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Influences of mineral nitrogen and phosphorous fertilization on yield and yield contributing components in hot pepper (*Capsicum annuum* L.)

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Hot pepper is widely cultivated in different parts of Ethiopia but, its productivity is low due to inadequate nutrient supply, moisture and poor agronomic practices. This experiment was conducted to determine the amount of N and P nutrients required to produce optimum amount of hot pepper marketable yield. Four different rates of DAP and urea fertilizers (25, 50, 75 and 100 kg/ha and control) were used as treatments. There was significant difference ($p < 0.05$) among treatment means for marketable yield; and highly significant difference ($p < 0.01$) for branch, fruit and height were observed. Mean comparison for marketable yield was non-significant difference ($p > 0.05$) between the control, and plots received 25 and 75 kg/ha DAP and urea. In contrast, the amount of marketable yield harvested from an experimental plots received 50 and 100 kg of DAP and urea fertilizers per hectare were significantly different ($p < 0.05$) from control. Mean comparison revealed marketable yield obtained from 50, 75 and 100 kg of DAP and urea fertilizers were similar thus applying 50 kg/ha is economically better than other treatments. Liner association was observed between marketable yield and amounts of DAP and urea fertilzers treatments. A unit increament in the rate of DAP and urea application contributed for the rise of pods per plant, height, branch per plant, and marketable yield by 2.07, 2.04, 6.67 and 62.22, respectively.

Key words: Hot pepper, marketable yield, mineral N and P fertilizers, yield contributors.

INTRODUCTION

Hot pepper (*Capsicum annuum* L.) belongs to genus *Capsicum* and family Solanaceae. It is one of the most important spice crops widely cultivated around the world for its pungent flavor and aroma (Ikeh et al., 2012; Obidiebub et al., 2012). In Ethiopia, hot pepper is commonly cultivated within an altitude ranges of 1400 to 1900 meter above sea level (m.a.s.l) (MoARD, 2009; EIAR, 2007), which receives mean annual rainfall of 600 to 1200 mm, and has mean annual temperature of 25 to 28°C (EIAR, 2007). The milled powder hot pepper is an essential coloring and flavoring ingredient in traditional diets and green pods is usually consumed with other foods in Ethiopia. Domestic consumption of hot pepper is supplied from the traditional subsistence production systems. In terms of total production the share of pepper is high as compared with other vegetables such as lettuce, tomatoes and others (CSA, 2012). According to Melkasa Agricultural Research Center (MARC) (2005)

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Table 1. N and P nutrients applied by urea and DAP fertilizer.

Type of nutrients	N and P nutrients (kg/ha) concentration in each treatments				
	0	25	50	75	100
Nitrogen (N)	0	16.00	32.00	48.00	64.00
Phosphorus (P)	0	4.95	9.89	14.84	19.79

activity report, the total area under hot pepper was about 770,349 ha. The amount of dry fruit harvested in smallholder farm was about 400 kg/ha, and national average yield is about 40 kg/ha (Fekadu and Dandena, 2006). In terms of price per unit weight, the price of hot pepper is higher than other vegetables and cereals in market (Shumeta, 2012).

As a result, the production is increasing in the smallholder farming system of Amahra, Oromia, and Southern Nation Nationality and Peoples (SNNP) Regional States of Ethiopia.

However, the productivity is still low as compared with other vegetable crops, this could be attributed to lack of adequate nutrient supply, diseases incidence, poor aeration, poor agronomic practices and lack of high yielding cultivars.

Beside, nutrient deficiency is the most yield limiting factor in vegetable production in Ethiopia. N and P nutrient deficiencies are the main constraint for cereal and vegetable crop production in the Ethiopia highlands (Agegnehu and Tsigie, 2004).

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, nutrient loss through leaching, P-fixation in acid soil and gaseous loss of N (Aticho, 2011; Amare et al., 2005; Eyasu et al., 1998).

