Int.J.Curr.Res.Aca.Rev.2020; 8(10): 56-70

International Journal of Current Research and Academic Review

ISSN: 2347-3215 (Online) Volume 8 Number 10 (September-2020)

Journal homepage: http://www.ijcrar.com

doi: https://doi.org/10.20546/ijcrar.2020.810.008

Influence of NPSZnB Blend Fertilization with Nitrogen Supplement on Nutrient Concentration, Uptakes and Dry Pod Yield of Marekofana Hot Pepper (*Capsicum annuum* L.) Variety

Nimona Fufa Hunde*

Ethiopian Institute of Agricultural Research, Kulumsa Agricultural Research Center, P. O. Box 489, Asella, Ethiopia

**Corresponding author*

Abstract

A field experiment was conducted at Assosa Research center, western Ethiopia during 2017 in order to determine the optimum fertilizer rate and nutrient uptakes of Marekofana variety of Hot pepper. Experimental design of treatments was laid out in randomized complete block design (RCBD). The trial has eight levels of treatments (Recommended NP, three different blended rates for each NPSB and NPSBZn and unfertilized plot). Soil laboratory analysis indicated that the soil of the study site was acidic in reaction, clay loam in texture, low in total N, low in organic carbon. Low to very low in available P, S, Zn, B and medium CEC. The experimental result shows that highest total yield was obtained from 150% NPSBZn (2.44 t ha^{-1}) as compared to other treatments; the nutrients concentration and nutrient uptake were significantly ($P<0.05$) varied among treatments and also nutrient use efficiency was improved by fertilizers application. The highest nitrogen (50.14), phosphorus (9.93) and sulfur (4.10) kg ha^{-1} pod uptake; higher agronomic efficiency (9.59 kg pod kg^{-1}) and the highest apparent nutrient recovery for N (48.97%) and P (12.80%) were recorded with the application of 150 kg + 44 N kg ha^{-1} blended fertilizer rate. The uptake of N, P, K and S were significantly and very strongly correlated ($P< 0.01$) with total dry pod yield. Thus, based on the results of this experiment, the optimum fertilizer rates for Marekofana variety was obtained from the treatment of 150 kg + 44 N kg ha^{-1} which recommended for the growers in the area.

Article Info

Accepted: 10 September 2020
Available Online: 20 October 2020

Keywords

Blended fertilizer, MarekoFana, NPSBZn, Nutrient uptake, Use efficiency

Introduction

Nutrient deficiency is the most yield limiting factor in vegetable production in Ethiopia, nitrogen, phosphorus and other micronutrient as S, B, Zn deficiencies are the main constraint for vegetable and other crop production (Alemu and Ermias, 2000). Application of balanced fertilizers is the basis to produce more crop output from existing land under cultivation and nutrient needs of crops is according to their physiological requirements and expected yields (Ryan, 2008). Previous fertilizer research work in Ethiopia has focused with N and P under different soil types and various climatic conditions, while very limited work has been reported with other essential macro and micro nutrients. Recently acquired soil inventory data from EthioSIS (Ethiopian Soil Information System) also revealed that in addition to N and P, nutrients such as S, B, Zn are deficient in Ethiopian soils and also Asossa area (ATA, 2013).

In smallholder farming system, the causes of nutrient deficiency includes high plant nutrient uptake, removal of entire crop residues, use of cattle dung as source of fuel energy for cooking, high rainfall, nutrient loss through leaching, P-fixation in acid soil and gaseous loss of N (Aticho, 2011; Amare *et al.*, 2005). Fertilizers are efficient exogenous source of plant nutrients (Akram *et al.*, 2007), since, plant growth and crop production require adequate and balanced supply of nutrients in order to maximize productivity by optimizing the plant nutrient uptake (Mengel and Kirkby, 2001).

For instance application of mineral N, P and K fertilizers improved dry marketable pod yield and yield contributors through better nutrient uptake, growth and development (Obidiebube *et al.*, 2012). In addition, some reports also indicated that supply of micronutrients along with NPK fertilizer can increase nutrient use efficiency of crops (Malakouti, 2008). The nutrient use efficiency determination for crop sustainability, profitability and productivity by agronomic use efficiency, physiological nutrient use efficiency and apparent recovery of the nutrients were the most important tools for soil fertility management practices particularly for fertilizers experiment.

In Ethiopia, farmers produce vegetable crops including hot pepper using blanket fertilizer recommendation such 100 kg Urea + 100 kg DAP ha^{-1} (EIAR, 2007). Nevertheless, essential micronutrients required for successful plant growth and productivity have never been included in the fertilizer program of Ethiopia. Such unbalanced application of plant nutrients may aggravate the depletion of other important nutrient elements in soils such as K, Mg, Ca, S and micronutrients (Wassie *et al.*, 2011). As a result the current productivity of hot pepper is very low compared to the potential yield of the crop, in all parts of the country. Recent studies have indicated that elements like N, P, K, S and Zn levels as well as B and Cu are becoming depleted in most Ethiopian soils and deficiency symptoms are being observed on major crops in different areas of the country (ATA, 2013).

The current productivity obtained from the hot pepper was 1.3-2.0 t ha^{-1}through using the recommended blanket fertilizers were very low compared to the potential yield of the crop, in all parts of the country as well in Asossa. Therefore, the objectives of the study were to assess the effects of NPSB and NPSBZn blend with N supplemented fertilizers rates on dry pod yield and to evaluate nutrient uptake and use efficiency of hot pepper

Materials and Methods

Description of the experimental site

The experiment was conducted at Assosa Agricultural Research Center, during 2017/18 cropping season. Benishangul Gumuz Regional State is geographically located at the latitude of 9^{o} 30' to 11^{o} 39" N and longitude of 34^{o}20' to 36^{o}30"E in western parts of Ethiopia. The study site is located at 10^{o}02' 05" N latitude and 34^{o}34' 09" E longitudes. It is situated at 1553 m a.s.l. (EARO, 2004). The study area is characterized by uni-modal rainfall pattern, which starts at the early may and extends to mid-November, with maximum rain is received in the months of June to September and annual total rainfall of 1316 mm. It has a warm humid climate with mean maximum and minimum temperatures of 32.0 ^{o}C and 17.0^{o}C, respectively. The soil of the area is characteristically reddish, brown, Nitosol, which is slightly acidic with average pH of 5.5 (EARO, 2004). The crops can be grown as a rain-fed or irrigated crop and the area was characterized as crop-livestock mixed farming systems with major crops grown in the area.

Experimental materials and nursery management

Marako Fana variety of hot pepper which is a high yielding and adapted to the agro-ecology of the area which is maintained by AsARC was used for the study. It has a wider adaptability and grows well at altitudes ranging from 1200-2000 meters above sea level with annul precipitation of 600-1337mm, which was released by Melkassa Agricultural Research Center in 1976 (MARC, 2003). The field for nursery bed was ploughed and harrowed to bring it to a fine tilth and a seed bed with 5m length and 1m width was prepared. Seeds were drilled by hand in to the nursery bed at the inter-row spacing of 15 cm on 20th May 2017. After sowing, the beds were covered with dry grass mulch and kept on until seedling emerged. Then based on the environmental conditions watering was done three times a week afterwards. Hand weeding was done as frequently as weeds emerged. A week before transplanting, water supply to the nursery seed bed was reduced in order to harden the seedlings and reduce transplanting shock. Uniform, healthy and vigorous seedlings were transplanted in to experimental plots after 4 weeks of sowing on seedbed or when they were about 20 cm height (Lemma *et al.*, 2008), whereas transplanting in the field was made on 10th July 2017. The seedlings were planted at 30 cm between plants and 70 cm between rows (EARO, 2004). Refilling of dead seedlings in the field was done after transplanting on the place where the first seedlings were planted.The other crop management practices were applied uniformly for all plots as per the recommendation of hot pepper.

Treatments and experimental design

NPSB and NPSZnB blended fertilizers type were selected for specific area of Assosa based on EthioSIS soil fertility map (ATA, 2013). In both blended fertilizers nitrogen adjustment was done to make up above recommended N for the shortfall of N fertilizer in blended. Furthermore, blanket recommended N and P from Urea and TSP fertilizers was employed as a test treatment. Blended fertilizers and TSP (the P sources) were applied at planting and half of nitrogen was applied after 30 days of transplanting.

