Response of Faba Bean to Starter Nitrogen Dose Application and Rhizobial Inoculation in the Major Growing Areas of Arsi Zone

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Abstract
Application of starter Nitrogenous fertilizer with rhizobial strains have been hypothesized to increase yield and yield parameters. Hence, to exploit productivity potential of Faba bean(Vicia faba L) a field study was conducted in Arsi zone 2015/16 and 2016/17.The test crop was uninoculated, inoculated with strain FB-1017,and supplied with six rates of Nitrogen (T1 = -Ve control (No input),T2 = 9 N kg/ha,T3 = 18 N (kg /ha),T4 = 27 - N (kg /ha),T5 = 36 - N (kg /ha),T6 = 54 - N (kg /ha)).The treatments were laid out in randomized complete block design with split plot arrangements with three replications. Application of inoculants and starter nitrogen at different levels indicated that plant height (at three locations), grain yield (at one location) and number of seeds per pod were improved significantly ($p<0.05$) otherwise did not improve none of yield and yield parameters in both years. In that case, though inconsistent a grain yield of more than five quintals per hectare than the negative control (uninoculated, unfertilized) was found by the highest fertilized treatment (54 kg ha-1). The results suggest that application of starter nitrogen to small holder farmers is not economical and inoculation with trust worthy and viable strains would suffice in compromise to environmental and profit margins and more studies in different locations ought to be executed for a few locations as such might not give required result.
Keywords: Arsi, Biological Nitrogen Fixation, Faba Bean, FB-1017, N starter
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Introduction

Enhancing agricultural productivity is one of the central challenges to achieving food security and poverty reduction in Ethiopia. Considering the fact that soil fertility is one of the biggest challenges, an obvious strategy is to increase fertilizer application and promote good agronomic practices to enhance productivity(Birhan Abdulkadir et al., 2017). Among which Nitrogen is one of the most abundant elements on earth. However, it is one of the most limiting factors of growth and production of crops. Which its requirements exceed any other and rarely do soils in the tropics have enough of this nutrient to produce high sustainable yields(Otieno et al., 2007).Currently inorganic fertilizer is an immediate supply but by far the most important source of fixed nitrogen derives from the activity of certain soil bacteria that absorb atmospheric N2 gas and convert it into ammonium which according to Zahran (1999) and Simon et al. (2014) approximately reduce 20 million tons of atmospheric nitrogen to ammonia which is 50% - 70% of the world Biological Nitrogen Fixation.

Integration of multipurpose, N-fixing legumes into farming systems commonly improves soil fertility and agricultural productivity through symbiotic associations between leguminous crops and Rhizobium. However, the contribution of N fixation to soil fertility varies with the types of legumes grown, the characteristics of the soils, and the availability of key micronutrients in the soil to facilitate fixation, and the frequency of growing legumes in the cropping system(Birhan Abdulkadir et al., 2017).

It is widely acknowledged that inoculation of legumes with effective rhizobia can improve yields and provide a substitute to inorganic fertilizers and different research works made in recent years revealed that inoculation of Faba Bean with R.leguminosarum increase yield by 10-50%(Asfaw Hailemariam and Angaw Tsgie, 2003;Chemining'wa et al., 2007). The technology, therefore, is good for Ethiopian soils where 85% are reported to have low levels of Nitrogen(EIAR, 2014) and several field demonstrations have confirmed that leguminous crops show remarkable growth and yield response to rhizobia inoculations in different agroecologies in Ethiopia. As a result, the use of rhizobia inoculants has shown spectacular growth in Ethiopia (EIAR, 2014).

Faba Bean is a crop of high economic value with its edible seed serving as an important protein complement in the cereal based Ethiopian diet (Tamene Temesgen et al., 2015) and also contribute to smallholder income (FAO, 2014). Furthermore, it supplies an important added value to the crop by fixing atmospheric nitrogen in symbiosis, with root nodule bacteria known as Rhizobium leguminosarum bv. Viciae (Mutch and Young, 2004).An estimate of 240-235 amounts of N2 fixed (kilograms of N2 fixed per hectare) by Faba Bean with Faba Bean-rhizobial symbioses(Somasegaran and Hoben, 1994) thus, reducing costs by less fertilizer use and minimizing impact on the environment by natural soil maintenance (IFPRI, 2010;Alghamdi *et al.*, 2012).

