# THE EFFECT OF TIME OF SULPHUR FERTILIZER APPLICATION ON THE GROWTH, YIELD AND SEED QUALITY OF OILSEED RAPE (Brassica napus L) GROWN UNDER GLASSHOUSE CONDITIONS

E. ASARE PhD (LONDON)
DEPARTMENT OF CROP SCIENCE
UNIVERSITY OF SCIENCE AND TECHNOLOGY - KUMASI, GHANA.

D .H. SCARISBRICK, PhD (NOTT)
DEPARTMNET OF AGRICULTURE
WYE COLLEGE, UNIVERISTY OF LONDON, LONDON

## ABSTRACT

*A glasshouse experiment was carried out to investigate the effect of varying the timing of sulphur fertilizer application on the morphology, reproductive structure and seed quality of oilseed rape (Brassica napus). Sulphur as potassium sulphate was applied at five growth stages to provide information on the response of the winter oilseed cv. Ariana. Results demonstrated that dry matter production, number of pods per plant, seed yield and glucosinolate concentration were increased by sulphur application. The response was greatest when 20mgS/kg soil was applied at green bud or Growth stage 3.3 (T4). Seed oil and protein percentages were not influenced by the treatments.*

***KEYWORDS:*** *Oilseed rape, Brassica napus, growth stage, glucosinolate, sulphur.*

## INTRODUCTION

Sulphur (S) is classified as a major plant nutrient Experimental studies have shown that it is important for the commercial production of oilseed rape [9] and other Brassicas. It has been recognised as an important plant nutrient influencing the seed glucosinolate content of oilseed rape [4] and the synthesis of protein and sulphur-containing amino acids such as cystine and methionine. In a study of sulphur uptake at various growth stages, Holmes [3] found that sulphur content tended to be low at the end of flowering, and that its levels in plant tissues fluctuated during the growing season. These results were associated with variations in sulphur and sulphur dioxide concentration in the soil and atmosphere.

With the recent introduction of double low varieties to meet EEC standards on seed quality, the effect of rate and time of sulphur application on seed quality has become important. Results from field trials on sulphur are extremely variable [7]. In fact the precise growth stage at which sulphur should be applied to commercial crops has not been defined in the Agricultural press. The objective of this experiment was to determine the most responsive growth stage of oilseed rape to apply sulphur fertilizer, and to relate timing with glucosinolate content.

## MATERIALS AND METHODS

The pot experiment was conducted in a glasshouse cubicle. Three dressed seeds of cv. Ariana were seeded at 1cm depth in pots 28cm wide and 22cm deep into seed compost. The compost consisted of three parts medium grade sphagnum moss to one part 3mm grit, with Bio P Base added. Sixteen days after planting, when plants were at the cotyledon stage and about 5cm tall, they were transferred to an unheated polytunnel to "harden up". The pots remained in the polytunnel for six weeks, after which they were thinned, one plant per pot was grown to maturity and harvested. Sulphur, as Potassium sulphate, was applied at a rate of 20mgS/kg soil. The solution was added on the dates and growth stages given in Table 1

Table 1: TIME AND GROWTH STAGE OF SULPHUR FERTILIZER APPLICATION

| Treatment | Date | Growth Stage(GS) | Description |
|---|---|---|---|
| T1 | - | - | Control (No S) |
| T2 | 27-10-89 | 0.0 | Seeding |
| T3 | 10-2-90 | 2.2 | Stem extension |
| T4 | 4-3-90 | 3.3 | Green bud stage |
| T5 | 19-3-90 | 3.6-3.7 | Yellow bud stage |
| T6 | 5-4-90 | 4.1 | Early flowering |


Dr. E. Asare

The experiment consisted of six treatments randomised within three blocks. There were four plants per treatment unit, and a total of 72 pots. Plants were watered daily and received each week, 20ml of a standard N, P, K solution of Instant Bio No.5 (2N: $3P_2O_5$: $3K_2O$) and No.7 (4N: $2P_20_5$: $2K_20$) in the winter and during the growing season, respectively. During the winter months (December-January), the temperature regime was maintained at 8°C day/ 4°C night. When temperatures were greater than 16°C, they were buffered by automatic ventilation. There was no supplementary lighting. Plants were harvested after 8 months growth. Growth parameters were recorded for each of the four plants per treatment. Dry matter, yield and yield components were recorded and analyzed. Seed protein and oil percentages were measured using the "Technicon 400 Auto Infralyser". Glucosinolate concentrations were assessed using X-ray fluorescence (XRF) recommended by Schnug and Haneklaus (11).

