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Response of NPS Fertilizer Rate to Improved Field Pea Varieties in the Highlands of Bale, South eastern Ethiopia

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Abstract: In Ethiopia field pea is produced in various regions and is widely grown in north, south, west and central parts of the country including, pocket areas in highland and mid highlands with altitude ranging from 1800-3000 m.a.s.l. Field pea can be grown on a wide range of soil types, from light sandy to heavy clay. Fertilizer responses of crops vary with the crop varieties used and climatic conditions of the production. Matching fertilizer application rates to crop needs is an essential component of optimizing crop production. The experiment was conducted at two locations in Bale, south eastern Ethiopia (Sinana on farm and Agarfa) to study effects of different levels of blended NPS levels on field pea performance for two consecutive years (2021-2022/23). The treatments were six rates of blended NPS fertilizer (0, 25, 50, and 75,100, and 125 NPS kg ha^{-1}) laid out in randomized complete block design (RCBD) with three replications. Field pea variety Harena and Weyib were used for the experiment. The results of the study revealed that the analysis of variance among fertilizer rates showed no significant differences ($P \leq 0.05$) on almost of field pea characters tested. Therefore, developing site specific fertilizer recommendations that consider existing soil nutrient supply and recommended fertilizer based on crop nutrient demand to achieve target yield is required.

Keywords: Blended Fertilizer, Field Pea, Yield

1. Introduction

Grain legumes are important sources of significant amounts of proteins, carbohydrates, fiber, vitamins and some minerals. Grain legumes alone contribute to about 33% of the dietary protein nitrogen needs of humans. Moreover, it is also a good source of minerals [7]. In general, cereals and legumes take a large place of human food consumption. Animal proteins being more expensive, especially people in developing countries depend largely on plant to fulfill their protein requirements. Proportionally legumes contain 20-25% protein, which is 2-3 times higher than the content in cereals. Therefore, they can be considered as a leading candidate for protein supply to poor areas of the world [6]. Especially in areas where there is a pressing need for high energy and protein, their contribution is significant [11].

Among the grain legumes pea is an annual plant with slender, succulent stems, grown in cool temperate zones throughout the world [3]. Field pea is a valuable cool-season pulse crop grown worldwide for its seed and soil fertility benefits [8]. The crop also better adapted under low rainfall environments as compared to other highland pulses such as Faba bean, lentil, and chickpea [9].

It has high levels of amino acids, lysine and tryptophan, which are relatively low in cereal grains. Moreover, Field pea contains approximately 21-25% protein and high levels of carbohydrates, are low in fiber. It is the second most important staple cool season food legume among the highland pulses in rural Ethiopia. In Ethiopia field pea is produced in various regions and is widely grown in north, south, west and central parts of the country including, pocket areas in highland and mid highlands with altitude ranging from 1800-3000 m.a.s.l. Field pea can be grown on a wide range of soil types, from light sandy to heavy clay.

This crop is primarily used for human consumption in Ethiopia in the form of whole, split and milled seed. Resource-poor farmers cultivate it as subsistence crop mainly

for self-consumption in low input agriculture where sustainability is major concern [2]. The flour mixed with other spices is popularly used as *shiro;* or the seed may be split as *kik* for the preparation of curry. The crop has high levels of amino acids: lysine and tryptophan, which are relatively low in cereal seeds. It is much important in Ethiopia since it fetches cash to the farming community. It also plays important role in soil fertility restoration and controlling diseases epidemic to the area as a suitable rotation and break crop where cereal mono-cropping is dominant such as Bale and Arsi. Field pea is grown by about 70% of the farmers in Bale highlands and occupied about 8% of the cultivated land in each season. Farmers used to produce field pea as a main crop or precursor of cereal crops in double cropping or rotation. Field pea production is affected by different factors such climatic conditions, soil fertility, water supply, varieties or genotypes, plant population density and planting method. Although peas are legumes and can fix their own N, supplementary applications of N fertilizer are suggested when soil N levels are likely to be low [10].

Fertilizer types applied in Ethiopia agriculture system were 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 field pea. To avert this situation the Ministry of Agriculture of the country 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. Phosphorus (P) and sulphur (S) are among the commercial fertilizers which contribute to the yield of major crops in particular pulse crops. The growth and grain yield of field pea is affected by the application of fertilizer. A review by [1] reported that response to fertilizer application was generally much greater by improved cultivars than it was by the local ones. Having all these multiple benefits in the economic lives of the farming communities, however, the average yield of the crop is only 1.24 t ha-1 in Ethiopia [4].

Fertilizer responses of crops vary with the crop varieties used and climatic conditions of the production. Matching fertilizer application rates to crop needs is an essential component of optimizing crop production.

Studies on the responses of blended NPS fertilizer on field pea did not conducted by SARC at Bale, southeastern Ethiopia.

2. Materials and Methods

The experiment was consisted of six different rates of blended NPS including one unfertilized control (0, 25, 50, 75, 100, and 125 NPS ha^{-1}) and twoimproved varieties (Haranna and Weyib) of field pea combined and 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 1.5m, 1m, and 1m respectively. Seeds sown using row planting. Each plot consisted of 5 rows 20cm apart and 4m 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 remaining net plots were used for data collection.

