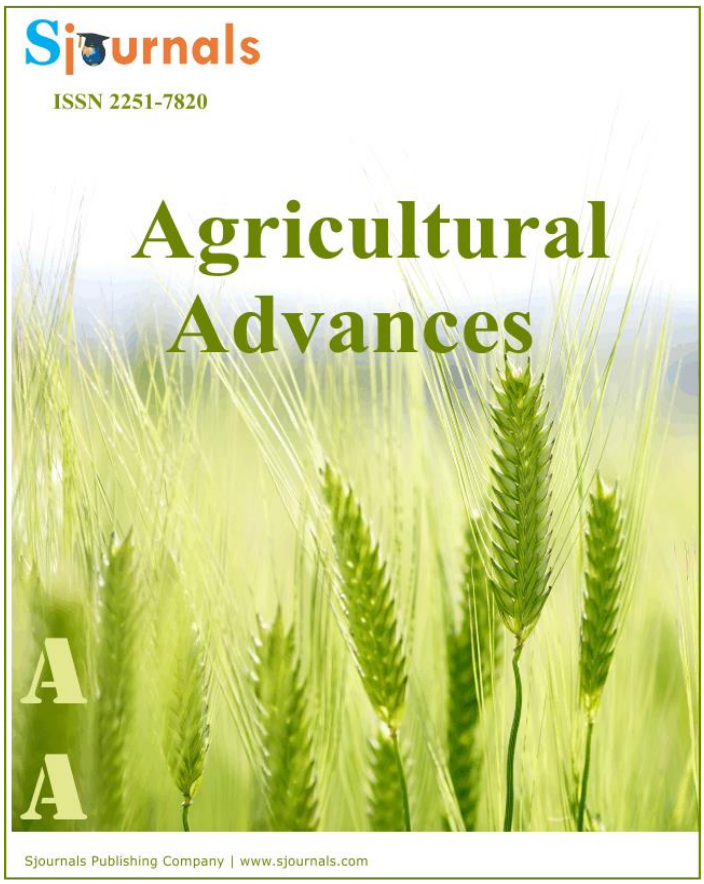

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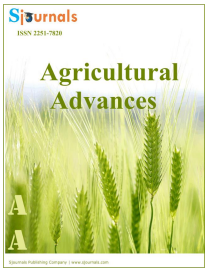

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Original article

Different levels and methods of NPS application impact on yield and yield components of Faba bean (*Vicia faba* L.) in Bale highlands, South eastern Ethiopia

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ABSTRACT

A field experiment was conducted at two locations in Bale, South eastern Ethiopia (Selka and Agarfa) for two consecutive years (2018-2019) to study the responses of improved Faba bean to rates and methods of NPS application and assessing the economic feasibility. The treatments were six levels of NPS (25, 50, 75, 100, and 125 kg ha^{-1}) and two methods of application (Broadcasting and Band application) laid in randomized complete block design (RCBD) with three replications. Faba bean variety 'Alloshe' was used as a test crop. The analysis showed that almost all parameters studied were not significantly ($P<0.05$) affected by the main effect of blended NPS fertilizer and methods of application at both locations over years. This could be due to relatively medium to high accumulation of studied nutrients in the soil and conducive environmental conditions in the specific area. Therefore, based on this findings future research should focus on prior soil test based fertilizers recommendations.

1. Introduction

Grain legumes are the most important protein and mineral food crops in the world, especially in developing countries. Faba bean is a crop of great economic merits in Ethiopia (Gemechu et al., 2006). The crop serves as a source of food and feed with valuable cheap sources of protein substitute as a complement to cereals for the majority of the poor population mainly for those who cannot afford to use proteins from animal source. Faba bean

is the most important pulse crop in terms of both area coverage and volume of annual production in Ethiopia. Ethiopia is the first producer of Faba bean in Africa and the second in the world next to the Peoples Republic of China (Mussa and Gemechu, 2006). However, the national yield per hectare of this crop was very low. The main reasons for the low yield of this crop were attributed to several factors such as; poor soil fertility, low use of inputs, weed, and depth of sowing, inadequate soil moisture and limited use of modern agronomic or cultural practices (population density and planting method, Asfaw et al., 1994). However, high yield of the crop was realized when those yield limiting factors are solved with the optimum management.