Currently rhizobial inoculants are widely used in various parts of the world. They are the solution to dwindling soil fertility, inexpensive, environment friendly, and easy to use with no side effects in most cases(Wondwosen Tena et al., 2016).In response to this, promising Faba Bean Rhizobia screening activities were carried out during

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the past ten years in the country and revealed that there is diversity in different agroecologies (Abere Mnalku *et al.*, 2009;Alemayehu Workalemahu, 2009;Zerihun Belay and Fassil Assefa, 2011;Anteneh Argaw, 2012;Solomon Legesse and Fassil Assefa, 2014;Dereje Tsegaye *et al.*, 2015;Getahun Negash 2015;Wendesen Melak *et al.*, 2018). Indeed,he symbiotic interaction is initiated after an initial exchange of signals: when nitrogen present in the soil is scarce, legumes exude a series of phenolic compounds into the rhizosphere, mainly flavonoids and isoflavonoid (Clúa et al., 2018),however, Crop yield increases of 51–158% were reported in nitisols at Holleta due to the combined application of 20 kg ha-1P with strain over non-inoculated ones ,none of the above studies reported on the agronomic efficiency, profitability and the level of risk associated with applying starter N fertilizer on Faba bean.

However crucial is the use of organic inputs as external nutrient sources and has been advocated as a logical alternative to expensive fertilizers in Africa, application of starter Nitrogen with biological nitrogen fixing bacteria has been hypothesized to ameliorate yield and yield related parameters, but not explored.This paper reports results from a study on the effects of starter N fertilizer application and to evaluate the symbiotic potential of popular faba bean against nitrogen fixing rhizobial isolates, the essence of starter N application and to determine the starter N dose that the farmer should use and its effects on yield, agronomic efficiency, profitability, the risk associated with faba bean, in selected districts of Arsi Zone.

Material and Methods

Study sites

The study was undertaken for two years in seven districts of two potential Faba bean production weredas namely Tiyo &Limu-Bilbilo(
Figure) The soils are classified as follows: at Bekoji a haplic Nitisol, and at Kulumsa an intergrade between a haplic Nitisol and a luvic Phaeozem(Amanuel Gorfu *et al.*, 2000) where Wheat is dominantly produced with mean annual rain fall 823 mm and 1020mm respectively of Kulumsa and Bekoji.

Experimental Design,

The Field trial were designed in split plot fashion with three replication for which two main plot factors two levels of inoculation(FB-1017 strain inoculated & uninoculated) and six levels of factorially combined inorganic N rates as sub plot factors (T1 = -Ve control (No input),T2 = 9 N kg/ha,T3 = 18 N (kg /ha),T4 = 27 - N (kg /ha),T5 = 36 - N (kg /ha),T6 = 54 - N (kg /ha)) were arranged in two way randomization.

