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The Response of Common Bean (*Phaseoluse Vulgaris* L.) to Various Levels of Blended Fertilizer

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ABSTRACT

A field experiment on common bean taking the variety Hawassa dume was conducted with five levels of NPSZnB (0, 50, 100, 150 and 200 kg/ha). AtMeskan District Southern Ethiopia during rainy seasons of 2017. The experiment was conducted in Randomized Complete Block Design with three replications. Growth, Yield and yield components of Common bean were significantly influenced by different levels of blended fertilizer treatments containing macro and micronutrients. Results showed significant effect of various levels of blended fertilizeron all tested parameters except number of seeds per pod. The highest number of main branches was obtained with 100kg /ha NPSZnB application and the lowest number of this parameter was obtained with 0kg/h. plant height, total biomass, number of nodule, nodule dry mass, number of pods per plant, seed yield, hundred seed weight and harvest index had the highest value with 100kg/ha NPSZnB applications, which was statistically at par to 150 and 200 kg/ha, Although, minimum value of those traits were obtained with 0 kg/ha. Similarly, application of 100 kg NPSZnB gave the highest net benefit (45214 ETB/ha) with highest marginal rate of return (12.78%). Therefore Application of 100kg NPSZnB ha $^{-1}$ might be considered as profitable dose for growing common bean in Meskan district.

Keywords: *Common bean, Hawassa dume, NPSZnB*

INTRODUCTION

Haricot bean (*Phaseolus vulgaris L.*) is an annual pulse crop with considerable variation in habit, vegetative characters, flower color and the size, shape and colour of the pods and seeds (Onwueme and Sinha, 1991). It is well adapted to the range of an altitude between 1200 and 2000 m above sea level (Wortmann, 1998), and in areas with annual average rainfall 500-1500 mm. It is not drought resistant; ideally needs moist soil throughout the growing period. However, rainfall towards the end of growing periods is undesirable. It can be grown successfully on most soil types, from light sands to heavy clays, but friable, deep and well-drained soils are best preferred (Onwueme and Sinha, 1991).

Common bean ranks third as an export commodity in Ethiopia, contributing about 9.5 % of total export value from agriculture (FAOSTAT, 2010). It is mainly used as sources of food and cash. It serves as a source of protein to supplement the protein deficient main dishes like maize and enset in the southern parts of our country especially in south Region(Tenaw and Yeshi, 1990).

Despite the importance of the crop to farmers and its importance for national revenue, average yields obtained by farmers are very low. The national average yields of common bean is 823 kg/ha. The low yield may be attributed to combinations of several production constraints among which imbalance soil nutrient, moisture stress, diseases and insect pests, weeds and untimely field operations play a major role (Kidane and Amare, 1990). However,no or little research has been done to investigate the effect of both macro and micro nutrients combined applications on yield of the crop. therefore, this research was initiated with the objective of investigating the effect of blended fertilizer application rate on growth and seed yield of common bean.

MATERIALS AND METHODS

Description of the Study Area

The experiment was conducted in South Ethiopia in 2017 cropping season at Meskan district, which is located at 8° 04'N latitude and

38° 22' E longitudes at an altitude of 1842 masl. The area receives annual rainfall of 1062.3 mm and has average annual temperatures of 17.4°c.

Experimental Design and Treatment

The experiment was conducted in Randomized Block Design with 5 (five) treatments which were replicated three times. These treatments were different doses of NPSZnB, that is, 0 kg/ha (T1), 50 kg/ha (T2), 100 kg/ha (T3), 150kg/ha (T4) and 200 kg/ha (T5). No other nutrient applications were done except NPSZnB application which was done according to the treatments. Blended fertilizer was applied as basal and it contains 16.9% N, 33.8% p_2o_5, 7.3% S, 2.23% Zn and 0.67% B. Hawassa dume common bean variety was planted at 5 m × 5 m distance. The seeds were sown manually in the furrow at a row distance of 40 cm and A plant spacing of 10 cm within the row was maintained by thinning done about 10 days after sowing. First weeding was done manually at 20 days and second weeding 40 days after sowing to control weeds. Phenological data that is date of flowering, growth attributes that is, plant height, number of branch per plant, number of root nodule per plant, dry nodule weight, total biomass and yield attributes i.e, number of pod per plant, number of seed per pod, test weight, seed yield and harvest index were measured.

