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The seasonal impact on nodulation, growth and yield of soybean

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ABSTRACT

A field experiment was conducted during summer and winter seasons of (2010/2011) and (2011/2012) years, on the Collage of Agricultural Studies Farm, Sudan University of Science and Technology, Shambat, Khartoum North. To determine the effect of summer and winter seasons on nodulation, growth, and yield of soybean Glycine max (L.) Merrill introduced genotype (E01). The treatments consisted of inoculation with Bradyrihzobium janponicum, strain USDA 122 and control (without inoculation) during two summers and winters season. A completely randomized block design with four replicates was used. The results showed that inoculation with Bradyrihzobium janponicum and winter's season gave significantly higher nodulation number/plant, relative growth rate, and grain yield of soybean as compared to uninoculation plants and summers season.

Key words: Inoculation, nodulation, seasonal, impact, soybean.

INTRODUCTION

Soybean *Glycine max*. L Merrill is a legume that grows in tropical, subtropical and temperate climate. Soybean is a crop which can provide complete protein, containing eight amino acids essential for human. That means it can play a major role in elevating nutritional standers of foods in developing countries, where human beings are facing protein deficiencies (samia, 2013). In the Sudan, soybean trials started as early as 1925 at Gezira Research Farm where a low yield was obtained. This low yield was attributed to lack of cultivars adaptable to the Sudan agro-ecological conditions. Lack of adaptable cultivar to the Sudan agro-ecological conditions has enormously contributed into the existing information gap on association of traits with seed yield (Tony *et al*, 2013). The country currently is importing vegetable oils for the local consumption, thus the introduction of new oil crop will cut these imports and help in the self sufficiency of such vital commodity. Moreover, the protein balanced meal will be of great significant for the dairy and poultry industries.

The well defined seasonal cycle of temperature for soybean determines the time of planting and harvesting of soybean. The large temperature perturbations above and below normal during the growing season constituted relatively unevaluated to the growing crop. The potential for damage from these temperature variations depends on the stage of crop development at which they occur (Dale, 1983). Inoculation of legumes is widely practiced with the objective of increasing production of the legume. Rhizobium inoculation of soybean has been reported to increase growth and seed yield (Kala *et al*., 2011; Faisal, 2013) Majid *et al*, (2009) revealed that total number of nodules

increased in inoculated over uninoculated control. This study tends to evaluate the summer and winter sowing of soybean introduced genotype.

MATERIALS AND METHOD

To evaluate the impact of seasons on nodulation, growth and yield of soybean *Glycine max* (L.) Merrill a field experiment was carried out during summer and winter seasons of (2010/2011) and (2011/2012) years, on the Collage of Agricultural Studies Farm, Sudan University of Science and Technology, Shambat, Khartoum North (latitude 15°: 31, N longitude 23°: 32′ E and altitude 288 meter above sea level), within the semi dry climate described by Adam, (2002).The land prepared by disc plough, harrowing, leveling and ridging. Spacing between ridges was 70 cm, and then it was divided into plots 4x3.5 meters with four ridges, each 3.5 meters long. In all seasons, introduced genotype (E01) of soybean was used. The sowing dates were on 15 June in summer and on 25 December in winter for each season. Inter-row spacing was 5 cm with one seed per hole on the top of the ridges and gaps were filled by replanting after germination. Irrigation was applied at an interval of 7 and 10 days during summer and winter seasons respectively. Weeding was done by hand whenever it was necessary to avoid weed competition. Seeds inoculated by *Bradyrihzobium janponicum* at the rate of 100 grams per kilogram of seeds. Bradyrhizobium inocolum was mixed with gum Arabic and water to coat the seed in shade just before sowing.

The treatments consisted of;

SC = check (control) without inoculation or during summer season.

SI = Inoculation with *Bradyrihzobium janponicum*, strain USDA 122 during summer season.

WC = check (control) without inoculation during winter season.

WI = Inoculation with *Bradyrihzobium janponicum*, strain USDA 122 during winter season.

