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Effect of NPSB Fertilizer Rates and Varieties on Yield Components and Yield of Bush Type Common Bean at Bako, Western Oromia Ethiopia

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Abstract **Original Research Article**

Information barrier on the use of fertilizer on common bean is a major problem on production and productivity of common bean at western Oromia Ethiopia. To overcome the problem the experiment was conducted to identify effect of NPSB fertilizer application rate and common bean varieties to produce better seed yields. A field experiment consisting of the combination of three common bean varieties and four fertilizer application rates were employed Randomized Complete Block in factorial arrangements with three replications. Data on phenological, yield components and yield were collected and analyzed. The results of the study revealed that significantly the highest number of pods per plant (18.7). The highest seed yield was obtained at the highest combined rates (150kg NPS ha^{-1} + Nasir variety (2199kg ha^{-1}) while the lowest seed yield (710kg ha^{-1}) was obtained from Loko variety treated without application of NPSB. Therefore, based on net benefit (77872 ETB) analysis and the value of MRR% (2,294.94) of the farmers could be used Nasir variety combined with 150 to obtain maximum yield and 100kg ha^{-1} to attain optimum yield.
Keywords: Bush type, Common Bean, NPSB fertilizer and Varieties.

1. INTRODUCTION

Common bean (*Phaseolus vulgaris* L.) is an annual leguminous plant that belongs to the genus *Phaseolus*, family Fabaceae with pinnately compound trifoliate large leaves. It is a food-security and nutritious crop, especially in Sub-Saharan Africa (SSA) countries (Beebes *et al.*, 2013). The common bean (*Phaseolus vulgaris* L.) is a major legume crop grown and consumed worldwide. Common bean holds great promise for fighting hunger, increasing income and improving soil fertility. It is an important source of protein, source of cash, and emergency. In Ethiopia common bean is consumed in traditional dishes. Dry beans are mostly prepared as 'nifro' (boiled whole grains), mixed with sorghum or maize and 'wat' (local soup) and also with 'kocho'.

Among pulse crops, common bean is the second in area of production in Ethiopia. The land coverage and production of common bean in the country is decreased (CSA, 2022). The total production and productivity of Common bean in 2021/22 cropping season in Ethiopia were 3,113,057.25 quintals and 17.13 Qt ha^{-1} (CSA, 2022) respectively which is below the potential yield range 20-30.8 quintals/ha obtained at research stations (Asfaw *et al.*, 2008). This could be attributed to various constraints related to low adoption of improved agricultural technologies, drought and poor cultural practices, disease, low soil fertility and improved variety which tolerant to low soil fertility (Darkwa *et al.*, 2016). The low soil fertility of the farmlands; i.e. deficiency of organic matter and the major plant growth limiting nutrients N and phosphorus (P) in soils and lack of nutrient inputs were reported as the main factors contributing to the low yields and productivities of the pulses (Abebe and Mekonnen, 2017; Zerihun, 2017).

Generally, among the nutrients, N limiting factor for plant growth and development (Daba and Haile, 2000). Deficiency in N caused decreased growth, branching, leaf yellowing and trifoliate leaves in beans (Tahir, 2009). Consequently, common bean is being generally considered as more responsive than other legumes to N fertilization (Gupta, 2000). Inorganic P had a positive effect on the yield and yield components of common bean. Redden and Herridge (2009) said that grain weight plant per plant exhibited a marked response to P. Sulfur (S) is a very necessary nutrient for growth and it accumulated 0.2 to 0.5% in plant tissue on a dry matter basis (Ali and Khattak, 2008). Sulfur nutrition application not only increased growth rate but also improved the quality of the seed. Boron has many functions in plants related to cell wall syntheses and integrity, carbohydrate transport, and reproductive growth (Prado 2008).

However, soil nutrient deficiency like low soil nitrogen and phosphorus, and acidic soil conditions are important limitations for common bean production in most areas (Graham *et al.*, 2003) and the decline of soil fertility necessitates the application of some amount of fertilizer which would be also essential in biological nitrogen fixation. According to the soil fertility mapping project in Ethiopia recently reported the deficiency of K, S, Zn, B and Cu in addition to N and P in major Ethiopian soils and thus recommends application of customized and balanced fertilizers (EthioSIS, 2014). Therefore, the Ministry of Agriculture and Natural Resource of Ethiopia has been introduced a new fertilizers directly to replace the use of DAP to more balanced form of blended fertilizer such as NPSB, NPS, NPSCuZB which is still used as a blanket recommendation for common bean in the lowland areas of Western Oromia.

Legumes response differently to inorganic fertilizers (Lafay and Burdon 1998). Some studies indicated that application blended a fertilizer which contains Sulfur and boron in addition to N and P influences on plant height, days to maturity, dry weight, and pods per plant and maximum seed yield per plant or hectare (Deeksha *et al.*, 2019). For instance, Abebe and Mekoneni, (2019) reported the maximum grain yield (2923.8 kg ha^{-1}) was recorded when applying high rate of blended NPSBK fertilizer rate (61.5:69:10.5:0.15:60 kg NPKSB ha^{-1}) and additionally, incorporation of K, S and B improved yield by 19.2% over the former NP fertilization at Arba Minch southern Ethiopia. Farmers around Bako Tibe district have been using 100kg ha^{-1} NPSB fertilizer which is not equivalent with amount of nitrogen and phosphorus nutrients found in 100 kg ha^{-1} DAP (Zerihun, 2017). However, due to the loss of soil fertility and unbalanced fertilizer rate requirements were among production constraints in crop production (Mesfin 2009; Ahmed *et al.*, 2017). Common bean differently responded to application of NPS fertilizers which could be due to genetic variation among the cultivars as haricot bean has high diversity. So, the emphasize is very important to develop an alternative means to meet the demand of nutrient in common bean by using of blended NPSB that contains S and B in addition to the commonly used N and P fertilizers in the study areas. Therefore, this research proposal has been designed with the objective to investigate optimum and economically feasible NPSB rate for common bean varieties at study areas to increase yield of common bean.

