Response to and benefits of Rhizobial Inoculation of Soybean in the South of Vietnam

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Abstract

Results from published experimental findings on inoculation of soybean in the south of Vietnam are reviewed. Soybean responded considerably to inoculation by producing more grain yields. On average, yields were improved by 38% (59% in Mekong River Delta and 16% in Eastern region of the south). Inoculation resulted in seed yield increase of 100-500 kg/ha and 500-1000 kg/ha in 67% and 30% of the trials, respectively. In most soils, savings in fertiliser N were 40-60 kg N/ha. The economic analysis of 4 experiments showed that farmers gained more benefits (19%) from inoculation compared to urea application. This benefits came from lower cost of fertilizer input (no urea was used) and grain yield increase. In virtually all situations, there would have been an economic benefit of inoculation, both for the legume itself and for subsequent crops. Unfortunately, farmers do not usually inoculate soybean in the south of Vietnam. Instead they apply large quantities of fertiliser N, at rates of 25 – 50 kg N/ha in some areas to as much as 80 – 150 kg N/ha in others. This is a large unnecessary expense. The money spent on fertiliser N could arguably be better spent on other inputs such as weeding, insect control and use of other fertilisers. What is needed is a coordinated program to develop a capacity to produce and supply sufficient quantities of high – quality inoculants to farmers and to educate extension workers and farmers about the benefits of inoculation.

Media summary

Need for rhizhobial inoculation of soybean in the south of Vietnam is examined.

Key words

Soybean, Nitrogen fixation.

Introduction

Soybean is grown on about 130,000 ha in Vietnam, of which 42,000 ha (33%) are grown in the south of the country, consisting of the Eastern region and the Mekong River Delta. *Rhizobium* inoculation is a cheaper and usually more effective agronomic practice for ensuring adequate nitrogen (N) nutrition of legumes, compared with the application of N fertilizer. The objective of this article is to evaluate the need for inoculation of soybean in the south of Vietnam using data from published inoculation experiments.

Response to inoculation in field experiments in the South of Vietnam

Table 1. Field performance summary of inoculation experiments.

Region	Seed yield (t/ha)			Relative frequency of response to inoculation (%)	Yield increase[D] (%)	Remarks
	UI + N[A]	UI[B]	I[C]			
Mekong	2.08	1.33	2.12	94	59	Data mean of 18 sites during

River Delta						1976 to 2001. N treatments were from 10 – 150 kg N/ha. Data from 14 sites during from 1994 to 2001. N treatments were from 40 – 60kg N/ha.
Eastern region of the south	1.49	1.29	1.50	86	16	

UI + N[A]: uninoculated + fertilizer N treatment; UI[B]: uninoculated; I[C]: inoculated treatment; Yield increase[D]: yield increase compared to uninoculated control. Source: Cao Ngoc Diep and Tran Phuoc Duong (1996), Tran Phuoc Duong et al. (1984a, 1984b), Nguyen Huu Hiep et al. (2001), Pham Thi Phuong Lan (1999), Nguyen Dang Nghia (1996), Tran Van Sanh and Tran Phuoc Duong (1996), Tran Yen Thao et al. (2001), Ha Huu Tien et al. (2001).

The 32 experiments showed that seed yields responded strongly to inoculation, with increase an average of 38% (59% in Mekong River Delta and 16% in Eastern region) in 90% of the trials (94% in Mekong Delta and 86% in Eastern region) when inoculated treatment was compared to uninoculated one (Table 1).

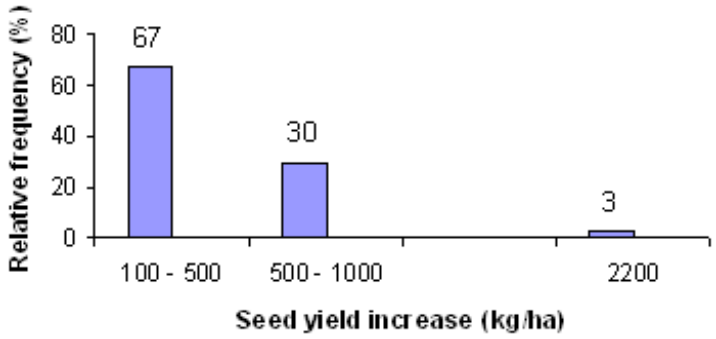

Figure 1. Relative frequency of increase in seed yield from inoculation compared to the uninoculated control.

Inoculation resulted in seed yield increase of 100-500 kg/ha and 500-1000 kg/ha in 67% and 30% of the trials, respectively. In one experiment (frequency of 3%), seed yield increase was 2200 kg/ha (Figure 1).

Economic significance of soybean nitrogen fixation

Soybean N_2 fixation has an economic value in terms of the N that it supplies to the plant from the air which otherwise should need to come from soil and/or fertilizer sources. There is also an economic value in the residual benefits for soil N fertility and resultant increased productivity of subsequent crops.

