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Effects of Blended NPS Fertilizer Rates on Yield and Yield Components of Pepper (Capsicum annuum L.) Varieties at Mizan Aman, South Western Ethiopia

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Abstract

Hot pepper (Capsicum annum L.) is the most widely cultivated and economically important spice and vegetable crop in Ethiopia. However, its production and productivity are constrained by lack of seeds of improved varieties and poor soil fertility. Thus, field experiment was conducted at Mizan ATVET College using three hot pepper cultivars (Mareko fana, Bako local and Gojeb local) and four blended NPS fertilizer rates (0,50,100,150 and 200kgNPS+100kg Urea) and one control to determine the growth and yield response of hot pepper under Mizan Aman condition. A 3*5 factorial experiment was laid in RCBD with three replications. Important growth parameters, phenolgy, yield and yield component data were collected for this study. ANOVA revealed that plant height, days to 50% flowering, days to 50% fruiting, number of leaf plant-1, number of primary branch plant-1, marketable, unmarketable and total dry pod yield, pod length, and number of primary branch were highly significantly (p<0.001) affected by the main effect of varieties, NPS +Urea fertilizer rate and interaction effect of cultivars and NPS + urea rates, while, pod length plant-1 were highly significant between varieties (p<0.01)and main effect of fertilizer rate show highly significance difference at (p<0.001) and its interaction with varieties were no significance effect at(p<0.05). Pod number plant-1 was highly significantly affected by the main effect of variety, NPS + urea rates and the interaction effect between varieties and NPS + Urea rates. The main effect of cultivars and NPS + urea, were very highly significance effect at (p<0.001) respectively. Marketable pod yield (1.18 t ha-1), total fresh pod yield (11.97 t ha-1) were recorded from Mareko fana with 150NPS + 100 urea kg ha-1. Pod length (12.38cm), unmarketable pod yield (0.29tha-1), total dry pod yield (1.39 tha-1) were observed when Mareko fana combined with 200kg NPS +100 urea kgha-1. The highest (10.33) number of primary and (9.27) secondary branches were recorded from Mareko fana cultivar combined with 150NPS + 100 urea kg ha-1.The main effect fertilizer and Bako local cultivar with 200NPS+ 100 urea kg ha-1 prolonged days to 50% flowering (85 days) and (115.33days) to 50% flowering. In general, the growth, phenological and yield of Mareko fana, Bako local and Gojeb local cultivars significantly influenced by NPS + urea rates whereby the highest marketable dry pod yield (1.18 t ha-1) and the most economically profitable yield was recorded when Mareko fana combined with 150 NPS +100 urea kg ha-1. Therefore, the combination of Mareko fana cultivar with 150 NPS +100 urea kg ha-1 can be recommended for hot pepper production the study area.

Keywords: Blended fertilizer (NPS), Cultivar, nutrient concentration, and nutrient uptake, yield

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Introduction

Pepper belongs to genus Capsicum which is a member of the Solanaceae family that consists of about 22 wild species and five domesticated species. The five domesticated species of pepper include C. annum L., C. frutescens L., C. chinenses, C. baccatum L., and C. pubescens R. (Bosland and Votava, 2000). It is an important crop, not only because of its economic importance, but also due to the nutritional and medicinal value of its fruit. The fruit is an excellent source of natural colors and antioxidant compounds whose intake is important to health and prevents widespread human diseases (Howard et al., 2000). The antioxidant, vitamin A, C and E are present in high concentrations in pepper (Robi and Sreelathakumary, 2004). Fine pungent powder of hot pepper ('berbere') is an indispensable flavoring and coloring ingredient in the daily preparation of different types of Ethiopian sauces ('wot'). The green pod is consumed as a vegetable with other food items (MARC, 2004).

In Ethiopia, the total area under hot pepper for dry pod (Berbere) and for green pepper (Karia) in 2015 was estimated to be 142,795.16 ha, and 7,449.59 ha, respectively, while in Southern Nation Nationalities and Peoples Regional State (SNNPRS) the total area covered with hot pepper in years 2017 were 22,940.78 ha red pepper and 1,612.24 ha by green pepper with 73,826 tonne production and in Mizan Aman 120 ha with red pepper 180tha-1 (CSA, 2017; BMZAB, 2015). The average national productivity of hot pepper in 2014/15 production season was 2.18 t ha-1 green peppers and 1.15 t ha-1 red peppers (CSA, 2016). Whereas under research condition of Ethiopia 1.8-2.5 t ha-1 dried pepper and 15-20 t ha-1 green pepper were recorded (Lema et al., 2008). Similarly, average dried pod yield in research condition at Mizan Aman area was reported to be 2.1 t ha-1 (BgARC, 2017). These findings showed that there are huge hot pepper yield differences between research station and farmers plots. In view of these different fertilizer rates were recommended for different parts of hot pepper producing areas of Ethiopia.

