of growth for every kilogram of weed growth. Herbicide efficacy depends on many factors such as application rate, time and method. Bateleur Gold (s-metolachlor + flumetsulam) is a factory mix of 630 g/L s-metolachlor and 20 g/L flumetsulam which is applied as a pre-emergent herbicide. This trial was the first time it was tested on Tobacco in the region. Flumetsulam is a sulfonanilide herbicide which inhibits the Acetolactate Synthase enzyme (ALS) and in particular, the formation of the amino acids valine, leucine and isoleucine. This herbicide was expected to show phytotoxicity in Tobacco as broadleaf crops are known to be sensitive (O’Sullivan, Thomas & Bouw 1999) even to carry over residues (Noy & Hollaway 1999). Dual Magnum (Metolachlor), 2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl) acetamide, inhibits the biosynthesis of very long chain fatty acids. The herbicide inhibits cell growth and cell division by perturbation of membrane formation, which subsequently leads to shoot and root growth inhibition in seedling weeds. This is how they, in pre-emergence applications, prevent weed seedling emergence of numerous annual grasses, nut sedges and some broadleaf weeds (Armel et al. 2008).

Wise herbicide usage requires weed identification, soil texture, soil organic matter, soil preparation, spray equipment and herbicide incorporation considerations (Johnson 2008). Herbicides applied before transplanting
have the potential to inhibit root growth and hence early plant growth and development. This risk is usually less for herbicides applied at or within a short time after transplanting (Johnson 2008). Herbicides may also pose a risk to the crops following Tobacco in a rotation.

By and large, herbicide usage in Tobacco and indeed many other crops has several vital benefits. When used as supplement to other components of integrated weed management, herbicides become a vital and useful component leading to very good weed control. Herbicides lead to good early season control, reducing weed competition and give a young crop an important advantage over weeds. In most cases hand weeding is reduced or made faster, thus lowering the cost of hand weeding. In other cases, when fields become inaccessible because of wet periods, herbicides could be the only viable control method affording weed suppression following transplanting.

The aim of this trial was to establish the time and rate of application of the herbicide Bateleur Gold (s-metolachlor + flumetsulam) which would be efficacious without being phytotoxic.

MATERIALS AND METHODS

Site Considerations

This study was carried out at Kutsaga Research Station (17° 55’ S, 31° 08'; 1480masl, 882mm average annual rainfall), Zimbabwe on a sandy Loam soil (72.8% sand, 8.8% silt and 18.4% clay).

Experimental Design and Protocols

The Tobacco variety T26 was used for this experiment and the experiment was a split plot of two main plots (weedy and weed free) and 4 subplots in year 2 and 6 subplots in the 3rd year. Phytotoxicity was estimated in the weed free main plot and herbicide efficacy in the weedy plots. The subplots during the 2nd year of trial were the following 4 treatments:

1. Bateleur Gold 0.455 kg a.i ha\(^{-1}\) after holing out (a.h.o.)
2. Bateleur Gold 0.455 kg a.i ha\(^{-1}\) immediately after planting (i.a.p.)
3. Dual Magnum 2.2 kg a.i. ha\(^{-1}\) i.a.p
4. Untreated control

In the third year the subplots were:

1. No herbicide application
2. Bateleur Gold 0.455 kg a.i ha\(^{-1}\) immediately after planting (i.a.p.)
3. Bateleur Gold 0.92 kg a.i ha\(^{-1}\) i.a.p
4. Bateleur Gold 1.365 kg a.i ha\(^{-1}\) i.a.p
5. Bateleur Gold 1.82 kg a.i ha\(^{-1}\) i.a.p
6. Dual magnum 2.2 kg a.i. ha\(^{-1}\) i.a.p

A calibrated knapsack was used to apply all herbicides. Weed counts were done with seven 0.3 x 0.3 m quadrants arranged to go across the width of two harvested rows such that the two sides and tops of the rows and the middle furrow were sampled. This was done at 3 positions in each treatment subplot. The full plot for each treated plot was 4.8 m x 17.92 m (i.e. 4 rows) and the harvested or assessed plot was 2.4 m x 16.80 m (i.e. 2 rows). Weed counts & dry mass were measured in the quadrants as described above.