2. MATERIAL AND METHODS

2.1. Description of the Study Area

The experiment was conducted at Bako Agricultural Research Center (BARC) which is located in Oromia Regional State, West Shoa Zone, at about 250 km away from the capital city Addis Ababa on the way to Nekemte town in Bako Tibe District at about 8 km from Bako town at an altitude of 1650 masl. The center is located at about $09^0$6’N latitude and $37^0$09’E longitude. The area has a warm humid climate with annual mean minimum and maximum temperature of 13.5 and 23.7^0C, respectively. The area receives an annual rainfall of 1237mm mainly from May to October with maximum precipitation in the month of June to August (Metreological station of the center). The predominant soil type of the area is Nitisols which is characteristically reddish brown with a pH that falls in the range of very strongly acidic to very acidic.

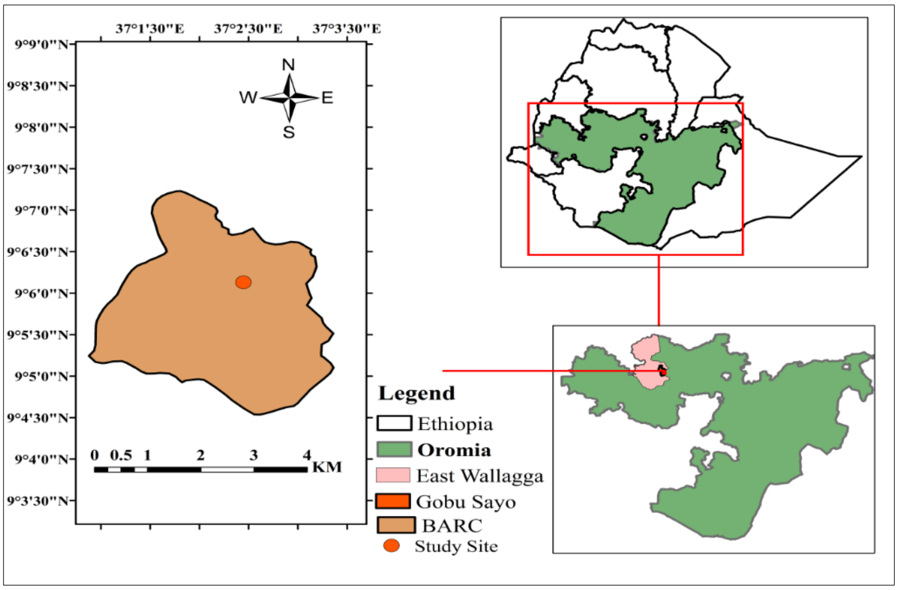

Figure 1: Bako Agricultural Research Center

2.2. Experimental Materials

Improved variety of common bean (Loko, Nasir and Waju) was used as a test crop based on growth habit (determinate, indeterminate and indeterminate prostrate). Loko was released by Bako Agricultural Research Center. Waju and Nasir were recommended varieties and commercial fertilizer NPSB was used.

2.3. Soil Sampling and Analysis

A representative composite soil sample was taken using a cylindrical auger from a surface layer of 0-20cm from the whole experimental field prior to planting. The collected soil samples were air dried ground and sieved using 2mm mesh size sieve for analysis of selected soil physic - chemical properties, i.e. total N, soil pH, available phosphorus, organic carbon (OC), cation exchange capacity (CEC) and texture analysis. The selected soil physico-chemical properties were analyzed at Bako Agricultural Research Center Soil Laboratory section.

2.4. Treatments and Experimental Design

The experiment was comprised two factors, namely four levels of NPSB (0, 50, 100, 150, kg ha^{-1}) and three common bean varieties (Loko, Nasir and Waju). The treatments were arranged as 3×4 in factorial combinations in Randomized Complete Block Design with three replications. The gross plot area was comprise of six rows of 3m length (6 x 0.4 x 3 = 7.2 m^2) and one row each from both sides of the plot was left as a border row. Thus, the central four rows (4 x 0.4 x 3 = 4.8 m^2) were used for data collection and as net plot size. Spacing between block and plots were 1.5m and 0.8 respectively.

2.5. Data collected

Phenological and Growth Parameters: days to 50% flowering and physiological maturity, Plant height and Number of primary branches

Yield Components and Yield: Number of pods per plant, number of seeds per pod, hundred seed weight and Grain yield were collected.

2.6. Data Analysis

All collected parameters were subjected to analysis of variance using of Gen stat 18 editions. Whenever the effects of the treatments were found to be significant, the means were compared using Least Significance Difference (LSD) test at 5% level of significance.

