Pakistan J. Sci. Ind. Res., Vol. 28, No. 6, December 1985

NODULATION STUDIES ON *SESBANIA SESBAN* (L) MERR. 2. GREEN MANURING FOR WHEAT

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(Received April 30, 1985)

A fertility cum inoculation trial was carried out on *Sesbania sesban.* Nodulation was studied four weeks after emergence. Nodule formation increased significantly in inoculated treatment in farm fertility level. The crop was ploughed under in the same field 86 days after its sowing and was allowed to decompose. Wheat variety Sonalika was cultivated in green manured and adjacent nongreen manured plots. The yield data on pair t test bases showed a signficant increase at 5% level of confidence overnon-green manured treatments.

INTRODUCTION

Annual Sesbanias accumulate more biomass and their maturity period is shorter than the tree type which are comparatively slow growing [10], *(Sesbania sesban* (Linn) Merr. is a commonly grown annual leguminous plant. Its nodulation in Pakistan was reported in 1977 and 1978 [15, 2]. It is more profusely nodulated by its homologous rhizobia [18].

Gaul, *et al.* [9] reported that Sesbania is a good accumulator of nitrogen in spite of its high water content. It is believed that it can supply 60 to 120 Kg N ha^{-1} to the following rice crop [5, 19]. The fixed nitrogen primarily accumulates in the plant, though some nitrogen may be excreted into the soil. In the case of leguminous crops green manuring, not only the organic matter content but also the N reserve of the soil is increased [8]. It was also found that when several legumes were compared maximum nitrogen was excreted by Sesbania followed by soybean, cowpea and and green gram. Sesbania is often planted as a green manure crop for soil improvement in India [21, 17] and Pakistan. Generally it is ploughed under when the plants are still succulent resulting in a net addition of nitrogen and organic matter in the soil [16]. Green manuring of Sesbania for rice crop has been reported [3], but may equally be used for other crops.

A study was initiated at NARC experimental farm to determine the efficiency of nodules of Sesbania and to assess its effect as a green manure on the subsequent wheat crop.

MATERIALS AND METHODS

Experiment 1. Sesbania was grown in 24 plots each measuring 2.4 x 7.5 metres with six treatments as shown in Table 1. Complete randomised block with four replications was used.

F treatments represent farmer's level of fertilizer and M treatments represents the recommended levels of fertilizer. Data regarding nodulation were recorded four weeks after sowing. The crop was ploughed under 86 days after planting representing the stage just before maturity.

Experiment 2. Sesbania crop was ploughed under 86 days after planting and was allowed to decompose. Fields were prepared on green manured and adjacent nongreen manured soils. The individual plot size was 3 x 10 metres. Mineral nitrogen and organic nitrogen (farm yard manare) were added as shown in Table 2.

These treatments were replicated four times in green manured and non-green manured plots for comparison. Wheat variety Sonalika obtained from the National Wheat Programme NARC was sown in these plots @ 120 kg/ha. Four irrigations were done during the whole crop season, together necessary weeding whenever required. Yield data were recorded after crop harvest at maturity.

RESULTS AND DISCUSSION

Results obtained in different treatments are presented in Tables 3 and 4. Inoculation of Sesbania significantly increased the nodulation at the lower fertility level. The presence of indigenous rhizobia likely accounted for nodules in uninoculated treatments (F_1 and F_2). Inoculation of seed in F_3 caused a significant increase in nodule formation in low fertility level because a large number of homologous rhizobia were present on the seeds as a result of incoulation. The other possible reason [12] may be the early infection of plants by the inoculated homologous rhizobia. Numerous investigators have mentioned

Table 1. Soil Treatment prior to the planting of *Sesbania sesban*

No.	Code	Treatment
1.	F_1*	No inoculum + No nitrogen + P, 50 Kg/ha + K, 30 Kg/ha.
2.	F_2	No inoculum + N,50 Kg/ha + P, 50 Kg/ha + K, 30 Kg/ha.
3.	F_3	Inoclum + No nitrogen + P, 50 Kg/ha + K, 30 Kg/ha.
4.	M_1**	No inoculum + No nitrogen + P, 100 Kg/ha + K 60 Kg/ha.
5.	M_2	No inoculum + N, 100 Kg/ha + P 100 Kg/ha + K 60 Kg/ha.
6.	M_3	Inoculum + No nitrogen +P, 100 Kg/ha + K, 60 Kg/ha.

*F-Treatments represent farm fertility level, i.e. a leve of fertilizer used by the farmers.

**M-Treatments represent maximum fertility level, i.e. a level of fertilizers recommended for maximum yield.

Table 2. Mineral and organic fertilizer as used in different treatments

No.	Code	Treatment
1	T_1	No mineral nitrogen + No oranic nitrogen 0 Kg/ha
2	T_2	*Organic nitrogen 100 Kg/ha + *Mineral nitrogen 0 Kg/ha
3	T_3	" " 75 Kg/ha + " " 25 Kg/ha
4	T_4	" " 50 Kg/ha + " " 50 Kg/ha
5	T_5	" " 25 Kg/ha + " " 75 Kg/ha
6	T_6	" " 0 Kg/ha + " " 100 Kg/ha

*Organic Nitrogen was given in the form of farmyard manure. The amount of nitrogen analysed in te manure was 0.39 ± 0.07 percent. Mineral nitrogen was added as Urea (46%).

