International Journal of Research in Agricultural Sciences
Volume 7, Issue 6, ISSN (Online): 2348 – 3997

Response of Some Common Bean Varieties to Different Rates of Nitrogen, Phosphorus, Sulfur Fertilizers and Rhizobium Inoculation on Nodulation, Yield, Yield Attributing Traits

Nuru Seid Tehulie [1]* and Taminaw Zewdie [1]
[1] Department of Plant Science, College of Agriculture, Mekdela Amba University, Ethiopia.
Corresponding author email id: befikrnuru@gmail.com

Date of publication (dd/mm/yyyy): 05/01/2021

***Abstract* – Inadequate use of NPS fertilizer and deficiency of proof on the utilization of Rhizobium inoculants are the significant yield limiting reasons for common bean creation in the investigation zone. Accordingly, the exploration was led at Gewane District, to assess the impact of NPS fertilizer rates and Rhizobium inoculation on nodulation, yield constantly parts of some common bean components. Variables contemplated were three regular bean components (Tabor, Melkie and Beshbesh), three degrees of NPS compost rate (0, 100, 200 kg ha^{-1}) and two degrees of Rhizobium inoculation (with and without). Randomized Complete Block Deign in factorial course of action with three replications was utilized. Information was exposed to examine by General Linear Model (GLM) technique of SAS adaptation 9.0. Result demonstrated the consolidated utilization of Rhizobium inoculation with NPS rates and components had huge impact on number of all out nodulation per plant and seeds per case. Where, the most noteworthy number of absolute nodulation per plant (78.53) and seeds per unit (6.5) were recorded from Rhizobium inoculation with NPS rate 100 kg ha^{-1} and for assortment Beshbesh. In light of the results of this examination, it tends to be concluded that Rhizobium inoculation with utilization of NPS pace of 100 kg ha^{-1} discovered to be appropriate for common bean assortment Beshbesh notwithstanding additional components, where assortment Beshbesh was more noteworthy creation in the investigation region.**

***Keywords* – Biological Nitrogen Fixation, Economic Analysis, Grain Yield.**

I. Introduction

Common bean (Phaseolus vulgaris L.) is one of the most essential grain vegetables to bear the cost of the calorie and protein hotspots for people. Common bean is presently one of the main wellsprings of supplements for in excess of 300 million individuals in pieces of Eastern Africa and Latin America, speaking to 65% of all out protein burned-through 32% of energy [1]. The yearly overall bean creation is around 12 million metric tons, with 5.5 and 2.5 million metric tons alone in Latin America Caribbean and Africa, individually [2]. In Ethiopia, where the utilization of NPS compost is restricted and common yields of common bean creation are low in farmhouse typically under 1 ton ha^{-1} [3]. The essential divers of low yield at rancher fields are low agrarian info, a helpless information level, and low productiveness soils, especially with low N placated [4]. Soil supplement lack like low soil nitrogen and phosphorus, and acidic soil conditions are significant cutoff points for common bean creation in a large portion of the common bean developing regions. In contrast with different vegetables common bean are low in advantageous N obsession rates, seed protein level and resilience to phosphorus lack [15].

NPS fertilizer is gives nitrogen, phosphorus, and sulfur supplements by truly mixing three fixings in a production line. Mixed fertilizer kinds of which Blend-1 (N, P, K, S, B and Cu), Blend-2 (N, P, S, B and Cu) and Blend-3 (N, P, K, S and B) were the most prevailing supplements in Ethiopia soil [5].

Inoculation isn't new information in Ethiopia. Rhizobium strains were chosen and circulated to the ranchers for six vegetables crop, in particular Faba bean, Chick pea, Common bean, Lentil, Soybean and Field pea yet it isn't broadly utilized by the ranchers. Inoculation altogether improved knob number per plant as contrasted and un-vaccinated treatment; this is a result of immunized microscopic organisms strain had great nodulation instigating limit over the local soil Rhizobium populace [6].