Mineral fertilizers are the major nutrient input source to improve crop productivity. The application of mineral nitrogen (N), phosphorus (P) and potassium (K) fertilizers improves dry weight of marketable yield and yield contributors through better nutrient uptake, growth and development (Obidiebube et al., 2012).Depending on chemical composition of fertilizers (e.g., urea [CO $(NH_2)_2$] contain 45 to 46% N; Diammonium phosphate $[NH_4)_2HPO_4]$ contain 18 to 21% N and 46 to 53% P_2O_5), (Havlin et al., 2005).

In Ethiopia, 100 kg N ha^{-1} and 100 kg P ha^{-1} is recommended to increase hot pepper productivity (EIAR, 2007). As Ethiopia is highly diverse in agro-ecological setting, soil of the country is diverse in terms of soil type, soil productivity and soil fertility status.

Thus, the amount of N and P fertilizers required to get optimum yield could consider this facts.

Therefore, the aim of this study is to determine the effects of different rates of N (urea- CO $(NH_2)_2$) and P (Diammonium phosphate – $(NH_4)_2$ HPO_4) fertilizer on hot pepper locally called Marako yield on Nitisol.

MATERIALS AND METHODS

Description of the site area

The experiment was conducted under partially irrigated condition from July 2012 to January 2013 at Eladale Research site of College of Agriculture and Veterinary Medicine, Jimma University. Abera et al. *(*2011) reported the mean annual rainfall, relative humidity and temperature of the study area is 1500 mm, 91% and 11.8 to 26.8°C, respectively. The dominant soils of the area are Nitisol and Cambsol which is drained and favorable physical property for agricultural practices and well recognized as the most productive soils in Ethiopia (Aticho, 2011).

Experimental treatment, design and procedures

The experiment was conducted in Randomized Complete Block Design (RCBD) with three replications and five treatments: 0, 25, 50, 75 and 100 kg of urea and DAP fertilizer per hectare (Table 1). The experimental plots size was 2 m × 3 m (6 m^2); *Marako* variety hot pepper seedlings were planted at 30 cm between plants and 40 cm between rows (EARO, 2004). The fertilizers were applied through band technique; DAP after a week of transplanting and urea after 30 days. The plots were properly managed through effectively controlling weeds using mulching with crop residues.

Before planting, composite soil samples were collected from the experimental site at depth of 15 cm with sampling auger. The collected samples were analyzed for electrical conductivity (EC), soil particle size distribution (% of sand, silt and clay), available P (P ppm), organic carbon (OC %), total nitrogen (TN %), Cation Exchange Capacity (CEC), and exchangeable basic cations (Exh.Na, Exh. Mg, Exh. K and Exh.Ca) in Soil Laboratory of College of Agriculture and Veterinary Medicine, Jimma University using standard procedures provided by Sahlemedin and Taye (2000). Soil pH was determined in 1:2.5 soil water ratios; organic carbon (OC %) using wet oxidation method (Walkley and Black, 1934); available phosphors (P avail.) using Olsen's method and P available in the extract was measured by spectrophotometer; total nitrogen (NT) by Kjeldahl method; Cation Exchange Capacity (CEC) was determined at pH 7 with ammonium acetate; electrical conductivity (EC) was measured using electrical conductivity meter; particle size distribution (% of sand, silt and clay) was determined using hydrometer method; exchangeable Ca, Mg, Na and K were extracted by ammonium acetate; and Ca and Mg in leachate were measured by atomic absorption spectrophotometry (AAS) whereas exchangeable K and Na using flame photometer.

Data collection

Three hot pepper plant stands were randomly selected from the middle rows of each treatment plot and tagged for sampling at various stages. The selected plants per treatments were sampled in each 15 days for number of fruits per plant but, data on plant height (cm), and number of main branches per plant were taken at the final harvest. In addition, mature fruits sample were harvested for

