Pak. J. Bot., 44(1): 317-320, 2012.

SEASONAL AND CULTIVAR EFFECTS ON NODULATION POTENTIAL OF SOYBEANS

ASIM MUHAMMAD[1*], SHAD KHAN KHALIL[1], AMIR ZAMAN KHAN[1] AND SULTAN MEHMOOD WAZIR[2]

[1]*Department of Agronomy, K.P.K Agriculture University Peshawar, Pakistan*
[2]*Department of Botany, University of Science & Technology, Bannu, Pakistan*

Abstract

Indigenous land races of soybean (*Glycine max* (L.) Merrill) have great potential for seed quality and grain yield. However information on its nodulation potential are limited. The objective of the present study was to explore its nodulation potential in comparison with improved varieties. Three indigenous land races, viz., Kulat brown, Kulat white and Mothi and two improved varieties (NARC-II, Swat-84) of soybean were planted at monthly interval from April to July in 2004 and 2005 growing season at K.P.K Agricultural University, Peshawar, Pakistan. The number and fresh biomass weight of nodules plant^{-1} was determined. The two years average of nodules plant^{-1}was significantly affected by years, planting dates, varieties and planting dates x varieties interaction. Maximum nodules number (24.3 plant^{-1}) was recorded for May planted crop. The smallest number of nodules (7 plant^{-1}) were produced by April planted crop. Kulat brown produced maximum nodules (18.4 plant^{-1}). Land races produced greater number of nodules than improved varieties. Nodules plant^{-1}decreased when planting was delayed from May to July. Maximum nodules weight (53.2 mg plant^{-1}) was recorded for May planted crop. Years, varieties and planting dates x varieties interaction did not affect nodules weight plant^{-1}. Land races exhibited greater nodulation potential than improved varieties.

Introduction

Soybean (*Glycine max* (L.) Merrill) is the world foremost provider of protein and oil. It is often called the miracle crop as it contains high protein content (38-45%) as well as high oil content (20%) (Hamayun *et al.*, 2010). Soybean is used as an important dinitrogen (N_2)-fixing crop throughout the world. The N_2 fixation potential of soybean varied ranging from 0-185 kg ha^{-1}atmospheric nitrogen annually with the help of root nodule bacteria (Abbasi *et al*., 2010). The nitrogen fixed is enough to produce acceptable grain yield without the application of fertilizer nitrogen except a starter dose of 25 kg ha^{-1}at the time of sowing (Scott & Aldrich, 1983). Symbiotic nitrogen fixation (SNF) resulting from mutual beneficial interaction between soybean and rhizobia, which provides a significant boost to N fertilization and additionally, does not cause any hazard to the environment (Appunu *et al.*, 2008). Wide variation in the range of nodules plant^{-1}(27-95) for different varieties has been reported by Amanullah & Hatam (2000). Ciafardini & Lambardo (1991) counted 5-40 nodules plant^{-1}. Planting time is crucial in many farming systems to avoid frost, drought, pests or diseases, which may occure early or late in the growing season (Khalil *et al.*, 2010). Several workers (Hatam, 1988; Hatam & Khan, 1988 and Asim *et al*., 2003) reported that nodule number and weight was higher in early planting and decreased with delay in planting. The results showed that early date of sowing resulted in a significant increase in vegetative growth, root growth, nodule number and nodule weight (Thalji & Shalaldeh, 2006). The present study aimed at comparing the nodulation deficiency of indigenous land races with improved soybean varieties under a wide range of climatic conditions imposed through different planting dates.

Material and Methods

Plant materials and growing conditions: Three indigenous land races (kulat brown, Kulat white, Mothi) and two improved varieties (NARC-II, Swat-84) of soybean were planted at four planting dates at monthly interval from April to July at New Developmental Farm, Khyber Pakhtun Khwa Agricultural University, Peshawar, Pakistan during 2004 and 2005 growing season. Seeds were surface sterilized by sodium hypochloride (5%) for 5 minutes and rinsed with distilled water for 3 times. Thereafter seeds were inoculated with Rhyzobium strain Nif TAL 377 in sugar solution to get uniform coating of inoculums on seeds before sowing. At full bloom stage, 10 plant samples were carefully uprooted, soil was removed carefully and the nodules were separated and counted. Fresh biomass weight of nodules was recorded. The average and weight of nodules plant^{-1}were average number and weight of nodules plant^{-1}were calculated.

Statistical analysis: The data was subjected to analysis of variance (MSTAT-C) and Lsd test (LSD) was applied for comparing means.