As of now, novel mixed NPS (19% N, 38% P_2O_5 and 7% S) and bio-fertilizer are spread to the cultivators in investigation region, yet their measure of utilization isn't tentatively decided for common bean creation. Accordingly, this examination was completed with objective of evaluate the effect of NPS rates and Rhizobium inoculation on the nodulation and yield a lot parts of some common bean components.

II. Materials and Methods

Description the Study Area

The test was led at Gewane Agricultural College showing site, Afar Regional State during 2017 trimming season. It is situated in Gewane Woreda at 10º10' N scope, 40º32' E longitude, and 356 km North East from Addis Ababa. The elevation of the site is around 626 meters above ocean levels. The mean yearly temperature of the exploratory spot is around 30 ºC with 39ºC greatest and 22.5ºC least.

Experimental Materials

The test materials utilized for the investigation were common bean components (Melkie, Tabor and Beshbesh). Mixed NPS fertilizers (19% N, 38% P2O5 7% S) and Rhizobium strain (EAL-429) were utilized for the investigation.

Experimental Design

The test was done in 3x3x2 factorial mix of three components of common bean (Melkie, Beshbesh, Tabor), three degrees of NPS fertilizer (0, 100, 200 kg ha^{-1}) and two degrees of Rhizobium inoculation (with and without) by utilizing RCBD with three replications.

Trial Procedures

The land was plowed by bulls. The dirt cleared from every single undesirable material and plant buildups, leveled and the field format was readied. The line separating was 40 cm and the dispersing between plants was 10 cm. The seed needed for plot was blended in slurry to have uniform covering of the inoculums over the seeds and the seed was dried under shade for around 30 minutes.

Phenological Information

Days to half blossom starting was controlled by checking the quantity of days from planting to when first blossoms showed up in half of the plants in a plot by tallying the quantity of plants. Days to physiological development was resolved as the quantity of days from planting to when 90% of the plants began senescence of leaves (yellowing of the foliage) and cases began to turn yellow. This was finished by tallying the quantity of plants.

Nodulation Parameter

Number of all out nodulation per plant was taken (removed) from haphazardly 10 irregular plants of dangerous columns from each plot at half blossoming for nodulation study. Roots were painstakingly washed utilizing faucet water on a strainer and nodulation were isolated and checked. For assurance of powerful number of nodulation, within shade of nodulation was seen by cutting every knob with the assistance of sharp edge and the pink hued nodulation were considered as compelling nodulation, while green hued nodulation were considered as non-successful.

Yield Components and Yield

Number of units per plant was recorded dependent on five plants in each net plot zone at gather and the common was taken as number of cases per plant. The absolute number of seeds in the cases of five plants was checked and separated by the complete number of units to locate the quantity of seeds per case. The dry biomass per plant was then duplicated by the complete number of plants per net plot and was changed over into kg ha^{-1}. This worth was utilized to ascertain the reap list also. Grain yield was estimated by collecting and sifting of the harvest from the net plot territory. The dampness was acclimated to 10%. Collect record was determined by partitioning grain yield per plot by the all out over the ground dry biomass yield per plot.

Data Analysis

Data collected were exposed to examination of change (ANOVA) reasonable to factorial test in RCBD as per the General Linear Model (GLM) method of SAS form 9.0. The translations were made by following Gomez and Gomez (1984). At whatever point the impacts of the medicines were discovered huge, the methods were analyzed utilizing least noteworthiness distinction (LSD) test at 5% degree of centrality.

III. Results and Discussion

Phenological Parameters of Common Bean

Number of days to half blooming indicated huge ($P< 0.01$) variety to components, NPS application rate and Rhizobium inoculation.

Components Beshbesh and Melkie were early blooming which required 41.22 and 41.50 days individually; than Tabor, which blossomed at 42.89 days in the wake of planting (Table 1). This may be because of inherited changes since common bean has exceptionally high variety in phenological characters. In adjustment to this outcome, [7] moreover expressed huge contrasts in the quantity of days needed to arrive at half blooming among 20 common bean genotypes which went from 26.67 to 45.