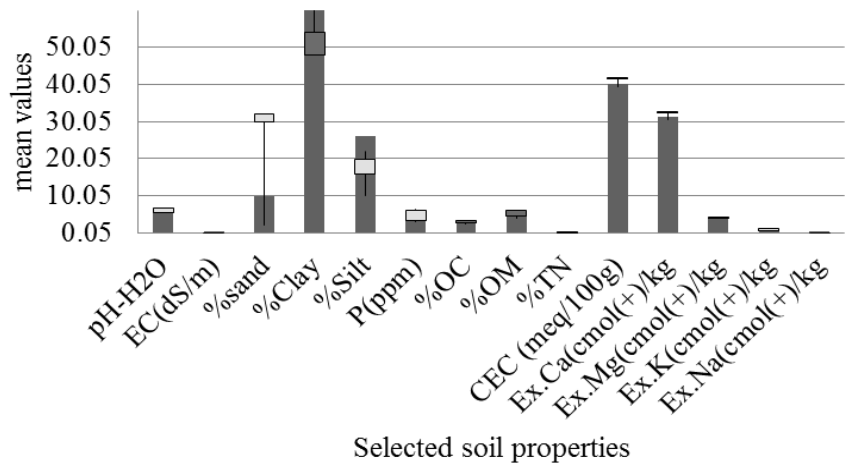

Figure 1. Selected soil physico-chemical properties of the experimental site.

each treatment at 15 days interval from October 25 to January 25, 2013. The matured fruits picked from each plots were sun dried and the dry matter (dry weight) were weighed by analytical balance scale.

Statistical analysis

The collected data were statistically analyzed using one way ANOVA (Analysis of Variance). When, the effects of treatments were significant, means were separated using LSD (Least Significant Difference) methods of mean separation at t- 5 and 1%. Simple regression analysis was conducted to test the relationship between treatment and response variables (marketable yield, height, main branches and pod per plant).

RESULTS AND DISCUSSION

Charactristics of soil of expermental site

Laboratory analysis revealed, clay, sand and silt proportions of the study site were 64.80 , 16.40 and 18.80%, respctively; and catagorized as clay loam texture (Figure 1). Mean value soil reaction (pH) of the study site was 5.65, which optmal for most ceareal and horticultural crop production. At this reaction the availablity of nitrogen (N) and phosphorus (P) mineral nutrients are high as compared with highly acidic and alicaline soils. The available phospherous (P ppm) content of ths soil was 4.48 ppm, according to Landon (1991) available phosphours blow 5 ppm is rated as low and less response for fertilizer. Organic carbon (OC), total nitrogen (TN) and organic matter (OM) contents of the study site was 2.9, 0.25 and 5.02%, respectively. According to Landon (1991) rating soil of the study site has low OC, and medium nitorgen and OM. The CEC value was 41.04, this scale is rated as very high and good agricultural soil (Landon, 1991). High CEC ensures the soil's ability of high nutrient retention ability and reduces fertilizer application frequence and amount.

Effects of treatments on marketable yield and selected yield contributing components

Analysis of variance showed that, the rates of N and P nutrients applied through DAP and urea fertilizers were contributed for the improvemt of marketable yiled, number of main branchs per plant, number of fruits per plant and plant height. Accordingly, significant difference ($p \leq 0.05$) was observed among the treatment means of marketable yield whereas highly significant difference ($p \leq 0.01$) was obesreved among treatment means of number of main bramch per plant, fruits per plant and plant height (Table 2). This could be due to relatively high amount of N nutrient (Table 1) received by the expermental unit as compared with P, which is responsible for vegetative growth such as branches, leaves and heights. This is agreed with the finding of El-Tohamy et al. (2006) stated adquate amount of nutrient sullpy improves the growth of hot pepper height, branch and pods.

Mean comparison for marketable yield showed, non-significant difference ($p > 0.05$) was observed between the control and plots received 25 and 75 kg/ ha DAP and urea fertilizers (Table 3). This indicates, in the experimental site producing hot pepper especially *Marako* variety without DAP and urea fertilizers (control), applying 25 kg and 75 kg DAP and urea per hectare has similar effects on marketable yield. In contrast, the amount of marketable yield harvested from experimental plots received 50 kg and 100 kg of DAP and urea fertilizers per hectare were significantly different ($p < 0.05$) from the control. However, the difference between marketable yield harvested from the plots received 50 and 100 kg of DAP and urea fertilizers per hectare were non-significant ($p > 0.05$). This implies the amount of

Table 2. ANOVA table of treatment effects on marketable yield and yield components.