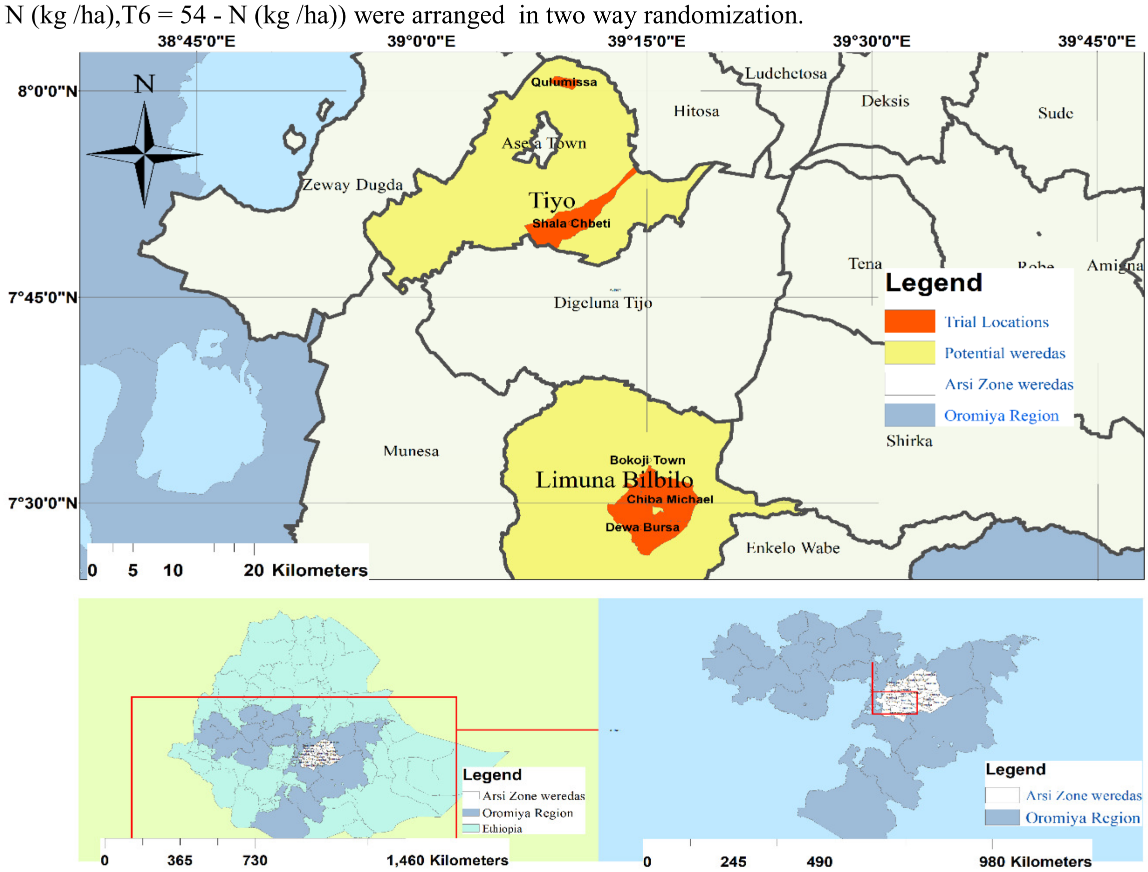

Figure 1 Map of Study area

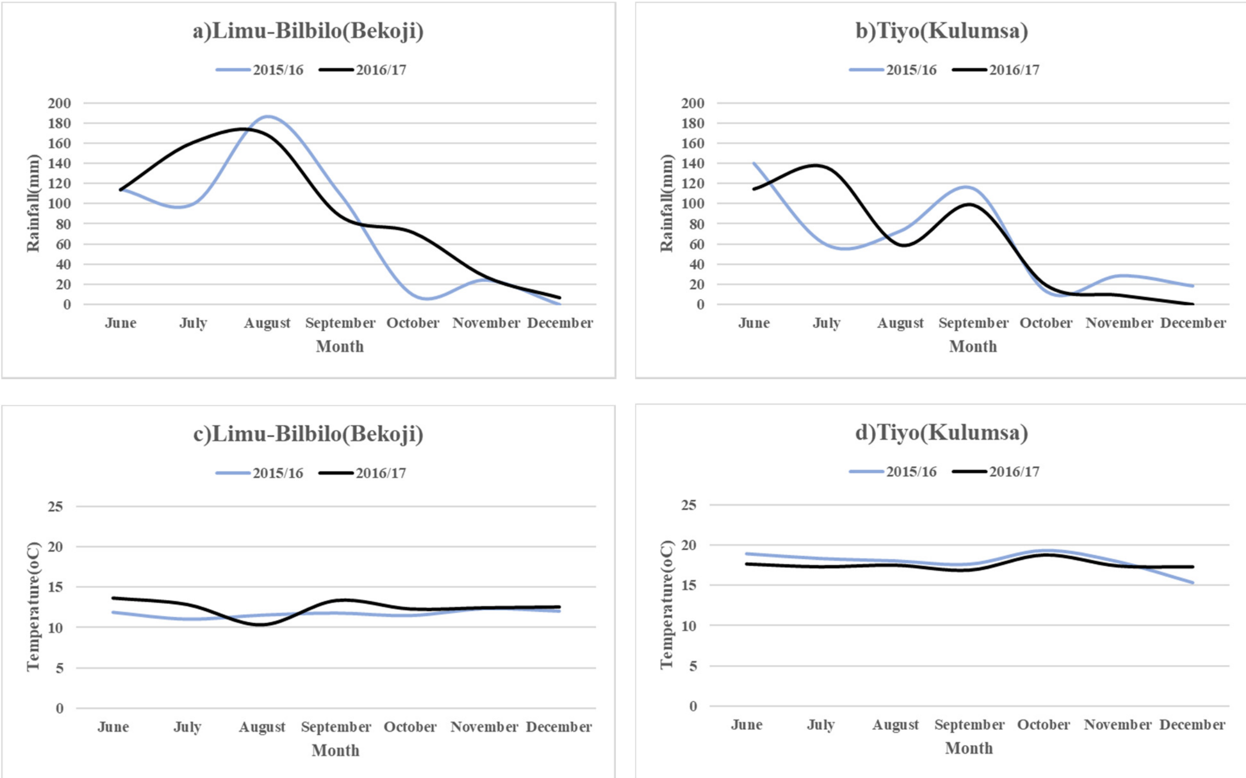

Figure 2 Rainfall and temperature patterns of districts during 2015/16 and 2016/17 growing seasons (**Source** kulumsa Agricultural Research Center meteorological stations)