2.7. Partial Budget Analysis

To compare the economic feasibility of the treatments used, the economic analysis was carried out using the procedures described by CIMMYT (1988). Economic evaluation of the effect of NPSB and varieties were performed on the seed yield. Partial budget was estimated for average yield of the different treatment combinations. Current costs of Common bean varieties and NPSB rates were used for analysis. The potential response of crop towards the added fertilizer and price of fertilizers during planting ultimately determine the economic feasibility of fertilizer application (CIMMYT, 1988).

To estimate economic parameters, Common bean yield was valued at an average open market price of 42 Birr kg^{-1}. To estimate the total costs, mean current costs of NPSB (34.10 Birr kg^{-1}) were collected at the time of planting. The cost of NPSB application was 70 Birr ha^{-1}. Cost of land preparation, field management, harvest, transportation, protection, storage, planting material, post-harvest, and others were not included in calculation as these are not variable costs. The economic analysis was based on the formula developed by CIMMYT (1988) and is shown as follows:

Adjusted Yield (AY): is the average yield adjusted downward by a 10% to reflect the difference between the experimental yield and yield of farmers.
AY = GAY- (GAY×0.1)

Gross Field Benefit (GFB): it was computed by multiplying field/farm gate price that farmers receive for the crop when they sale it as adjusted yield.
GFB = AY×field/farm gate price of a crop

Net Benefit (NB): was calculated by subtracting the total variable costs from gross field benefit for reach treatment. NB = GFB – TC.

The dominance analysis procedure as described in CIMMYT (1988) was used to select potentially profitable treatments from the range that were tested using the equation: MRR = (Change NI/change TVC) x 100, Where NI = change in net income, TVC = change in total variable cost, MRR = Marginal rate of Return. Thus, MRR of 100% implies a return of one Birr on every Birr of expenditure in the given input. Finally, a treatment having marginal rate of return (MRR) greater than 100% and with the highest net benefit was considered to be economically the best.

3. RESULTS AND DISCUSSIONS

3.1. Soil Physic-Chemical before Planting

The result of laboratory indicated that the selected physic-chemical properties indicate that the soil texture of the study area is dominated by clay and the textural class of soil of experimental site is clay (Table 1). The soil pH of experimental site is 5.33, which is strongly acidic according to Tekelign (1991). The organic carbon content of the soil is 1.83% which is medium according to the rating of Landon (1991). The medium organic carbon content of the soil might be attributed to the intensive cultivation and continuous removal of crop residues. Organic carbon in soils influences physical, chemical and biological properties of the soils such as soil structure, water retention, nutrient contents and retention and micro-biological life and activities in the soils. Hence, amending the soils with organic fertilizers is important for enhancing crop yields as well as soil health.

The available soil phosphorus (5.48 mg kg^{-1}) of the experimental site was low according to the rating of Cottenie (1980). The low available phosphorus could be ascribed to the high phosphorus sorption and due to high P fixing capacity of the soil at Bako (Wakene *et al.*, 2003). Total nitrogen (0.23%) was medium according to the rating of Landon (1991) who classified soil nitrogen content very high (>0.5), high (0.25-0.50), medium (0.15-0.25), low (0.05-0.15) and very low (<0.05). The medium nitrogen content could be related with low soil organic matter content of the soil. This medium total nitrogen might also have been caused by soil acidity that tend to reduce microbial activity that results in poor organic matter decomposition, immobilizations of nitrogen and N uptake by plants (Massawe *et al.,* 2016). Cation exchange capacity (CEC) is an important parameter of soil, because it gives an indication of the type of clay mineral present in the soil and its capacity to retain nutrients against leaching. According to Landon (1991), top soils having CEC greater than 40 cmol (+) kg^{-1} is rated as very high and 25-40 cmol (+) kg^{-1} as high, 15-25, 5-15 and < 5 cmol (+) kg^{-1} of soil were classified as medium, low and very low, respectively in CEC. According to this classification the experimental site soil has medium CEC (20.39 cmol (+) kg^{-1}), indicating its very high capacity to retain the cations. Medium CEC of the soil might be due to moderate organic matter content and high soil acidity.

Table 1: Selected soil physico-chemical properties of the experimental site before planting

Soil properties	Value	Rating	Reference
1. Soil textural class	Clay		
2.Chemical Properties			
pH (1:2.5 H_2O) Suspension	5.33	Strongly acidic	Tekalign (1991)
Organic carbon (%)	1.83	Medium	Tekalign (1991)
Total nitrogen (%)	0.23	Medium	Tekalign (1991)
Available phosphorus (mg kg^{-1} soil)	5.48	Low	Cottenie (1980)
CEC cmol (+) kg^{-1}	20.39	Medium	Landon (1991)

3.2. Analysis of Variance

The use of NPSB fertilizer application rate had a significant impact on flowering and maturity date, Plant height, Number of primary branches per plant, number of pods per plant, pod length and grain yield (Table 2). This may be due to variations in rate of fertilizer application. The varieties had a significant influence on plant height, number of pods per plant, seed per pod, pod length, hundred seed weight, and grain yield (Table 2). This may indicated that variability is due to genotypic variability of the varieties. Year also had a significant influence on plant height, number of primary branches per plant, seed per pod, pod length, hundred seed weight, and grain yield (Table 2). This illustrates how the climate varies from year to year. Yield variation may have been the result of temperature and rainfall distribution that happened during the growing season (Khan *et al.,* 200).