Five holes were selected randomly from the tow inner ridges, leaving one meter at each end of the plot, then the mean plant was recorded. The Nodulation number /plant were counted 38 days of germination. Relative growth rate (RGR) determined by taken samples from area equivalents 3.5m² twice, first after 30 days of germination (dw1) and second after 10 days of first one (dw2) and dried by oven immediately for 48 hours then weighed and counted according to formula dw2 – dw2 /time x area. Grain yield /ha (kg) were calculated by dividing the plot yield by plot area and multiplied by 10.000m². Data generated was subjected to statistical analysis system "MSTAT-C software. One factor randomized complete block design (RCBD) was performed. Analysis of variance was carried out for treatments and means were tested and separated using Duncan Multiple Range Test (DMRT) referred to Steel et *al* (1997) at $P = 0.05$.

RESULT AND DISCUSSION

Nodulation number/plant

In the present investigation as shown in table (1) Inoculum increased significantly nodulation number/ plant over control. In this connection Islam *et al* (1987); Young *et al* (1989); Majid *et al* (2009) and Faisal (2013) found that rhizobium inoculation gave greater number of nodules/ plant than uninoculation soybean plant, which agree with the results. During all experimental periods winter seasons produced significantly higher nodulation number/plant than summer seasons, Mike (2012) reported that very high soil temperatures (90 degrees F or 32° C) can cause decreased nodulation and nitrogen fixation to occur in soybeans, which agree with the study result. Nodulation failed in control treatment which could be related to absence of suitable rhizobium strain on fields.

Similar result was reported by Papastylianou (1986) and Yanni *et al* (1987) who reported in general that soybean in non-inoculated plots with *Rhizobium japonicum* failed to nodulate.

Table (1). The seasonal impact on nodulation number/plant of soybean.

Treatments	Nodulation number/plant	
	(2010-2011)	(2011-2012)
SC	0.0 [c]	0.8 [c]
SI	8.3 [b]	9 [b]
WC	0. 0 [c]	0.8 [c]
WI	24.5 [a]	17.3 [a]
S.E	±0.4	±0.8
C.V%	9	19

Any two means with same letter are not significantly different at 5% level, using Duncan Multiple Range Test.

Relative growth rate (g/m²/day)

A perusal of Table (2) it is clear that inoculum increased significantly relative growth rate over control during all seasons of the study with exception of summer of 2010-2011. In this connection Ali *et al* (2011) found similar result on chickpea. Winter seasons gave significantly higher relative growth rate than summer seasons. Similar result was reported by Rufty *et al* (1981) who showed that cool temperature increased relative growth rate.

Grain yield (kg/ha)

It is evident from the data presented in Table (3), that inoculum increased significantly grain yield, over control during winters season. Hamid (1981) and Ibrahim *et al* (2011) reported that inoculation significantly improved yield of soybean, which agree with the study. This result was expected in view of the fact

Table (2). The seasonal impact on relative growth rate (g/m²/day) of soybean.

Treatments	Relative growth rate (g/m²/day)	
	(2010-2011)	(2011-2012)
SC	0.3[c]	0.4[c]
SI	0.2[c]	0.6[b]
WC	0.6[b]	0.6[b]
WI	0.9[a]	0.9[a]
S.E	±0.2	±0.3
C.V%	19	27

Any two means with same letter are not significantly different at 5% level, using Duncan Multiple Range Test.

That inoculum fixed nitrogen in agricultural soils which is definitely beneficial to agriculture. Inoculum had no significant effect on grain yield in summer's season which may be attributed to the little nodulation number/plant in inoculum treatment. Winter seasons produced significantly higher grain yield/ha than summer seasons. This result disagreed with finding of Samia *et al* (2013) and Ibrahim (2012) who recommended that soybean could be grown in Sudan as summer crop, This

may be due to the cultivar habits, but this agrees with the findings of other workers, Wolfram *et al*, 2009 and Mike (2012) who reported in general that temperatures above 95 degrees Fahrenheit have been shown to significantly decrease yield.

Table (3). The seasonal impact on grain yield/ha of soybean.

Treatments	Grain yield kg/ha	
	(2010-2011)	(2011-2012)
SC	145.7 [c]	202.3 [c]
SI	164.2 [c]	215.6 [c]
WC	576.9 [b]	236.4 [b]
WI	760.2 [a]	274.1 [a]
S.E	±7	±29.0
C.V%	11	25

Any two means with same letter are not significantly different at 5% level, using Duncan Multiple Range Test.

CONCLUSION

The genotype (E01) produced higher growth and yield of soybean during winter season than summer season under Khartoum condition. The result of this study also illustrates the importance inoculation with *Bradyrihzobium janponicum* for increasing the growth and yield of irrigated soybean.

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