In Ethiopia, low soil fertility is one of the factors limiting the yield of crops, including Faba bean. It may be caused as a result of removal of surface soil by erosion, crop removal of nutrients from the soil, total removal of plant residue from farmland, and lack of proper crop rotation program (Tamirie, 1982). Mineral nutrients or chemical fertilizers along with adequate amounts of all other growth limiting factors play an important role in increasing crop productivity (Fageria, 2009). Phosphorus (P) and sulphur (S) are among the commercial fertilizers which contribute to the yield of major crops in particular pulse crops. Both nutrients are required by legume crops in larger quantities than any other nutrients and the crops give good response to them (Scherer et al., 2006; Murat et al., 2009).

The type and rate of fertilizer applications, among several agronomic practices are influenced by the crop types. Fertilizer types applied in Ethiopia agriculture system are only urea and di-ammonium phosphate (DAP) which contain only nitrogen and phosphorous. However, they may not probably satisfy the nutritional requirements of crop plants such as Faba bean. To avert this situation, the Ministry of Agriculture has recently introduced a new compound fertilizer containing nitrogen, phosphorous and sulfur with the ratio of 19% N, 38% P_2O_5 and 7% S (NPS fertilizer) that substituted DAP in Ethiopian agriculture. Matching fertilizer application rates to crop needs is an essential component of optimizing crop production. However, its rate and methods of application for the production of most of the crops including for Faba bean is not yet known. Therefore, the present study was initiated with the objectives of evaluating the responses of improved Faba bean to rates and methods of application of NPS and assessing the economic feasibility.

2. Materials and methods

Faba bean variety *'Alloshe'* which was released by Sinana Agricultural Research Center was used for the experiment. The experiment consisted of five rates control, 25, 50, 75, 100, and 125 NPS (kg ha^{-1}) of each NPS including one unfertilized control with two methods of application (Broadcasting and Band application) laid out in randomized complete block design (RCBD) with three replications. A field layout was prepared and the treatments were assigned randomly to each plot within a block. The replications, blocks and experimental units were separated by 1.5 m, 1 m, and 1 m respectively. Seeds were sown using row planting. Each plot consisted of 8 rows that are 40 cm apart and 4 m in length. The outer most rows on both sides of each plot and 0.25m length on each side of a row served as a border. The remained net plots were used for data collection.

Soil samples were taken in a zigzag pattern from five sampling spots of the entire experimental field at 0-30cm depth using an auger before sowing. The composite soil samples were prepared by quartering and air-drying at room temperature, ground using a pestle and a mortar and allowed to pass through a 2mm sieve. Working samples were obtained from bulk sample and analyzed for total nitrogen, available P, cation exchange capacity (CEC) and pH.

3. Results and discussion

3.1. Soil chemical properties

The results of soil analysis (Table 1) shows that the soil reaction of the experimental sites was moderately neutral at Sinana and Agarfa, where the pH was 6.83 and 6.7, respectively this indicates that the soil reaction of the experimental sites is suitable for optimum growth and yield of most crops. The CEC value of the soil was high at Agarfa and very high at Sinana; this indicates that the soil has relatively high capacity to hold nutrient and supply to the crop. The experimental soil is medium in available P (10.12 and 11.7 at Sinana and Agarfa respectively). Data also indicates that the soils of the experimental sites had Medium total N which means fertilizer addition may increase growth and yield.

Table 1
Chemical properties of the experimental soil before planting.

	Parameters	
Chemical properties	**Selka**	**Agarfa**
pH in water (1:2.5)	6.83	6.7
CEC (cmol. (+) kg soil^{-1})	48.24	37.26
Total N (%)	0.18	0.16
Av. P (ppm), Olsen	10.12	11.7
Av. S (mg kg^{-1})	22.17	21.42

3.2. Effects on yield and yield components of Faba bean at Selka and Agarfa

Table 2
Effect of different levels and methods of application of NPS on yield and yield components of Faba bean at Selka, 2018/19.