Table 2: Mean square of ANOVA for phenological and growth parameters, yield, and yield components of Common bean as affected by NPSB fertilizer rates and varieties

	Mean Square									
SV	DF	DF	DM	PH	NPB	NPPP	NSPP	PL	HSW	SY
NPSB	3	28.9*	16.25*	327.8*	0.79*	10.78**	0.74^{ns}	2.14*	30.69^{ns}	2679125**
Variety(Vr)	2	0.78^{ns}	1.19^{ns}	5441.6**	0.92^{ns}	20.94**	9.61**	9.39*	1341.13*	1626545**
Year(Y)	1	0.44^{ns}	0.56^{ns}	738.6*	37.34*	0.31^{ns}	2.53*	23.57*	264.5*	5115088**
NPSB*Vr	6	0.15^{ns}	0.75^{ns}	127.9^{ns}	0.27^{ns}	2.37^{ns}	0.55^{ns}	0.47^{ns}	20.25^{ns}	92527*
NPSB*Vr*Y	6	0.18^{ns}	0.67^{ns}	78.4^{ns}	0.42^{ns}	4.74^{ns}	0.44^{ns}	0.45^{ns}	32.62^{ns}	23910^{ns}
Rep	2	1.19^{ns}	0.78^{ns}	84.6^{ns}	0.46^{ns}	0.22^{ns}	0.31^{ns}	0.14^{ns}	5.1^{ns}	374023^{ns}
Residual	46	0.89	0.8	108.8	0.34	2.95	0.38	0.64	4.52	66012

3.2.1 Phenological and Growth Parameters

Analysis of variance indicated that plant height, number of pod per plant pod length parameters were significantly affected by NPSB and varieties (P<0.05) while the main effect of varieties influence number of seed per plant and main effect of NPSB rate influence the number of primary branch per plant.

3.2.2 Flowering Date

The results of analysis of variance indicated that application of different NPSB rate influenced the days needed to attain at 50% flowering date in common bean varieties but, varieties were not significant (Table 2). Increasing the rate NPSB rate from 0 kg NPSB ha^{-1} to 150 kg NPSB ha^{-1} delayed the days needed to attain at half flowering from 32.7 to 41.3 days (Table 2). This might be due to the fact that excessive supply of N promotes luxuriant and succulent vegetative growth, dominating the reproductive phase. This result is agreed by that of Tewari and Singh (2000) who investigated that common bean with 150 kg N ha^{-1} needed more number of days to 50% flowering as compared to 40 and 80 kg N ha^{-1}. This result is also in contrast to the finding of Tedesse, (2012) who reported non-significant interaction effects of nitrogen and sulfur on days to flowering of common bean.

3.2.3 Physiological Maturity Date

The use of different rate of NPSB fertilizer significantly affected the days needed to attain at physiological development in common bean varieties but, varieties were not significant (Table 2). Maximizing the rates of NPSB from 0 kg NPSB ha^{-1} to 150 kg NPSB ha^{-1} prolonged the number of days needed to attain at physiological development from 87.4 days to 90.4 days (Table 2). The longest number of days required to physiological maturity was recorded with 150 kg NPSB ha^{-1} while the shortest was recorded in control. The results indicated that days to maturity in most cases were prolonged in increased NPSB rates that promoted vegetative growth. Also, Tedesse, (2012) reported a significant effect on days to maturity on common bean. In line with this results, (Nuru and Taminaw 2021) reported that 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.

3.2.4 Plant Height

The main effect of NPSB and varieties had significance ($P<0.05$) influence on plant height. Among the three Common bean varieties the tallest plants were recorded from Waju variety (76.5cm) followed by Nasir (62.3cm) while the shortest plant was recorded from Loko variety (52.4cm) (Table 2). This difference in Plant height among the varieties might be due to genetic variation among the cultivars as haricot bean has high diversity in their physiological growth characters. On the other hand the tallest plant (65.5cm) was recorded when 150 kg ha^{-1} NPSB fertilizer rate applied statically par with 100kg ha^{-1} while the shortest plant was recorded from control plot. The tallest plant height might also be ascribed of better root formation due to sulfur, which in turn activated higher absorption of N, P, K and sulfur from soil and improved metabolic activity inside the plant (Jawahar *et al.,* 2017). Similarly, Turuko and Mohammed, (2014) and Negash and Rezene, (2015) also reported that P rate at 0 - 40 kg ha^{-1} had a significant effect on plant height in common bean. In line with Meseret and Amin, 2014 who reported the increment in NPSB per plant might be the importance of P_2O_5 fertilizer for cell division activity. Variety Nasir gave the highest plant height with application of 150 kg NPS ha^{-1}(Shumi *et al.,* 2018)

3.2.5 Number of Primary Branches

Analysis of variance shown that statistically, there was no significant difference in varieties in terms of number of primary branches per plant ($P<0.05$). Numerically, Nasir variety has more number of primary branches per plants (3.2) while the lowest number of primary branch per plant (2.8) was recorded from Loko variety. This was due to the genetic makeup of the varieties. Otherwise the rates of NPSB fertilizer influenced the number primary branch per plant. The highest number of primary branch per plant (3.4) was recorded from application of 150kg ha^{-1} NPSB fertilizer followed by 100 kg ha^{-1} which was high number of primary branch per plant (3.0) (Table 2). This might be attributed the increased availability of those nutrients in the soil for uptake by plant roots, which may have necessarily enhanced vegetative growth that support cell division and elongation. The result is line with the findings of Asrat, (2013) who investigated those maximum branches per plant could be obtained with the highest rate of NPSB. In addition (Lake and Jemaludin, 2018) reported application of NPS at the rate of 250 kg ha^{-1} gave maximum primary branches.

