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Growth and Yield Characters of Inoculated and Un-Inoculated Soybean under Nitrogen Broadcast and Fertigation Practices

F.C. OAD, S.K. AGHA, U.A. BURIRO AND M.H. SIDDIQUI†
Sindh Agriculture University, Tandojam–Pakistan
†*University College of Agriculture, Rawalakot, Azad Kashmir*

ABSTRACT

A field experiment was conducted to determine the effect of N-fertigation + inoculation (*Rhizobium japonicum*), N-broadcast + inoculation (*Rhizobium japonicum*) and recommended N + no inoculation on the growth and yield parameters soybean. Data revealed that N-fertigation + inoculum was superior to other treatments in producing taller plants, more branches, nodule count and final seed yield, but days to maturity increased. N-broadcast + inoculum and un-inoculated treatments were at the second and third place, respectively, for these parameters except days to maturity. Data suggest that bio-fertilizers are better source for crop production and improving soil fertility. Furthermore, nitrogenous fertilizers especially urea should be applied as fertigation, because this practice evenly distributes fertilizer in the soil with irrigation water.

Key Words: Soybean; Rhizobium; Fertigation; Growth; Yield

INTRODUCTION

Fertigation is the application of fertilizer through irrigation water, which increases both fertilizer and water use efficiencies (Magen, 1995) and enables farmers in adding fertilizers to soil in desired frequency, concentration and at appropriate time (Kumar *et al.*, 2000). Better crop yield and quality are the advantages of adopting this practice. Moreover, it is an ideal way to bring fertility to semi-arid regions, and getting better crop yield to meet the food needs of rapidly increasing population (Asia Fab, 1996).

The placement of inoculants in the soil are relatively remote from the location of infection loci on the seeding roots; a circumstance likely to be exacerbated by inefficient natural transport of rhizobia. This is one of several reasons that provoke the use of alternative means of inoculation (Brockwell *et al.*, 1980). Liquid inoculants sprayed into seedbed, less widely use, are equally successful in promoting nodulation (Hely *et al.*, 1980; Hale, 1981).

Thus, the act of inoculation leading to efficient nodulation was a means of conserving soil N, which enhances the growth and yield of crops. Inoculation of previous crop of a non-legume with *R. japonicum* can be used to establish rhizobia in the soil that is likely to provide inoculum for a subsequent soybean crop (Guar *et al*., 1980). Kuykendall *et al*. (1982) demonstrated that, when nodulating and non-nodulating isolines of soybean and other legumes are planted in soil inoculated with *R. japonicum*, best establishment of the bacteria occurs with nodulating line of soybean. This suggests that rhizobia multiply more prolifically within the nodule than elsewhere, and that rhizobia recently released from nodules can better survive than those present in the soil. Once established in soil, *R. japonicum* appears to persist even in the absence of soybean crops (Crozat *et al*., 1982), although there may be seasonal fluctuations in their populations (Mahler & Wollum II, 1982). However, appreciable growth of rhizobia in soil apparently occurs only in the presence of germinating seeds, growing roots and decomposed nodules (Pena-Cabriales & Alexander, 1983). In view of the above facts, a field study was conducted to observe the effect of nitrogen fertilizer application as fertigation and broadcast on the growth and yield characters of inoculated soybean.

MATERIALS AND METHODS

The field experiment was laid down at Student's Experimental Farm, Sindh Agriculture University, Tandojam. The treatments were: 75 N kg ha^{-1} Fertigation + *Rhizobium japonicum* inoculum, 75 N kg ha^{-1} Broadcast + *Rhizobium japonicum* inoculum and recommended nitrogen (75N kg ha^{-1}). The inoculated seeds were immediately drilled to the soil with single coulter hand drill. The nitrogen fertilizer at the rate of 75 kg ha^{-1} was applied to all the plots using broadcast and fertilization methods in three splits i.e., with second, third and fourth irrigations. The distance between the row and plants was maintained at 60 x 25 cm respectively. All the cultural practices for area maintenance and growth of the crop were adopted.