## RESULTS AND DISCUSSION

Timing of sulphur fertilizer application significantly increased plant dry matter, treatments T3, T4 and T5 being significantly greater than the control (Table 2). The highest plant dry matter yield of 64.7g was recorded in treatment T4.

There were no significant treatment differences in plant height. The greatest of 172.3cm was recorded from T4, the overall mean being 166.1cm. The number of reproductive branches (NRB) per plant was not influenced by timing of sulphur fertilizer application, the overall mean was 9.8 (Table 2).

Number of pods at each branch site was assessed at final harvest (249 days after planting) when most seeds were black and hard (GS 6.8) Table 3. The total number of pods per plant was significantly increased by some of the timing treatments. For example, Treatment T4 which produced the highest plant dry matter gave the greater number of pods (333), approximately 25 more pods per plant than the control.

Neither seed protein nor oil contents were significantly affected by the treatmeents. However, timing of sulphur application significantly increased seed glucosinolate content (Table 2). The highest value of 11.0μmol/g seed recorded for treatment T3 and T4 was 37.5% greater than the control without sulphur.

Results of the trials demonstrated that development from sowing to harvest took 80% of the time taken in field trials carried out during the same growing season [1]. Plants grown in containers in the glasshouse were taller and heavier than those grown in the field, and produced greater seed material per plant. The wide difference in plant population must have contributed to these morphological changes. Plants in the glasshouse trial were grown at extremely low density (one plant per pot) or 15 plants/m² compared with 80-100 plants/m² under field conditions [10].

Sulphur application at treatment T4 produced a large increase in seed yield per plant compared with sulphur applied at early flowering T6 (GS 4.1) and at seeding (T2). These results indicate that application of S at times not later than T6 during the growing season was effective in preventing or reducing potential seed yield losses arising from S deficiency.

**Table 2: THE EFFECTS OF TIMING OF SULPHUR FERTILIZER APPLICATION ON PLANT MORPHOLOGY, YIELD COMPONENTS AND SEED QUALITY**

| | Time of sulphur fertilizer application | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | T5 | T6 | Mean | +SED | CV% |
| Plant dry matter (g) | 52.27 | 55.9 | 60.2 | 64.7 | 58.9 | 56.1 | 58.1 | 3.01 | 5.7 |
| Plant height (cm) | 163.1 | 165.9 | 171.8 | 172.3 | 160.9 | 162.3 | 166.1 | 6.15 | 3.8 |
| NRB | 9.9 | 10.6 | 9.3 | 10.2 | 9.3 | 9.3 | 9.8 | 0.69 | 7.7 |
| Seed Wt per plant (g) | 16.0 | 18.8 | 20.6 | 20.8 | 19.8 | 17.5 | 18.2 | 1.56 | 9.0 |
| Number of seed/pod | 17.7 | 17.8 | 18.2 | 17.1 | 17.5 | 17.6 | 17.6 | 0.54 | 3.4 |
| T.S.W (g) | 4.09 | 4.23 | 4.25 | 4.28 | 4.14 | 4.09 | 4.18 | 0.10 | 2.5 |
| Protein content (%) | 21.1 | 21.1 | 21.2 | 21.3 | 20.4 | 20.8 | 21.0 | 0.50 | 2.6 |
| Oil content (%D.M) | 41.7 | 42.4 | 42.8 | 43.0 | 42.5 | 41.8 | 42.4 | 0.74 | 1.9 |
| Glucosino-late content (μmol/g) | 8.0 | 9.3 | 11.0 | 11.0 | 10.3 | 10.0 | 9.9 | 0.78 | 9.7 |

