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Effects of *Rhizobium* Inoculation and N-fertilization on the Productivity of Two Faba Bean Cultivars

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ABSTRACT

A factorial field experiment was carried out to study the effect of *Rhizobium* inoculation and nitrogen fertilization on faba bean productivity. Results from two faba bean cultivars, namely Agabat and Silaim, showed that both Rhizobium inoculation and nitrogen fertilization significantly increased yield (Kg/feddan). *Rhizobium* inoculation gave significantly higher yield than nitrogen fertilization. Silaim cultivar out yielded Agabat in the *Rhizobium* inoculation and nitrogen fertilization treatments. The financial analysis, adopting simple cost/benefit analysis techniques and using real prices for the year 1992/93, showed that both treatments were financially feasible, but the net returns obtained from *Rhizobium* inoculation were by far greater than those of nitrogen fertilization for the two cultivars. At the same time, Silaim cultivar recorded higher returns compared with Agabat.

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Introduction

Nitrogen fertilization of faba bean (*Vicia faba* L.) has long been practiced in various parts of the Sudan. In the Middle East where faba bean is widely grown, the crop is usually fertilized and sometimes it is inoculated for nitrogen fixation. Inoculation of faba bean with *Rhizobium leguminosarum* can improve plant growth, nodulation, nitrogen fixation and yield (Osman and Elsheikh (4); Mahdi (3); Yousif & Sprent (7)). The response of this crop to inoculation was found to vary with the cultivar, soil type and presence of indigenous rhizobia (Osman (5)).

Traditionally, most of the field experiments tend to concentrate too heavily on the technical aspects of the production process. Little effort is done so far to study both the technical and economic aspects of results of experiments. Technical feasibility of a certain treatment does not necessarily mean that it is financially and economically feasible. The treatment would only be acceptable if its marginal returns outweigh its marginal costs.

This study aimed to determine the effect of nitrogen fixation and nitrogen fertilization on yield of faba bean cultivars; and to determine and analyze the cost and benefits of these treatments.

Materials and methods

Faba Bean Cultivars and *Rhizobium* strain

Two faba bean cultivars namely Agabat and Silaim were kindly supplied by the Agricultural Research Corporation, Shambat, Sudan. *Rhizobium leguminosarum* biovar *viceae* strain TAL 1397 was kindly supplied by NifTAL Project, USA.

Field Experiment

The field Experiment was conducted in the Demonstration Farm of the University of Khartoum Latitude 15° 40'N and longitude 32° 32'E during 1992/1993 cropping season. Seeds of both cultivars were either inoculated with *Rhizobium* strain TAL 1397 or nitrogen fertilized (21.5 50 Kg N/feddan) in addition to untreated control. The experiment was arranged in a factorial design with four replicates. Plants were irrigated every ten days. At maturity seeds were collected and the yield of each treatment was expressed on per hectare basis.

Production Costs and Returns

In order to run the financial analysis data on inputs prices and the different production costs were collected from faba beans growers in Khartoum North area using random sampling techniques. Prices of faba beans were collected from local markets in Khartoum North. The use of market prices per se may be criticized as being irrelevant. Inflation rate in 1992/93, the year over which the study was conducted, was extremely high. Hence,

costs paid at the beginning of the season are not comparable with returns obtained by the end of the season. This, coupled with the heavy annual and seasonal variability in prices of faba beans may render the use of market prices inappropriate for accurate and reliable financial analysis. To remove inflation differentials, all prices used were deflated by the consumer price index (CPI) to obtain real prices. Further attempt was undertaken to remove annual and seasonal trends, so that the adjusted prices could reflect more accurately prices that normally exist in the market.

Costs Benefit Analysis Technique

Financial profitability is calculated using the following formula (Gittinger, (1):

$$B/C = \frac{\sum b_i}{\sum c_j} \qquad (1)$$

Where B = Total returns per feddan

C = Total costs per feddan

b_i = benefit of output i

c_j = cost of input j

B/C is the benefit/cost ratio. B/C ratio greater than unity indicates positive profitability, whereas a less than unity B/C ratio indicates negative profitability.

The financial feasibility of the *Rhizobium* inoculation and Nitrogen fertilization treatments were examined by calculating their effect on the B/C ratio as follows:

$$NR = \frac{\Delta \sum b_i}{\Delta \sum c_j} \qquad (2)$$

Where, NR = Net returns per pound invested in the treatment.

b_i = Change in total revenue as a result of the specific treatment

c_i = Change in total costs of production as a result of the specific treatment.

Equation 2 can be expressed as follows:

$$NR = \frac{B_t - B_c}{C_t - C_c} \qquad (3)$$

Where, B_c, C_c = Total returns and costs of the controlled experiment

B_t, C_t = Total returns and costs of treatment t.

The numerator of equations 2 and 3 is actually the marginal returns resulting from the specific treatment, whereas the denominator of these equations is the marginal cost of the treatment. Thus, the ratio of the two marginal effects will reflect the overall net effect of the treatment.