The utilization of NPS rate essentially impacted the days needed to arrive at half blossoming in like manner bean. Expanding NPS rate from 0 kg NPS ha^{-1} to 100 kg NPS ha^{-1} expanded the quantity of days needed to arrive at half blooming from 39.61 to 44.11 days (Table 1). The expanded paces of NPS may be credited to the delayed vegetative development. Essentially, [8] revealed that elevated level of nitrogen (160 kg N ha^{-1}) altogether increment the quantity of days to half blossoming on common bean.

Rhizobium inoculation essentially affected the days needed to arrive at half blossoming in like manner bean. In concurrence with this outcome, such postponed blooming with inoculation was additionally detailed for chickpea by [9].

Number of days to physiological development was exceptionally huge (P<0.01) with the impacts of components, NPS application rate, and Rhizobium inoculation. Components Beshbesh and Melkie were early developing which required 73.56 and 77 days individually; than Tabor, which developed on 79.56 days in the wake of planting (Table 1).

The utilization of NPS rate fundamentally impacted the days needed to arrive at physiological development in like manner bean. Expanding NPS rate from 0 kg NPS ha^{-1} to 100 kg NPS ha^{-1} expanded the quantity of days needed to arrive at half blossoming from 39.61 to 44.11 days (Table 1). The expanded paces of NPS may be ascribed to the drawn out vegetative development. Essentially, [8] detailed that elevated level of nitrogen (160 kg N ha^{-1}) fundamentally increment the quantity of days to half blossoming on common bean.

Rhizobium inoculation altogether affected the days needed to arrive at half blooming in like manner bean. In concurrence with this outcome, such postponed blossoming with inoculation was likewise announced for chickpea by [9].

Number of days to physiological development was exceptionally critical (P<0.01) with the impacts of components, NPS application rate, and Rhizobium inoculation. Components Beshbesh and Melkie were early developing which required 73.56 and 77 days individually; than Tabor, which developed on 79.56 days in the wake of planting (Table 1).

The use of NPS rate essentially impacted the days needed to arrive at physiological development in like manner bean. Expanding NPS rate from 0 kg NPS ha^{-1} to 100 kg NPS ha^{-1} expanded the quantity of days needed to arrive at physiological development from 70.56 days to 73.72 days (Table 1).

Table 1. Days to 50% flowering and 90% physiological maturity of common bean as influenced by varieties, NPS rate and *Rhizobium* inoculation.

Treatment	**Days to 50% flowering**	**Days to 90% Physiological Maturity**
Varieties		
Tabor	39.89a	79.56a
Melkie	37.50b	77b
Beshbesh	37.22b	75.56c
LDS (0.05)	0.745	1.121
NPS rate (kg ha^{-1}) **Beshbesh Variety**		
0	36.61c	70.56c
100	41.11a	73.72b
200	39.89b	87.83a
LSD (0.05)	0.745	1.121
Inoculation **Beshbesh Variety**		
With	39.59a	80.19a

Treatment	Days to 50% flowering	Days to 90% Physiological Maturity
Without	38.15b	74.56b
LSD (0.05)	0.608	0.916
CV (%)	2.6	2.1

Means in the table followed by the same letter (s) are not significantly different to each other at 5% level of significance. Here, SD = Least significant difference; and CV (%) = Coefficient of variation.

The use of NPS rate essentially impacted the days needed to arrive at both half blossoming and 90% physiological development in like manner bean. The expanded paces of NPS flexibly may be credited to the drawn out vegetative development because of joined use of nitrogen with phosphorus and sulfur. The outcome was additionally as per that of [6] who revealed when the nitrogen and phosphorus flexibly was expanded from 0 kg ha^{-1} to 46 kg ha^{-1} of P_2O_5 and 0 kg ha^{-1} to 41 kg $ha^{-1}$of N, the days to arrive at both half blossoming and 90% physiological development half blooming was drawn out essentially in like manner bean.

Rhizobium inoculation essentially impacted the days needed to arrive at both half blooming and 90% physiological development in like manner bean. The conceivable explanation behind deferred blossoming and physiological development with the Rhizobium inoculation may be because of the way that inoculation upgraded nitrogen obsession and along these lines expanding N take-up by plants added to improved vegetative development of basic bean in this way postponed blooming. In concurrence with this outcome, such postponed both half blossoming and 90% physiological development with inoculation was likewise announced for chickpea [9].