Measurements

Stalk height measurement was done at chosen periods in the weeded subplots. Weed counts were done at 35 d.a.p. in year 2 and at 42, 55, 67, 85 and 166 d.a.p. in year 3. Weed dry mass and crop yield was taken at the end of the experiment. Counts were transformed (square root) and Analysis of Variance (ANOVA) carried out while Fischer’s Protected Least Significant Difference (LSD) test was used for mean separation.
Field management

The land used for the trial was rotated to a Nematode resistant grass, *Chloris gayana* cv Katambora Rhodes grass for three years. Regardless, Ethyl Dibromide (EDB) (98%) applied by tractor mounted applicator at 125 ml/100m of ridge was used for all plots to control Nematodes. Sprinkler irrigation was used to irrigate the crop at 50% moisture depletion. The ploughed and disced land was transplanted to tobacco on 0.2m high ridges at a spacing of 1.2 m between rows and 0.56 m apart in row. Weeding in the weed free plot was done by hand and by herbicide as per treatment. All herbicides were applied as per treatment and settled in with an irrigation of 12 mm.

The land was pre-irrigated to field capacity before transplanting. Tobaccoreft (6-18-15) at 700 kg ha\(^{-1}\) was applied as basic fertilizer and Ammonium nitrate (34-0-0) at 100 kg N ha\(^{-1}\) and 10 kg N ha\(^{-1}\) as topdressing at 3-4 weeks after planting and at topping, respectively. The fertilizer was dolloped 10 cm from the plant and 5 cm deep.

RESULTS

In this experiment, Bateleur Gold 650EC (a factory mix of s-metolachlor and flumetsulam) was studied and Dual magnum (metolachlor at 2.2 kg a.i. ha\(^{-1}\)) product) was included as a control. In the 2\(^{nd}\) year of trial Bateleur Gold was applied at 0.455 kg a.i. ha\(^{-1}\) either i.a.p. or a.h.o. and in the 3\(^{rd}\) year at 0.455, 0.92, 1.365 and 1.82 kg a.i. ha\(^{-1}\) i.a.p.

(a) Broadleaf Weeds Control

Weed control at 35 d.a.p. was poor with the Bateleur Gold regardless of time of application during the 2\(^{nd}\) year of the trials. The metolachlor alone (Dual Magnum) treatment gave the best control (Table 1). At 42 d.a.p. Dual Magnum gave the best control while the other rates except Bateleur Gold at 0.455 kg a.i ha\(^{-1}\) were the same and better than the control (Table 2). At 55, however, all treatments were the same whether Dual Magnum and the highest Bateleur Gold rate tended to stand out. At both rates there was a significant (P<0.05) linear relationship between broadleaf control and herbicide rate (Table 2). In general, at 67, 85 and 166 d.a.p. broad leaf control was similar for Dual Magnum and Bateleur Gold at 1.365 and 1.82kg a.i. ha\(^{-1}\) and similarly the linear relationship was significant (P<0.05) (Table 3).

(b) Grass & Nut Sedge Control

Applied i.a.p. and a.h.o., Bateleur Gold gave better control than the untreated control. For the i.a.p. treatment, this control was as good as that of Dual Magnum alone. Grass control was best with Dual Magnum followed by the i.a.p. treatment and lastly the a.h.o treatment. Although the a.h.o. treatment compromised weed efficacy relative to the i.a.p. treatment, it was better than the untreated control (Table 1). Nut sedge control was essentially the same for all the herbicides at all dates (42, 55, 67, 85 and 166 d.a.p.) of assessment (Table 2 & 3) except that the lowest rate of Bateleur Gold tended to give poor control. A significant (P<0.05) linear relationship could only be established at 85 and 166 d.a.p. although at P<0.1 the linear relationship was consistent throughout. The grass control was similar to the nut sedge control for all assessment dates and the linear relationship was not significant (Table 2 & 3).

(c) All weeds, Together

With regards to all weeds the efficacy of the herbicides could be arranged as Dual Magnum > Bateleur Gold i.a.p. > Bateleur Gold a.h.o. All herbicides were better than the untreated control (Table 1). Overall, the control for total weeds (Table 2 & 3) and dry mass (Table 4) reflected the average control for all the weeds and showed all rates except the lowest rate of Bateleur Gold giving similar weed control. The trend shown in the control of all weed types in the 3\(^{rd}\) years was confirmed by the weed dry mass at both 42 and 166 d.a.p. (Table 5).