Sources of seeds and Rhizobium strain

Faba bean variety Dosha was supplied by Highland pulse research of Kulumsa Agricultural Research Center, Ethiopia.Variety was selected based on their yield, their maturity time and recentness of year of release. Strain of Rhizbium spp. (FB-1017) was obtained from Holeta Agricultural Research Center.

Planting and Agronomic Practices

Field experiments were carried out in the two successive years of growing seasons, 2015/2016 and 2016/2017at seven locations in Arsi zones where Faba bean production is at potential and monoculture production system is dominant. Faba bean seeds were sown in the rate of 100 kg seeds ha−1 and were cultivated in strips. Each block (4m× 37.2 m) consisted of twelve plots. Each plot area was 10.4m^2 and consisted of 10 rows, spaced 0.4m apart. An additional eleventh row was placed in each plot and served as a border, and was not involved in calculations. Each strip was spaced apart by 1m apart to prevent bacterial migrations. Weeds, insects, and fungal pathogens were controlled by chemical spray applications, as required, at rates according to manufacturers' recommendations. At harvest, yield was determined by the manual mechanical harvesting of the entire plot.

Statistical Analysis

The ANOVA model was used according to Jones and Nachtssheim (2009) which is given by

$$Y_{ijk} = \mu_{..} + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \gamma_{k(i)} + \varepsilon_{ijk}$$

Where μ..is constant; a whole-plot treatment effects, are constants subject to $\sum \alpha i = 0$; βj, the b split-plot treatment effects, are constants subject to $\sum \beta j = 0$; $(\alpha\beta)_{ij}$, the ab interaction effects, are constants subject to $\sum_i (\alpha\beta)_{ij} = 0$ for all j and $\sum_j (\alpha\beta)_{ij} = 0$ for all i; γk(i),the nw = ac whole-plot errors, are independent $N(0,\sigma^2)$; ε_{ijk} independent are $N(0, \sigma^2)$; i =1,...,a, j =1,...,b, k =1,...,c. and Tukey Honest Significant Difference (HSD) test was used to separate treatment means at a probability level of 0.05 (SAS, 2009;R, 2018)

Yield and Yield Components

yield and yield attributes of faba bean were recorded. Plant height (PH),Pods per plant(PPP),seeds per pod(SPP) ,Total grain yield(GY) per hectare adjusted to 10% moisture content, biological yield(BY) per hectare and harvest index(HI) content were determined.

Results and Discussions

Rhizobial inoculation with starter-N treatments had no significant effect on all of parameters studied(Table and Table) the two years growing seasons but plant height at Bekoji where unfertilized plots performed significantly ($p<0.05$) less than other treatments during the first year. This result did not agree to previous studies, that goes in line with the general notion that biological nitrogen fixation is affected by inorganic nitrogen. Starter nitrogen caused decline in grain yield that was explained could suppress nodulation and hence yield related parameters, but it was also noted that a moderate dose of starter-N demonstrated to stimulate seedling growth and subsequent nitrogen fixation(Chemining'wa *et al.*, 2007).Inorganic Nitrogen is required by legume plants during the 'nitrogen hunger period' for their nodule development, shoot and root growth before the onset of N_2-fixation. The success of legume grain crops is dependent on their capacity to form effective nitrogen-fixing symbioses with root-nodule bacteria(Youseif *et al.*, 2017). However, many soils may do not have adequate amounts of native rhizobia in terms of number, quality, or effectiveness to enhance biological nitrogen fixation.