The experiment was laid out in a randomized complete block design (RCBD) with three replications. The size of each plot was 3m wide and 4.2m long (12.6m^2 area) with 0.75m space between plots and 1m between blocks. There were six rows per plot and ten plants per row with a total of 60 plants per plot. Fertilizer rates involved for the study includes (T1) – Control (no fertilizer), (T2) - Recommended NP (100 Kg Urea and 100 Kg TSP ha^{-1}+ 39 Urea), (T3)- 100 Kg NPSB + 28 kg N ha^{-1}, (T4)- 150 Kg NPSB +42 kg N ha^{-1}, (T5)- 200 kg NPSB + 56 kg N ha^{-1}, (T6)- 100 kg NPSBZn + 29 kg N ha^{-1}, (T7)- 150 kg NPSBZn + 44 kg N ha^{-1}, (T8)- 200 kg NPSBZn + 58 kg N ha^{-1}was used as treatments. The other crop management practices were applied uniformly for all plots as per the recommendation.

Soil sampling and analysis

Prior to planting, twelve representative soil samples (0 to 20 cm) were randomly collected from the entire experimental in W-shaped pattern using an auger. The samples were bulked into one composite sample. The soil samples were air dried, ground using pestle and mortar and allowed to pass through a 2mm sieve. Soils were analyzed for soil texture, soil pH, OC, total N, CEC, available K, P, S, B and Zn) using standard laboratory procedures.

Soil physical properties

Undisturbed core sampled soil were used for analysis of bulk density. Determination of particle-size distribution was done by using hydrometer procedure of Sahlemedhin and Taye (2000). The contents of sand, silt and clay were computed and the soil textural class was identified from textural triangle (Motsara and Roy, 2008).

Soil chemical properties

Organic carbon(OC) content was determined by the Walkey and Black method of wet oxidation procedure as outlined by Sahlemedhin and Taye (2000).Total nitrogen content was analyzed by Micro-Kjeldhal method (Horneck *et al.*, 2011). The pH of the soil was determined using 1:2.5 soil sample to water ratio using a digital pH meter (FAO, 2009). Cation exchange capacity (CEC) was measured after saturating the soil with 1N ammonium acetate(NH_4OAc) and displacing it with 1NNaOAc (Chapman, 1965). Available phosphorous was determined by Olsen's method (Olsen *et al*., 1954). Available potassium was determined with a flame photometer (Hesse, 1971). The available S in the soil samples was extracted with monocalcium phosphate extract, while available Zn and B in the soil samples were extracted with DTPA (diethylinetriaminepenta acetic acid) and quantified by atomic absorption spectrophotometer as described by Okalebo *et al*., (2002).

Data collected

Data on quantitative and qualitative parameters were collected from the three middle rows, leaving aside plants in the border rows in order to avoid edge effects.

Harvesting and Drying Procedure

Pods were harvested when they fully turned to red on the plant. After harvesting, the pods were further dried in partial shade.

Total dry pod yield (t ha^{-1})

Weight of total (marketable and unmarketable) fruits at each successive harvesting from the net plot area was recorded and summed up to estimate yield per hectare.

Plant tissue sampling analysis

The vegetative above ground parts and pods were sampled from one row of each treatment at early flowering stage and at maturity respectively. The samples were dried at 65^{o}C for 72 hours in oven and fine ground to less than 1mm size and wet digested for determination of nutrients content of the tissues and pods using standard procedures. The total N was analyzed by Kjeldhal method (Bremner and Mulvaney, 1982). After the digestion of the plant materialwith di-acidic (HNO_3-$HClO_4$), the concentration of P in this solution was determined ashing and using spectrophotometer (FAO, 2006), Potassium (K) was determined by dry ashing and using atomic absorption spectrophotometer measuring (Motsara and Roy, 2008). The concentration of Sulfur was determined by Turbidimetric method using calorimeteras described by (Moberg, 2000) and the concentration of Zn were determined by an atomic absorption spectrophotometer which described by Okalebo *et al.*, (2002).

Plant nutrient uptake and use efficiencies

The nutrient accumulation and partitioning were calculated by multiplying nutrient concentration with the dry matter of the respective plant parts and the uptake of nutrient in economic and by-product of hot pepper plant parts were estimated (Mengel and Kirkby, 2001).

Shoot and pod nutrient uptake

Nutrients (N, P and S) uptake in the shoot andpodwere calculated by multiplying N, P and S concentrations with total biomass weight for shoot and total dry pod weight for pod uptakes.

$$\text{Shoot Nutrient Uptake} = \text{Nutrient concentration in shoot} * \text{biomass dry weight}$$

$$\text{Pod Nutrient Uptake} = \text{Nutrient concentration in pod} * \text{total pod dry weight}$$

Statistical analysis

The data were subjected to analysis of variance (ANOVA) using Proc Mixed procedure with SAS software version 9.2(SAS Institute Inc. Cary NC, 2008). All significant treatment mean differences were separated using the Least Significant Difference (LSD) test at 5% probability level.

Results and Discussions

Pre experiment soil physical and chemical properties

The soil properties studied were particle size distribution (texture), pH, OC, total N, available P, available K, available Zn and B, available S and Cation exchange capacity (CEC). The soil at experimental fields was clay loam in textural class (Ryan *et al.*, 2001). Furthermore the clay loam soil texture was suitable for hot pepper production and other major crop production, due to its good ability to retain nutrients and water, and having a bulk density of 1.36 gm cm^{-3}. According to Miller and Donahue (1995), for good plant growth, bulk densities should be below 1.4 g cm^{-3} and 1.6 g cm^{-3} for clay and sand soils, respectively. So the bulk density values observed in these soils were within the normal range for mineral soils. Accordingly, the experimental soil was moderately acidic in reaction (pH = 5.5) as to Jones (2003) rating, low in total N (0.18%) as rating of Landon (1991), low in organic carbon (1.47%) Berhanu (1980) and low to moderate in organic matter (2.53%) (Tekalign, 1991). Many previous studies reported that land use history, cropping systems and soil management had contributed to high soil OM variability in Ethiopian soils (Dawit *et al.*, 2002). Similarly, available P (5.0mg kg^{-1} soil) was low according to Olsen (1954). In general, most of Ethiopian soils are characterized by low concentration of available P (Tekalign and Haque, 1991; Yihenew, 2002; Wakene and Heluf, 2003). Similarly available K (16.67 mg kg^{-1} soil) was very low as rating of Jones (2003) which may probably be due to leaching caused by high precipitation, which needs to add K fertilizer but, as information we have and ATA (2013) suggested no need of K fertilizer application on soils of the study site (ATA, 2013; IFIA, 1992). While CEC (22.6Cmol(+) kg^{-1}) was moderate according to Hazelton and Murphy (2007). This showed that moderate capacity of the soil to retain cations in exchangeable form for the plant. According to the rating established by Jones (2003), the contents of S (2.12 mg kg^{-1}), Zn (0.34 mg kg^{-1}) and B (0.64 mg kg^{-1}) were insufficient to low respectively, in the soil of study sites. Generally, the fertility status of the study site was low (Table 1).

Influence of fertilizers on dry pod yield

Total dry pod yield (t ha^{-1})

Different levels of blended fertilizer application significantly ($P \leq 0.05$) increased total dry pod yield (Figure 1). Blended fertilizer level at 150 kg NPSBZn + 44 kg N ha^{-1} produced the highest total dry pod yield (2.4 t ha^{-1}) compared to the recommended NP (1.6 t ha^{-1}) and the control (1.0 t ha^{-1}). Here the application of blended fertilizers can improve the hot pepper dry pod yield. This could be attributed to the higher mean pod length, width, weight, seed number and relatively larger number of marketable fruits obtained at this level of fertilizers. This result confirmed the findings of Sam-Aggrey and Bereke-Tsehai (2005) who reported positive impact of vegetative growth up on yield and yield components of hot pepper. There was a yield decline at the highest rate of fertilizers supply. An increased in yield of pepper up to a certain optimum level by increasing fertilizer level and then a decrease afterwards was reported by (Roy *et al.*, 2011).