Nodulation

The principle impact of Rhizobium inoculation, NPS rate, components, and the connection impact of NPS rate with assortment was profoundly huge ($P<0.01$) on all out quantities of nodulation per plant.

The greatest number of all out nodulation (68.53) was seen from the connection impact of Rhizobium inoculation with NPS pace of 100 kg ha^{-1} for assortment Beshbesh (Table 2). Rhizobium inoculation brought about expanded number of nodulation per plant contrasted with un-vaccinated treatment which could be because of the way that vaccinated microscopic organisms strain had great nodulation instigating limit.

Table 2. Number of total nodules per plant of common bean as influenced by the interaction of Rhizobium inoculation with NPS rates and varieties.

Inoculation	NPS rate $Kgha^{-1}$	Varieties		
		Tabor	Melkei	Beshbesh
With	0	19.87m	22.00l	25.00k
	100	44.53e	59.20b	65.53a
	200	35.47h	37.07g	37.60g
Without	0	6.87o	12.87n	13.53n
	100	39.20f	48.17d	50.80c
	200	27.93j	33.10i	35.50h

Inoculation	NPS rate Kgha^{-1}	Varieties		
		Tabor	Melkei	Beshbesh
LSD (0.05)	1.478			
CV (%)	2.4			

Means in the table followed by the same letter(s) are not significantly different to each other at 5% level of significance, LSD (0.05) =Least significant difference at 5%; and CV(%) =coefficient of variation.

The most elevated number of viable nodulation (16.32) was seen from the collaboration impact of NPS pace of 100 kg ha^{-1} for assortment Beshbesh (Table 3). Use of NPS brought about critical improvement of nodulation. It very well may be a direct result of the way that phosphorus is known to start knob arrangement, expanding the quantity of nodulation and basic for the turn of events and capacity of the nodulation [10].

Table 3. Number of effective nodules per pant as influenced by the interaction effect of NPS rates with varieties.

NPS Rate (kg ha^{-1})		Varieties	
	Tabor	Melkie	Beshbesh
0	3.80d	4.87c	5.47c
100	10.55b	15.10a	16.32a
200	9.87b	9.37b	9.80b
LSD (0.05)		1.296	
CV (%)		8.9	

Means in the table followed by the same letter(s) are not significantly different to each other at 5% level of significance, LSD (0.05) = Least significant difference at 5%; and CV(%) =coefficient of variation.

(a) Total number of nodules (b) Effective number of nodules

Fig. 1. Total and Effective number of nodules.

Use of NPS brought about an exceptionally huge upgrade of absolute knob and powerful nodulation. It very well may be a direct result of the way that phosphorus is known to start knob arrangement, expanding the quantity of nodulation and basic for the turn of events and capacity of the nodulation. Additionally, this may be expected to sulphure assumes fundamental function in controlling certain dirt borne sicknesses and nitrogenase arrangement which utilized in nitrogen obsession. Phosphorus is known to advance early root arrangement and the development of parallel, sinewy and solid roots, which assume a significant part in N2 obsession, supplement and water take-up. Announced that, knob number per plant was altogether expanded with expanding levels of phosphorus where the most elevated worth (31.85) was acquired from the use of 20 kg P_2O_5 ha^{-1} [10].

Yield Components and Yield of Common bean

Fundamental impacts of Rhizobium inoculation, NPS rates and components were exceptionally huge on quantities of units per plant, while the association impact was non-huge.

Among the components, the greatest number of cases per plant (10.70) was recorded for the assortment Beshbesh while the least number of cases per plant was recorded for assortment Tabor (Table 4), which may be because of hereditary contrasts related with development of number of branches and other sink that decides the yield of assortment.

Table 4. Number of pods per plant, hundred seed weight and harvest index of common bean as influenced by the main effects of *Rhizobium* inoculation, NPS rate and varieties.