3.2.6 Number of Pods per Plant

The results of analysis of variance indicated that the highest number of pods per plant (18.7) was recorded from Nasir variety statistically comparable with Waju variety, while the lowest number of pods per plant was recorded from Loko variety (16.8). The variation was due to genetic makeup of the varieties for producing pods (Fageria *et al.,* 2010). Similarly, Zewde (2016) obtained the highest mean number of pods per plant for the variety 'Hawassa Dume than varieties red Wolaita and Omo-95.

Likewise, the main effect of NPSB rate also influence the number of pod per plant. The highest number of pod per plant (18.5) was recorded from application of 150kg ha^{-1} NPSB fertilizer followed by 100 kg ha^{-1} which was high number of pod per plant (17.9) (Table 2). The increase in number of pods per plant due to NPSB fertilizer application might be attributed to better supply of other nutrients such as S, P, and B from blended NPSB fertilizer, which leads to improved dry matter accumulation, growth, and yield component formation (Yoseph and Shanko, 2017). Also, (Shumi, 2018) found that at a rate of 250 kg NPS ha^{-1}, the largest number of pods per plant was recorded, whereas the unfertilized plot had them lowest number of total pods. Tesfaye and Balcha (2015) investigated that phosphorus application at 75 kg ha^{-1} significantly increased the number of pods per plant.

Table 3: Main effect of NPSB fertilizer and Varieties on Phenological and Growth parameters of Common bean

			Phenological and growth Parameters					
Variety	FD	MD	PH	NPB	NPPP	NSPP	PL	HSW
Loko	39.0	88.5	52.4c	2.8	16.8b	3.4c	8.5a	48.9a
Nasir	39.3	89.0	62.3b	3.2	18.7a	4.7a	7.2b	38.6b
Waju	39.5	89.1	76.5a	2.8	17.7ab	4.0b	8.0a	34.3c
LSD (0.05)	NS	NS	6.1	NS	0.98	0.36	0.46	3.0
NPSB rate								
0	37.7c	87.4c	57.6b	2.8b	16.7b	3.8	7.6b	39.4
50	37.9c	88.1c	58.5ab	2.7b	17.6ab	4.3	7.7b	40.4
100	40.2b	89.4b	65.3a	3.0a	17.9a	4.1	8.1ab	40.6
150	41.3a	90.4a	65.5a	3.4a	18.5a	4.0	8.3a	42.6
LSD(0.05)	0.9	0.9	7.0	0.34	1.15	NS	0.53	NS
CV (%)	2.4	1.3	16.9	19.9	20.3	15.3	10.1	12.7

3.2.7 Number of Seed per Plant

Analysis of variance showed that the interaction effect of NPSB and variety as well as the main effect of NPSB application rates were not significant, however the main effects of varieties had highly significant ($P<0.05$) effect on the number of seeds per pod (Table 3). The highest number of seeds per pod (4.7) was recorded for variety Nasir followed by Waju (4.0) whereas the least number of seeds per pod (3.4) was recorded for Loko variety (Table 3). This indicates that the trait is mainly controlled by genetic factors than the management. Consistent with the results of this study, the significant variations in number of seeds per pod among common bean genotypes were reported by (Mourice *et al.,* 2012). The variation in number of seeds per pod could be attributed to the variation in the size of seeds of the cultivars where variety Loko with highest seed size produced lower number of seeds per pod. In agreement with this result, (Fageria *et al.,* 2010) also reported that the number of seeds per pod of different common bean genotypes varied in the range of 3.1 to 6 and attributed the difference due to the genetic variation of cultivars.

3.2.8 Pod Length

Analysis of variance showed that the pod length was influenced by main effect of varieties and NPSB rate. The longest pod (8.5 cm) was recorded from the Loko variety followed by Waju variety (8.0cm) while the lowest (7.2cm) was recorded from Nasir variety. The difference in pod length of common might be attributed the difference due to the genetic variation of cultivars. Likewise, as rates of NPSB fertilizer increases the pod length of common bean was also increase. The longest pod length (8.3 cm) recorded from 150 kg ha^{-1} NPSB fertilizer while the shortest (7.6cm) was recorded from control treatment (Table 3)

3.2.9 Hundred Seed Weight

Hundred seed weight was significantly ($P<0.05$) affected due to the main effects of varieties. However main effects of fertilizer application rates and interaction effect were not significant (Table 3). Maximum (48.9g) and minimum (34.3g) hundred seed weight were recorded on variety Loko and Nassir, respectively (Table 3). This result is in conformity with the finding of (Girma *et al.,* 2014) who reported significant differences in hundred seed weight among common bean varieties. Variation in hundred seed weight might have occurred due to the presence of difference in seed size among the common bean varieties as hundred seed weight increases with the increase in the seed size. In line with this result, (Tanaka and Fujita, 1979) stated that the number of seeds per pod and weights of hundred seeds were strongly controlled genetically in field bean (*Pisum ativim*). The higher 100 seed weight for variety Loko is associated with the size of the seed by (Fageria *et al.,* 2010) who explained that the larger the seed the higher its seed weight.