The lower yield obtained at the lower levels of fertilizers could be attributed to the decrease in yield and yield components leading to reduced total dry pod yield. Here the results were highly influenced by those nitrogen and phosphorus which are mostly influenced by those micronutrient levels as Zn in the treatment. The optimum amount of B stimulated the phosphorus uptake by plant roots and promoted development of flower clusters and flowering directly (Day, 2000).

Marketable pod yield (t ha^{-1})

Application of blended fertilizer was significantly ($P\leq 0.05$) affected marketable pod yield. The results showed that the highest marketable pod yield (2.22 t ha^{-1}) was obtained from plots treated with blended fertilizer rates of 150 kg NPSBZn + 44 kg N ha^{-1}. On the other hand, from unfertilized plots and recommended NP, the minimum marketable pod yield of 0.95 and 1.43 t ha^{-1} were recorded respectively (Figure 1). The variation in marketable pod yield might be due to varying levels of fertilizers treatment and the nutrient status of the growing area. But, further increases in applied fertilizers from 150 to 200 kg ha^{-1} reduced marketable pod yield, implying that 150 kg N ha^{-1} could be optimum for hot pepper production. The increase in marketable pod yield from 0 kg ha^{-1} to 150 kg ha^{-1}, followed by a decrease at 200 kg ha^{-1} were in agreement with the findings of Siti *et al.*, (1993) who reported that total marketable fruit weight per plant decreased by 0.5 kg per plant as N level were increased from 112 to 448 kg ha^{-1} in pepper.

In agreement with this result, Leghari and Oad (2005) reported that pod length, width, higher seed weight, seed number per pod and total dry pod weight per plant were positively correlated with marketable green pod yield in pepper. Marketable pod yield increased in response to addition of nutrients in nutrient deficient soils, as a result application of essential nutrients increases vegetative growth, leaf area; photosynthetic capacity and better partitioning of assimilate towards the pods. This in turn had resulted in development of pods which are relatively healthy, attractive and acceptable in markets. Mavengahama (2003), who reported significantly lower total and marketable yields from pepper plants grown in plots not fertilized with nitrogen in pepper.

Unmarketable dry pod yield (t ha^{-1})

The application of blended fertilizers was non-significantly ($P\leq 0.05$) influenced unmarketable pod yield. The highest unmarketable pod yield (0.24 t ha^{-1}) was obtained from unfertilized plot while the least unmarketable pod yield recorded from blended fertilizers treatment at 150 kg NPSBZn + 44 kg N ha^{-1} (Figure 1). This unmarketable yield was recorded through subjective judgment based on shrunken shaped fruits, small sized, and discolored fruits that were estimated to be due to the differences in nutrients uses. In addition, those lacked uniformity when drying, and or due to physiological disorders (bleaching) during the fruit set or due to the climatic conditions of the growing environment during harvesting were considered as unmarketable pod yield. The increased unmarketable pod yield at highest level of nitrogen could be also be ascribed to, the production of large proportion of leaf and dense branches that shade the pods, that affected with white and yellowish pod spots. This result was in conformity with earlier result of Aloni *et al.*, (1994) who reported that colour spot incidence increased with nitrogen application and was more pronounced in densely planted peppers due to shading effect.

Nutrients concentration and uptakes of hot pepper shoot and pod nutrients concentration

The shoot and matured pod nutrient concentrations were significantly ($p\leq 0.05$) affected by the application of different sources of fertilizers as compared with control (Figure 2). Both the shoot tissue and pod N,P and S concentrations showed increasing trend with increasing the amount of nutrient added. Accordingly, the highest value of nitrogen (5.03%), phosphorus (0.45%) and sulfur (0.13%) concentration in the shoot was obtained from application of blended fertilizer rate of 200 kg NPSB + 56 kg N ha^{-1}. Also the highest nutrient concentrations of N,P and S in pods were 2.07%, 0.43%and 0.20%respectively were obtained with rate of 200 kg NPSBZn + 58 kg N ha^{-1}and the least nutrient concentration in shoot and pods were from the unfertilized plots this might be attributed to low P and N availability in the experimental soil, as confirmed by soil analysis before planting (Figure 2).

The increase in N uptake as a result of S application may be due to an increment in protein synthesis and enhance photosynthesis (Zhao *et al.*, 2008). In the absence of S, amino acids cannot be transformed into proteins, which results in reduced N acquisition (Varin *et al.*, 2009).

Table.1 Soil physical and chemical properties of the experimental sites before planting

Soil properties	Results	Rating	Reference Authors
Bulk density (g cm^{-3})	1.36	Moderate	Miller and Donahue (1995)
pH (1:2.5 H_2O)	5.5	Low	Jones (2003)
OC (%)	1. 47	Low	Berhanu (1980)
OM (%)	2.53	Low to medium	Tekalign (1991)
Total N (%)	0.18	Low	Landon (1991)
Available P (mg kg^{-1})	5.0	Low	Olse (1954); Cottenie (1980)
Available K (mg kg^{-1})	16.67	Very low	Jones (2003)
CEC (cmol(+) kg^{-1})	22.6	Moderate	Hazelton and Murphy (2007
Available S	2.12	Very low	Ethio SIS, 2014
Available Micronutrients (mg kg^{-1}) (ppm)			
Available Zn	0.34	Low	Jones (2003)
Available B	0.64	Low	Jones (2003)
Soil textural class	Clay loam		Ryan *et al*., 2001
Clay (%)	39		
Sand (%)	35		
Silt (%)	25		

OM = Organic matter; Total N=Total nitrogen; OC= Organic carbon; Avail. P = Available phosphorus; Avail. K= Available Potassium, CEC= Cation exchange capacity; B= Boron, S= sulfur, Zn= Zinc

Table.2 Correlation coefficient analyses among total nutrients (NPSBZn) uptake and dry pod yield as influenced by blended fertilizer at Assosa area

	TPY	N	P	S	Zn
TPY	1				
N	0.8447**	1			
P	0.8995**	0.8782*	1		
K	0.7037**	0.6176*	0.6209*		
S	0.7839**	0.7704*	0.7701*	1	
Zn	0.1137^{ns}	0.0487^{ns}	0.174^{ns}	0.3324^{ns}	1

* ,**: significant correlation at $P < 0.05$ and $P < 0.01$ probability levels respectively; ns: non-significant; TPY=Total pod yield; N= Nitrogen, P= Phosphorus; K=Potassium; S= Sulfur; Zn = Zinc

Figure.1 Influence of NPSZnB blend fertilizer rates with Nitrogen supplements on weight of unmarketable, marketable yield and total dry pod yield of hot pepper

