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EFFECT OF INOCULATION WITH VAM-FUNGI AND BRADYRHIZOBIUM ON GROWTH AND YIELD OF SOYBEAN IN SINDH

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Abstract

Inoculation of soybean seeds variety William 82 and NARC-II with rhizobase inocula of vesicular-arbuscular mycorrhizal (VAM) fungi – *Glomus macrocarpum* and *G. warcupii* and root nodule bacterium, *Bradyrhizobium japonicum*, showed an increase in VAM-infection and root nodulation over the control. An increase in fresh weight, dry weight and seed weight was also observed as compared to control.

Combined inoculation of the VAM-fungi and *Bradyrhizobium japonicum* showed further increase in VAM-infection (28.6%) root nodulation (30.3%) fresh weight (14.5%), dry weight (15.5%) and seed weight (15.3%) as compared to their separate use. The combined inoculation of *G. macrocarpum* and *B. japonicum* in soybean var. William 82 gave the best result.

Soybean (*Glycine max* (L.) Merrill,) a good source of protein and vegetable oil is grown to some extent everywhere in the world. In Pakistan, soybean is grown on 17.6 thousand hectares with an average yield of 423 kg/hec., mostly to meet the demand of edible oil. On account of the wide gap between production and consumption of edible oil in Pakistan, it is imperative to improve upon the yield of oilseed plants.

Vesicular-arbuscular mycorrhizal (VAM) fungi form symbiotic association which enhance water and nutrient transport particularly phosphorus (P) and thereby increase growth and yield of many a crop plants (Ross & Harper, 1970; Safir Boyer & Gerdemann, 1971; Carling & Brown, 1980). Strains of *Rhizobium* and *Bradyrhizobium* on infection of compatible species of legume participate in the symbiotic association, root nodulation leading to more N_2 fixation, which increase growth and yield (Dixon & Wheeler, 1986). In recent years the effect of combined inoculation with VAM-fungi and Rhizobia have been reported to further increase the growth and yield of some crops including soybean (Azcon, 1979; Bagyaraj *et al*., 1979; Young *et al*., 1988. The tripartite association of symbiotic VAM-fungi, root nodule bacteria *Bradyrhizobium japonicum* was investigated to find its effect on the promotion of growth and yield of soybean var. William 82 and NARC-II.

Materials and Methods

The methods for isolation, purification and mass inoculation of VAM-fungi was followed as described by Schenck (1982) and Brundrett *et al.*, (1996) and for identification as given by Schenck & Perez (1990) was adopted. Similarly for the isolation, purification and inoculation of root nodule bacteria, the methods given by Vincent (1970) and Subba Rao (1976) were followed.

Of the soybean varieties, soybean variety William 82 and NRC-II were comparatively found to be high yielding varieties under natural condition in the ecological niche of Tandojam in Sindh. These were therefore selected for symbiotic association with two species of indigenously isolated VAM-fungi, *Glomus macrocarpum* and *G. warcupii* and a root nodule bacterial strain, *Bradyrhizobium japonicum* isolated from farmers field soil of Tandojam. The proportion of inocula @ 10 g rhizobase cultures per 1000 g of soil per pot for both VAM-fungi and *Bradyrhizobium* alone or combine was maintained throughout the course of this research work.

Results

Inoculation of soybean with the rhizobase culture of 2 indigenous VAM-fungi (*G. macrocarpum* and *G. warcupii*) sown with soybean seeds separately were grown in a series of soil pots. *G. macrocarpum* showed maximum VAM infection with the roots of soybean variety William 82. Similarly soybean seeds inoculated with rhizobase culture of *Bradyrhizobium japonicum* were separately grown in another series of soil pots and were inoculated together with *G. macrocarpum* in two soybean vars., in a series of pots.

A tripartite association with two soybean vars., two *Glomus* spp., and *B. japonicum* was established in a series of soil pots with aliquot parts of inocula in each pot on randomised block method to find out the effect of separate and combined inoculation of VAM infection and root nodulation, fresh and dry weights and seed weight of soybean. The result of combined inoculation of *G. macrocarpum* and *Bradyrhizobium japonicum* in soybean var. William 82 showed increase in VAM infection, root nodulation, fresh and dry weights and seed weight as compared to the other combined inoculations of VAM-fungi and bacteria (Table 1, Figs. 1 and 2). The result was in close conformity with the findings of Bagyaraj *et al*., (1979) and Young Juang *et al*., (1988).