(d) Phytotoxicity and Yield

An examination of the yield in Year 2 showed that weeds suppressed yield significantly (P<0.05) (compare weedy and weed free plots in the control). A similar comparison shows how excellent control was for Dual Magnum. The Bateleur Gold at i.a.p. and a.h.o. treatments, although they were better than the control, showed compromised control, with the a.h.o. treatment giving the worst control among the herbicide treated plots (Table 4). No stunting of the crop was evident for all herbicides in year 2 (Table 4). The results were similar for year 3 except that there was a slight but significant (P<0.05) stunting by Dual Magnum relative to the control at 49 d.a.p (data not shown) and subsequently there was a resultant suppression of yield (compare weed free plots, Table 5) perhaps a lower overall weed control also contributed to this (compare weedy plots). A comparison of the weedy plots shows that Bateleur Gold at 0.92 gave the highest yield.
Table 1: No of weeds /m² at 35 d.a.p. (Sqrt transformed-Year 2).

| Treatment                  | Broad Leaf | Nut sedge | Grasses | Total |
|----------------------------|------------|-----------|---------|-------|
| Bateleur Gold a.h.o.       | 3.76       | 2.99      | 6.41    | 8.01  |
| Bateleur Gold i.a.p.       | 4.02       | 1.93      | 3.98    | 5.86  |
| Dual Magnum                | 2.49       | 1.17      | 1.48    | 3.23  |
| Untreated control          | 4.26       | 4.06      | 9.72    | 11.37 |
| LSD                        | 0.95*      | 1.13*     | 1.29*   | 1.13* |

Table 2: No of weeds /m² at 42, and 55 d.a.p. (Sqrt transformed-Year 3)

(a) 42 days after sowing

| Treatment                                      | Broad Leaf | Nut sedge | Grasses | All Weeds |
|------------------------------------------------|------------|-----------|---------|----------|
| No herbicide                                   | 12.40      | 4.54      | 14.14   | 19.38    |
| Bateleur Gold 0.455kg a.i ha⁻¹                 | 4.22       | 1.10      | 1.10    | 4.45     |
| Bateleur Gold 0.92 kg a.i ha⁻¹                 | 1.93       | 1.03      | 0.82    | 2.09     |
| Bateleur Gold 1.365 kg a.i ha⁻¹                | 2.11       | 0.71      | 1.05    | 2.24     |
| Bateleur Gold 1.82kg a.i ha⁻¹                  | 1.87       | 0.94      | 1.10    | 2.16     |
| Dual Magnum (metolachlor) 2.2 kg a.i ha⁻¹      | 0.94       | 0.71      | 0.71    | 0.94     |

F-Test probabilities

| Treatment                  |          |          |         |         |
|----------------------------|----------|----------|---------|---------|
| Treatment                  | 0.004    | 0.59     | 0.78    | 0.01    |
| Bateleur Gold Linear       | 0.01     | 0.42     | 0.87    | 0.02    |
| LSD (treatment)            | 1.3*     | 0.69     | 0.89    | 1.59    |

(a) 55 days after sowing

| Treatment                                      |          |          |         |         |
|------------------------------------------------|----------|----------|---------|---------|
| No herbicide                                   | 5.81     | 3.89     | 6.38    | 9.61    |
| Bateleur Gold 0.455kg a.i ha⁻¹                 | 3.86     | 1.36     | 1.78    | 4.49    |
| Bateleur Gold 0.92 kg a.i ha⁻¹                 | 3.50     | 0.71     | 1.05    | 3.59    |
| Bateleur Gold 1.365 kg a.i ha⁻¹                | 2.09     | 0.71     | 1.45    | 2.44    |
| Bateleur Gold 1.82kg a.i ha⁻¹                  | 1.59     | 0.71     | 1.49    | 2.02    |
| Dual Magnum (metolachlor) 2.2 kg a.i ha⁻¹      | 1.87     | 1.25     | 0.91    | 2.22    |