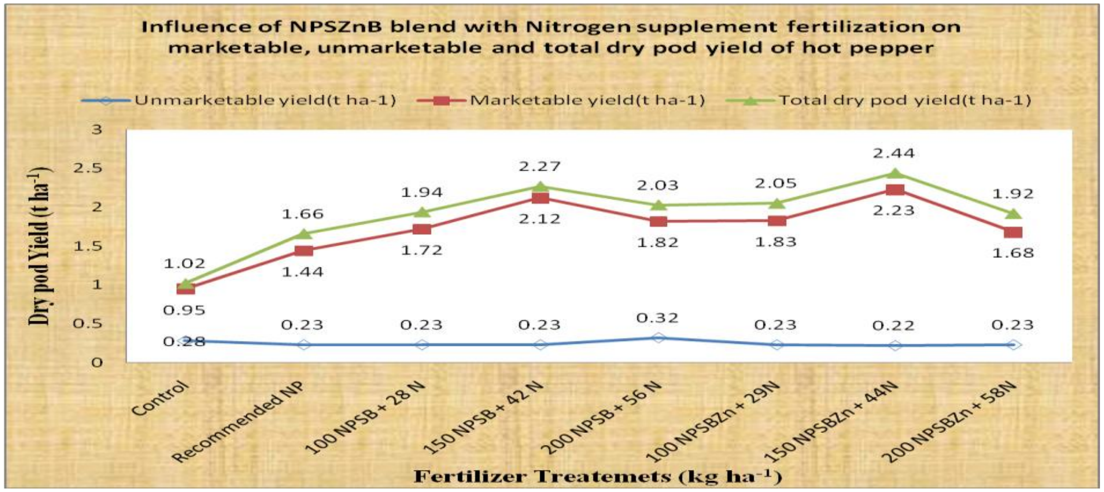
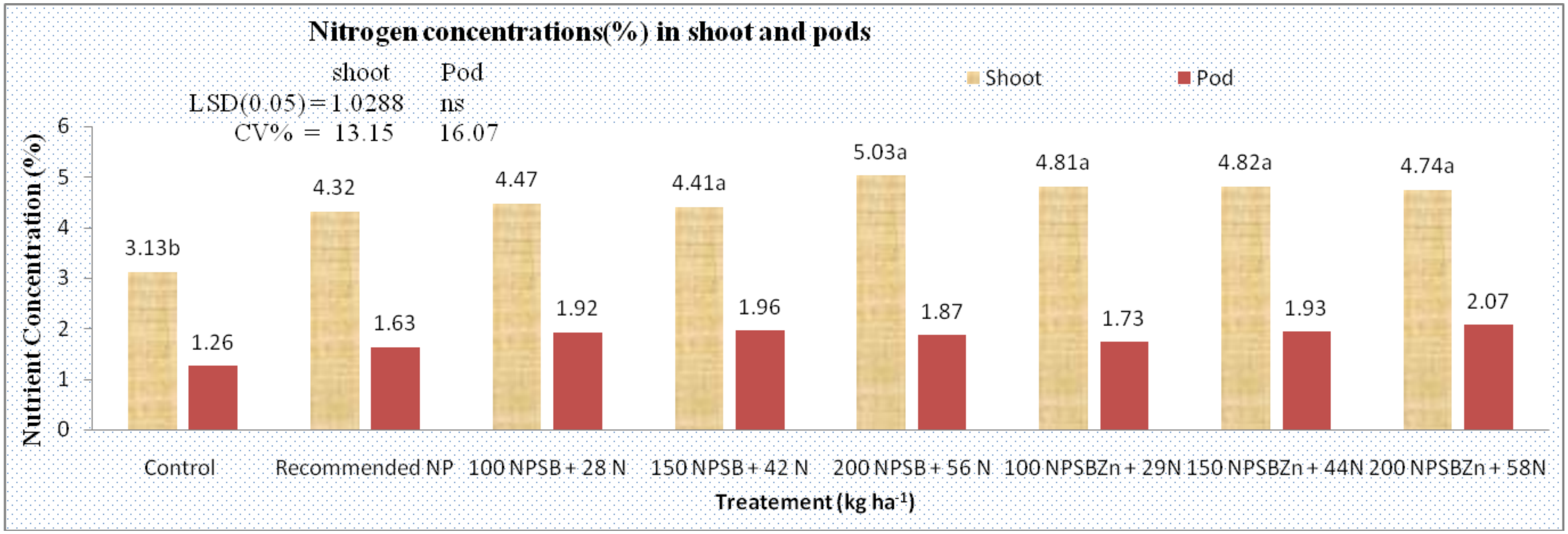
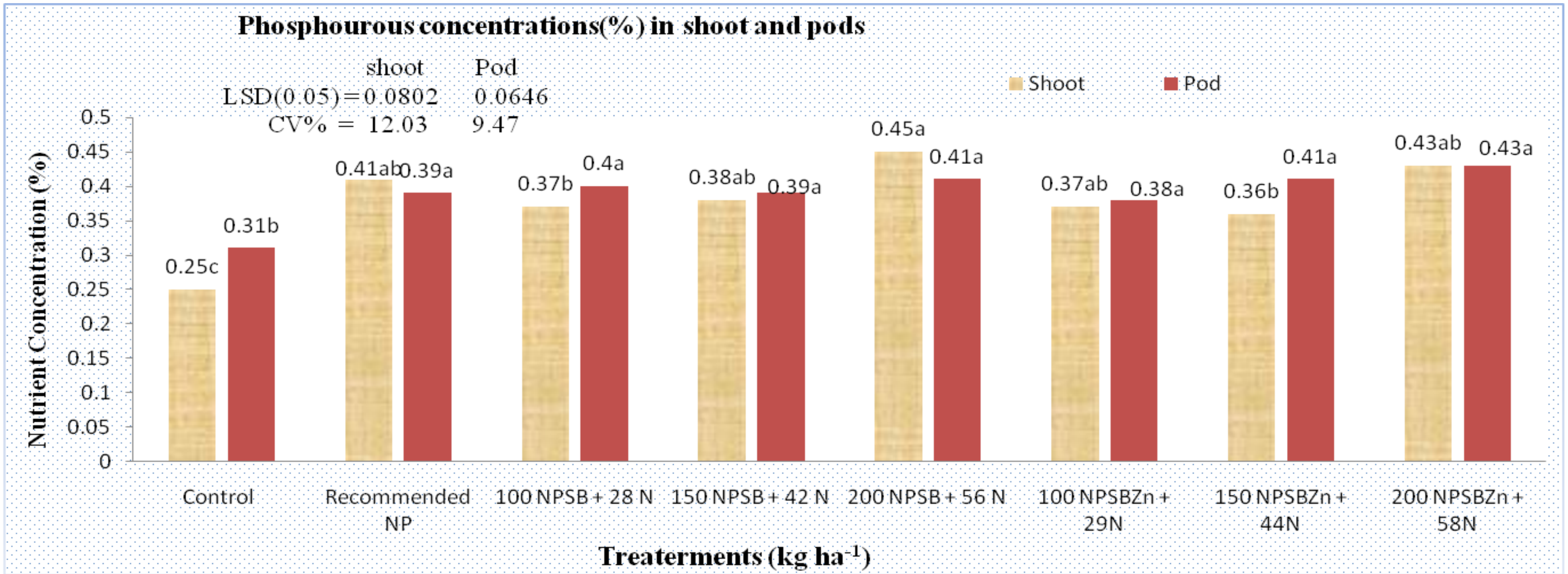
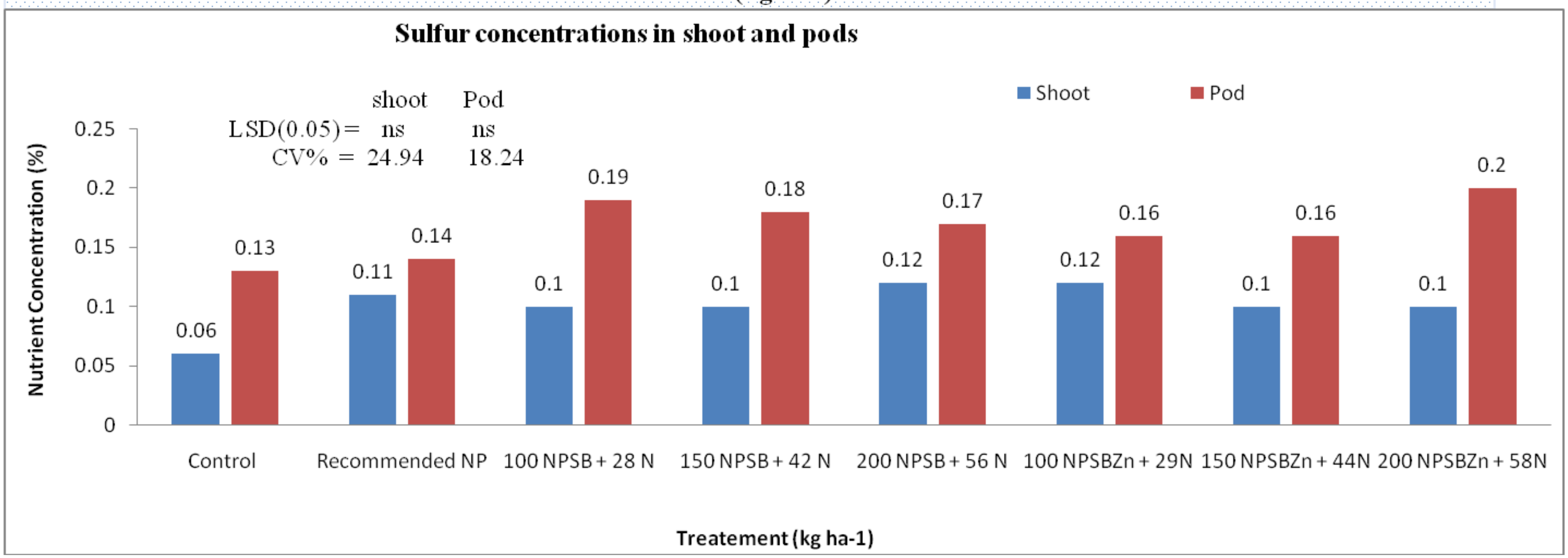
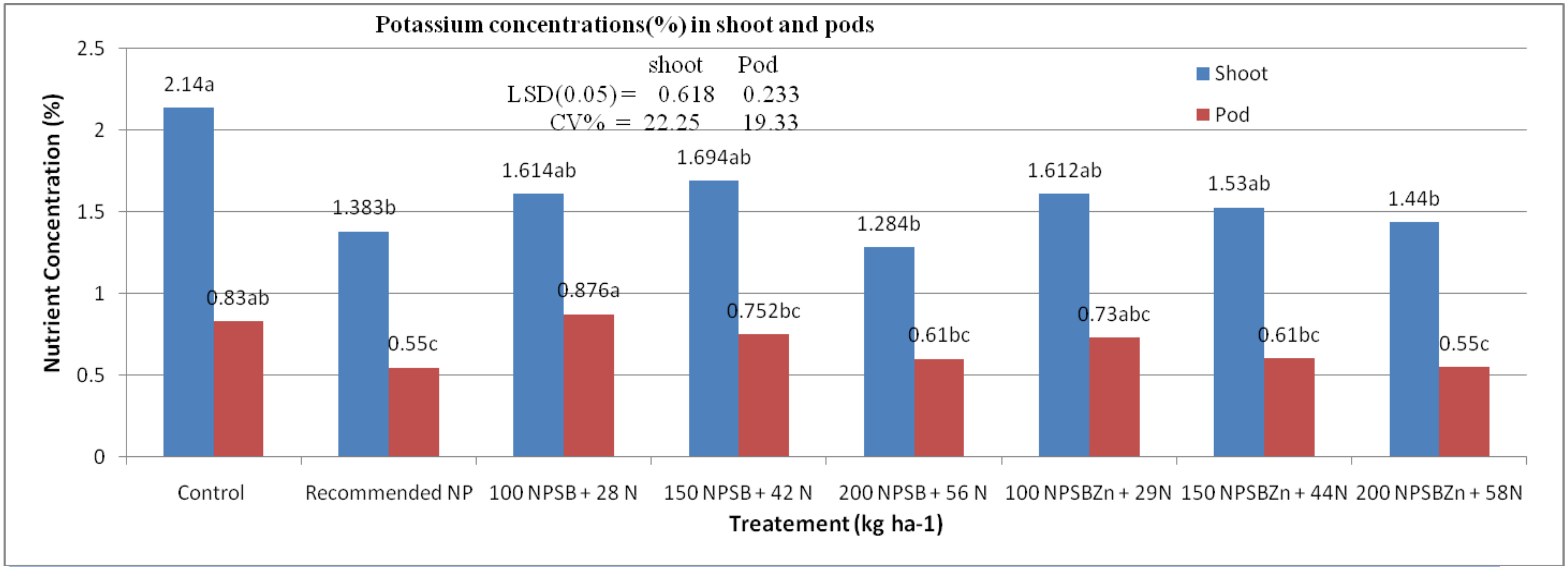