Parameter	MS	MSE	CV (%)	F-obtained values	F-tabular values	
					5%	1%
Yield (g/6 m^2)	938.94	9.97	13.02	6.29*	3.84	7.00
Branch/plant	68.42	2.29	13.23	8.67**		
Fruits/ plant	51.60	1.76	18.20	11.06**		
Plant height (cm)	337.36	3.60	7.60	17.31**		

*, Significantly different p ≤ 0.05; **, highly significant different p ≤ 0.01.

Table 3. Treatment means comparison.

Response variable	Treatment means differences					LSD values	
	100 kg/ha	75 kg/ha	50 kg/ha	25 kg/ha	Control	5%	1%
Yield (g/ m^2)	57.43	43.10	57.59	19.40	25.63	23.03	33.40
	31.80*	17.47^{ns}	31.96*	-6.23^{ns}			
	38.03**	23.70*	38.19**				
	-0.16^{ns}	-14.49^{ns}					
	14.33^{ns}						
Plant height (cm)	28.00	23.00	24.00	17.00	17.00	8.32	12.06
	11.00*	6.00^{ns}	7.00^{ns}	0.00^{ns}			
	11.00*	6.00^{ns}	7.00^{ns}				
	4.00^{ns}	-1.00^{ns}					
	5.00^{ns}						
Number of main branches/ plant	18.00	11.00	14.00	8.00	9.00	5.29	7.67
	9.00**	2.00^{ns}	5.00^{ns}	-1.00^{ns}			
	10.00**	3.00^{ns}	6.00*				
	4.00^{ns}	-3.00^{ns}					
	7.00*						
Number of fruits/ plant	72.07	60.20	62.87	47.67	47.20	4.07	5.90
	24.87**	13.00**	15.20**	0.47^{ns}			
	24.40**	12.53**	15.67**				
	9.20**	-2.67^{ns}					
	11.87**						

^{ns}, treatment effect was non-significant at p > 0.05; *, treatment effect was significant at p ≤ 0.05; **, treatment effect was highly significant at p < 0.01.

marketable yield obtained from plots that received 50 and 100 kg of DAP and urea per hectare were similar. This is approved with the finding of Aliyu (2003) who reported high N nutrient application reduce the number of fruit and yield. Therefore, applying 100 kg DAP and urea per hectare as sources of N and P nutrients in the experimental site on hot pepper Marako variety could cause the increment of production cost and reduction of profit. But, adding 50 kg of DAP and urea fertilizers per hectare increase the profitability through reducing the cost of fertilizer by half. In addition, treatment mean comparison for height and main branch per plant revealed; a significant difference (p ≤ 0.05) between plant heights that were received 100 kg of DAP and urea per hectare and control groups and highly significant difference (p ≤ 0.01) between number of main branches. As compared with other treatments, the amount of N nutrient found in 100 kg of DAP and urea is greater than other treatments (Table 1). The amount of N received by the plots could enhance the vegetative growth such as number of branches and height of the plant. Except the plots that received 25 kg of DAP and urea per hectare, treatment means of other plots were highly significantly different (p ≤ 0.01) from control for number of pod per plant. This finding is agreed with finding reported from Indonesia (Vos and Duiat, 1995) stated improper agronomic practices, inadequate nutrient application and management practices reduce hot pepper yield and