Table 3. Sesbnia plant heights, nodule number, dr weight as influenced by inoculation and fertlity level

Treatments	Plant hights (cm)	Number of nodules	Dry weight of nodules. (g)
F_1	24.58 ±2.62	8.50 bc* ±1.07	0.040
F_2	29.83 a ±4.29	8.35 b ±1.29	0.039
F_3	29.80 a ±2.45	10.70 a ±1.82	0.046
M_1	28.33 a ±1.72	11.50 a ±1.82	0.047
M_2	29.90 a ±3.74	9.45 a ±2.24	0.037
M_3	29.98 a ±2.13	11.10 a ±1.62	0.052

*Treatment means followed by thesame superscript do not differ significantly at 5% level of significance.

supression of nodule formation in the presence of mineral nitrogen fertilizer [14, 13, and 7], but Dart and Wildon [6] and Gibson [11] reported that the application of low doses (starter dose) of mineral nitrogen can enhance the formation of nodules. Formation of nodules by indigenous rhizobia in F_2 where low doses of nitrogen were present was noted in this study. The number of nodules did not differ significantly in high (recommended) fertility level.

Table 4. Coefficient of correlation between number of nodules and dry weight of nodules of sesbania sesban

Treatment	Coefficient of corelation (r)
F_1	0.658
F_2	–0.555
F_3	0.704
M_1	0.334
M_2	–0.293
M_3	0.914

The relatively high rate of applied potassium together with phosphorus may have contributed in the formation of nodules as has been observed by Tanha [20]. The slight depression in nodules formation in M_2 may be related to the high level of mineral nitrogen [7].

The plant heights were not found significantly different except in F1. The values of correlation coefficient (r) between the number of nodules and the dry weight of nodules are given in Tables 3 and 4.

The data recorded are shown in Tables 5 and 6. Table 5 presents the yield obtained from treatments where Sesbania was not manured. Maximum grain and straw yield were obtained in treatments T_5, where 25 Kg ha^{-1} organic nitrogen was added along with 75 Kg ha^{-1} of mineral fertilizer both in greenmanured and non-green-manured plots. The

Table 5. Yield data of green manured wheat

Treatment	Total biomass Kg $plot^{-1}$	Straw Kg $plot^{-1}$	Grain yield Kg $plot^{-1}$	% Increase in grain over control
T_1	14.75 ±1.71	10.80 ±3.58	3.89 ±2.59	–
T_2	15.00 ±2.16	10.92 ±0.94	4.07 ±0.94	3.56
T_3	16.00 ±2.16	11.22 ±2.16	4.77 ±0.25	24.68
T_4	16.50 ±1.29	11.57 ±1.57	4.92 ±0.72	25.19
T_5	17.50 ±2.64	11.66 ±4.67	5.83 ±0.61	48.34
T_6	17.00 ±1.41	11.74 ±4.69	5.25 ±0.25	33.58

Table 6. Yield data of un-green manured wheat

Treatments	Total biomass Kg $plot^{-1}$	Straw Kg $plot^{-1}$	Grain yield Kg $plot^{-1}$	% Increase in grain over control
T_1	14.25 ±1.50	9.93 ±0.31	4.31 ±1.40	–
T_2	16.00 ±1.40	11.27 ±1.22	4.27 ±0.29	9.51
T_3	16.87 ь4.63	11.87 ±3.83	4.99 ±0.39	15.77
T_4	18.75 ±1.50	13.55 ±1.46	5.20 ±0.19	20.64
T_5	20.75 ь5.12	14.98 ±5.83	6.01 ±0.61	39.44
T_6	20.25 ±6.18	14.77 ±5.89	5.47 ±0.33	26.91

reason which seems to justify the results may be that mineral nitrogen was readily available to the crop during most of its growth period and organic nitrogen (farmyard maure) which is decomposed very slowly and steadly [22] compensated at a later stage when the mineral nitrogen supply was exhausted. The amount of mineral nitrogen in T_3 and T_4 treatments is probably not appropriate to keep the time until organic nitrogen from farmyard manure become available, so in spite of high doses of farmyard manure yield decreased. It is noteworthy that even at higher rate of applied urea but in the absence of green manuring, wheat yielded 5.25 Kg plot^{-1} while in green manured plots where same amount of urea was added the yield obtained was 5.47 Kg plot^{-1} in treatments T_6. This is in conformity with Alves [1] who obtained similar results with maize.

The average means of green manured treatments are significantly higher than non-green maured. The pausible explanation may be that there was a sustained supply of nitrogen from previously green manured areas as compared to non-green maured, which led to this increase. Similar results have been reported by Bhardwaj *et al.* [5] who used *Crotalaria juncea* and *Sesbania cannabina* as green manure for rice and wheat. They observed that both green manures gave higher yields of following rice and wheat crops than control plots.

CONCLUSIONS

The high doses of 100 Kg P ha^{-1} and 60 Kg K ha^{-1} in maximum fertility level have probably the same effect as inoculum in F_3 treatment, because the nodule formation did not increase significantly in M_3. This suggests that there is a need to further investigate the optimum amounts of phosphorus and potassium required for maximum nodulation, when the seeds are inoculated with effective homologous strain.

All the green manured treatments showed a significant increase over the non-green manures which may be due to the presence of already decomposed *Sesbania.* The treatments where less mineral N fertilizer was added along with organic nitrogen proved good in green manured and non-green manured, because the initial requirements of nitrogen fertilizer. If may be therefore, concluded that the organic forms of N which are cheap and easily available should be used instead of expensive chemical N fertilizer, but a starter dose of chemical N fertilizer is necessary for optimum economical yields.

Acknowledgement. The authors are greatly indebted to Dr. Murray Dawson, Professor Emeritus, Oregon State University for critically going through the manuscript and for his valueable suggestions.

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