Results and Discussion

Nodules plant^{-1}: Years, planting dates (D), varieties (V), and D x V interaction significantly affected the number of nodules plant^{-1} for the 2 years average (Table 2). Soybean planted in 2004 counted 10 % more nodules Plant^{-1} than 2005 planted crop (Table 1). Maximum nodules (24.3 plant^{-1}) were recorded in May planting and minimum (7 plant^{-1}) in April planting. Similar results were observed by Uslu & Esendal (1996) who reported that early sowing dates (May) produced the highest number of nodules in all three years as compared to late sowing dates. Nodules plant^{-1} in June was lower than nodules in July planting. Nodules plant^{-1} were highest in May than the other planting dates. This could be attributed to low temperature in April ranging from 15-31^{o}C and optimum temperature between 19 and 34.5^{o}C in May (Fig. 1). The decline in nodule number in June and July may be because of high temperature, 25 to 39^{o}C and short growing period (Fig. 1). Similar reductions in nodule count due to late planting were reported by Hatam (1988) and Asim *et al*., (2003).

*Corresponding author: E-mail:asimmuh@yahoo.com

Table 1. Number of nodules plant^{-1} and nodules weight plant^{-1} of soybean varieties as affected by planting dates over two years (2004 to 2005).

Varieties	Nodules Plant^{-1}					Nodule Weight Plant^{-1}				
	April, 2	May, 2	June, 2	July, 2	Mean	April, 2	May, 2	June, 2	July, 2	Mean
Kulat brown	6.9 ij	30.9 a	17.3 e	18.6 d	18.4 a	30.4	55.0	20.1	29.5	33.8
Kulat white	7.0 ij	18.6 d	8.0 i	14.3 f	12.0 d	24.5	48.9	16.4	26.0	28.9
Mothi	5.8 j	21.3 c	17.0 e	14.5 f	14.6 b	17.8	53.3	19.1	30.4	30.1
NARC-II	7.1 i	25.5 b	7.9 i	17.1 e	14.4 bc	20.6	51.1	17.6	27.3	29.2
Swat-84	8.0 i	25.0 b	10.4 h	12.1 g	13.9 c	22.3	57.9	14.8	18.5	28.3
Means	7.0 d	24.3 a	12.1 c	15.3 b	-	23.1 b	53.2 a	17.6 c	26.3 b	-

p≤0.05	Dates	Varieties	DxV	Dates	Varieties	DxV
LSD	1.25	0.60	1.22	5.28	NS	NS
Land races			15.0	Land races		30.9
Improved varieties			14.1	Improved varieties		28.8
Year-I (2004)			15.4	Year-I (2004)		33.9
Year-II (2005)			13.9	Year-II (2005)		26.3

Means of the same category followed by different letters are significantly different at 0.05 level of probability using LSD test.

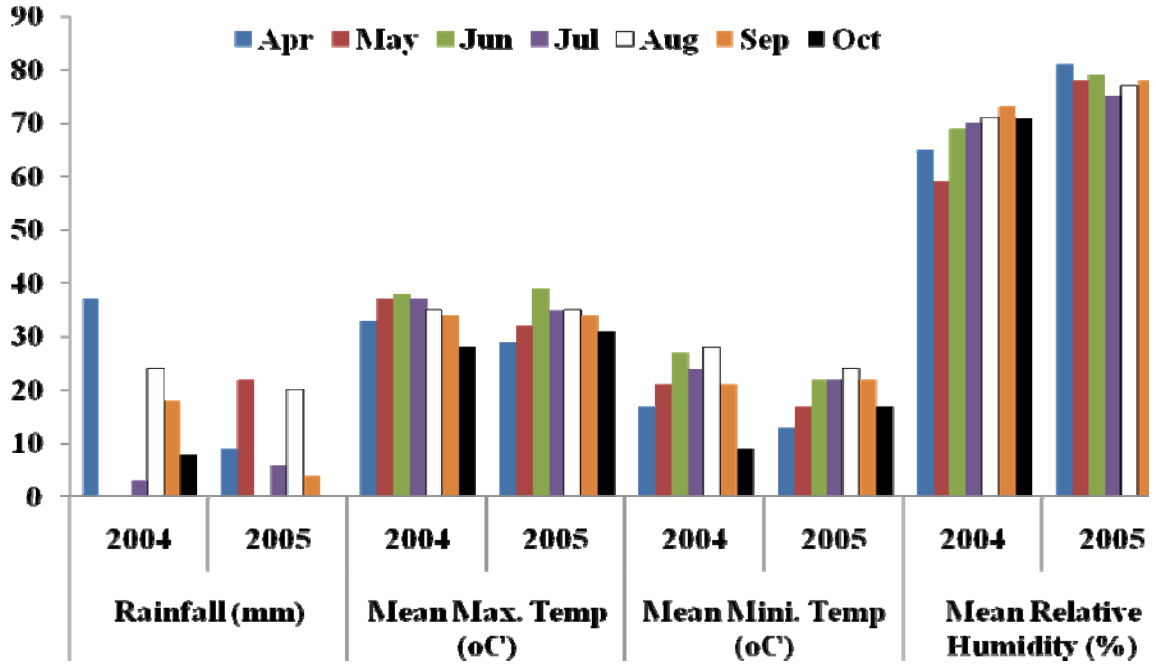

Fig. 1. Mean monthly Rainfall (mm), Minimum & Maximum temperature (^{o}C) and relative humidity (%) of the experimental site during 2004-2005.