3.3. Common Bean Grain Yield

Analysis of variance indicated that the main effects of NPSB and Varieties non-significantly ($p<0.01$) influenced grain yield. However, the interaction of NPSB × Variety had significant influence on grain yield. Thus, the highest seed yield was obtained at the highest combined rates (150kg NPS ha^{-1} + Nasir variety (2199kg ha^{-1}) while the lowest seed yield (710kg ha^{-1}) was obtained from Loko variety treated without application of NPSB (Table 3). This higher yield from the combined application of mineral fertilizer and Nasir variety might be attributable to the availability of macro and micro-nutrients and occurrence of different beneficial microorganisms, presence of growth promoting substances. Moreover, all varieties responded to fertilizer application beyond 100 kg by yield reduction which may be associated with a higher rate of nitrogen that might discourage nitrogen fixations and enhance vegetative growth thereby reducing the seed yield. It might be due to increased levels of S, its availability along with major nutrients and higher uptake of crop and influencing growth and yield components of the crop, which ultimately lead to effective, assimilate partitioning of photosynthetic from the source to sink in the post flowering stage and resulted in highest seed yield, enhances chlorophyll concentration, root nodules, and dry matter production which contributed to yield increment. Similarly, Arega and Zenebe (2019) indicated high seed yield (2923.8 kg ha^{-1}) were recorded from the maximum rate of blended NPKSB rate (61.5:69:60:10.5:0.15 kg NPKSB ha^{-1}) applied. Highest yield might be due to better availability of P from the soil solution and translocate to crop for grain formation (Mulugeta, 2011).

Yield is a quantitative trait that is influenced by genetic and environmental factors among which nutrients have basic functions in biological processes and growth. Therefore, grain yield is a cumulative effect of different nutrient constituents and variety of which each has its influence in maximizing or minimizing magnitude. Grain yield may vary among the common bean varieties due to their difference in genotypic variations in nutrient absorption and use efficiency. Gobeze and Legese (2015) reported significant variations in seed yield among common bean varieties due to genotypic variations for P use efficiency which might arise from variation in P acquisition and translocation and use of absorbed P in seed formation in common bean. The plots received low rate of fertilizers gave the lowest grain yield, possibly because of reduced nitrification rates and fixation of P in the acidic soil that made N and P unavailable hence limited uptake by the Common bean crop and consequently resulting in poor performance. In agreement with this result, (Girma *et al.*, 2014) reported significant yield increase with increasing levels of phosphorus resulting in maximum yield (2326 kg ha^{-1}) for haricot bean at the rate 40 kg P_2O_5 ha^{-1} as compared to control.

Table 4: Interaction effect of Blended NPSB fertilizer and Common bean Varieties on yield of Common bean

	NPSB fertilizer rate (kg/ha)			
Variety	**0**	**50**	**100**	**150**
Nasir	1128efg	1533cd	1884b	2199a
Waju	1075g	1122efg	1766bc	1772bc
Loko	710h	1106fg	1408def	1438de
LSD (0.05)	298.6			
CV (%)	18.0			

3.4. Partial Budget Analysis

Information on costs and benefits of treatments are a prerequisite to adopt technical innovation by farmers. This study assessed economic benefits of the treatments to develop recommendation from the agronomic data. This enhances selection of the best combination of resources by farmers in the study area. The result in this study indicated that the Nasir variety and applied NPSB resulted in higher net benefits than other treatment (Table 4). The partial budget analysis was done on the basis of costs of NPSB fertilizer, Variety and cost of application of NPSB fertilizer.

The partial budget analysis showed that the application of 150kg NPSB ha^{-1} + Nasir variety produced the highest net benefit of 77872 Birr ha^{-1} with marginal rate return (2,294.9%) (Table 4). This implies that farmers would be better to use 150kg/ha + Nasir variety as these increases common bean yield income. Thus, application of 150 kg NPSB ha^{-1} and Nasir variety is profitable and recommended for the farmers in the study areas and other areas with similar agro-ecological conditions.

On the other hand, maximum MRR was produced from the treatment that received 150 kg ha^{-1} NPSB fertilizer and Nasir variety with net benefit of 77872 Birr ha^{-1} while net benefit (38858 Birr ha^{-1}) gained from the treatment that received Nasir without fertilizer application (Table 4). The results in line with (Melkamu *et al.*, 2023) reported that applying 150 kg ha^{-1} of NPSB with the Rhizobium yields a good economic return in southern Ethiopia. Also, (Tamirat *et al.*, 2022) report the finding suggests that the highest net benefit (79,245.78 ETB ha^{-1}) was obtained from a combination of inoculated Nasir variety with the application of 100 kg ha^{-1} blended NPSB fertilizer.

In addition MRR of return are greater than 100% while the Nasir variety combined with 50, 100 and 150 kg ha^{-1} which could be recommended to use (CIMMYT, 1988). Waju variety combined with 100 kg ha^{-1} also used as alternative based on net benefit (63205) and MRR (742.25%) value.