F-Test probabilities

| Treatment                  |          |          |         |         |
|----------------------------|----------|----------|---------|---------|
| Treatment                  | 0.06     | 0.17     | 0.55    | 0.07    |
| Bateleur Gold Linear       | 0.01     | 0.09     | 0.80    | 0.01    |
| LSD (treatment)            | 1.75     | 0.74     | 1.27    | 1.86    |
Table 3: No of weeds /m² at 67, 85 and 166 d.a.p. (Sqrt transformed-Year 3).

| Treatment                        | Broad Leaf | Nut sedge | Grasses | All Weeds |
|----------------------------------|------------|-----------|---------|-----------|
| (a) 67 days after planting       |            |           |         |           |
| No herbicide                     | 5.98       | 4.52(20.4)| 5.32    | 9.29      |
| Bateleur Gold 0.455 kg a.i ha⁻¹   | 4.28       | 1.72 (2.95)| 1.81    | 4.88      |
| Bateleur Gold 0.92 kg a.i ha⁻¹    | 3.78       | 1.11(1.23)| 0.91    | 3.92      |
| Bateleur Gold 1.365 kg a.i ha⁻¹   | 2.87       | 1.11(1.23)| 0.91    | 3.09      |
| Bateleur Gold 1.82kg a.i ha⁻¹     | 1.79       | 1.11(1.23)| 1.15    | 2.24      |
| Dual Magnum (metolachlor) 2.2 kg a.i ha⁻¹ | 2.16 | 1.25(1.56) | 0.71 | 2.39 |
| F-Test probabilities            |            |           |         |           |
| Treatment                        | 0.07       | 0.27      | 0.09    | 0.05      |
| Bateleur Gold Linear             | 0.01       | 0.09      | 0.12    | 0.01      |
| LSD (treatment)                  | 1.86       | 0.69      | 0.89    | 1.59      |
| (a) 85 days after planting       |            |           |         |           |
| No herbicide                     | 6.70       | 4.12      | 4.56    | 9.30      |
| Bateleur Gold 0.455kg a.i ha⁻¹    | 4.48       | 1.87      | 1.45    | 5.00      |
| Bateleur Gold 0.92kg a.i ha⁻¹     | 3.66       | 0.71      | 1.11    | 3.75      |
| Bateleur Gold 1.365kg a.i ha⁻¹    | 2.66       | 0.71      | 1.25    | 2.91      |
| Bateleur Gold 1.82kg a.i ha⁻¹     | 1.81       | 1.05      | 0.91    | 2.06      |
| Dual Magnum (metolachlor) 2.2 kg a.i ha⁻¹ | 2.38 | 1.05 | 0.71 | 2.51 |
| F-Test probabilities            |            |           |         |           |
| Treatment                        | 0.0033     | 0.02      | 0.49    | 0.002     |
| Bateleur Gold Linear             | 0.0003     | 0.02      | 0.30    | 0.001     |
| LSD (Treatment)                  | 1.10       | 0.64      | 0.97    | 1.10      |
| (b) 166 days after planting      |            |           |         |           |
| No herbicide                     | 5.01       | 2.77      | 4.21    | 7.11      |
| Bateleur Gold 0.455kg a.i ha⁻¹    | 3.33       | 1.66      | 1.11    | 3.80      |
| Bateleur Gold 0.92kg a.i ha⁻¹     | 2.29       | 0.71      | 0.71    | 2.29      |
| Bateleur Gold 1.365kg a.i ha⁻¹    | 2.04       | 0.71      | 0.91    | 2.14      |
| Bateleur Gold 1.82kg a.i ha⁻¹     | 1.25       | 1.15      | 0.71    | 1.54      |
| Dual Magnum (metolachlor) 2.2 kg a.i ha⁻¹ | 1.45 | 0.91 | 0.71 | 1.56 |
| F-test probabilities             |            |           |         |           |
| Treatment                        | 0.03       | 0.05      | 0.15    | 0.02      |
| Bateleur Gold Linear             | 0.01       | 0.13      | 0.10    | 0.004     |
| LSD (Treatment)                  | 1.26       | 0.65      | 0.39    | 1.27      |
Table 4: Total saleable yield (kg ha\(^{-1}\)), stalk height and dry mass (Year 2).