Table 2. Analysis of variance for nodules plant^{-1} and Nodules fresh weight of soybean varieties as affected by planting dates for two years.

S.O.V.	D.F.	Nodules plant^{-1}	Nodules weight
Year (Y)	1	94.56**	2310.40**
Replications (R)	6	19.40 ns	199.70 ns
Planting dates (D)	3	2112.1**	10056.81**
YxD	3	570.02**	1583.55**
Error I	18	7.42	132.90
Varieties (V)	4	175.67**	149.14 ns
Land races vs Improved	(1)	28.36 ns	183.75 ns
YxV	4	64.85**	93.38 ns
DxV	12	77.18**	113.93 ns
YxDxV	12	57.13**	102.72 ns
Error II	96	12.83	94.35
Total	**159**		

Kulat brown produced maximum nodules (18.4 plant^{-1}) and Kulat white, the minimum nodules (12 plant^{-1}). Nodules produced by Mothi was statistically equal to the number produced by NARC-II but higher than the number produced by Swat-84. Land races produced greater number of nodules than improved varieties.

The interaction between DxV revealed that in land races and improved varieties nodules plant^{-1} increased when planting was advanced from April to May. However, nodules plant^{-1} decreased when planting was delayed from May to July (Fig .2). Masefield (1968) reported that mean number of nodules per plant was lowered when bean was sown in April, while it gradually increased in May up to June.

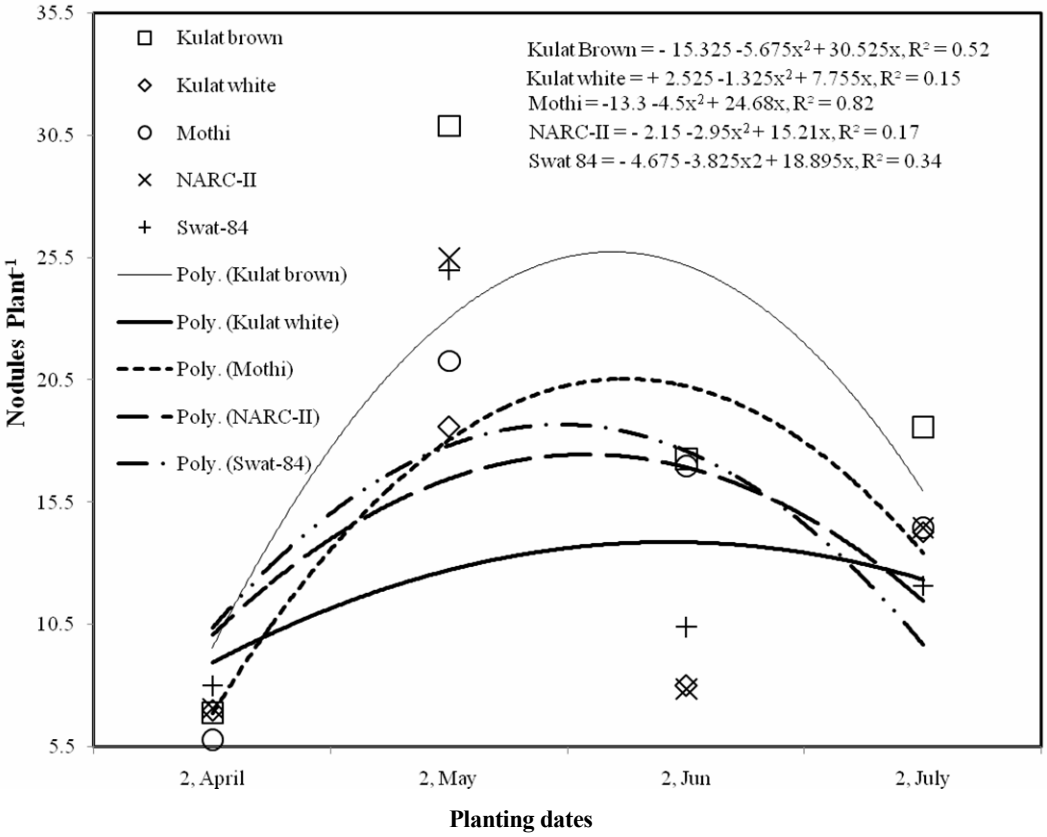

Fig. 2. Nodules plant^{-1} of soybean varieties as affected by planting dates over two years average.