Table 5: Partial Budget Analysis of NPSB fertilizer rates on Common bean varieties yield at Bako

Treatments	**Yield (kg/ha)**	**Adj. yield 10%(kg/ha)**	**Cost of Application (ETB ha^{-1})**	**Cost of NPSB (ha^{-1})**	**TVC (ha^{-1}**	**Cost CB (kg/ETB)**	**GB (ETB ha^{-1}**	**NB (ETB/ ha^{-1})**
Nasir + 0	1128	925.2	0	0	0	42	42638.4	38858
Nasir + 50	1533	1379.7	75	1700	1775	42	57947.4	56172
Nasir +100	1884	1695.6	150	3400	3550	42	71215.2	67665
Nasir +150	2199	1979.1	150	5100	5250	42	83122.2	77872
Waju + 0	1075	877.5	0	0	0	42	40635	36855D
Waju + 50	1122	1009.8	75	1700	1775	42	42411.6	40637D

Waju +100	1766	1589.4	150	3400	3550	42	66754.8	63205
Waju +150	1772	1594.8	150	5100	5250	42	66981.6	61732D
Loko + 0	710	639	0	0	0	42	26838	26838D
Loko + 50	1106	995.4	75	1700	1775	42	41806.8	40032D
Loko +100	1408	1267.2	150	3400	3550	42	53222.4	49672D
Loko +150	1438	1294.2	150	5100	5250	42	54356.4	49106D

Table 6: Marginal Analysis of NPSB fertilizer rates on Common bean varieties yield

Treatments	TVC (ETB ha^{-1})	MC (ETB ha^{-1})	Net benefit (ETB ha^{-1})	MB (ETB ha^{-1})	MRR (%)
Nasir + 0	0	_	38858	_	_
Nasir + 50	1775	1775	56172	17314	975.44
Nasir +100	3550	1775	67665	28807	1622.93
Nasir +150	5250	1700	77872	39014	2,294.94
Waju +0	0	-	36855	-	-
Waju + 100	3550	1775	63205	26350	742.25

4. CONCLUSION AND RECOMMENDATION

The experiment was conducted to identify optimum rate of NPSB for common bean varieties to produce better seed yield. The analysis of variance indicated that interaction of Nassir variety with 150kg/ha NPSB significantly influenced yield of common bean varieties. Maximum yield is obtained when 150kg/ha NPSB fertilizer applied on Nassir variety. It could be concluded that under the similar conditions, application of 150kg/ha NPSB on Nassir varieties better and economic to boost the yield of common bean. The maximum MRR was produced from the treatment that received 150 kg ha^{-1} NPSB fertilizer and Nasir variety with net benefit of (77872 Birr ha^{-1}) which was less by 38858 Birr ha^{-1} than net benefit of treatment that received Nasir without fertilizer application Therefore, based on net benefit analysis and the value of MRR% of the farmers could be used Nasir variety combined with 150 to obtained maximum yield and 100kg ha^{-1} to attain optimum yield. Also, Waju variety combined with 100 kg ha^{-1} could be used as alternative based on net benefit and MRR (742.25%) value.

Conflict of Interesting: NA

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REFERENCE

- Abebe, G. (2009). Effect of NP fertilizer and moisture conservation on the yield and yield components of haricot bean (*Phaseolus vulgaris* L.) in the Semi-arid zones of the Central Rift Valley in Ethiopia. *Advances in Environmental Biology*, *3*(3), 302-307.
- Abebe, Z. (2017). On-farm yield variability and responses of common bean (*Phaseolus vulgaris* L.) varieties to rhizobium inoculation with inorganic fertilizer rates. *J Animal Plant Sci*, *32*(2), 5120-5133.
- Ahmed, M., Siraj, M., & Mohammed, S. (2017). Marketing practices and challenges of Mung bean in Ethiopia Amhara Regional State: North Shewa Zone in focus. *Afr J Market Manag*, *9*(4), 35–45.
- Ali, R., Khan, M. J., & Khattak, R. A. (2008). Response of rice to different sources of sulfur at various levels and its residual effect on wheat in rice-wheat cropping system. *Soil Environment*, *27*(1), 131-137.
- Arega, A., & Zenebe, M. (2019). Common bean (*Phaseolus Vulgaris* L.) varieties response to rates of blended NPKSB fertilizer at Arba Minch, Southern Ethiopia. *Adv Crop Sci Technol*, *7*(3), 429.
- Asfaw, A., Assefa, T., Amsalu, B., Negash, K., Alemayehu, F., & Grum, F. (2008). Adaptation and yield stability of small red bean elite lines in Ethiopia. *Int J Plant Breed Genet*, *2*(2), 51–63.
- Asrat, A. (2013). Response of chickpea (*Cicer arietinum* L.) varieties to rates of nitrogen and phosphorus fertilizer at Debre Zeit, central Ethiopia. M.Sc. Thesis. Haramaya University, Haramaya, 28.
- Beebe, Rao. M. I., Blair, W. M., & Acosta-Gallegos, A. J. (2013). Phenotyping common beans for Adaptation to drought. *Africa Crop Science*, *4*(35), 1-20.
- CIMMYT. (1988). Agronomic data to farmers' recommendations: an economics training manual. Completely revised edition. Mexico, 27-18.
- Darkwa, K., Ambachew, D., Mohammed, H., Asfaw, A., & Blair, M. W. (2016). Evaluation of common bean (*Phaseolus vulgaris* L.) genotypes for drought stress adaptation in Ethiopia. *Crop J*, *4*, 367–376.
- Deeksha, K., Sachan, H. K., & Chaudhary, N. K. (2019). Effect of sulphur fertilization on performance and production potential of mung bean [*Vigna radiata L. Wilczek*]. *Legume Res Int J*, *1*(0), 1–6.
- Ethiopian Agricultural Transformation Agency (ATA), 2014. Soil Analysis Report. Agricultural Transformation Agency (Unpublished).
- Fageria, N. K., Baligar, V. C., Moreira, A., & Portes, T. A. (2010). Dry bean genotypes evaluation for growth, yield component, and phosphorus use

efficiency. *Journal of Plant Nutrition, 33*(14), 2167-2181.