| Treatment                        | Weedy   | Weedy free | Stalk height (52 d.a.p) | Dry mass (log) |
|----------------------------------|---------|------------|-------------------------|----------------|
| Bateleur Gold 0.455 kg a.i. a.h.o.| 2064    | 3163       | 66.6                    | 1.35           |
| Bateleur Gold 0.455 kg a.i. i.a.p.| 2571    | 3185       | 68.7                    | 0.73           |
| Dual Magnum (metolachlor)        | 3048    | 3197       | 66.3                    | 0.49           |
| Untreated control                | 1889    | 3076       | 69.4                    | 1.88           |
| LSD (Stalk height & Dry mass)    |         |            | 3.38                    | 1.00           |
| Herbicide within each cultivation |         |            | 205.37*                 |                |
| Herbicide in different cultivations|        |            | 324.88*                 |                |

Table 5: Total saleable yield (kg ha\(^{-1}\)) and weed dry mass (Year 3)

| Treatments                        | Main plots | Weed dry mass g/m\(^2\) |
|-----------------------------------|------------|-------------------------|
|                                   | Weedy | Weed free | 42 dap | 166 dap |
| No herbicide                      | 2995  | 3949       | 22.62  | 111.58  |
| Bateleur Gold 1.82kg a.i ha\(^{-1}\)| 3561  | 3913       | 0.90   | 8.60    |
| Bateleur Gold 1.82kg a.i ha\(^{-1}\)| 3997  | 3691       | 0.68   | 1.26    |
| Bateleur Gold 0.92kg a.i ha\(^{-1}\)| 3551  | 3854       | 0.09   | 2.75    |
| Bateleur Gold 1.82kg a.i ha\(^{-1}\)| 3628  | 3824       | 0.25   | 0.27    |
| Dual Magnum (metolachlor)         | 3374  | 3639       | 0.01   | 0.37    |

F-test probabilities

| Treatment                        | Treatment | Bateleur Gold Linear | LSD (Treatment) |
|----------------------------------|-----------|----------------------|-----------------|
|                                  | 0.16      | 0.73                 | 500.4           |
|                                  | 0.39      | 0.83                 | 344.7           |

DISCUSSION

Broadleaf Control

In the first of a series of three year trials, Bateleur Gold was screened. The screening trial included twelve materials from various herbicide manufacturing companies. In this trial, it was applied by knapsack immediately after transplanting (data not shown). As a result of its good efficacy in this trial, it was chosen for detailed tests to investigate its efficacy when applied both immediately after planting (i.a.p.) and after holing out (a.h.o.). Thus in year 2 it was applied at 0.455 kg a.i. ha\(^{-1}\) immediately after planting (i.a.p.) and after holing out (a.h.o).

The common broadleaf weeds encountered were Hibiscus museei, Acanthospermum hispidum, Tagetes minuta, Richardia scabra, Amaranthus hybridus, Portulaca oleracea and Bidens pilosa.

The i.a.p. treatment was a spray soon after transplanting while the a.h.o treatment was done just before planting but after planting positions had been marked manually on the ridges. In essence, the efficacy of the two
application times was the same probably indicating reduced risk of phytotoxicity for the mix than would be expected for the individual herbicides.

Nut sedge Control

The common nut sedge species present in the plots was *Cyperus rotundus*. The rate used for Dual Magnum was the 2.2 kg a.i. /ha which is recommended for broadleaf, grasses and nut sedge control. In year 2, although the a.h.o. and i.a. treatments gave similar control, the i.a.p. treatment gave control as good as by Dual Magnum (positive control). This is significant since Dual Magnum is the most popular pre-plant herbicide in the region and also across cropping systems. Year 3 results indicated that all rates of Bateleur Gold were effective and gave control comparable to that of Dual Magnum. The good control of nut sedge was not anticipated since s-metolachlor in the factory mix was below the rate (2.2 kg a.i.) that is known to be necessary for yellow nut sedge control. This suggests that there could be synergism in the mix. However, such findings arguably make the herbicide more valuable in tobacco production as yellow nut sedge is an important weed of Tobacco in the region.