TABLE 3: AVERAGE NUMBER OF PODS ON THE TERMINAL RACEME AND PRIMARY BRANCHES AT HARVEST, 249 DAYS AFTER PLANTING

| | Time of sulphur fertilizer application | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Br. Site | T1 | T2 | T3 | T4 | T5 | T6 | Mean | +SED | CV% |
| TR | 48.7 | 51.0 | 54.7 | 57.3 | 48.7 | 48.0 | 51.4 | 4.28 | 9.0 |
| B1 | 30.3 | 30.0 | 31.0 | 28.7 | 27.7 | 31.2 | 29.8 | 2.59 | 9.5 |
| B2 | 33.7 | 32.3 | 32.0 | 32.7 | 34.0 | 33.7 | 33.1 | 3.47 | 11.4 |
| B3 | 35.7 | 34.0 | 38.3 | 36.3 | 34.7 | 36.0 | 35.8 | 3.69 | 11.2 |
| B4 | 35.6 | 37.3 | 36.0 | 37.7 | 35.0 | 36.3 | 36.3 | 3.39 | 10.1 |
| B5 | 32.0 | 32.3 | 33.3 | 37.3 | 39.0 | 32.0 | 34.3 | 3.04 | 10.7 |
| B6 | 32.3 | 33.7 | 30.0 | 30.0 | 34.7 | 31.7 | 32.1 | 4.26 | 12.7 |
| B7+ | 60.0 | 66.0 | 70.0 | 73.0 | 67.0 | 62.0 | 66.3 | 5.15 | 20.5 |
| TOTAL | 308.3 | 316.6 | 325.3 | 333.0 | 320.8 | 310.9 | 319.1 | 6.57 | 12.5 |

TR - Terminal raceme

B1...B7+ -Branch numbers 1-7 or more, respectively

The highest number (333) achieved in treatment T4 was due to greater number of pods at the terminal raceme and lower primary branches particularly branch site B7+ (Table 3). Chapman [2] working on cv. Jet neuf and Shahid [13] working on cv. Rafal found that the upper half of the terminal raceme of field plants contributed more to the seed yield than the lower half. In their experiment, insect damage, disease and natural pod losses were greater in the basal portion, despite the fact that pods there were nearest to supplies of water and assimilates.

Number of seeds per pod was not influenced by timing of S application although T3 had the greatest number. Data obtained are based on undamaged pods which were mainly larger in length and contained greater seeds than those recorded for the cv. Ariana under field conditions with sulphur application. However, seed numbers per pod were lower than the potential mentioned by Norton and Shipway [8] and Mendham [5].

Mean seed weight was anot influenced by timing of S application. However, T4 produced the greatest thousand seed weight. This yield component has been shown to be constant under different environmental conditions [6, 12] but thousand seed weight obtained may indicate that this component may have been influenced by S application. Evidence for this is supported by higher seed weight reported by Mailer [4] in a controlled experiment with oilseed rape cvs. Bunyip and Wesbrook.

The importance of sulphur as a major plant nutrient influencing oilseed rape quality has been outlined [1]. Results of this experiment demonstrated that neither seed protein nor oil content was significantly affected by timing of S application. The overall mean protein and oil contents were 21.0% and 42.4%. These results are comparable with those obtained for the field trials [1]. Data on seed glucosinolate content with timing of sulphur application showed a significant increase. These results emphasise the importance of sulphur in glucosinolate synthesis. Increase in seed glucosinolate content with sulphur application has been reported by several workers including [9] and [4] who cited equally relevant references.

The conditions in the glasshouse allowed for greater realisation of the yield potential of individual oilseed rape plants. Each plant would be under less competition for light and, as each had a self-contained and regular supply of water and nutrients, these factors would also be less limiting. Response to timing of sulphur application may also have been modified by the higher glasshouse temperatures and humidity, and restricted root growth. It is also possible that the more uniform conditions allowed the expression of effects of sulphur not seen in the field. However, it was not conclusive that conditions in the glasshouse were more uniform as development was not synchronous.

Sulphur requirements of rapeseed observed in controlled environment experiments indicate that care should be taken to ensure that S is available for commercial crops [4]. Application of S at times during the growing season is effective in preventing or reducing potential seed yield losses arising from S deficiency. However, its application rates and timing should be controlled as its availability in excess has an adverse influence on the resulting glucosinolate concentration. The result demonstrated greater response when sulphur fertilizer was applied with 20mgS/kg soil at T4 (Green bud or growth stage 3.3). It is suggested that application of sulphur fertilizer including probably different rates at T4 (the Green bud stage) should be explored under field conditions. It is also suggested that diagnosis of S deficiency in the soil and by plant tissue test at the rosette stage will allow successful correction of S deficiency in the oilseed rape crop without sacrificing yield or quality.

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