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# SHORT NOTE

## Reduction of yield of *Vicia faba* by foliar fertilization during the seed-filling period

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*Vicia faba*, in common with other grain legumes, rarely gives economic yield increases in response to soil application of nitrogenous fertilizer either before sowing or at flowering (McEwen, 1970*a*, *b*; Day, Roughley & Witty, 1979). The lack of response was attributed to poor uptake of the applied fertilizer particularly at flowering (Day *et al.* 1979). Garcia & Hanway (1976), however, increased the yield of soya beans from 3695 to 5225 kg/ha with foliar sprays containing N as urea, P, K and S applied during the seed-filling period. Day *et al.* (1979) using four foliar sprays of the same composition increased yield of *V. faba* by 361 kg/ha (8·6%) following the uptake of 15% of the 80 kg N/ha applied. However, Robertson, Hinson & Hammond (1977) reported no yield responses of soya beans with up to five foliar sprays of the same composition and noted that those containing ammonium polyphosphate and $KNO_3$ caused leaf damage that significantly reduced yield.

This note reports results obtained with a spray similar to that used by Garcia & Hanway (1976) and others containing N, P, K and S formulated with readily available agricultural chemicals.

### MATERIALS AND METHODS

*V. faba* cv. Minden was planted in 53 cm rows in four randomized blocks of 15 plots each 2·66 × 3·66 m separated by 1 m paths. All plots received chalk at 7·5 t/ha, farmyard manure at 35 t/ha and simazine pre-emergence herbicide (0·84 kg a.i./ha). Two plots in each block received no further nutrients; other plots received either two or four sprays of the nutrient solutions at 540 l/ha/spray, of compositions shown in Table 1. The first spray was applied as pods began to form, and later sprays at weekly intervals. $^{15}N$-labelled fertilizer was used in both applications when only two sprays were applied but restricted to the third and fourth application when four sprays were applied. One metre of the centre row of each plot of selected treatments was protected during spraying and then sprayed with a solution of the same composition but containing $^{15}N$-labelled compounds. At physiological maturity plants sprayed with $^{15}N$ were harvested and the total nitrogen and $^{15}N$-enrichment determined by Kjeldahl analysis and emission spectroscopy respectively. The remaining plants were harvested for yield when seeds were mature.

### RESULTS

The effect of spray formulation on yield is shown in Table 2. All sprays containing N, P, K and S, i.e. treatments 1–4, significantly reduced yield. Treatments 5 and 6 which contained only some components of the other sprays, and thus had a lower total salt concentration, had no significant effect on yield. Urea alone caused a little scorching of the leaves and slightly reduced yield; this reduction was directly related to the extent of leaf burning which in turn was related to total concentration of salts. Leaf burning was particularly severe with the first spray of treatment 4, because of the high concentration of $NH_4^+$ salts used. In later sprays the ammonium phosphate concentration was reduced and nitrogen was supplied in part as urea.

The amount of nitrogen recovered from the foliar sprays is shown in Table 3. With sprays containing polyphosphate the recovery of nitrogen from urea was 28%, with those containing ammonium hydrogen phosphate (spray treatment 3) it was only 18·5%. When ammonium polyphosphate was included nitrogen from urea was incorporated equally from sprays 1 + 2 and 3 + 4. With the other treatments more nitrogen was taken up from the first two sprays.

### DISCUSSION

The results show that although 28% of the urea was taken into the plant this did not increase yield but served only to reduce the amount of N

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Table 1. *Composition of nutrient solutions applied as foliar sprays*

| Spray treatment | $K_4P_2O_7$ (g/l) | Ammonium poly-phosphate‡ (g/l) | $(NH_4)_2HPO_4$† + $NH_4H_2PO_4$ (g/l) | $K_2SO_4$ (g/l) | Urea (g/l) |
|---|---|---|---|---|---|
| 1 | 19·4 | — | — | 4·6 | 80* |
| 2 | — | 33·2 | — | 31·2 | 80* |
| 3 | — | — | 20·4 | 31·2 | 80* |
| 4*a* 1st spray | — | — | 113* | 31.2 | — |
| 4*b* 2nd, 3rd, 4th spray | — | — | 20·4 | 31.2 | 60 |
| 5 | 19·4 | — | — | 4·6 | — |
| 6 | — | — | — | 31·2 | — |
| 7 | — | — | — | — | 80 |

* Containing 3·34 atoms $^{15}N$/100 atoms N in excess of the natural abundance of $^{15}N$.
† Mixed to give pH 7.
‡ Kalipol 35AZ. Albright & Wilson.