Inoculation **Beshbesh Variety**	**No. of Pods per plant**	**Harvest index**
With	9.68a	36.67a
Without	8.83b	33.03b
LSD (0.05)	0.624	1.503
NPS fertilizer Rate **Beshbesh Variety**		
0	5.17c	26.16c
100	14.72a	40.69a
200	9.38b	37.69b
LSD (0.05)	0.764	1.841
Varieties		
Tabor	8.68c	31.57b
Melkie	9.88b	35.58a
Beshbesh	10.70a	37.40a
LSD (0.05)	0.764	1.841
CV (%)	8.8	7.2

Means in the table followed by the same letter (s) are not significantly different to each other at 5% level of significance, LSD(0.05) = Least significant difference at 5%; and CV(%) = Coefficient of variation.

The quantity of seeds per unit was altogether ($P < 0.01$) influenced by three route cooperation of *Rhizobium* i-

-noculation, NPS rates and components.

Essentially most noteworthy number of seeds per case (6.5) was seen from the association impact of *Rhizobium* inoculation with NPS rate at 100 kg ha^{-1}and for assortment Beshbesh while the least number of seeds per case (3.4) was for assortment Tabor at NPS pace of 100 kg ha^{-1}without inoculation (Table 5). Appropriate flexibly of supplements in NPS compost may be the purpose behind knob arrangement, products of the soil development. In accordance with this outcome, [11] additionally revealed the most noteworthy number of seeds per case (5.85) at applied NPS pace of 150 kg ha^{-1}.

Table 5. Number of seeds per pod as influenced by the interaction of varieties, NPS rate and *Rhizobium* inoculation.

	NPS rate Kg ha^{-1}	**Tabor**	**Melkie**	**Beshbesh**
With	0	4.700h	4.733gh	4.833gh
	100	5.600d	6.233b	6.500a
	200	5.167f	5.333e	5.200ef
Without	0	4.400i	4.533i	4.733gh
	100	5.500d	5.833c	6.100b
	200	4.833gh	4.867g	5.167f
SD	0.1354			
CV	1.3			

Means in the table followed by the same letter (s) are not significantly different to each other at 5% level of significance, SD (0.05) = significant difference at 5%; and CV(%) = Coefficient of variation.

The fundamental impact of *Rhizobium* inoculation, NPS rate and components and the association impact of *rhizobium* inoculation with NPS rate were profoundly critical on over the ground dry biomass yield of common bean, while the other connection impacts were not huge.

As for the connection outcome, the most extreme over the ground dry biomass (4006 kg ha^{-1}) was trial from the game plan of *Rhizobium* inoculation with NPS rate at 100 kg ha^{-1} and this was measurably at standard with NPS pace of 100 kg ha^{-1} lacking inoculation (Table 6). This dry issue amassing may be because of the good gracefully of N, P and S might have improved leaf zone which thus improved photosynthetic region and number of units per plant [10].

In concurrence with this result, [13] expressed the highest absolute biomass (3597 kg ha^{-1}) from the treatment with the use of 40 kg P ha^{-1}. Stated that deficiency of S restrictions the effectiveness of added N [14]; consequently, S adding becomes necessary to attain extreme effectiveness of useful nitrogenous fertilizer.

The main effects of *Rhizobium* inoculation, NPS rate and varieties and the interaction effect of *Rhizobium* inoculation with NPS rate and *Rhizobium* inoculation with varieties were highly significant ($P<0.01$) on grain yield of common bean, while the interaction effect of NPS rate with varieties was highly significant ($P<0.01$).The highest grain yield (1257 kg ha^{-1}) was obtained from interaction effect of *Rhizobium* inoculation with NPS rate of 100 kg ha^{-1} (Table 6).

Table 6. Above ground dry biomass and grain yield of common bean Beshbesh variety as influenced by the interaction effect of *Rhizobium* inoculation with NPS rate.

	Above ground dry biomass (kg ha^{-1})			Grain yield (kg ha^{-1})		
	NPS rate (kg ha^{-1})			NPS rate (kg ha^{-1})		
Inoculation	0	100	200	0	100	200
With	2495^{d}	4006^{a}	3601b	119e	1257a	927b
Without	1526^{e}	3959a	3275c	65f	97b	683d
LSD (0.05)		205.8		93.1		
CV (%)		4.2		6.0		

Means in the table followed by the same letter (s) are not significantly different to each other at 5% level of significance, LSD (0.05) = Least significant difference at 5%; and CV (%) = Coefficient of variation.