Results and Discussion

Effect of N fertilization and N fixation on yield

Both N fertilization and N fixation significantly increased the number of pods/ plant, number of seeds/plant and the 100 seed weight (g) of the two faba bean cultivars, Agabat and Silaim (Table 1). Figure 1. shows the effect of N fertilization and N fixation on yield of the two cultivars, Agabat and Silaim. Nitrogen fixation and N fertilization significantly increased yield per unit area for both cultivars. The yield of cultivar Agabat was significantly lower than that of cultivar Silaim (Fig. 1) for all treatments. In this investigation N fertilization alone or N fixation alone significantly improved yield of faba bean. The increment of yield due to nitrogen fixations indicates the efficiency of this *Rhizobium* strain with these two faba bean cultivars. The response of faba bean to inoculation was found to vary from no response (Musa (4)) to that equivalent to the addition of 86 kg N/feddan (Mahdi, (2)), depending on the variety, *Rhizobium* strain and the climatic condition (Mahdi,(3); Osman (5)).

Net financial returns of the different treatments

Application of the simple cost/benefit analysis outlined above, showed that all treatments for the two cultivars of faba beans were financially feasible (Table 1). But the cost/benefit ratios for *Rhizobium* and nitrogen treatments were far greater compared with the control treatment. The B/C ratio for Agabat cultivar, for instance, was 12.6 for the control, it increased to 14.2 with N fertilization and reached 18.1 with *Rhizobium* treatment.

Table (1). The effect of N fertilization and N fixation on number of pods /plant, number of seeds /plant and 100 seed weight (g) of two faba bean cultivars, Agabat and Silaim.

Treatments	Number of pods/ plant	Number of seeds/ plant	100 seed weight (g)
Control			
Agabat	17.25	44.00	42.80
Silaim	13.25	26.34	69.68
Nitrogen			
Agabat	22.00	53.50	45.20
Silaim	17.00	34.08	72.26
Rhizobium			
Agabat	25.25	61.08	47.31
Silaim	19.66	42.00	74.35
SE ±	1.41	3.17	2.08

Table (2). Financial Costs and Benefits of Nitrogen Application and *Rhizobium* Inoculation of Faba Beans

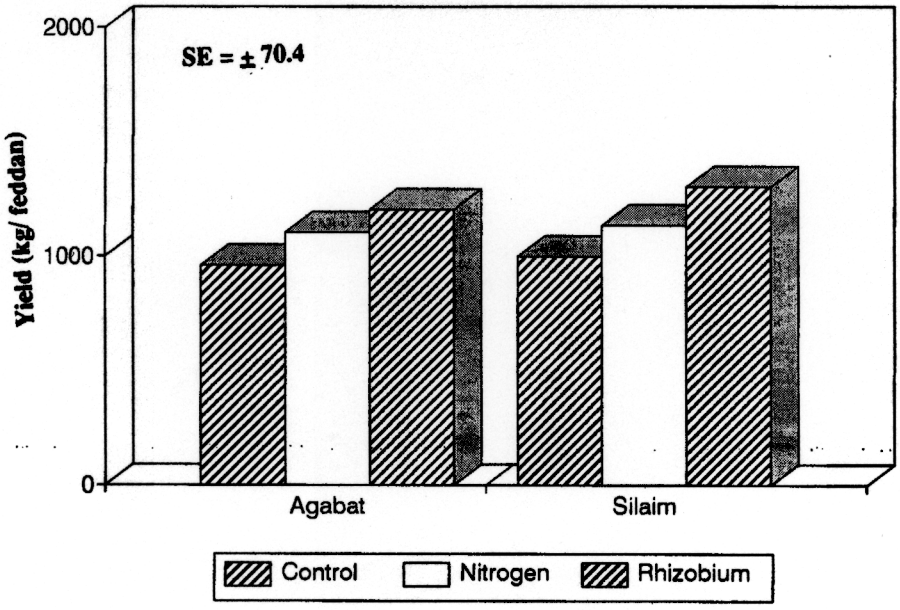
Treatments	Cost of urea / feddan '000' LS	Cost of inoculum / feddan '000' LS	Gross Returns / feddan '000' LS *	Total costs / feddan '000' LS	B/C Ratio	NR '000' LS
Control						
Agabat	0	0	440.9	34.0	12.6	-
Silaim	0	0	654.6	38.9	16.8	-
Nitrogen						
Agabat	2.178	0	527.3	37.1	14.2	39.2
Silaim	2.178	0	763.6	41.1	18.6	49.6
Rhizobium[1]						
Agabat	0	0.698	645.6	35.6	18.1	296.7
Silaim	0	0.698	933.3	39.6	23.6	398.1

Note: The 1992/93 prices for Agabat and Silaim were 56 and 75 Sudanese Pounds per kg.

* LS denotes Sudanese Pound

[1] The cost of the inoculum includes the carrier material, chemicals for growth and gum arabic as an adhesive.

The effect of inoculation and nitrogen
fertilization on two faba bean cultivar



Effects of Rhizobium Inculation

Comparing nitrogen fertilization and *Rhizobium* inoculation, the latter appears to have created far greater benefits than the former. The NR results in Table 1 indicate that a pound invested in *Rhizobium* inoculation produced substantial returns compared with other treatment. The foregoing analysis indicates that treating faba beans with *Rhizobium* inoculation and nitrogen fertilization is both technically and financially rewarding.

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