Figure.2 Mean Macro- and Micro- nutrients concentration of shoot and pod of hot pepper as influence of fertilizer rate at Assosa




Phosphourous concentrations(%) in shoot and pods
shoot Pod
LSD(0.05)=0.0802 0.0646
CV% = 12.03 9.47
Shoot
Pod
Nutrient Concentration (%)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.25c
0.31b
0.41ab
0.39a
0.37b
0.4a
0.38ab
0.39a
0.45a
0.41a
0.37ab
0.38a
0.36b
0.41a
0.43ab
0.43a
Control
Recommended NP
100 NPSB + 28 N
150 NPSB + 42 N
200 NPSB + 56 N
100 NPSBZn + 29N
150 NPSBZn + 44N
200 NPSBZn + 58N
Treaterments (kg ha-1)


Sulfur concentrations in shoot and pods
shoot Pod
LSD(0.05)= ns ns
CV% = 24.94 18.24
Shoot
Pod
Nutrient Concentration (%)
0.25
0.2
0.15
0.1
0.05
0
0.06
0.13
0.11
0.14
0.1
0.19
0.1
0.18
0.12
0.17
0.12
0.16
0.1
0.16
0.1
0.2
Control
Recommended NP
100 NPSB + 28 N
150 NPSB + 42 N
200 NPSB + 56 N
100 NPSBZn + 29N
150 NPSBZn + 44N
200 NPSBZn + 58N
Treatement (kg ha-1)


Potassium concentrations(%) in shoot and pods
shoot Pod
LSD(0.05)= 0.618 0.233
CV% = 22.25 19.33
Shoot
Pod
Nutrient Concentration (%)
2.5
2
1.5
1
0.5
0
2.14a
0.83ab
1.383b
0.55c
1.614ab
0.876a
1.694ab
0.752bc
1.284b
0.61bc
1.612ab
0.73abc
1.53ab
0.61bc
1.44b
0.55c
Control
Recommended NP
100 NPSB + 28 N
150 NPSB + 42 N
200 NPSB + 56 N
100 NPSBZn + 29N
150 NPSBZn + 44N
200 NPSBZn + 58N
Treatement (kg ha-1)