In like manner expressed the extraordinary seed yield (2160 kg ha^{-1}) of common bean from the utilization of the N rate (23 kg ha$^{-1)}$ [12]. Essentially, [13] detailed that, the most noteworthy grain yield (2547 kg ha$^{-1)}$ of basic bean from the use of 40 kg P ha^{-1}.

Gather file is important in ascertaining supplement isolating in harvest plants, which gives an indication of how competently the plant utilized acclimatized supplements for grain creation. The impact of *Rhizobium* inoculation, NPS rate and components was incredibly huge on gather record of basic bean, while all the association impacts were non-critical.

Concerning, assortment Beshbesh delivered the most noteworthy collect list (40.40%), which was measurably at standard with assortment Melkie (38.58%), while the least gather list was recorded for assortment Tabor (34.57%) (Table 4). This may be because of hereditary cosmetics of the components.

NPS fertilizer essentially improved the yield constantly segments of vegetables, for example, number of cases per plant, number of seeds per unit, number of seeds per plant, and seed yield comparative with control. The noticed yield enhancements with inoculation and NPS application may be because of the expanded N as aftereffect of environmental nitrogen obsession from powerful strain and P and S accessibility by direct application.

Rhizobium inoculation altogether improved the yield a lot segments of vegetables, for example, number of cases per plant, number of seeds per case, number of seeds per plant, 100 seed weight, and seed yield comparative with control. Moreover expressed the extraordinary seed yield (1416.3 kg ha^{-1}) from seed inoculation with *Rhizobium* strain (HB-129) [12].

IV. Conclusion

NPS rates, *Rhizobium* inoculation and components affected by days to half blossoming, days to 90% physiological development, quantities of viable nodulation, quantities of all out nodulation, number of seeds per case, number of units per plant, over the ground dry biomass, grain yield and reap file. Expanding NPS rate from 0 kg NPS ha^{-1}to 100 kg NPS ha^{-1} expanded the quantity of days needed to arrive at half blooming, and 90% physiological development. *Rhizobium* inoculation and components impacted by grain yield and compelling number of nodulation of common bean. For the most part, it tends to be concluded that NPS fertilizer pace of 100 kg ha^{-1} with *Rhizobium* inoculation gave greatest agronomic yield notwithstanding monetary advantage for components Beshbesh and Melkie.

REFERENCES

[1] Blair, M., Gonzales, L.F., Kimani, P.M. & Butare, L. (2010). Genetic diversity, inter-gene pool introgression and nutritional quality of common beans from central Africa. *Theoretical Application Genetics.* 121: 237-248. DOI: 10.1007/s00122-1305-x

[2] CGIAR (Consultative Group on International Agricultural Research). Common Bean, (2012). Available online: http://www.cgiar.org/our-research/crop-factsheets/beans/(accessed on January, 2017).

[3] CSA (Central Statistical Agency). (2013). Report on area and production for major crops in 2012/2013.*Central Statistical Authority (CSA),* Addis Ababa, Ethiopia. http://www.csa.gov.et

[4] Beebe, S.E., Rao, I.M., Blair, M.W. & Acosta-Gallegos, J.A. (2013). Phenotyping common beans for adaptation to drought. *Frontiers in Plant Physiology*, 4:1–20.