RESULTS AND DISCUSSION

Germination. The maximum germination percentage (82.75) was recorded in the plots where nitrogen fertigation was applied to inoculated soybean followed by N broadcast + inoculum (79.25). The minimum germination (76.50) was recorded in the un-inoculated soybean were recommended

nitrogen was incorporated (Table I). The increase in germination of seeds appears to be the result of improved soil productivity due to bacterial activity and availability of nutrients (Gunarto, 2000).

Plant height. Inoculated soybean exhibited significantly tall plants (38.50 cm) under nitrogen fertigation followed by nitrogen broadcast (31.00 cm) however, dwarf plants were observed (22.05 cm) in un-inoculated plots. These results are fully supported by Wu and Wu (1996), who reported that *Rhizobium japonicum* inoculation in soybean increased height of crop at seedling, flowering and fruiting stages.

Branches per plant. Greater number of branches per plant (6.70) was observed N fertigation + inoculum treatment followed by nitrogen broadcast + inoculum (3.70), while un-inoculated soybean plants (1.85 branches per plant) remained at the bottom (Table I). The increased branching in the inoculated plots can be attributed to greater nitrogen fixation and improved soybean nutrition which caused greater vegetative growth. These data corroborate the findings of Stafanescu and Palanciuc (2000).

Nodule count per plant. Nodule count reflected the efficiency of rhizobia. Nodule number per plant was significantly higher in the inoculated plots especially where N-fertigation practice was adopted followed by N broadcast by recording 4.90 and 2.15 nodules per plant respectively, whereas minimum nodule number were observed in the uninoculated plots (Table I). These results are supported by Zhang-Feng *et al*. (1997) who reported that inoculation of *B. japonicum* increased the nodule number.

Days to maturity. The maturity prolonged (105-106 days) equally in the inoculated plots where nitrogen fertilizer was broadcast or applied as fertigation. However, the early maturity (99.25 days) was noted under un-inoculated soybean. These results are in agreement with those of Wafaa *et al*. (2002), who reported that *R. japonicum* inoulum enabled the soybean to display better growth and hence an increase in the days to maturity.

Seed yield per hectare. The inoculated soybean produced maximum seed yield under N-fertigation (1183.41 kg ha^{-1}) followed by N broadcast (1049.20 kg ha^{-1}) whereas, minimum seed yield (866.48 kg ha^{-1}) was obtained in the un-inoculated plots (Table I). The results agree with the findings of Stefanescu and Palanciuc (2000) who also found greater seed yield of soybean crop due to *Rhizobium japonicum* inoculation. The increase in seed yield up to 7.8% could be achieved through inoculants (Hungria *et al*. 2001). Further reports indicated that nitrogen fertilization increased the seed yields (Mehasen, *et al*., 2002; Wafaa *et al*., 2002).

Conclusions and recommendations. Fertigation is a novel practice of applying fertilizers with the water at the time of irrigating crop in Pakistan. Many researchers are of the idea that fertigation spread the fertilizer uniformly in the soil which increases the use efficiency of both fertilizer and irrigation. Rhizobial inoculation is also becoming popular due to its ability for enhanced nodule number and consequently the vegetative growth and final seed yield, in addition to supplying nutrients for the subsequent crop. It is therefore, recommended that fertigation and inoculation practices should be adopted for achieving acceptable yields and increased soil fertility.

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Table I. Growth and yield traits of soybean under nitrogen fertigation and broadcast

Treatments	Germination (%)	Plant height (cm)	Branches per plant	Nodule count	Maturity (days)	Seed yield (kg ha^{-1})
N-fertigation + inoculum	82.75a	38.50a	6.70a	4.90a	105.25a	1183.41a
N-broadcast + inoculum	79.25ab	31.00b	3.70b	2.15b	105.50a	1049.20b
75N kg ha^{-1}	76.50b	22.05c	1.85c	1.12c	99.25b	866.48c
Cv(%)	3.28	6.67	7.44	9.46	1.28	4.93
S.E	1.30	1.02	0.15	0.12	0.66	20.42
LSD (5%)	4.54	3.52	0.52	0.41	2.28	70.67
LSD(1%)	6.25	5.34	0.79	0.62	3.46	107.10

Means sharing same letter differ non-significantly (P > 0.05).

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