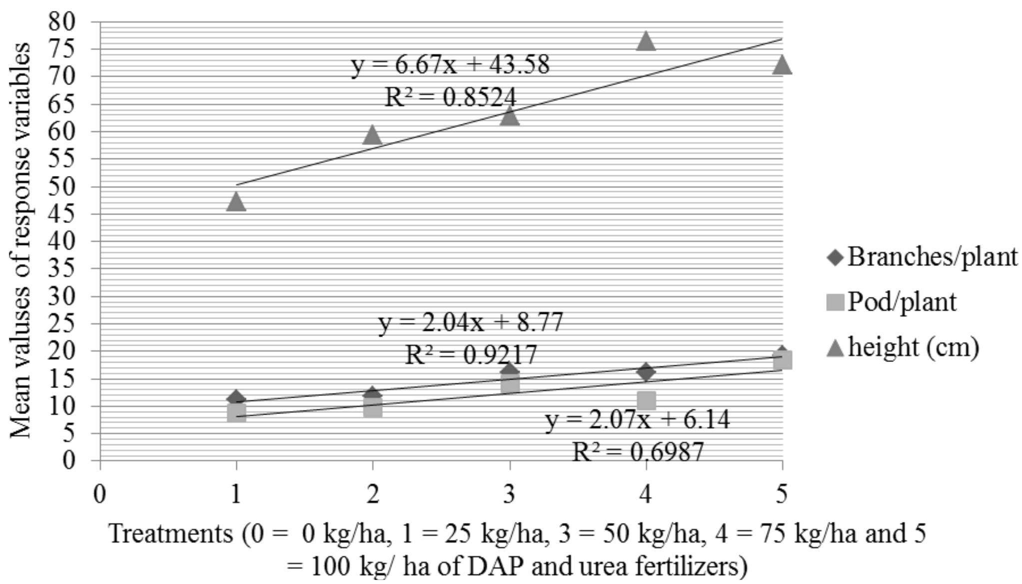

Figure 2. Association of selected yield contributing components and treatments.

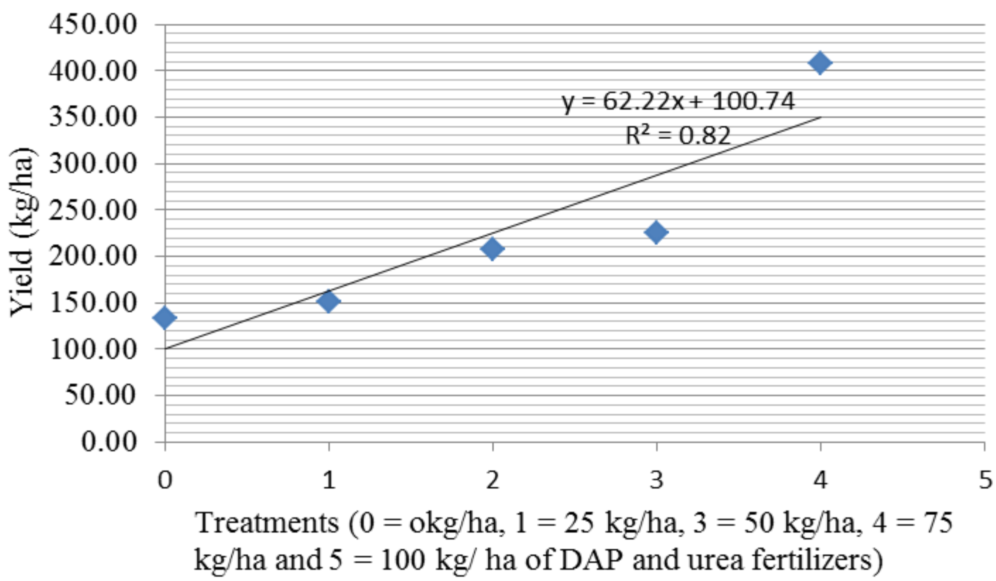

Figure 3. Association of yield and rates of treatment.

increase production cost.

Association between marketable yield, yield contributing components and treatments

The relationship between plant height, number of main branchs and pods per plant were positively infulanced by N and P nutrients (Figure 2). A unit increase in N and P nutrients resulted in the raise of height, branch and pods with 6.67 cm, 2.04 and 2.07 unit, respectively. The sources of N and P fertilizers were contributed for 85.24% (r^2 = 0.8524) of plant height raise and the rest 14.76% contribution was from other factors. Also, 92.17% (r^2 = 0.9217) of pod per plant and 69.87% (r^2 = 0.6987) for branch per plants were increased due to the the applied N and P nutrients. Morover, the relationship between marketable yield and N and P nutriensts was linear and positive (Figure 3). A unit increament in N and P nutrient application resulted in 62.22 kg marketable yield raise per hectare. The N and P nutrients were contributed for 82.00% (r^2 = 0.82) of marketable yield increment and the rest of contribution was from agronomic practices, and environmental factors (like soil moisture, humidity, temperature). This result is agreed with the finding of Aleemullah et al. (2000) who reported hot pepper yield has positive association with yield contributing components.