Data Analysis

The analysis of variance was carried out using statistical packages and procedures appropriate to RCBD using SAS Computer Software. Mean separation was carried out by using least significance difference (LSD) at 5% probability level.

Physico-Chemical Properties of Soil

The soil textural class of the experimental fields was loam and its pH value of the soil was 6.5 which is only slightly acidic and within the optimum range for crop production (Havlin et al. 1999).

According to Havlin et al. (1999), total nitrogen content (TN) of a soil can be classified as very low (<0.1%), low (0.1-0.15%), medium (0.15-0.25%), and high (>0.25%). According to this classification, the total nitrogen content of the soils from the study farms was found to be upper range of the low total nitrogen class (Table 1).

Indicative ranges of available phosphorus have been established by Olsen et al. (1954), including < 5 mg kg-1 (very low), 5-15 mg kg-1 (low), 15-25 mg kg-1 (medium), and > 25 mg kg-1 of soil (high). Based on this criterion, the available phosphorus content was low. As far as soil organic carbon (OC) is concerned, the value was 1.6%, which is within the range of low organic carbon content (Landon 1991). The cation exchange capacity (CEC) is referred to be low (5-15 cmol kg-1), medium (15-25 cmol kg-1), high (25-40 cmol kg-1). For this parameter, soils of experimental field had a medium CEC (Table 1).

The nutrient class range identified by Karltun (2013) indicated that soils containing >100, 80-100, 20-80, 10-20, <10 mg/kg of sulfur ranging as very high, high, medium, low and very low, respectively. Thus, the experimental soil is very low in available S (Table 1).

The extractable Zn (1.25mg/kg) was bellow the critical level (1.5 ppm) suggested by Karltun *et al*. (2013), indicating the experimental soil is deficient and Zn fertilization is required for a better crop production. Similarly, the extractable B (0.65 mg/kg) is also bellow the critical level (0.8 mg/kg soil) in accordance with Karltun *et al*. (2013).

Table1. *Selected physico-chemical properties of the experimental soil*

Parameters	Texture	pH	TN (%)	OC (%)	available P (mg/kg)	S (mg/kg)	Zn (mg/kg)	B (mg/kg)	CEC(cmol (+)/kg soil)
Value	Loam	6.5	0.14	1.6	12.5	18.6	1.25	0.65	23.5

Results and Discussion

Growth Parameters

The analysis of variance showed significant ($P < 0.05$) differences in number of main branches plant heightdue to the NPSZnB levels (Table 2).

Table 2. *Mean squares of growth and nodule parameters of common bean*

Source of variations	DF	NMB	PH	TBM	NN	NDW

REP	2	0.51ns	1.13**	3.04*	1.50ns	16.25ns
NPSZnB levels	4	6.02**	43.77**	55.71**	95.16**	282.17**
Error	8	0.13	0.12	0.49	4.51	23.26
CV (%)		6.45	0.68	1.49	5.90	4.74

**, ** significant at 0.05 and 0.01 level respectively; ns= non-significant; DF = degree of freedom; NMB = number of main branch; PH = plant height; TBM = total biomass; BM = biomass; NN = number of nodule; NDW = nodule dry weight.*

Maximum number of main branches per plant and plant height were recorded from 100 kg/ha followed by 150 kg/ha NPSZnB applications, While, significantly minimum number of main branches was recorded from 0 kg/ha (Table 3). In line with Meseret and Amin, 2014, who reported highest number of branches per plant (5.67) was recorded at rate of 20 kg P ha-1. The increment in number of branches per plant might be importance of P for cell division activity. With the increase in NPSZnB application rates, there were increases in plant height until 100 kg/ha.

In line with (Nebret and Nigussie, 2017) who reported that increasing nitrogen from 0 to 23 and 46 kg N ha-1, plant height increased by about 5.4% and 9%, respectively. However, further increasing beyond 100 kg/ha were decrease plant height with no significance difference. This result was supported by Hossain *et al*, 2016 who reported that increasing levels of Zn and B until 4 and 3 kg/ha significantly increased both number of branches and plant height of chickpea but above those levels both number of branches and plant height were reduced. The significant increase in plant height and number of branches in response to the increased rates of NPSZnB application might be ascribed to the increased availability of those nutrient in the soil for uptake by plant roots, which may have sufficiently enhanced vegetative growth through increasing cell division and elongation.