A survey work on the occurrence of VAM-fungi and root nodule bacteria in soil of farm fields indicated that symbiotic VAM-fungi and the root nodule bacteria are present scantly and not uniformly in the soybean fields of Sindh to bring about VAM infection and root nodulation to an extent necessary for promoting the growth and yield of soybean. It is concluded that species of VAM-fungi and strains of *Rhizobia* and *Bradyrhizobia* present in farm field soil vary in biological phosphorus and nitrogen fixation. While some can fix 'P' and 'N_2' to some extent others show a preference for a certain soybean variety for the promotion of growth and yield. The combined inoculation of the VAM-fungus. *Glomus macrocarpum* and *Bradyrhizobium japonicum* in soybean var. William 82 was found to promote maximum growth and yield. A strategy of combined inoculation for the maximization in production of soybean under farm field condition is needed.

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Table 1. Effect of combined inoculation of *Glomus macrocarpum*, *G. warcupii* and *Bradyrhizobium japonicum* on growth and yield of soybean in soil pots.

	VAM infection %	No. of nodules	Weight of nodules g	Plant height cm	Fresh weight g	Dry weight g	Weight of 100 seeds g
NARC-II							
Control	0.0	90.0	0.0	11.0	93.1	20.5	13.5
G. warcupii +*B.japonicum*	40.5	0.0	0.0	47.2	107.2	23.0	14.7
G. macrocarpum	56.4	0.0	0.0	55.0	112.7	25.0	15.9
G. japonicum	0.0	16.0	5.6	49.2	110.2	24.0	16.0
G. warcupii +*B.japonicum*	58.6	16.0	6.0	55.0	113.4	24.7	16.8
G. macrocarpum + *B. japonicum*	67.4	21.0	7.9	57.4	122.5	26.2	17.9
WILLIAM 82							
Control	0.0	0.0	0.0	44.0	91.5	22.0	14.2
G. warcupii +*B.japonicum*	47.5	0.0	0.0	49.2	106.0	24.2	15.1
G. macrocarpum	53.6	0.0	0.0	56.0	114.2	27.2	17.1
G. japonicum	0.0	18.0	6.2	54.0	110.2	25.7	17.5
G. warcupii +*B.japonicum*	67.5	19.0	6.7	58.0	111.2	27.6	18.1
G. macrocarpum + *B. japonicum*	75.1 (28.6)	24.0 (25.0)	8.9 (30.3)	59.5 (5.8)	133.6 (14.5)	32.2 (15.5)	20.2 (15.3)
$LSD_{0.05}$ (Treatments)	2.3	1.7	0.8	2.3	2.4	2.3	2.3
(Varieties)	1.3	0.9	0.5	1.3	1.4	1.3	1.3

Values in parenthesis show an increase in soybean var. William 82 on combined inoculation with *B. japonicum* and *G. macrocarpum*.