Grass Weeds Control

The common grass weeds encountered in the plots included *Rottboliea conchichinensis*, *Setaria pumula*, and *Eleusine indica*. Bateleur Gold applied at 0.455 kg a.i. ha⁻¹ a.h.o. compromised grass weed control showing perhaps that at this level the s-metolachlor component of the mix was below the threshold for grass control. The i.a.p. timing, although better than the a.h.o. treatment, was also not as good as Dual Magnum, perhaps for the same reason given above. In the subsequent year of trial, however, the same rate but applied i.a.p. and at higher rates showed similar control although the 0.455 kg a.i. ha⁻¹ rate seemed consistent in giving somewhat reduced efficacy confirming, perhaps the earlier suggestion.

Overall Weed Control

In terms of total weed control the superiority of the i.a.p. over the a.h.o. was confirmed. In year 3, the weed dry mass comparisons also reinforced the observations from weed counts and suggested perhaps that the best rate could be the 1.365 kg a.i. ha⁻¹ as it seemed to give a consistent overall weed control efficacy across weed types.

Yield and Stalk Height

In the second year, this work showed that Bateleur Gold a.h.o compromised grass and overall weed control (Table 5) but did not show any phytotoxicity (Table 4). This is an important finding for farmers likely to favour this type of application and machinery incorporation in one pass. However, more research would be needed to confirm this aspect with a larger measure of confidence. Usually applications a.h.o. have a risk of phytotoxicity as herbicide is most likely to easily reach the root system at planting since the tradition is to apply water to an opened planting hole followed by inserting a seedling into the hole. Such effects of herbicides, when applied at pre-planting, have been reported with other herbicides (Johnson 2008) and mixtures of s-metolachlor and flumetsulam in Lima Bean (*Phaseolus lunatus*) (Vangessel, Monks & Johnson 2000) and white bean, *Phaseolus vulgaris* L. (Soltani et al. 2004). Trials in year 3 deliberately chose the i.a.p. application as it is normal practice and has been shown to hold less risk for phytotoxicity (Johnson 2008).

CONCLUSIONS AND RECOMMENDATIONS

Overall, Bateleur Gold may be applied i.a.p based mainly on weed control findings. If this herbicide is applied a.h.o., it does not cause stunting of Tobacco, but more work may be needed to show this with greater confidence. Further research could look at application of this material in irrigation in order to cater for those farmers with centre pivots.

ACKNOWLEDGEMENTS

I unreservedly thank the Tobacco Research Board of Zimbabwe for funding all aspects of this work.

REFERENCES

Armel, G, Rhodes, GN, Klingeman, W, Steckel, L & Breeden, G (2008), *Common Commercial Pre-packaged Herbicide Mixtures*, University of Tennessee Extension., USA.
Dhanapal, GN, Borg, SJ & Struik, PC (1998), ‘Post Emergence Chemical Control of Nodding Broomrape (orobanche cernua) in bidi Tobacco (Nicotiana tabacum) in India.’, Weed Technology, vol. 12, no. 4, pp. 652–659.

Johnson, CJ (2008), Weed Control in Burley Tobacco., Virginia Cooperative Extension, USA, pp. 49–55.

Noy, D & Hollaway, K 1999, ‘Leaching and Persistence of Flumetsulam and Imazethapram’, Twelfth Australian Weeds Conference Proceedings.

O’Sullivan, J, Thomas, RJ & Bouw, WJ (1999), ‘Yield and Injury Effects on Vegetable Crops Planted in Flumetsulam-treated Soil’, Can. J. Plant Sci., vol. 79, pp. 417–420.

Soltani, N, Shropshire, C, Cowan, T & Sikkema, P (2004), ‘White Bean Sensitivity to Preemergence Herbicides’, Weed Technology, vol. 18, no. 3, pp. 675–679.

Tremola, MG & Carotenuto, R 1996, ‘Weeds and Weed Control. Tobacco’, vol. 4, pp. 15–22.

Vangessel, MJ, Monks, DW & Johnson, QR (2000), ‘Herbicides for Potential Use in Lima Bean (Phaseolus lunatus) Production’, Weed Technology, vol. 14, no. 2, pp. 279–286.

Yousafzai, HK, Marwat, KB, Khan, MA & Hassan, G (2007), ‘Efficacy of Some Pre and Post Emergence Herbicides for Controlling Weeds of FCV Tobacco (Nicotiana tabacum) in Pakistan.’, African Crop Science Conference Proceedings, African Crop Science Society, El-Minia, Egypt, pp. 1099–1103.