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Response of starter nitrogen dose on rhizobial inoculants applications for the productivity of soybean in Metekel zone of North western Ethiopia

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Abstract

Nitrogen is the most important and growth limiting plant nutrient. The main source of plant available nitrate is symbiotic nitrogen fixation by legume plants. However, the role of starter N application during planting on rhizobia inoculated legumes remains arguable across the globe. An experiment was conducted to know the effect of starter nitrogen for soya bean yield. It was conducted for two years in Pawe and Dangur districts of Metekel zone. 0, 9, 18, 27, 36, 54 kg N/ha was applied in split plot design with a main plot of inoculation and without inoculation of MAR 1495. The application of N increases grain and biomass yields and addition of 27 kg/ha N is the best candidate than others. The application of inoculant was not significantly difference.

Keywords: Nitrogen, nodules, Grain yield, Inoculants

Introduction

Nitrogen is one of the most important nutrients that plants require for healthy growth. Almost all plants depend on some outside source of nitrogen, but plants of the legume family are able to fix their own nitrogen. Nitrogen fixation likely evolved when the geochemical reserves of fixed-N in the biosphere were depleted. Symbiotic N fixation is not happening at random; it exists whenever the legume needs extra N beyond the inherent soil N. The world has agreed up on the detrimental effect of rich *rhizosphere* N for symbiotic N fixation, though the amount is relatively small. The considerable uncertainty about when prokaryotes acquired the ability to fix is highlighted by the opposing views of the composition of the pre-biological paleo atmosphere. It may have been strongly reducing and contained large amounts of ammonia, methane, carbon monoxide and hydrogen sulfide. It means they are able to convert atmospheric nitrogen, which is unusable to all plants, into a form of nitrogen that plants can use. Legumes

accomplished this through a symbiotic relationship with *Rhizobium*, bacteria that are naturally found in the soil.

However, the role of starter N application during planting on rhizobia inoculated legumes remains arguable across the globe. For instance, Brazil does not recommend starter N (Koutroubras et al. (1998) whereas Mukhtar and Babiker, (1993) recommended 10 kg for faba bean in Sudan. Generally, the soil N content, crop type, cropping system etc. determine starter N effect. Unfortunately research on starter N dose issue has not been done in Ethiopia. Therefore, the main objectives of this trial had been to determine the necessity of starter N application and starter N dose that the farmer should use.

Materials and Methods

The trial was laid down in Benishangul Gumuz regional state of Metekel zone of two district Pawe on Pawe agricultural research center station and Dangur district of sub-station which was used split plot design with three replicated at each location. The treatment arrangement were six nitrogen level (0, 9,18, 27, 36, 54 kg N/ha) and 2 inoculation levels (with inoculation and without inoculation). It was conducted for two cropping seasons. The inoculant used was *MAR 1495*.

Soil sample before planting was taken and was processed and subjected to pH, Total N, Available. P and exchangeable acidity (EA) test using the procedures described by Taye and Sahilemedihin (2001). Soybean *TGX* variety was used as test crop. The distance between rows and plants were 60cm and 5cm. respectively. The distance between two plots and replication was 1m and 1.5m respectively. The net plot area for each plots are 12.6m^2, therefore, crop was sown according to the recommended soybean production practices. There were seven rows, hence; four harvestable rows, one row for disturbed row sampling and two border rows. 46 kg/ha P_2O_5 was applied as basal to all treatment as constant variable. Nodulation data; nodule number and nodule dry weight was taken and analyzed. The rest yield and yield related parameters like No of pods/plant, No of seeds/pod, Plant height, above ground dry biomass, grain yield was also collected and analyzed.

Table 1. Treatment arrangement and Layout used

S.N	Treatment	Treatment for single plot	Remark
1	I_1+ 0 kg N/ha	I_1+ 0 gm N /plot	With inoculation (Murdock strain)
2	I_1+ 9 kg N /ha	I_1+ 2 4 . 7 g m . N/plot	With inoculation (Murdock strain)
3	I_1 + 18 kg N /ha	I_1 + 49.3gm. N/plot	With inoculation (Murdock strain)
4	I_1 + 27 kg N /ha	I_1 + 74 gm N /plot	With inoculation (Murdock strain)
5	I_1 + 36 kg N /ha	I_1 + 98 gm N /plot	With inoculation (Murdock strain)
6	I_1+ 54 kg N /ha	I_1+ 147.9 gm N/plot	With inoculation (Murdock strain)
7	0 kg N /ha	0.0 gm. N /plot	Without inoculation
8	9 kg N /ha	24.7 gm. N /plot	Without inoculation
9	18 kg N /ha	49.3 gm. N /plot	Without inoculation
10	27 kg N /ha	74.0 gm. N /plot	Without inoculation
11	36 kg N /ha	98.6 gm. N /plot	Without inoculation
12	54 kg N /ha	147.9 gm. N /plot	Without inoculation

Results and Discussion

Table 2. Effect of Starter N on soybean yield at Pawe on station Season 1.