CONCLUSION AND RECOMMENDATION

The mean value of marketable yield for the experimental plot that received each 50 kg DAP and urea per hectare as source of N and P nutrients for hot pepper specifically Mareko variety production was higher than the others that were received 25, 75 and 100 kg per hectare. Consequently, in the experimental site it is advisable to apply 50 kg DAP and urea fertilizers per hectare as source of N and P to get optimum yield and profit from the production. Beside N and P nutrients rates, the results of this finding may be influenced by different environmental factors such as temperature, rainfall and humidity that are directly and indirectly related with hot pepper production. Therefore, repeated (in terms of season, location and soil types) experiment in the experimental site and on farmer field at different locations of Jimma Zone is very important.

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REFERENCES

Abera A, Lemessa F, Muleta D (2011). The antifungal activity of some medicinal plants against coffee berry disease caused by colletotrichum kahawae. Int. J. Agric. Res. 6(3):268-279.

Agegnehu G, Tsigie A (2004). The roles of phosphorous fertilization on growth and yields of faba bean on acid Nitisols of central highlands of Ethiopia. SINET: Ethiop. J. Sci. 29(20):177-182.

Aleemullah M, Haigh AM, Holford P (2000). Anthesis, anther dehiscence, pistil receptivity and fruit development in the Longum group of *Capsicum annum*. Austr. J. Exper. Agric. 40:755-762.

Aliyu L (2003). Effect of manure type and rate on the growth, yield and yield component of pepper (*Capsicum annum* L.) J. Sustain. Agric. Environ. 5:92-98.

Amare H, 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.

Aticho A (2011). Soil fertility management and nutrient balance in southwest Ethiopia. ISBN 978-3-639-33792-1, 64P. VDM Verlag Dr. Muller e.K.

CSA (Central Statistical Agency) (2012). Agricultural sample survey volume VII report on Crop and livestock product utilization. Addis Ababa, Ethiopia.

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

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.

El-Tohamy WA. Ghoname AA, Abou-Hussein SD (2006). Improvement of pepper growth and productivity in sandy soil by different fertilization treatments under protected cultivation. J. Appl. Sci. Res. 2:8-12.

Eyasu E, Morse S, Belshaw R (1998). Nitrogen and phosphorus balances of Kindo Koisha farms in southern Ethiopia. Agric. Ecosyst. Environ. 71:93-113.

Fekadu M, Dandena G (2006). Status of Vegetable Crops in Ethiopia. Ugandan J. Agric. 12(2):26-30.

Havlin JL, Beaton JD, Tisdale SL, Nelson WL (2005). Soil Fertility and Fertilizers. An Introduction to Nutrient Management. Pearson Education, Inc. Upper Saddle River, New Jersey.

Ikeh AO Ndaeyo NU Uduak IG Iwo GA Ugbe LA Udoh EI, Effiong GS (2012). Growth and yield responses of pepper (*Capsicum Frutescens* L.) To varied poultry manure rates in Uyo, Southeastern Nigeria. ARPN J. Agric. Biol. Sci. 7(9).

Landon JR (1991). Booker Tropical Manual. Hand book for soil survey and agricultural land evaluation in the tropics and sub tropics. pp. 58-144.

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

Ministry of Agriculture and Rural Development (MoARD) (2009). Variety Register. Issue 9, 2006. Addis Ababa, Ethiopia.

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.

Sahlemedin S, Taye B (2000). Procedures for Soil and Plant Analysis; National Soil Research Center Ethiopian Agricultural Research Organization, Technical Addis Ababa, Ethiopia. P. 74.

Shumeta Z (2012). Hot Pepper Production and Marketing in Southwest Ethiopia: An Alternative Enterprise for Small Scale Farmers. J. Trends Agric. Econ. 5(3):83-95.

Vos JGM, Duriat AS (1995). Hot pepper (Capsicum spp.) production on Java, Indonesia: Toward integrated crop management. Crop Prot. 14:205-213.

Walkley A, Black CA (1934). An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. Soil Sci. 37:29-38.