Table 3. *The effects of NPSZnB levels on growth and nodule parameters of common bean at Meskan district*

NPSZnB levels	NMB	PH	TBM	NN	NDW
0	3.70d	45.58c	41.12c	28.07b	88.32b
50	4.76c	48.47b	43.67b	31.95b	95.27b
100	7.17a	54.08a	50.52a	40.98a	112.11a
150	6.61ab	53.67a	50.34a	39.6a	107.92a
200	6.09b	53.45a	49.95a	39.17a	104.67a
LSD (0.05)	0.69	0.65	1.33	3.99	9.08

Nodule Parameters

Nodule number and nodule dry mass were significantly affected by various levels of NPSZnB applications (Table 2). Maximum number of nodule per plant and heavier dry mass of nodule were obtained with 100 kg/ha NPSZnB blended fertilizer applications which was statistically at par to 150 and 200 kg/ha (Table 3). Although, minimum number of nodule per plant and lighter dry mass of nodule were obtained with 0 kg/ha but statistically at par to 50 kg/ha NPSZnB blended fertilizer applications. This result is in line with the finding of (Tsai *et al.*, 1993). reported that application of nitrogen in the range of 22 to 33 kg N ha-1 enhanced nodulation

and Ganeshamurthy and Reddy (2000) who found a significant increase in the number of active nodules with the application of sulphur up to 20 kg ha-1 because sulfur is involved in the formation of nitrogenous enzyme known to promote nitrogen fixation in legumes (Scherer *et al.*, 2006). This result also supported by Attar *et al*, 2012 who reported that various levels of P fertilizer applications significantly affected both nodule number and dry mass of common bean.

Total Biomass

The analysis of variance showed significant ($P < 0.05$)differences in total biomass due to the NPSZnB levels (Table 2). Maximum value of total biomass was obtained with 100 kg/ha NPSZnB applications. While, minimum value of total biomass was obtained with 0 kg/ha (control). With the increase in NPSZnB applicationrates, there were increases in total biomass optimum rate of blended fertilizers. When the rate of NPSZnB was increased from 0 to 50 and 100 kg N ha-1, total biomass increased by about 5.84% and 18.61% respectively. However increasing above 100 kg/ha decreases this trait with no significance (Table 3). In line with (Tarekegn and Serawit, 2017), (Veeresh, 2003) and(Cakmak, 2008) who reported that N applications increased shoot dry mass of common bean,dry matter production of French bean increased significantly with the application of different levels of nitrogen and phosphorus fertilizers, the biological yield was enhanced due tomicronutrient (Zn) respectively. Similar result was also observed by Shil *et al*. (2007) who found that increase dose of boron until optimum rate showed better performance regarding total dry matter of chickpea.

Table 4. *Mean squares of yield and yield components of common bean*

Source of variations	DF	NPP	NSPP	SY	HSW	HI
REP	2	1.24ns	0.01ns	1.54*	0.71*	0.00095**
NPSZnB levels	4	20.69**	0.002ns	69.59**	24.79**	0.0012**
Error	8	0.78	0.014	0.33	0.16	0.000082
CV (%)		4.28	2.29	2.61	1.79	1.91

**, ** significant at 0.05 and 0.01 level respectively; ns= non-significant; DF = degree of freedom; NPP = number of pod per plant; NSPP = number of seed per plant; SY = seed yield; HSW = hundred seed weight; HI = harvest index.*

Yield Components

The analysis of variance showed significant ($P < 0.05$)differences in number of pods per plant, hundred seed weight and harvest index of common bean due to the NPSZnB levels (Table 4).