Nodules weight plant^{-1}: Analysis of the 2 years combined data detected differences in nodules weight for the planting dates only (Table 2). Nodules weight was not affected by years. Maximum nodules weight (53.2 mg plant^{-1}) was recorded for May planted crop, followed by July planted crop. June planted crop produced nodules of smallest weight 17.6 mg plant^{-1} (Table 1).

Varieties and DxV interaction did not affect nodules weight plant^{-1}. Collectively Land races showed maximum nodules weight plant^{-1}(30.9) as compared to improved varieties (28.8). These results are in line with Wesike *et al*., (2010) they reported maximum number and weight of nodules plant^{-1} when local Nayala soybean variety was compared with improved varieties (SB8 and SB19). The data shows that nodules weight followed the pattern of nodules number and all nodules were of the same size except nodules produced by April planted crop. Which displayed smaller weight as compared to its number. Several workers (Hatam, 1988; Hatam & Khan, 1988; Amanullah & Hatam 2000, and Asim *et al*., 2003) have reported direct relationship between nodule number and nodule weight.

References

Abbasi, M.K., M. Manzoor and M.M. Tahir. 2010. Efficiency of *Rhizobium* inoculation and P fertilization in enhancing nodulation, seed yield and phosphorous use efficiency by field grown soybean under hilly region of Rawalakot Azad Jammu and Kashmir, *Pakistan. J. Plant Nut.*, 33: 1080-1102.

Appunu, C., D. Sen, M.K. Singh and B. Dhar. 2008. Variation in symbiotic performance of *bradyrhizobium japonicum* strains and soybean cultivars under field conditions. *J. Central Europ. Agri*., 9(1): 185-190.

Amanullah and M. Hatam. 2000. Performance and nodulation efficiency of soybean cultivars. *Pak. J. Biol. Sci*., 3: 1822-1823.

Asim, M., P. Shah, M. Hatam and M.T. Jan. 2003. Comparative seasonal nodulation efficiency of land races and improved varieties of soybean. *Sarhad J. Agri*., 19: 443-445.

Ciafardini, G. and G.M. Lombardo. 1991. Nodulation, nitrogen fixation, and yield improvement in second crop soybean cover

inoculated with *Bradyrhizobium japonicum*. *Agron. J.*, 83: 622-625.

Hamayun, M., S.A. Khan, Z.K. Shinwari, A.L. Khan, N. Ahmad and I. J. Lee. 2010. Effect of polyethylene glycol induced drought stress on physio-hormonal attributes of soybean. *Pak. J. Bot*., 42(4): 977-986.

Hatam, M. 1988. *Yield potential, agronomic performance, nitrogen fixation and climatic adaptation of determinate and indeterminate soybean cultivars*. Ph..D . Dissertation, Sind Agri. Univ. Tandojam, Sind, Pakistan.

Hatam, M., and S. Khan. 1988. *Seasonal pattern of nodulation and nodule activity in soybean cultivars*. Proc. of Regional symposium and workshop on biotechnology of nitrogen fixation in the tropics Aug 25-29, 1986. Uni. Petanian, Serelang, Selongor, Malysia.177-187.

Masefield. G.B. 1968. Seasonal effects on the root nodulation of legumes. *Expl. Agri*., 4: 335-338.

Scott, W.O. and S.R. Aldrich. 1983. *Planting and cropping systems*. In: Modern soybean production, Second Ed. S and A publications Inc. Champain ILL. USA. 83-86.

Khalil, S.K., A. Wahab, A. Rehman, F. Muhammad, S. Wahab, A.Z. Khan, M. Zubair, M.K. Shah, I.H. Khalil and R. Amin. 2010. Density and planting date influence phonological development assimilate partitioning and dry matter production of faba bean. *Pak. J. Bot*., 42(6): 3831-3838.

Thalji. T. and G. Shalaldeh. 2006. Effect of planting date on Faba Bean (*Vicia faba* L.) nodulation and performance under semi arid conditions. *World J. Agri. Sci*., 2(4): 477-482.

Uslu. N. and Enver Esendal. 1998. Response of inoculation and sowing date of soybean under Bafra plain conditions in the northern region of Turkey. *Tr. J. Agri. & For*., 22: 525-531.

Wasike, V., B. Vanlauwe, N. Mungai, F. Wachira, L. Mumera, N. Sanginga, L. Hermann, H. Mbura, P. Malala, L. Wasilwa and D. Lesueur. 2010. The competitivenss of indigenous *Bradyrhizobium* spp., and *Bradyrhizobium Elkanii* strains on promiscuous and specific soybean varieties in Kenyan soils. Proceeding of the 12th KARI biennial scientific conference. November 8-12, 2010. Kenya Agricultural Research Institute, Nairobi, Kenya.

(Received for publication 24 April 2009)