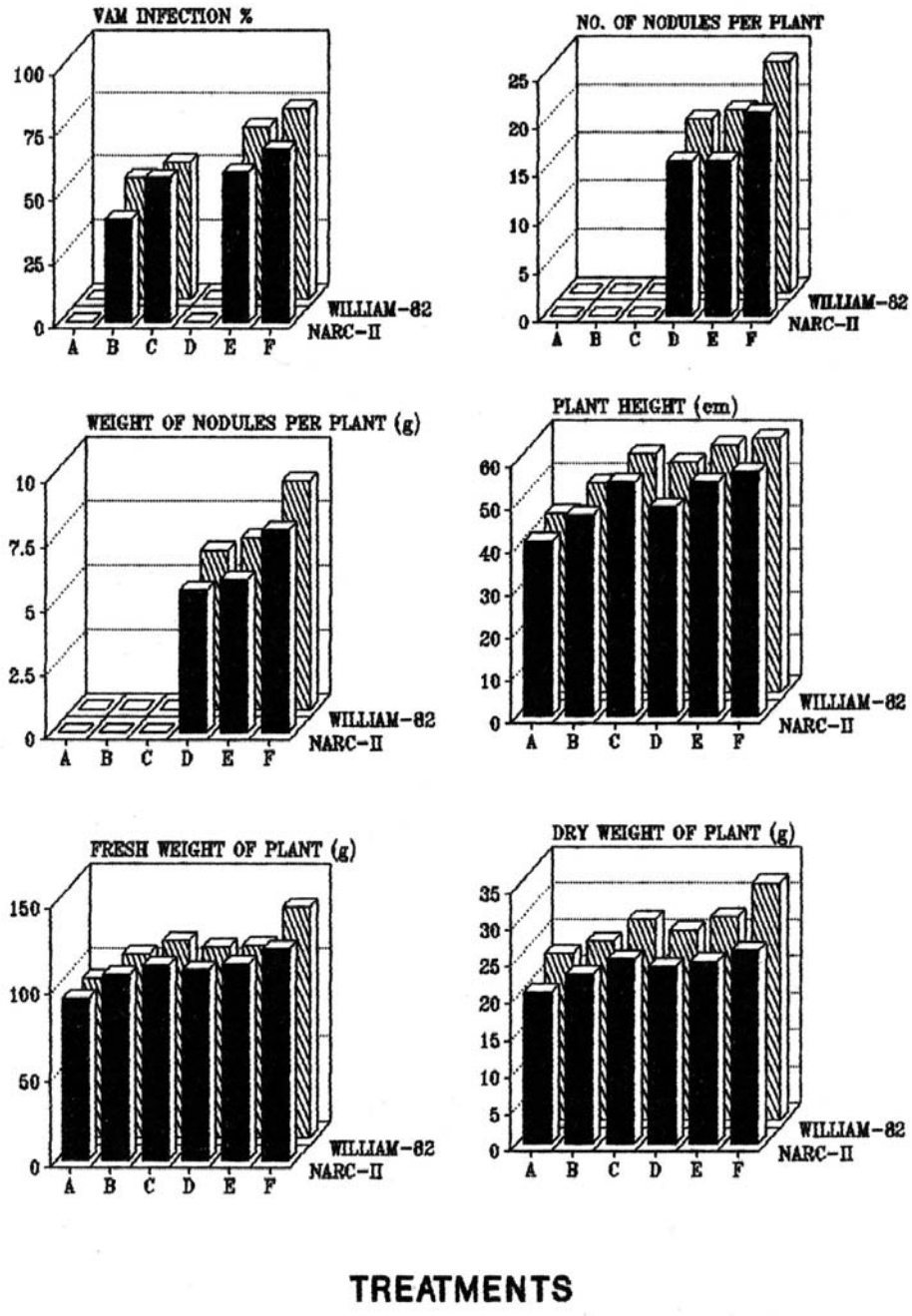

Fig. 1. Effect of combined inoculation of VAM-fungi and *Bradyrhizobium japonicum* on VAM and nodule bacterial infection, plant height, fresh and dry weights of soybean.

A= Control, B= *G. warcupii*, C= *G. macrocarpum*, D= *B. japonicum*, E= B+D, F= C+D

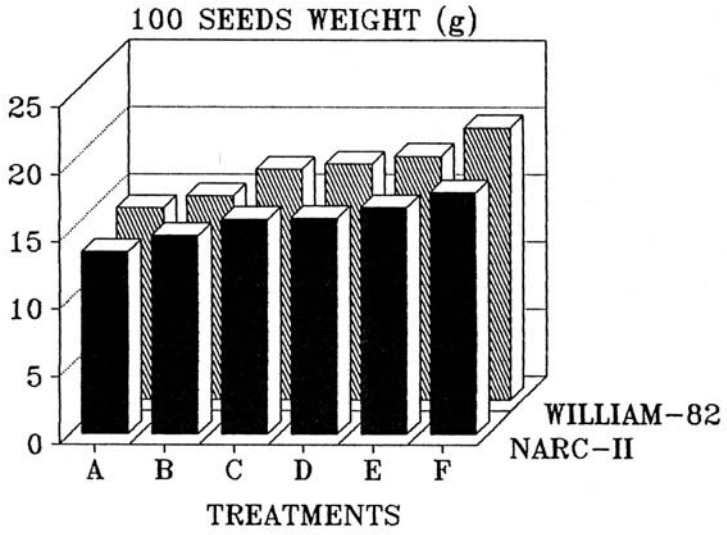

Fig. 2. Effect of combined inoculation of VAM-fungi *Bradyrhizobium japonicum* on seed weight.

A= Control, B= *G. warcupii*, C= *G. macrocarpum*, D= *B. japonicum*, E= B+D, F= C+D

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