- Girma, A., Demelash, A., & Ayele, T. (2014). The response of haricot bean varieties to different rates of phosphorus at Arbaminch, southern Ethiopia. *ARPN J Agri Biol Sci, 9*, 344–350.
- Gobeze, L., & Legese, H. (2015). Evaluation of common bean varieties at phosphorus deficient and sufficient condition in southern Ethiopia. *Ashese J Agr Sci, 1*(4), 20–27.
- Graham, P. H., Rosas, J. C., de Jensen, C. E., Peralta, E., Tlusty, B., Acosta Gallegos, J., & Arraes Pereira, P. A. (2003). Addressing edaphic constraints to bean production: the bean/cowpea CRSP project in perspective. *Field Crops Res, 82*, 179–192.
- Gupta, R. P., & Sharma, V. P. (2000). Effect of different spacing and levels of nitrogen for production of export quality onion bulbs planted on raised bed. *News Letter National Horticultural Research and Development Foundation, 20*(1&4), 13-16.
- Jawahar, S. V., Vaiyapuri, V., Suseendran, K., Kalaiyarasan, C., Sriramachandrasekharan, M. V. (2017). Effect of sources and levels of sulphur on growth and yield of rice fallow blackgram (Vigna mungo). *International Journal of Chemistry*, ISSN: 2123-2845
- Lake, M., & Jemaludin, S. (2018). “The Response of Common Bean (*Phaseolus Vulgaris* L.) To various Levels of Blended Fertilizer”. *International Journal of Research in Agriculture and Forestry, 5*(7), 15-20.
- Melkamu, D., Dereje, S., & Dawit, D. (2023). Biofertilizer and NPSB fertilizer application effects on nodulation and productivity of common bean (*Phaseolus vulgaris* L.) at Sodo Zuria, Southern Ethiopia. *Open Life Sciences, 18*, 20-22.
- 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.
- Mourice, S. K., & Tryphone, G. M. (2012). Evaluation of common bean (*Phaseolus vulgaris* L.) genotypes for adaptation to low phosphorus. *Int Sch Res Notices Agron*, 1-9.
- Mulugeta, A. (2011). Factors affecting adoption of improved haricot bean varieties and associated agronomic practices in Dale woreda. SNNPRS M.Sc. Thesis in Plant Sciences (Agronomy), Hawassa University, Hawassa, Ethiopia, Africa.
- Negash, F., & Rezene, Y. (2015). Nitrogen and phosphorus fertilizers rate as affecting common bean production at Areka, Ethiopia. *J Agric Crops, 1*, 33-37.
- Nuru, S., &Taminaw, Z. (2021). Response of Some Common Bean Varieties to Different Rates of Nitrogen, Phosphorus, Sulfur Fertilizers and Rhizobium Inoculation on Nodulation, Yield, Yield Attributing Traits. *International Journal of Research in Agricultural Sciences, 7*(6), 2348 – 3997
- Redden, R. J., & Herridge, D. F. (2009). Evaluation of genotypes of navy and culinary bean (*Phaseolus vulgaris* L.) selected for superior growth and nitrogen fixation. *Australian Journal of Experimental Agriculture, 39*, 975-980.
- Shibru, D., & Mitiku, H. (2000). Effects of Rhizobial inoculant and nitrogen fertilizer on yield and nodulation of common bean, *Journal of Plant Nutrition, 23*(5), 581-591.
- Shumi, D. (2018). Response of common bean (*Phaseolus vulgaris* L.) varieties to rates of blended NPS fertilizer in Adola district, Southern Ethiopia. *Afr J Plant Sci, 12*(8), 164–79.
- Singh, A. K., & Singh, S. S. (2000). Effect of planting dates, nitrogen and phosphorus levels on yield contributing factors in French bean. *Legume Research, 23*(1), 33-36.
- Tanaka, A., & Fujita, K. (1979). Growth, photosynthesis, and yield components about seed yield of the field bean. *Journal of the Faculty of Agriculture Hokkaido University, 59*(2), 145-238.
- Tarekegn, Y., & Serawit, S. (2017). Growth, symbiotic and yield response of N-fertilized and Rhizobium inoculated common bean (*Phaseolus vulgaris* L.). *African Journal of Plant Science, 11*(6), 197-202.
- Tedesse, N. (2012). Effect of nitrogen and sulphur application on yield components and yield of common bean (*Phaseolus vulgaris* L.) in Eastern Ethiopia. M.Sc. Thesis. Haramaya University of Agriculture, Haramaya. 23-25.
- Tesfaye, T., & Balcha, A. (2015). Effect of phosphorus application and varieties on grain yield and yield components of common bean (*Phaseolus vulgaris* L.). *Am J Plant Nutr Fertilization Technol, 5*, 79-84?
- Tewari, J. K., & Singh, S. S. (2000). Effect of nitrogen and phosphorus on the growth and seed yield of French bean (*Phaseolus vulgaris* L.). *Vegetable Sci, 27*, 172-175.
- Turuko, M., & Mohammed, A. (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.
- Zewde, P. (2016). Effect of phosphorous rates on yield and yield related traits of common bean varieties on Nitisols at Wolaita Sodo, southern Ethiopia. Haramaya University, Ethiopia.