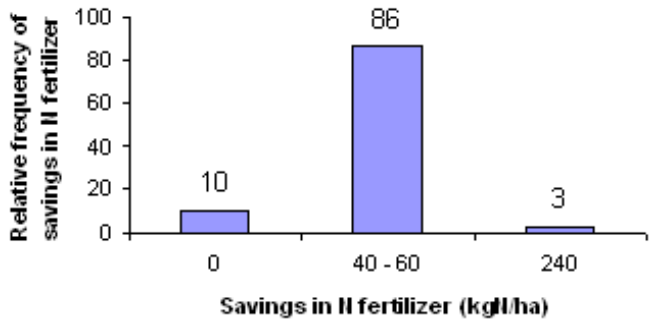

Figure 2. Relative frequency of savings in N fertilizer from inoculation compared to the N fertilizer treatment.

In most soils, the savings were 40 – 60 kgN/ha (the frequency of 86%). In one report, 240 kg N/ha would have been required to produce the equivalent seed yield as the inoculated treatment (Figure 2).

Figure 3. Field experiments of inoculation in Eastern region.

Yellow leaves due to deficiency in N of N fertilizer treatment (40 kgN/ha)(left), and in the uninoculated control of the field where the “promiscuous”TGX1448-2E was used (right).

The economic value of soybean N_2 fixation can be calculated using Ndfa and N fixation values (table 2). When averages for the inoculation treatments were calculated, 59% of the soybean N was derived from N_2 fixation, equivalent to 201 kgN/ha. Inoculated plants accumulated, on average, 97 kg/ha in seeds. Thus, the effective inoculation meant that the N requirement of the plants for the high yields were easily met by N_2 fixation. Moreover, the net N balance (104kg N/ha, equivalent to 226 kg urea/ha) will benefit the soils and subsequent crops.

Table 2. Effects of rhizobial inoculation on N_2 fixation and N yields.

Treatment	Shoot N (kg/ha)	Grain N (kg/ha)	% Ndfa	Crop N fixed[A] (kg/ha)	Net N balance[B] (kg/ha)
N fertilizer application	122	79	15	28	-51
Uninoculation	118	58	45	80	22
Inoculation	227	97	59	201	104

Crop N[A] fixed = (shoot N x 1.5 x %Ndfa)/100, to account for below-ground N. Net N balance[B] = crop N fixed – grain N harvested. Source: Tran Yen Thao et al. (2001).Data from 2 sites in Mekong Delta and

Eastern region of south during 2000 – 2001. Applied N as urea at rates of 40 and 60 kg/ha. Five different inoculant formulations were used.

Table 3. Economic analysis of effects of inoculation and uninoculation on grain yield of soybean.

Treatment	Grain yield (t/ha)	Fertilizer input (VND)	Total input (VND)	Output (VND)	Benefit (Gross margin) (VND)	Benefit from N fertilizer or inoculation (VND)
1.Uninoculation	1.57	2,134,000	6,252,000	7,850,000	1,598,000	-
2.Urea application	1.83	2,396,000	6,592,000	9,150,000	2,558,000	960,000
3.Inoculation	1.89	2,184,000	6,398,000	9,450,000	3,052,000	1,454,000

Source: Tran Yen Thao et al. (2001). Mean values were from 4 sites. Price of 1 kg soybean grain (March 2001): 5000 VND (1US$ = 14,6000 VND). VND: Vietnamese dong.

There were differences in profitability for the inoculation and uninoculation treatments (Table 3). It was 91% more profitable in inoculation treatment than the uninoculation one because of grain yield increase. The benefit that farmers gained from the inoculation was 19% higher over urea application. This benefit came from the lower costs of fertilizer input (no urea was used) and higher grain yield.

Figure 4. Field trial of inoculation and farmer's field in Cu Chi, Eastern region, dry season 2001.

Soybean leaves were very yellow at farmer's field due to lack of N even though 80 kgN/ha was used.

Conclusions

Research on inoculation of soybean in the south of Vietnam has clearly demonstrated that the practice will result in large seed yield increases. On average, yields were increased by 38% (59% in Mekong River Delta and 16% in Eastern region of the south). The inoculation increased crop seed yield above uninoculation more than 67% and 30% of the trials producing seed yield increase of 100-500 kg/ha and 500-1000 kg/ha, respectively. In most soils, savings in fertiliser N were 40-60 kg N/ha. The economic analysis of 4 experiments showed that farmers gained more benefits (19%) from inoculation compared to urea application. This benefits came from lower cost of fertilizer input (no urea was used) and higher grain yield. In virtually all situations, there would have been an economic benefit of inoculation, both for the legume itself and for subsequent crops. Unfortunately, farmers do not usually inoculate soybean in the

south of Vietnam. Instead they apply large quantities of fertiliser N, at rates of 25-50 kg N/ha in some areas to as much as 80-150 kg N/ha in others. This is a large unnecessary expense. The money spent on fertiliser N could arguably be better spent on other inputs such as weeding, insect control and use of other fertilisers. What is needed is a coordinated program to develop a capacity to produce and supply sufficient quantities of high-quality inoculants to farmers. In conjunction with that is the need to educate extension workers about the benefits of inoculation so that they in turn will inform the farmers.

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