NPS (kg ha^{-1})	DFL	DPM	PHT	TPP	PPP	SPP	BYD	GYD	TSW
0	50.3	129.3	140.3	1.8	13.2	3.2	34679	2032.1	998.37
25	49.3	129.8	131.7	1.8	13.1	3.3	35417	2066.1	974.80
50	47.2	129.8	131.9	1.9	12.3	3.1	39583	2462.0	969.33
75	49.8	128.8	132.3	2.1	11.1	3.3	35729	2418.0	961.73
100	49.7	128.8	136.9	2.1	13.9	3.4	36979	2155.9	952.80
125	50.0	126.3	137.2	1.9	13.8	3	36458	2014.9	991.93
$LSD_{0.05}$	ns	ns	ns	ns	ns	ns	ns	ns	ns
Application method									
Broadcasting	49.6	128.9	137.6^{a}	1.8	13.7	3.2	35969	2212.0	973.92
Banding	49.2	128.7	132.5^{b}	2.1	12.1	3.2	36979	2171.0	975.73
$LSD_{0.05}$	ns	ns	5.1	ns	ns	ns	ns	ns	ns
CV (%)	5.1	11.3	8.4	33	20.8	14.6	27.3	26.8	7.0

Keys: DFL= Days to flowering, DPM= Days to physiological maturity, PHT= Plant height, TPP= Tillers per plant, PPP= Pods per plant, SPP= Seeds per pod, BYD= Biological yield, GYD= Grain yield, TSW= Thousand seed weight, LSD= Least significant difference ($P \leq 0.5$), and CV= Coefficient of variation.

Table 3
Effect of different levels and methods of application of NPS on yield and yield components of Faba bean at Agarfa, 2018/19.

NPS (kg ha^{-1})	DFL	DPM	PHT	TPP	PPP	SPP	BYD	GYD	TSW
0	48.5^{ba}	135.7^{a}	125.3	1	13	2.9	22917	2073.5	994.80
25	47.5^{bc}	135.8^{a}	129.7	0.4	12.2	3.2	18333	1959.1	1031.20
50	47.7^{bc}	136.2^{a}	127.2	0.6	12.5	3.1	20938	1887.2	962.30
75	47.2^{c}	135.2^{a}	128.9	1	11.9	3.2	20833	1943.7	981.13
100	47.8^{bc}	134.8^{a}	129.2	0.9	13.8	3.2	20833	2228.5	1066.60
125	49.2^{a}	132.3^{b}	126.1	0.8	13.5	3.1	18333	2087.3	1032.47
$LSD_{0.05}$	1.15	2.01	ns	ns	ns	ns	ns	ns	ns
Application method									
Broadcasting	47.9	135.1	127.9	1^{a}	13.9^{a}	3.2	21389	2021.3	1000.89
Banding	48	135.0	127.6	0.6^{b}	11.7^{b}	3	20938	2043.2	1021.94
$LSD_{0.05}$	ns	ns	ns	0.29	1.92	Ns	ns	ns	ns
CV (%)	5.0	3.6	7.3	22.9	21.6	13.7	18.4	18	7.6

Keys: DFL= Days to flowering, DPM= Days to physiological maturity, PHT= Plant height, TPP= Tillers per plant, PPP= Pods per plant, SPP= Seeds per pod, BYD= Biological yield, GYD= Grain yield, TSW= Thousand seed weight, LSD= Least significant difference ($P \leq 0.5$), and CV= Coefficient of variation.

The statistical results revealed that most of the parameters considered were not significantly (P<0.5) affected by the main effect of blended NPS fertilizer and methods of application conducted over two years at Selka and Agarfa (Table 2 and 3). This might be due to relatively medium to high accumulation of studied nutrients in the soil. Under nutrient sufficient and conducive environmental conditions, plants in the range of studied factor levels did not interact or compete.

4. Conclusion

The results of the present study showed that NPS fertilizer rates and methods of application were not significant. This may be due to the fact that legumes satisfy their nutrient demand through nitrogen fixation as well as relatively medium to high accumulation of studied nutrients in the soil. Under nutrient sufficient and conducive environmental conditions plants in the range of studied factor levels did not interact or compete. The fertilizer application by the farmers in the field without knowledge of soil fertility status and nutrient requirement of different crops usually leads to adverse effect on soil as well as crops by way of nutrient deficiency or toxicity due to over use or inadequate use of fertilizer. Therefore, based on this findings future research should focus on prior soil test based fertilizers recommendations.

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