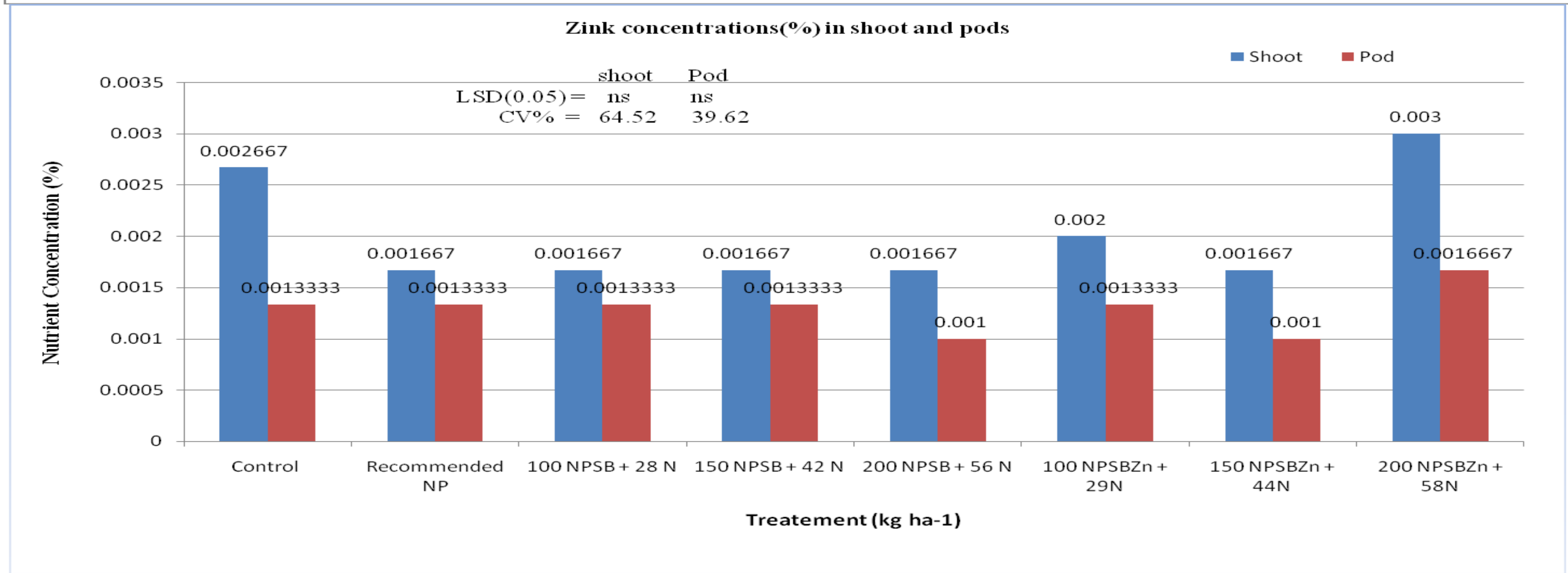
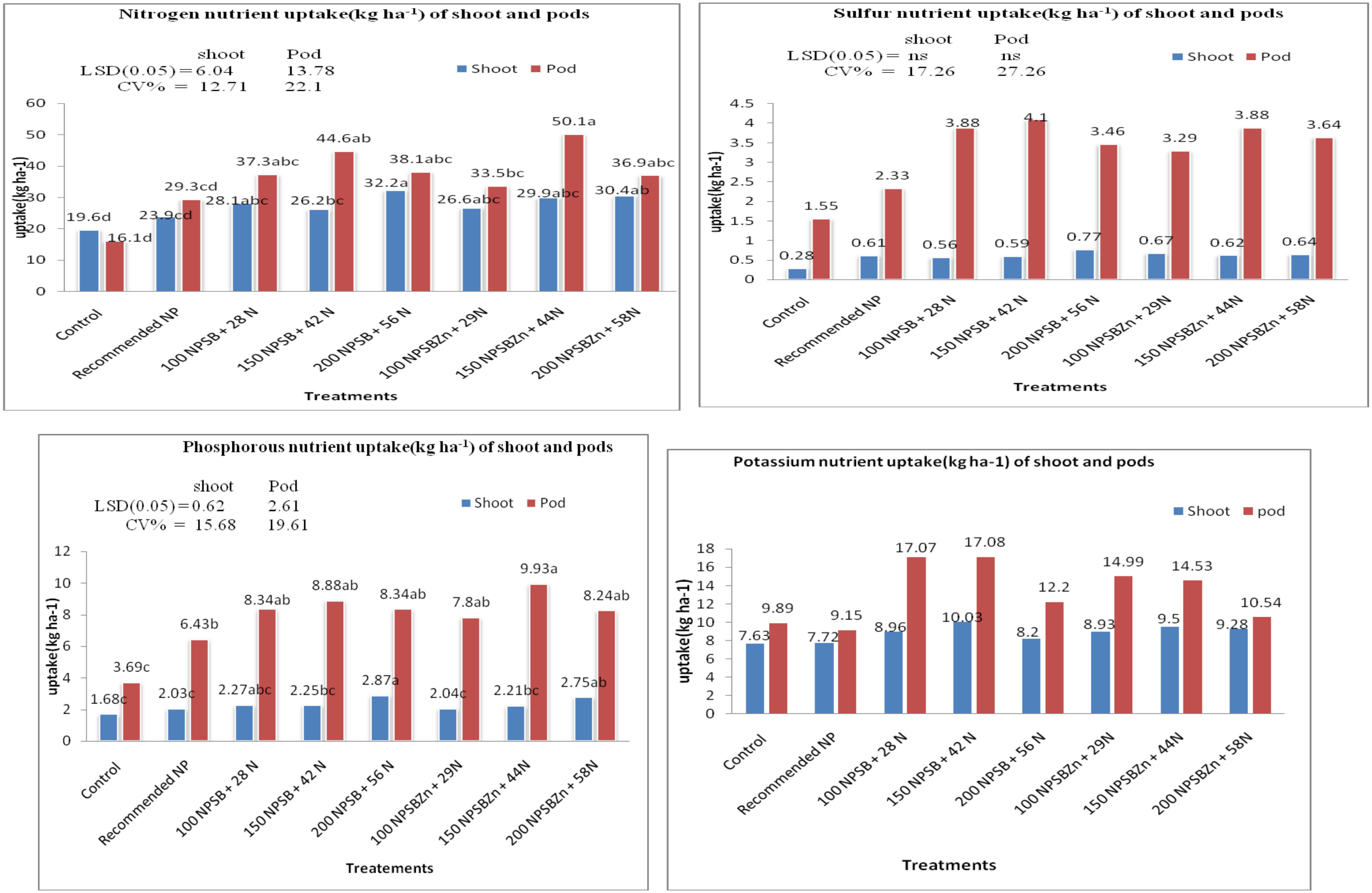

Zink concentrations(%) in shoot and pods
Shoot
Pod
shoot Pod
LSD(0.05)= ns ns
CV% = 64.52 39.62
Nutrient Concentration (%)
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
0.002667
0.0013333
0.001667
0.0013333
0.001667
0.0013333
0.001667
0.0013333
0.001667
0.001
0.002
0.0013333
0.001667
0.001
0.003
0.0016667
Control
Recommended NP
100 NPSB + 28 N
150 NPSB + 42 N
200 NPSB + 56 N
100 NPSBZn + 29N
150 NPSBZn + 44N
200 NPSBZn + 58N
Treatement (kg ha-1)

Figure.3 Micro nutrient uptake of pod and shoot of hot pepper MarekoFana variety with effect of fertilizer rate application



The present shoot nutrient concentration agreed with Portree (1996) who reported that the range of sufficiency of nitrogen in the leaf tissue of pepper is (3.5-5.5%) in leaf dry matter. Therefore, it is evident from the results of this study that the pepper plants took up sufficient nitrogen (4.82%) from the soil with 150 kg NPSBZn + 44 kg N ha^{-1} fertilizer application, implying that concentration alone may be a misleading in predicting yield. However, unlike pod yield which was reduced at the highest level of N supply, the concentration of the nutrient in the shoot did not decrease. This shows that there was luxury consumption of the nutrient, at the highest level of nutrient fertilizer, which led a decline in yield attributable to the promotion of vegetative growth at the expense of pod development (Roy *et al.*, 2011). As Nigussie *et al.*, (2001) investigated that plants supplied with P had significantly increased P concentration in potato, cabbage and carrot shoots than those not supplied with P at all stages of growth. Moreover, the N and P nutrient concentrations in the shoot were greater than the N and P nutrient concentrations in pods. As cited by Reis and Monnerat (2000) nutrient concentration varies with the sampled organ on the plant and sampling time, this makes their difference in the nutrient concentration at shoot and pod parts of hot pepper plant and in different sampling stage at flowering and maturity stage

Shoot and pod nutrient uptakes

The shoot and pod N and P uptakes were significantly ($P \leq 0.05$) affected by the application of different blended fertilizer rates, while S effect was non-significantly different among the fertilizers tested. The maximum shoot uptake values of N, P and S were 32.22, 2.87 and 0.77 kg ha^{-1} respectively with application of blended fertilizer rate 150 kg NPSB + 42 N kg ha^{-1} with this rate high above ground total biomass was also produced. The results showed very low amount of P and S uptake in shoot biomass, perhaps due to the fact that the study soil is strongly acidic and hence P fixation occurred in Al and Fe oxides.