Table 2. *Effect of foliar fertilization on yield of* Vicia faba

| | Spray treatment | Total salt concn g/l | Yield t/ha 85% D.M. | Mean |
|---|---|---|---|---|
| 1. | $K_4P_2O_7 + K_2SO_4$ + urea | 104 | 4·09 | 4·01 |
| 2. | $NH_4$ polyphosphate + $K_2SO_4$ + urea | 144 | 4·15 | |
| 3. | Mixed ammonium hydrogen phosphates† + $K_2SO_4$ + urea | 132 | 3·98 | |
| 4. | Mixed ammonium hydrogen phosphates† + $K_2SO_4$ | 144 | 3·82 | |
| 4a. | Mixed ammonium hydrogen phosphates† + $K_2SO_4$ + urea | 92 | | |
| 5. | $K_4P_2O_7 + K_2SO_4$ | 24 | 4·33 | 4·38 |
| 6. | $K_2SO_4$ | 31 | 4·55 | |
| 7. | Urea | 80 | 4·26 | |
| 8. | Unsprayed | — | 4·49 | |

† Mixed to give pH 7.
S.E. of the differences between all treatments except $K_2SO_4$, 0·175
S.E. of the differences between $K_2SO_4$ and all other treatments, 0·184
S.E. of the difference between the mean of treatments 1–4 and treatment 8, 0·138
S.E. of the difference between the mean of treatments 5–7 and treatment 8, 0·146.

Table 3. *The recovery of* $^{15}N$*-labelled nitrogen applied as a foliar spray*

| Spray treatment | Total N in crop (kg/ha) | N derived from spray (kg/ha) | % N recovered from 1st and 2nd application | % N recovered from 3rd and 4th application |
|---|---|---|---|---|
| 1. $K_4P_2O_7 + K_2SO_4$ + urea* | 229 | 21·3 | 36·3 | 16·9 |
| 2. Ammonium polyphosphate + $K_2SO_4$ + urea* | 220 | 23·2 | 29·7 | 28·4 |
| 3. Mixed ammonium hydrogen phosphates + $K_2SO_4$ + urea* | 192 | 14·8 | 21·5 | 15·5 |
| 4. Mixed ammonium hydrogen phosphate* + $K_2SO_4$ (+ urea) | 210 | 15·2 | 24·2 | 13·8 |
| Unsprayed | 223 | — | — | — |
| S.E. of a difference | 12·8 | 5·48 | 9·70 | |

* $^{15}N$-label in both applications when sprayed twice but restricted to the third and fourth application when four sprays were used.

derived from the soil and/or fixation. Yield was reduced by 10·7%, probably as a result of leaf damage. The effect on yield is in contrast to our previous results (Day *et al.* 1979), where 15% incorporation of the applied urea increased yield by 361 kg/ha (8·6%). In that experiment sown in 1977, the plants showed no signs of moisture stress; 210 mm of rain was recorded during June, July and August compared with an average of 182 mm. In 1979 the rainfall for the same period was only 142 mm and 10·2 mm was recorded during the 4-week spraying period. The difference in response between these experiments cannot be attributed solely to the degree of leaf damage but was more severe in water stressed plants. The degree of leaf burning in *V. faba* is less than with other legumes tested at Rothamsted. *V. faba* was particularly tolerant of urea; only spray 1 of treatment 4 caused more than 10% leaf damage. The results of previous experiments on the effects of shading (Sprent, Bradford & Norton, 1977) and defoliation (Day *et al.* 1979) suggest that this amount of leaf damage would not usually affect yield of *V. faba*. McEwen (1972) showed that yield of *V. faba* was significantly affected only when the leaves subtending pods were removed. We attribute the reduction in yield to an interaction between moisture stress and the moderate amount of leaf burning which would make foliar application of nitrogen to *V. faba* a risky recommendation to farmers.

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