[5] Ethio-SSI (Ethiopian Soil Information System), (2014). *Soil analysis report*, Agricultural Transformation Agency. https://wle.cgiar.org /solutions/ethiopian-soil-information-system-ethiosis

[6] Habtamu, A., Berhanu, A., & Tamado, T. (2017). Response of common bean (*Pharsalus vulgaris* L.) cultivars to combined application of *Rhizobium* and NP fertilizer at Melkassa, Central Ethiopia. *International Journal of Plant & Soil Science, 14*(1): 1-10. DOI: 10.9734/IJPSS/2017/30864

[7] Nchimbi-Msolla, S. & Tryphone, G.M. (2010). The effect of the environment on iron and zinc concentrations and performance of common bean genotypes. *Asian Journal of Plant Science*, 9(8):455-462. DOI: 10.3923/ajps.2010.455.462

[8] Tewari, J.K., & Singh, S.S. (2000). Effect of nitrogen and phosphorus on the growth and seed yield of french bean (*Phaseolus vulgaris* L.). *Journal of Vegetable Science,* 27(3): 172-175. https://doi.org/10.9734/ajrcs/2019/v4i230071

[9] Verma, J.P., Yadav, J., Tiwari, K.N. & Kumar A. (2013). Effect of indigenous *Mesorhizobium spp*. and plant growth promoting rhizobacteria on yields and nutrients uptake of chickpea (*Cicer arietinum* L.) under sustainable agriculture. *Ecological Engineering* 51(1): 282-286. https://doi.org/10.1016/j.ecoleng.2012.12.022

[10] Amare, G., Assaye, D., & Tuma, A. (2014). The response of haricot bean varieties to different rates of phosphorus at Arbaminch, Southern Ethiopia. *ARPN Journal of Agricultural and Biological Science, 9* (10): 344-350. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.1066.8423&rep=rep1&type=pdf, https://www.frontiersin.org/articles/10.3389/fphys.2013.00035/full

[11] Meseret, T., & Amin, M. (2014). Effect of different phosphorus fertilizer rates on growth, dry matter yield and yield components of common bean (*Phaseolus vulgaris* L.). *World Journal of Agricultural Research*, 2(3): 88-92. DOI:10.12691/WJAR-2-3-1

[12] Abera, H., & Tadele, B. (2016). Effect of *rhizobium* inoculation and nitrogen fertilization on nodulation and yield response of common bean at Boloso Sore, southern Ethiopia. *Journal of Biology, Agriculture and Healthcare*, *6* (13): 72-75. https://iiste.org/Journals/index.php/JBAH/article/view/31846

[13] Gifole, G., Sheleme, B., & Walelign, W. (2011). The response of haricot bean to phosphorus application on *ultisols* at Areka, Southern Ethiopia**.** *Journal of Biology, Agriculture and Healthcare, 1*(3): 38-49. https://www.iiste.org/Journals/index.php/JBAH/article/view/1116

[14] Fazli, I.S., Jamal, A., Ahmad, S., Masoodi, M., J.S., Khan, J.S. & Abdin, M.Z. (2008). Interactive effect of sulphur and nitrogen on nitrogen accumulation and harvest in oilseed crops differing in nitrogen assimilation potential. *Plant Nutrition Journal*, 31: 1203-1220. DOI: 10.1080/019416003765745

[15] Broughton, W. J., Hernandez, G., Blair, M., Beebe, S., Gepts, P., Vanderleyden, J. (2003).Common beans model food legumes. *Plant Soil*, 252: 55–128. https://doi.org/10.1023/A:1024146710611

AUTHOR'S PROFILE

First Author
Nuru Seid Tehulie, joined in University of Gondar in 2011 and graduated in July 2013 with BSc. degree in Plant Sciences. In December 2014, the Ministry of Agriculture at Gewane Agricultural Technical Vocational Education Training (GATVET) College employed him. After working for three years as a plant science instructor, in July 2016, he joined the postgraduate program at Haramaya University, School of Plant Science, and graduated in February 2019 with Master of Science degree in Agronomy. Now the author is Plant Science Lecturer in Mekdela Amba University, Ethiopia.

Second Author
Taminaw Zewdie, Joined in University of Gondar in 2011 and graduated in July 2013 with BSc. degree in Plant Sciences. In December 2017, the Ministry of Agriculture at Gewane Agricultural Technical Vocational Education Training (GATVET) College employed him. After working for one year as a plant science instructor, in July 2018, he joined the postgraduate program at Haramaya University, School of Plant Science, and graduated in February 2020 with Master of Science degree in Agronomy. Now the author is Plant Science Lecturer in Mekdela Amba University, Ethiopia.