The increments in seed yields in most of the N-fertilized plots and/or inoculated plots, in relation to the uninoculated non-N fertilized plots controls indicate that, in these soils, nitrogen is not a limiting factor, and that crop yields could be strongly improved by means of competitive and viable strains inoculation but fertilization might not help. However, we found that response to inoculation with the best rhizobia strains was greater comparably better than the full N fertilization even though statistically not different. Our results showed that faba bean inoculation could effectively reduce the need of applied inorganic N-fertilizers while achieving higher grain yield, but in this particular case even the main plot factor ,that inoculating did not have improved difference than un inoculated control while a study reported in Youseif *et al.* (2017) from which effective inoculation improved grain yield by 35%-48% and faba bean yield and yield components could be significantly improved through the combined use of Rhizobium/Agrobacterium inoculations and starter N application (48kg N·ha−1) under low fertility sandy soil conditions but according to Chemining'wa *et al.* (2007) even Rhizobia inoculation failed to improve yield .The mean grain yield in the two years varied 3.69 to 4.34 ton ha^{-1} in 2015/16 and 2.80 to 5.40 ton ha^{-1} in 2016/17 which actually is far better than the national average 1.91 and 2.05 ton ha^{-1} (CSA, 2016;CSA, 2017),that can be ascribed to the relatively low precipitation and higher temperature (Figure) during floral initiation when nodule initiation Is maximum

Table 1 Effects of Starter nitrogen dose on yield and yield traits of faba bean (2015/16)

Variables	Kulumsa						Dawa Bursa						Bekoji					
	PH (cm)	PPP	SPP	GY (ton/ha)	BY (ton/ha)	HI (%)	PH (cm)	PPP	SPP	GY (ton/ha)	BY (ton/ha)	HI (%)	PH (cm)	PPP	SPP	GY (ton/ha)	BY (ton/ha)	HI (%)
Inoculation																		
Inoculated	137.06a	13.21a	2.74a	3.65a	10.65a	35.58a	130.60a	21.82a	2.97a	3.63a	7.05a	54.44a	113.84a	14.17a	2.74a	4.38a	9.04a	55.21a
Uninoculated	133.78a	12.14a	2.81a	3.76a	10.29a	38.37a	130.72a	21.20a	2.89a	3.74a	7.23a	51.68a	113.72a	14.93a	2.81a	4.41a	8.92a	54.52a
LSD	13.44	2.03	0.14	1.54	3.40	3.36	8.23	2.74	0.19	0.34	0.66	5.94	12.77	3.11	0.59	0.63	2.08	7.11
CV	6.9	11.2	3.6	29	22.6	6.3	4.4	8.9	4.6	6.5	6.4	7.8	7.8	14.9	14.3	10.1	16.2	9
N(kg/ha)																		
0	136.83a	11.90a	2.67a	3.65a	10.25a	37.50a	129.33a	20.67a	2.83a	3.48a	7.21a	51.77a	105.87b	13.73a	2.80a	4.32a	8.98a	53.71a
9	136.83a	12.70a	2.83a	3.78a	10.36a	38.00a	132.17a	20.93a	2.90a	3.86a	7.54a	53.58a	109.17ab	14.60a	2.83a	4.28a	8.25a	57.28a