Composite soil sample per blocks, each made from five sub-samples surface soil from (0-30cm) depth, was collected in Z-shaped pattern using augur before sowingand after harvesting and were collected and prepared and ready for analysis for pH, total nitrogen, available phosphorus and sulphur. On the other hand, all other recommended cultural practices were properly followed in order to successfully grew the crop. Weeds were controlled by hand weeding. Any disease and insect pests also controlled using available controlling method.

3. Results and Discussions

3.1. Soil Chemical Properties

The results of soil analysis (Table 1) showed that the soil reaction of the experimental sites were moderately neutral at Sinana and Agarfa, where the pH was 6.83 and 6.7, respectively according to rating done [5]. 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 cation and supply to the crop. The analysis results of soil NPS showed that medium to high for each nutrient analyzed.

Table 1. *Chemical properties of the experimental soil before planting.*

Parameters	Sinana	Agarfa
Chemical Properties		
pH in water (1:2.5)	6.83	6.7
CEC (cmol. (+) kg $soil^{-1}$)	48.56	37.38
Total N (%)	0.18	0.17
	10.12	11.7
AV. S (mg kg^{-1})	22.17	22.17

3.2. Effect of NPS Levels on Yield and Yield Components of Field Peaat Sinana and Agarfa

The effect of blended fertilizer treatments did not show significant influence on most of yield and yield components of field pea conducted at two locations over years. However, they had a numerical difference among the treatments.

Table 2. *Response of NPS fertilizer rates on improved field pea varieties at Selka, 2022/23.*

Treatments	DFL	DM	PHT	NPP	NSP	BYD	GYD	TSW	HI
NPS kg ha^{-1}									
0	69.5	12.3	168.3	25.8	59.2	14000	2729.2	191.1	19.5a
25	69.8	13	223.2	23.9	56.5	12444	2179.5	181.8	17.6ab
50	69.5	13.1	165.5	25.4	55.9	12889	2574.2	191.5	20.2a
75	70.8	12.5	177.3	23.3	56.1	12333	1773.2	180.3	14b
100	68.6	13	164.8	26	56.2	13944	2649.6	188.2	18.8ab
125	70.5	12.3	172.7	24	53.7	13000	1917.4	182.2	14.2b
$LSD_{0.05}$	ns	ns	ns	ns	ns	ns	ns	ns	5.0
Variety									
Haranna	68.6a	13.1a	188.8	26	60.2a	13000	2424.4	197.2a	18.6
Weyib	71b	12.3b	168.5	23.5	52.3b	13203.7	2183.5	174.5b	16.2
$LSD_{0.05}$	1.42	0.75	ns	ns	7.3	ns	ns	6.8	ns
CV (%)	3	8.5	27.4	20.7	18.7	15	32.5	5.2	23.6

Keys: DFL=Days to flowering, DM= Days to maturity, PHT= Plant height, NPP= Number of pods per plant, NSP= Number of seeds per pod, BYD= Biological yield, GYD= Grain yield, TSW=Thousand seed weight, HI= Harvest index, LSD=Least significant difference (5%), CV=Coefficient of variation

Table 3. *Response of NPS fertilizer rates on improved field pea varieties at Agarfa, 2022/23.*

Treatments	DFL	DM	PHT	NPP	NSP	BYD	GYD	TSW	HI
NPS kg ha^{-1}									
0	67.3ab	117.7	116.3	10.5	35.2	7889b	2032.2	176	25.2
25	67.7a	117	127.5	8.7	37.7	7944b	2029.4	178.2	26.6
50	67ab	117.2	106.1	9	29.1	9639ab	2436.2	176	25.2
75	67ab	118	122.5	11	41.4	8417ab	2282.4	177.7	27.3
100	67.5ab	117.6	125.4	8.7	33	11750a	2592.5	177	22.0
125	66.5b	118.3	117	9.2	40.3	105000ab	2592.7	180.9	25.1
$LSD_{0.05}$	0.09	ns	ns	ns	ns	3316	ns	ns	ns
Variety									
Haranna	67.2	118	114.3	10.1	36	10907.4a	2778.6a	181.8a	25.6
Weyib	67.2	117.2	123.9	9	36.2	7805.6b	1876.5b	173.5b	24.8
$LSD_{0.05}$	ns	ns	ns	ns	ns	1915	525.4	6.2	ns
CV (%)	1.2	1.2	18.3	43	46	29.5	32.5	5	25.6

Keys: DFL=Days to flowering, DM= Days to maturity, PHT= Plant height, NPP= Number of pods per plant, NSP= Number of seeds per pod, BYD= Biological yield, GYD= Grain yield, TSW=Thousand seed weight, HI= Harvest index, LSD=Least significant difference (5%), CV=Coefficient of variation

4. Conclusion and Recommendations

The results of present study showed that NPS fertilizer levels did not significantly affect most of the crop parameters both at Sinana and Agarfa specific localities in the two consecutive years. Therefore, based on the results of the study, it can be recommended that further study should be conducted on split application of blended fertilizer and soil test based application of blended fertilizer should be done on site specific conditions because availability of the element may vary depended on the nature of soil type and environmental conditions. Generally soil test based recommending blended fertilizer usage provides macro and micro nutrients that is needed by the crop which provides maximum yield and economically feasible for growers.

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Conflicts of Interest

I declare no conflicts of interest.

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