Nitrogen level Kg/ha	Nodule no.	Nodule dray weight/g	Biomass yield kg/ha	Grain yield kg/ha
0	83.4ab	0.73ab	7704	3041
9	73.17b	0.65b	7985	3038
18	86.93ab	0.77ab	8070	3306
27	118.23a	1.10a	7223	2928
36	95.57ab	0.82ab	7198	2993
54	70.87b	0.58b	7038	2767
LSD	*	*	ns	ns
CV	39.09	46.4	16.72	18.34

Table 3. Effect of inoculations on soybean yield, Pawe and Manbuk on station Season 1.

Inoculation	Nodule no.	Nodule dray weight/g	Biomass yield kg/ha	Grain yield kg/ha
non inoculated	86.84	0.779	7026.4b	2831
inoculated	89.21	0.773	8046.4a	3193
LSD	ns	ns	*	ns
CV	39.09	46.4	16.72	18.34

Table 4. Effect of Starter N on soybean yield, Pawe and Manbuk stations Season 2.

N rate (Kg/ha)	**Pawe on station**		**Manbuk on station**	
	BMY	**GY**	**BMY**	**GY**
0	4277.8b	1079.7b	3226.2d	1468.1c
9	4243.2b	1218.3ab	3551.3cd	1642.1c
18	5028.3ab	1373.7ab	4592.9cd	2196.7c
27	5759a	1611.9a	5380.7c	2391.2c
36	5573.1ab	1536.8ab	7516.2b	3453.2b
54	6256.6a	1622.6a	9662.5a	4523.1a
CV (%)	21.57	29.18	30.26	31.80
LSD /0.05/	*	*	*	*

Table 5. Effect of inoculations on soybean yield , Pawe and Manbuk on station Season 2.

Inoculation	**Pawe On station**		**Manbuk on station**	
	BMY	GY	BMY	GY
Non Inoculated	5345.5	1413.9	5287.1	2436.5
Inoculated	5033.9	1400.4	6022.9	2788.3
CV (%)	21.57	29.18	30.26	31.80
LSD /0.05/	ns	ns	ns	ns

BMY biomass yield, GY grain yield, CV coefficient of variance, LSD list significant difference, NS no significant different,

In the first season highly significant nodule number and nodule dry weight were obtained at 27 kg/ha N. This result was in contrast with Zerihun Getachew and Lijalem Abeble (2020) but biomass and grain yield were not statistically different due to the addition of different nitrogen levels. Inoculation of soya bean had a significant yield advantage in biomass. But for grain yield even if there is a yield difference between inoculated and non-inoculated it is statistically the same.

During the second season work the highest grain yield and biomass yield was obtained from 27 kg/ha N at Pawe station while in Manbuk the highest grain and biomass yield was obtained from 54 kg/ha N. in both locations as N level increase grain and biomass yield also increase. This is because nitrogen is the most important plant nutrient. Where the same work by Zerihun Getachew and Lijalem Abeble (2020) in line with this achievement.

The inoculant MAR 1495 didn't show any significant different than non-inoculated treatments in both locations and both seasons. Also except the biomass yield of soybean in the first season the rest dependent variables the inoculated treatments didn't show significant response as compared to non inoculated ones. However, this effect depended on a variety of factors such as the amount of N applied and type of soil, climate, and farming system this might be due to the presence of potential competent native Bradyrhizobial strains in the soil.

Conclusion

In this experiment the role of tested rhizobial inoculants were not either favored or suppressed due to the application of starter N fertilizer from the inorganic sources but the utilization of different level of inorganic fertilizer sources showed significant difference in its economic yield. With this the maximum amount of inorganic fertilizer source gave the highest economic yield and significant difference were observed on the nitrogen level of 27Kg/ha. In this experiment the response of soybean for nitrogen fertilizer were magnified by the agronomic performance improvement of soybean through ascending the rate of nitrogen to be applied per ha. Consequently, the rhizobial inoculants with a potential of fixing highest amount of N from the atmosphere will be an advantage for the productivity improvement of soybean. Therefore, rather than exposing for the loss by using inorganic N fertilizer together with nitrogen fixing inoculants it will be better to utilize best nitrogen fixer rhizobia alone.

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