18	135.17a	12.80a	2.70a	3.92a	10.86a	36.38a	129.97a	21.00a	2.93a	3.65a	7.26a	52.00a	116.83ab	14.27a	2.90a	4.35aa	8.77a	56.20a
27	135.50a	13.70a	2.90a	3.78a	9.83a	38.93a	130.00a	21.17a	3.00a	3.75a	6.70a	53.54a	114.83ab	14.23a	2.77a	4.20a	9.58a	50.28a
36	140.50a	12.23a	2.73a	3.59a	10.48a	36.55a	130.00a	22.33a	2.93a	3.74a	7.06a	53.50a	116.17ab	15.33a	2.93a	4.38a	8.79a	56.01a
54	133.67a	12.73a	2.83a	3.56a	11.07a	34.49a	132.50a	22.97a	2.97a	3.63a	7.08a	53.95a	119.83a	15.13a	2.97a	4.83a	9.51a	55.73a
LSD	10.63	3.02	0.25	0.89	2.85	10.34	9.31	6.90	0.33	0.59	1.23	9.26	11.81	2.44	0.33	0.87	2.77	7.43
I:N																		
Uninoculated:0	134.67a	12.47a	2.80a	3.50a	10.04a	38.67a	127.33a	20.87a	2.80a	3.43a	7.17a	50.03a	109.67a	13.60a	2.73a	4.36a	9.18a	51.43a
Uninoculated:9	136.33a	13.87a	2.87a	3.72a	9.56a	40.83a	132.33a	20.73a	2.87a	3.71a	7.69a	49.89a	110.67a	15.20a	2.87a	4.45a	8.33a	58.47a
Uninoculated:18	134.67a	12.60a	2.80a	3.75a	11.31a	33.82a	130.67a	21.60a	2.93a	3.68a	6.99a	53.45a	116.00a	15.07a	2.93a	4.40a	8.47a	57.03a
Uninoculated:27	136.00a	14.87a	2.80a	4.01a	10.00a	40.15a	130.67a	20.47a	2.93a	4.19a	6.77a	54.28a	111.67a	14.13aa	2.80a	4.03a	8.97a	50.42a
Uninoculated:36	139.00a	12.47a	2.80a	3.79a	10.52a	37.85a	129.67a	20.47a	2.87a	3.76a	7.51a	50.05a	114.67a	15.20a	2.93a	4.38a	9.19a	53.42a
Uninoculated:54	134.00aa	13.00a	2.80a	3.84a	10.34a	38.90a	133.67a	23.07a	2.93a	3.67a	7.29a	52.37a	119.67a	16.40a	3.07a	4.83a	9.36a	56.39a
Inoculated:0	139.00a	11.33a	2.53a	3.80a	10.46a	36.32a	131.33a	20.47a	2.87a	3.53a	7.25a	53.51a	102.07a	13.87a	2.87a	4.29a	8.78a	55.99a
Inoculated:9	137.33a	11.53a	2.80a	3.84a	11.16a	35.16a	132.00a	21.13a	2.93a	4.01a	7.39a	57.28a	107.67a	14.00a	2.80a	4.10a	8.17a	56.09a
Inoculated:18	135.67a	13.00a	2.60a	4.09a	10.41a	38.94a	129.27a	20.40a	2.93a	3.62a	7.53a	50.55a	117.67a	13.47a	2.87a	4.31a	9.07a	55.37a
Inoculated:27	135.00a	12.53a	3.00a	3.55a	9.66a	37.71a	129.33a	21.87a	3.07a	3.32a	6.64a	52.81a	118.00a	15.47a	2.73a	4.37a	10.19a	50.14a
Inoculated:36	142.00a	12.00a	2.67a	3.39a	10.43a	35.26a	130.33a	24.20a	3.00a	3.72a	6.60a	56.95a	117.67a	14.33a	2.93a	4.38a	8.39a	58.61a
Inoculated:54	133.33a	12.47a	2.87a	3.28a	11.81a	30.08a	131.33a	22.87a	3.00a	3.59a	6.87a	55.54a	120.00a	13.87a	2.87a	4.82a	9.66a	55.07a
LSD	17.59	5.00	0.42	1.48	4.71	17.10	15.41	11.41	0.54	0.97	2.03	15.31	19.51	5.70	0.55	1.44	4.58	12.30
CV	4.3	13.2	5	13	15	15.4	3.9	17.7	6.2	8.8	9.5	9.6	5.7	13	6.4	10.9	17	7.5
Mean	136.41	12.67	2.78	3.71	10.47	36.97	130.66	21.51	2.93	3.69	7.14	50.06	113.78	14.55	2.87	4.34	8.98	54.87