The maximum pod uptake of N (50.14 kg ha^{-1}) and P (9.93 kg ha^{-1}) were obtained from blended fertilizer rate (150 kg NPSBZn + 44 kg N ha^{-1}) which also gave the highest pod yield, while higher S (4.10 kg ha^{-1}) uptake were from (150 kg NPSB + 42 kg N ha^{-1}).The least nutrient uptakes for tissue and pods were from the unfertilized plots (Figure 3). This result show that pod and tissue uptake linearly increased in response to increasing specially N and P fertilizer rates in blended fertilizers. This could be because of the fact that N and P fertilizer application do have synergistic effect and hence N might have stimulated the uptake of P and vice versa (Sharma and Tandon, 1992). And also S availability can improves the efficiency and uptakes of N and P. Fazili *et al.*, (2008) reported that lack of S limits the efficiency of added N, therefore, S addition becomes necessary to achieve maximum efficiency of applied nitrogen fertilizer. The pod N uptake was higher than the shoot N uptakes this can be expected due to partition of nutrients from plant parts to pod formation at maturity stage and also due to yield difference, at flowering biomass produced was low in relative to total pod production at maturity stage. Thus, 150 kg NPSBZn + 44 kg N ha^{-1} treatment increased the total nitrogen, phosphorus and sulfur uptake compared to other treatments. This is due to the application of combination of macronutrients with micronutrients in balanced form of fertilizer to nutrient deficient soil; thereby it improves the nutrient concentration and uptake as a result yield is increased. On the other hand, a treatment that accumulates the maximum of N, P and S nutrients gave the highest yield. Similar to this finding, Assefa (2008) reported that the grain yield at maximum accumulation of nutrient occurs when increasing that nutrient rate does not increase uptake and yield.

Correlation of nutrient uptake and total dry pod yield

There were significant and strong correlations between total dry pod yield and nutrients uptake. The correlations between N, P, S and K uptakes and total dry pod yields were very strong and significant (Table 2). This indicates the improvement of total dry pod yield production of hot pepper by application of blended fertilizers; Fageria and Baligar (2005) reported similarly high yields obtained due to increased uptake of nutrient, that perhaps led to reduced losses of nutrient applied. In specific the uptake of N, P and S were significantly and very strongly correlated ($P < 0.01$) with total dry pod yield. While the zinc uptakes was positively, but non-significantly ($P < 0.05$)correlated. All the above positive and strong association of nutrient uptakes implies these factors are most important for dry pod yield and hot pepper production improvement at Assosa area. Significantly positive correlation was also reported between applied nitrogen dose and dry matter production by Deshmukh (2008) on pepper.

Summary and conclusions are as follows:

The results of the study revealed that significantly affected was obtained by the fertilizer application. The highest and significantly different total dry pod yield (2.44 t ha^{-1}) and the highest marketable pod yield (2.37 t ha^{-1}) were obtained from plots that received blended fertilizers rate of 150 kg NPSBZn + 44 kg N ha^{-1}. The nutrient concentrations and uptakes were linearly increased in response to the application of blended fertilizers rates increased, whereas the maximum values for shoot concentration of N (5.03%), P (0.45%) and S (0.13%) and pod concentration of N (2.07%), P (0.43%) and S (0.20%) was recorded at 200 kg NPSB and NPSBZn ha^{-1} respectively. The highest uptakes of shoot N (32.22 kg ha^{-1}), P (2.87 kg ha^{-1}) and S (0.77 kg ha^{-1}) and pod uptake of N (50.14 kg ha^{-1}), P (9.93 kg ha^{-1}) and S (4.10 kg ha^{-1}) were obtained at 200 kg ha^{-1} and 150 kg ha^{-1}blended fertilizer rates respectively. In addition where the highest agronomic efficiency (9.59 kg kg^{-1}), apparent recovery of N (48.97%), P (12.80%) and physiological efficiency of N (49.49kg kg^{-1}), P (210.0kg kg^{-1}) was obtained from blended fertilizer. The relationship of the uptake of N, P and S were significantly and very strongly correlated ($P < 0.01$) with total dry pod yield, this indicates the improvement of total dry pod yield was through nutrient uptake. Finally, by virtue of its greater solubility in the soil, total nutrient uptake and fertilizer use efficiency, and apparent recovery were the inclusion of micronutrients in its formulation, application of 150 kg NPSBZn + 44 kg N ha^{-1} blended fertilizer brought higher pod yield, compared to recommended NP fertilizer has been practiced to the users at the study area.

References

Akram A, Fatima M., Ali S, Jilani G, Asghar R. 2007. Growth, yield and nutrients uptake of sorghum in response to integrated phosphorus and potassium management. *Pak. J. Bot.*, 39(4): 1083-1087

AlemuHaiylie and Ermias Abate. 2000. Horticultural crops production and associated constraints in North-west Ethiopia. Working paper. Agricultural Economics Research Division, Agricultural Research Centre, Adet. 18p.

Aloni B, Karni L, Rylski I and Zaidman Z (1994) The effect of nitrogen fertilization and shading on the incidence of 'Colour spots' in sweet pepper (*Capsicum annuum* L.) fruit. *Journal of Horticultural Science*, 69 (4): 767-773.

AmareHailesilase, Priess J, Veldkamp E, Teketay D, Lesschen P, 2005. Assessment of soil nutrient depletion and its spatial variability on smallholder's mixed farming systems in Ethiopia using partial versus full nutrient balances. Agric. Ecosyst. Environ. 108:1-16.

Assefa Abegaz. 2008. Indigenous soil nutrient supply and effects of fertilizer application on yield, N, P and K uptake, recovery and use efficiency of barley in three soils, the Northern Highlands of Ethiopia. African Journal of Agricultural Research Vol. 3 (10) 688-699.

ATA (Agricultural Transformation Agency) 2013.Status of soil resources in Ethiopia and priorities for sustainable management. Ethiopian agricultural transformation agency In: Global Soil partnership (GSP) for eastern and southern Africa. March 25-27: 2013, Nairobi, Kenya.

Aticho Abebayehu. 2011. Soil fertility management and nutrient balance in southwest Ethiopia. ISBN 978-3-639-33792-1, 64P.

Berhanu Debel, 1980. The physical criteria and their rating proposed for land evaluation in the highland region of Ethiopia. Land use planning and regulatory department, ministry of agriculture, Addis Ababa, Ethiopia.

Bremner JM, Mulvaney CS. 1982. Nitrogen- Total, In: A.L. page, methods of soil analysis, American Society of Agronomy Inc., American Society of Soil science Inc., Madison, 1982, pp.595-624.

Chapman H.D. 1965. Cation exchange capacity by ammonium saturation. In: C.A. Black, L.E. Ensminger and F.E Clark (eds). Methods of soil analysis. American society of Agronomy. Madison Wisconsin, USA. 9: 891 – 901.

Cottenie I. 1980. Soil and plant testing as a bases for fertilizer recommendation. FAO soils bulletin No. 38/2, FAO, Rome, Italy

Dawit Solomon, Fritzsche F., TekalignMamo, Lehmann J. and Zech W. 2002.Soil organic matter composition in the sub-humid Ethiopian highlands as influenced by deforestation and agricultural management. *Soil Science Society of American Journal*.66: 68-82.

Day Sc. 2000. Tomato crop in vegetable growing.Agrobios, New Delhi, India, 59-61p

Deshmukh, A.K., 2008. Response of pepper (*Capsicum annuum* L.) to Site Specific Nutrient Management. An MSc Thesis presented to Dharwad University of Agricultural Science. 103p.

EARO (Ethiopian Agricultural research Organization) 2004. Released crop varieties and their recommended cultural practices. Progress report. Addis Ababa, Ethiopia.

EIAR (Ethiopia Institute of Agricultural Research) 2007.Technology guideline for different crops.

Amharic Version Addis Ababa, Ethiopia. pp. 121-124.

EthioSIS (Ethiopian Soil Information System) 2014.Soil fertility status and fertilizer recommendation atlas, Ethiopia.

Fageria N.K. and Baligar V.C. 2005.Enhancing nitrogen use efficiency in crop plants. Advanced agronomy. 88: 97-185.

FAO (Food and Agricultural Organization) 2006. Guidelines for soil profile description. Soil Resources, Management and Conservation Service, Land and Water Development Division, FAO, Rome

FAO (Food and Agriculture Organization) 2009. FASTAT Database for production of pepper http://faostat.fao.org/site/3339/default.aspx

Fazli IS, Jamal A, Ahmad S, Masoodi M, Khan JS, Abdin MZ .2008. Interactive effect of sulphur and nitrogen on nitrogen accumulation and harvest in oilseed crops differing in nitrogen assimilation potential. J Plant Nutri 31: 1203-1220

Hazelton P. and Murphy B. 2007. Interpreting soil test results: What do all the numbers mean? 2nd Edition. CSIRO Publishing. 152p.