Increasing of NPSZnB rate until 100 kg/ha increase those yield component parameters but beyond 100 kg/ha reduces their value. Maximum value of number of pods per plant, hundred seed weight and harvest index were obtained with 100 kg/ha NPSZnB applications. While, the minimum value of those traits were obtained with 0 kg/ha (Table 5). Despite, different rate of NPSZnB applications hadn't significant effect on number of seed per pod.This result was supported by (Salehin and Rahman, 2012), (Meseret and Amin, 2014), (Kaya *et al*, 2005), (Hossain et al, 2016) who found that N and Zn applications improve yield component of common bean, the application P 20 kg ha-1has significantly improved yield components, yield components of common bean was improved due to Zn pre seed treatments, the interaction effect of boron and zinc was significant for yield contributing characters respectively. Thus the increment of yield components due to application of NPSZnB may be due to its cumulative effects on promoting nodes and pods formation in legumes.

Table 5.*The effects of NPSZnB levels on yield and yield components of common bean at Meskan district*

NPSZnB levels	NPP	NSPP	SY	HSW	HI
0	16.21c	5.19	15.42d	18.19c	0.439469c
50	20.10b	5.21	18.57c	20.49b	0.469213b
100	22.43a	5.27	26.23a	24.62a	0.487426a
150	22.17a	5.22	25.29ab	24.24a	0.481733ab
200	22.10a	5.21	25.00b	24.23a	0.485348ab
LSD (0.05)	1.67	ns	1.09	0.75	0.017

Seed Yield

Seed yield was maximum with 100 kg being at par with 150 kg NPSZnB per hectare but significantly different with rest of the doses. Minimum seed yield was obtained with 0 kg NPSZnB per hectare which was significantly inferior to all the treatments (Table 5). Increasing of NPSZnB over 150 kg/ha (i.e. >3.345 kg Zn and 1.005 kg B) decrease the seed yield of common bean. However, Hossain et al, (2016) reported that increasing of Zn and B up to 4 kg and 3 kg ha-1 respectively can be increase grain yield of chickpea in Rajshahi region. It may be due to the difference in initial status of soil. In agreement with Meseret and Amin, (2014) who reported that increase P fertilizer up to 20 kg/ha increase seed yield of common bean. Similarly, Nebret and Nigussie, (2017) supported the current result by reporting maximum grain yield of common bean was obtained with 23 kg/ha N applications beyond this level the yield were reduced. The negative effect of higher rate of nitrogen on grain yield may be attributed to decreasing of nitrogen fixations or the tendency of higher rates of nitrogen to enhance vegetative growth that might have resulted in self-shading thereby reducing the overall yield, which was evident from the lower harvest index.

Economic Analysis

To assess the costs and benefits associated with different treatments the partial budget technique as described by CIMMYT (1988) was applied on the yield results. Grain yield's of common bean receiving from each plot for each treatment was adjusted downwards by 10% to represent the yield obtained by farmers. It is evident from the data that maximum and minimum gross benefit recorded 47214 and 27756 ETB ha^{-1} from NPSZnB level of 100 kg and 0 kg P per hectare respectively. Data indicates that the total cost of cultivation also followed the same trend. The highest net benefit 45214 ETB was recorded from the NPSZnB dose of 100 kg/ha, while minimum net return obtained with 0 kg/ha 27756 ETB. Similarly, the maximum marginal rate of return (12.78%) was recorded with 100 kg NPSZnB per hectare (Table 6).

Table 6.*Economics of common bean as influenced by various blended fertilizer levels under rain fed conditions at Meskan district*.

P levels	AGY (kg/ha)	GB (ETB/ha)	TVC (ETB/ha)	NB (ETB/ha)	MRR (%)
0	1387.8	27756	0	27756	0
50	1671.3	33426	1000	32426	4.67
100	2360.7	47214	2000	45214	12.78
150	2276.1	45522	3000	42522	D
200	2250	45000	4000	41000	D

AGY = adjusted grain yield; GB = gross benefit; TVC = total variable cost; NB = net benefit and MRR = marginal rate of return

CONCLUSION

Significant response observed in growth, yield and yield components up to blended fertilizer application level of 100 kg/ha, yet above this level those traits were reduced. Similarly, economic analysis shows the highest net benefit (45214 ETB/ha) was obtained from 100 kg NPSZnB per hectare with highest marginal rate of return (12.78%). From the above results and discussion it could be suggested that application of 100kg NPSZnB per hectare could be the profitable dose for maximizing grain yield of common bean for the variety, Hawassa dume in the Meskan districts of South Ethiopia

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