Means followed by the same letter within a column are not significantly different at the P=0.05 level using LSD test(**PH**=plant height,**PPP**=number of pods per plant,**SPP**=number of seeds per pod,**GY**=grain yield,**BY**=Biomass yield,**HI**=harvest index)

Table 2 Effects of Starter nitrogen dose on yield and yield traits of faba bean (2016/17)

Variables	Kulumsa						Shala Chebeti					
	PH (cm)	PPP	SPP	GY (ton/ha)	BY (ton/ha)	HI (%)	PH (cm)	PPP	SPP	GY (ton/ha)	BY (ton/ha)	HI (%)
Inoculation												
Inoculated	164.33a	17.14a	2.86a	5.07a	15.46a	36.60	116.72a	12.42a	2.56a	3.00a	5.84a	51.64a
Uninoculated	161.17a	19.42a	2.81a	4.99a	13.93a	38.73	116.39a	13.30a	2.57a	3.32a	6.57a	49.49a
LSD	27.99	5.66	0.21	1.47	3.08	3.23	11.82	3.52	0.31	1.94	4.08	12.90
CV	12	21.6	5.1	20.4	14.6	6	7.1	19.1	8.5	43	45	17.8
N(kg/ha)												
0	166.33a	18.57a	2.80a	5.00a	14.93a	37.55	113.50a	12.47a	2.50a	3.27a	6.56a	48.62a
9	163.00a	19.07a	2.77a	4.72a	12.83a	39.75	113.00a	12.13a	2.53a	3.11a	6.00a	50.30a
18	161.67a	15.73a	2.90a	5.05a	14.09a	38.77	120.67a	13.13a	2.50a	3.30a	6.65a	48.30a
27	165.50a	18.47a	2.83a	4.95a	15.86a	34.13	117.17a	12.13a	2.53a	2.80a	5.58a	49.47a
36	160.17a	20.07a	2.73a	5.03a	13.84a	39.90	118.83a	13.93a	2.63a	3.16a	6.15a	50.18a
54	159.83a	17.80a	2.97a	5.42a	16.62a	35.90	116.17a	13.37a	2.67a	3.31a	6.29	56.53a
LSD	19.10	6.29	0.32	1.50	6.01	8.46	11.21	3.02	0.38	0.64	1.78	15.36
I:N												
Uninoculated:0	160.33a	19.93a	2.73a	4.83a	13.27a	38.83	111.33bc	13.80a	2.53a	3.32a	6.34a	51.03a
Uninoculated:9	166.67a	19.67a	2.80a	4.71a	12.75a	40.43	110.33bc	12.47a	2.47a	3.22a	6.01a	52.40a
Uninoculated:18	160.00a	16.27a	2.87a	5.41a	15.11a	38.67	118.33abc	13.47a	2.47a	3.58a	7.22a	47.87a
Uninoculated:27	161.33a	20.33a	2.87a	4.95a	14.29a	37.43	119.00ab	11.93a	2.60a	2.89a	5.66a	50.10a
Uninoculated:36	159.00a	20.93a	2.67a	4.81a	13.29a	39.53	115.00abc	13.80a	2.67a	3.22a	6.38a	49.40a
Uninoculated:54	159.67a	19.40a	2.93a	5.20a	14.85a	37.50	124.33a	14.33a	2.67a	3.67a	7.81a	46.13a
Inoculated:0	172.33a	17.20a	2.87a	5.16a	16.58a	36.27	115.67abc	11.13a	2.47a	3.22a	6.77a	46.20a
Inoculated:9	159.33a	18.47a	2.73a	4.73a	12.92a	39.07	115.67abc	11.80a	2.60a	3.00a	6.00a	48.20a
Inoculated:18	163.33a	15.20a	2.93a	4.69a	13.07a	38.87	123.00a	12.80a	2.53a	3.02a	6.09a	48.73a
Inoculated:27	169.67a	16.60a	2.80a	4.95a	17.44a	30.83	115.33abc	12.33a	2.47a	2.71a	5.49a	48.83a
Inoculated:36	161.33a	19.20a	2.80a	5.26a	14.38a	40.27	122.67a	14.07a	2.60a	3.11a	5.91a	50.97a
Inoculated:54	160.00a	16.20a	3.00a	5.65a	18.39a	34.30	108.00c	12.40a	2.67a	2.94a	4.76a	66.93a
LSD	31.59	10.40	0.53	2.48	9.95	13.99	10.52	13.80	0.62	1.07	2.95	25.41
CV	6.5	18.9	6.3	16.4	22.6	12.4	5.3	12.9	8.1	11.3	11.8	16.7
Means	162.50	18.28	2.83	5.03	14.69	37.67	116.56	12.86	2.56	3.16	6.20	50.57