Hesse P. R. 1971.A textbook of soil chemical analysis. John Murry Limited, London, Great Britain.

Horneck D. A., Sullivan, D. M., Owen, J. S., and Hart, J. M.. 2011. Soil test interpretation guide(p. 1478). EC: Oregon State University.

Jones J.B. 2003. Agronomic Handbook: Management of Crops, Soils, and Their Fertility. CRC Press LLC, Boca Raton, Florida, USA.

Leghari G and Oad. F. 2005. The effect of nitrogen fertilizer regimes on the growth and yield of pepper. *Indus Journal of Plant Sciences*, 4(3): 386-390.

Lemma Desalegn and ShimelisAklilu. 2008. Achievement and research experience on capsicum crop Melkasa Agricultural Research center. EIAR. Un published report.

Malakouti M. J. 2008. The effect of micronutrients in ensuring efficient use of macronutrients: Soil Science Department; Tarbiat Modares University. *Turk J. Agric* (32) 215-220.

Mavengahama S, Ogunlela V.B. and Mariga I.K. 2003.Response of pepper (*Capsicum annuum* L.) to different basal fertilizers application. *Journal of African Crop Science Society*, 6: 9-13.

Melkasa Agricultural Research Center (MARC) 2005. Progress Report on Completed Activities. Melkassa, Ethiopia. pp. 1-7. *unpublished report*.

Mengel K. and Kirkby E.A.2001. Principles of Plant Nutrition, 5th ed. Kluwer Academic publishers: dordrecht, the Netherlands, pp. 481–509.

Miller R. W., Donahue R.L. and Miller J.U. 1995.Soils in our environment, 7th edition. New Jersey. 649.

Motsara M.R. and Roy, R.N. 2008. Guide to Laboratory Establishment for Plant nutrient Analysis: FAO Fertilizer and Plant Nutrition bullet no 19.

Morberg, J. P., 2000. *Soil and plant analysis Manual*, Royal Veterinary and Agricultural University.Chemistry Department, Copenhagen, Denmark. 133pp.

NigussieDechassa, 2001. Phosphorus efficiency for selected vegetable. A PhD dissertation presented to Hanover university filderstadt, Germany.

Obidiebube EA, Eruotor PG, Akparobi SO, Emosaariue SO, Achebe UA, Kator PE. 2012. Response of four cultivars of pepper (*Capsicum frutescens* L.) to different levels of N, P and K fertilizer in rainforest Agro-ecological zone. Int. J. Agric. Sci. 2(12):1143-1150.

Okalebo J.R., Gathua K.W. and Woomer P.L. 2002. Laboratory methods of soil and plant analyses: a working manual, 2nd ed. TSBF-CIAT and SACRED Africa, Nairobi, Kenya.

Olsen S.R., Cole C.V, Watanabe F.S and Deen L.A. 1954.Estimation of available P in soils by extraction with sodium bicarbonate. USDA. Circ 939: 1-19.

Portree, J., 1996. Green house vegetable production guide for commercial growers. Ministry of Agriculture, Fisheries and Food, Colombia.118p.

Roy S.S., Khan M.S. and Pall K.K. 2011. Nitrogen and Phosphorus Efficiency on the Fruit Size and Yield of Capsicum. *Journal of Experimental Sciences*, 2(1): 32-37.

Ryan J. and Rashid A. 2001.Soil and plant analysis laboratory manual. Second edition. Jointly published by the International center for agricultural research in the dry areas (ICARDA) and the National Agricultural Research Center (NARC), Aleppo, Syria, pp. 172.

Ryan, J. 2008. A Perspective on balanced fertilization in the Mediterranean Region. *Turky journal of Agriculture*, 32: 79-89.

Sahlemedhin Sertus and Taye Bekel. 2000. Procedures for Soil and Plant Analysis. Addis Ababa, Ethiopia.

Sam-Aggrey, Godfrey and Bereke_T, Tuku. 1985. Proceedings of the 1st Ethiopian Horticultural workshop. 20-22 February. IAR. Addis Ababa, Ethiopia.212p.

SAS Institute Inc. Cray. 20008. Users Guide. Version 9.2.NC.USA.

Sharma P. and Tandon H.L.S. 1992. The interaction between nitrogen and phosphorus in crop production. In Tandon, H.L.S. (ed) FDCO. New Delhi.

Siti A.H., Gerber, J.M. and Splittstoesser W.E. 1993. Growth and yield potential of green pepper as affected by nitrogen at transplanting. *Journal of Tropical Agriculture Science*, 16 (2): 101-105.

Tekalign Tadese.1991. Soil, plant, water, fertilizer, animal manure and compost analysis. Working document No.13.International Livestock Research Center for Africa, Addis Ababa, Ethiopia.

Varin, S., B. Leveel, S. L. Lavenant and J.B. Cliquet. 2009. Does the white clover response to sulphur availability correspond to phenotypic or ontogenetic plasticity? Acta Oecologica, 35: 452-457.

Wakene Negassa and Heluf Gebrekidan. 2003. Forms of phosphorus and status of available micronutrients under different land-use systems of Alfisols in Bako area of Ethiopia. *Ethiopian Journal of Natural Resources*. 5(1): 17-37.

Wassie Haile and Shiferaw Boke. 2011. Response of Irish Potato (*Solanum tuberosum*) to the Application of Potassium at Acidic Soils of Chencha, Southern Ethiopia. International Journal of Agriculture and Biology 13:595-598.

Yihenew Gebreselassie. 2002. Selected chemical and physical characteristics of soils of Adet Research Centre and its testing sites in Northwestern Ethiopia. *Ethiopian Journal of NaturalResources*.4 (2): 199-215

Zhao, Y., Xiao X., Bi, D. and Hu, F. 2008. Effect of sulphur fertilization on soybean root and leaf traits and soil microbial activity. Journal of Plant nutrition, 31: 473-483.

How to cite this article:

Nimona Fufa Hunde. 2020. Influence of NPSZnB Blend Fertilization with Nitrogen Supplement on Nutrient Concentration, Uptakes and Dry Pod Yield of Marekofana Hot Pepper (*Capsicum annuum*L.) Variety. *Int.J.Curr.Res.Aca.Rev*. 8(10), 56-70.
doi: https://doi.org/10.20546/ijcrar.2020.810.008

APPENDICES

Appendix 1. Ranges of soil pH in water

Soil reaction class Soil	pH
Extremely acidic	< 4.5
Very strongly acidic	4.5-5.0
Strongly acidic	5.1-5.5
Moderately medium acidic	5.6-6.0
Slightly acidic	6.1-6.5
Neutral	6.6-7.3
Slightly alkaline	7.4-7.8
Moderately alkaline	7.9-8.4
Strongly alkaline	8.5-9.0
Very strongly alkaline	> 9.1

Source: Jones (2003)

Appendix 2. Ratings of organic matter(OM) and total nitrogen(TN) values

Rating	(a) OM (%)	(b) Total N (%)
Very low	< 0.86	< 0.1
Low	0.86-2.59	0.1 - 0.2
Moderate	2.59-5.17	0.2 - 0.5
High	> 5.17	> 0.5 -1

Very high	Not Given	>1

Sources: (a) Tekalign (1991); (b) London (1991)

Appendix 3. Rating of soil for available phosphorus (avail. P) and cation exchange capacity (CEC)

Rating	**[(a)]Available P (mg kg-1)**	**[(b)]CEC (cmolc (+) kg^{-1})**
Very low		< 6
Low	< 5	6–12
Medium	5–10	12–25
High	> 10	25–40
Very high		> 40

Sources: (a) Olsen *et al.*, (1954); (b) Hazelton and Murphy (2007)

Appendix 4. Rating of sulfur (S), potassium (K) and zinc (Zn)in soils

Sulfur (mg/kg)[a]	**Potassium (mg/kg)[b]**	**Zinc (mg/kg)[b]**	**Rating**
>100	>300		Very high
80-100	140-300	>1.5	High
20-80	91-140	1.0–1.5	Optimum
10-20	51-90	0.0–0.9	Low
<10	1-50		Very low

Source: (a)-Ethio SIS team analysis, 2014; (b)- Jones (2003)