Variables	Dawa Bursa						Chiba Michael					
	PH (cm)	PPP	SPP	GY (ton/ha)	BY (ton/ha)	HI (%)	PH (cm)	PPP	SPP	GY (ton/ha)	BY (ton/ha)	HI (%)
Inoculation												
Inoculated	119.50a	14.16a	2.88a	5.43a	11.26a	51.76a	103.78a	14.58	2.84a	3.09a	6.00a	53.70a
Uninoculated	115.94b	14.16a	2.68a	5.38a	11.04a	53.22a	98.56a	14.89	2.77a	3.04a	5.75a	55.25a
LSD	0.63	1.52	0.30	0.81	0.68	5.29	19.93	1.74	0.61	2.35	4.50	4.48
CV	0.4	7.6	7.5	10.5	4.3	7	13.8	8.3	15.2	53.4	53.5	5.7
N(kg/ha)												
0	120.33a	13.73a	2.80a	5.57a	11.11a	53.88a	103.67a	15.07	2.77a	3.26a	6.17a	55.20a
9	115.50a	13.43a	2.77a	5.27ab	10.95a	52.28a	102.33a	14.63	2.90a	3.18a	6.18a	53.83a
18	116.33a	13.57a	2.77a	5.56a	11.49a	52.62a	100.67a	14.83	2.63a	3.02a	5.77a	54.73a
27	118.67a	15.20a	2.80a	5.56a	11.79a	51.37a	95.67a	13.10	2.93a	3.16a	5.91a	56.05a
36	114.67a	15.27a	2.77a	4.86b	10.15a	52.03a	101.00a	15.47	2.70a	2.91a	5.58a	54.05a
54	120.83a	13.73a	2.77a	5.59a	11.41a	52.73a	103.67a	15.30	2.90	2.85a	5.64a	52.98a
LSD	16.13	3.07	0.34	0.70	1.85	6.04	9.56	4.02	0.40	0.92	1.73	3.52
I:N												
Uninoculated:0	115.33a	13.53a	2.67a	5.56a	11.31a	53.20a	100.00a	14.53	2.80ab	3.10a	5.65a	56.93a
Uninoculated:9	112.00a	12.80a	2.67a	5.46a	11.10a	54.30a	98.33a	16.13	3.07ab	3.23a	6.12a	55.20a
Uninoculated:18	112.67a	13.27a	2.80a	5.27a	10.75a	53.43a	98.33a	16.33	2.53b	3.00a	5.87a	54.07a
Uninoculated:27	122.67a	14.73a	2.60a	5.53a	11.74a	51.90a	90.00a	13.67	2.60b	3.26a	6.01a	57.97a
Uninoculated:36	114.33a	16.13a	2.67a	4.89a	10.09a	52.90a	100.67a	14.47	2.80ab	3.06a	5.89a	53.77a
Uninoculated:54	125.33a	14.47a	2.67a	5.56a	11.24a	53.57a	104.00a	14.20	2.80ab	2.57a	4.96a	53.57a
Inoculated:0	119.00a	13.93a	2.93a	5.59a	10.91a	54.57a	107.33a	15.60	2.73ab	3.43a	6.69a	53.47a
Inoculated:9	120.00a	14.07a	2.87a	5.08a	10.81a	50.27a	106.33a	13.13	2.73ab	3.13a	6.25a	52.47a
Inoculated:18	114.67a	13.87a	2.73a	5.85a	12.23a	51.80a	103.00a	13.33	2.73ab	3.04a	5.67a	55.40a
Inoculated:27	115.00a	15.67a	3.00a	5.58a	11.83a	50.83a	101.33a	12.53	3.27a	3.06a	5.80a	54.13a
Inoculated:36	123.00a	14.40a	2.87a	4.84a	10.21a	51.17a	101.33a	16.47	2.60b	2.77a	5.28a	54.33a
Inoculated:54	118.67a	13.00a	2.87a	5.62a	11.59a	51.90a	103.33a	16.40	3.00ab	3.14a	6.31a	52.40a
LSD	26.69	5.08	0.56	1.23	3.06	10.00	15.81	6.66	0.66	1.52	2.90	5.82
CV	7.6	12	6.5	7.6	9.1	6.3	5.2	15.1	7.8	16.6	16.3	3.6
Means	117.72	14.15	2.78	5.40	11.15	52.49	101.17	14.73	2.80	3.06	5.87	54.47

Means followed by the same letter within a column are not significantly different at the P=0.05 level using LSD test

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Conclusions and recommendations

Application of starter nitrogen with faba bean had not had any apparent effect on yield and yield components. The reason could be attributed to poor inoculant viability, adequate soil mineral, or highly competitive indigenous strains, besides to that Legumes have a high internal phosphorous requirement for their symbiotic nitrogen fixation, in addition to the nodule formation, deficiency of phosphorous in legumes also markedly affects the development of effective nodules and the nodule leghaemoglobin content which directly affect productivity. It is therefore suggested that the status of available phosphorous in soils ought to be taken through as in the soils of the experimental field may be beneficial to nodule nitrogen fixation through the prevention of the decrease of the phosphorous concentration in the plants at the later growth stage. Hence For better verification of this investigation it is also suggested to repeat the study in other carefully evaluated in prevalent N depleted in small holder farmers with other cultivars and bio-fertilizers and even the inoculants of different strains of rhizobia that was formed from indigenous soils of Arsi.

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