The productivity of pepper is still low in SNNPR attributed to lack of proper nursery and field agronomic management practices, such as inadequate nutrient supply, lack of diseases control, poor aeration, unbalanced nutrient supply and lack of high yielding cultivars. Among these, nutrient deficiency is the most yield limiting factor in vegetable production in Ethiopia. Nitrogen (N), phosphorus and Sulfur(S) deficiencies are the main constraint for pepper and other crop production (Alemu and Ermias, 2000). Recently acquired soil inventory data from EthioSIS (Ethiopian Soil Information System) also revealed that in addition to N and P, nutrients such as S are deficient in Ethiopian soils including Mizan Aman area (ATA, 2013).

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 macronutrients 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 . 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.

Therefore, the present study was designed to evaluate effects of different NPS blended fertilizer rates on production of hot pepper varieties to come up with relevant recommendations that will help farmers for better production to the area.

MATERIALS AND METHODS

The experiment was conducted in SNNPR at Mizan ATVET College demonstration site in 2018 cropping and main rainy season. The study site is located at 7° 4ˈ to 9° 39'' N latitude and 35° 36'6.07'' to 37° 40''E longitudes. It is situated at a range of 500-2400 m a.s.l. The total annual precipitation and monthly average temperature of the area during the crop growth period was 2020mm and 21.3ºC, respectively. The soil type of the area is Nitisol with silt loam textural class. It is moderately acidic with average pH of 5.9 the soil organic matter content was 3.86%, available P was2.67ppm, total N was 0.18%, available S was 2.12% and the CEC value of the area was 23.28 coml. kg-1 of soil analysis result were gained on sample taken before planting (EARO, 2004).

Fertilizer treatments involved for the study includes (T1) – Control (no fertilizer), (T2) - NPS(50 kg and 100 kg Urea ha-1 (T3)- 100 kg NPS + 100 Urea kg ha-1, (T4)- 150 kg NPS +100 kg Urea ha-1, (T5)- 200 kg NPS + 100 kg Urea ha-1 was used as treatments where as varieties include Gojeblocal, Mareko fana and Bakolocal. The study was conducted in a factorial randomized complete block design with three replications. The size of each plot was 3 m wide and 3 m long (9 m2 area) with 0.5m space between plots and 1m between blocks. There were five rows per plot and ten plants per row with a total of 50 plants per plot. The other crop management practices were applied uniformly for all plots as per the recommendation. Data were collected on growth, phonology, yield and yield related traits of pepper. Pre-sowing soil and the plant tissue samples for N, P and S concentration were analyzed following standard laboratory procedures as outlined. The data were subjected to analysis of variance (ANOVA) using GLM procedure with SAS software version 9.0 (SAS Institute Inc. Cary NC, 2002). All significant treatment mean differences were separated using the Least Significant Difference (LSD) test at 5% probability level.

RESULTS AND DISCUSSION

Effect of Blended fertilizers on Crop Growth Parameters and Phenology

Growth parameters

Plant height and Number of leaf plant-1: Analysis of variances (ANOVA) revealed that varieties differed significantly ($P<0.001$) in mean plant height and number of leaves which was affected by the main effect of variety, NPS + Urea rate and the interaction between variety and NPS rates (Table 1). Mareko fana variety produced the highest plant height (53.05; 53.28cm) when 150 kg and 200kg NPS+100 kg UREA were applied. On the other hand, the least plant height was recorded in Bako local variety of unfertilized plots (38.53cm) which might be due to varietal inherited genetic characteristics. In line with this application of nitrogen fertilizer at the levels of 100 and 150 kg N ha-1 produced the tallest plant. Similarl, the highest plant height (41.67 cm) at reproductive stage was recorded by cultivar received 150 kg N ha-1. The maximum and minimum number of leaf plant-1 was recorded by Marekofana (246.57) and Gojeb local (237.56) respectively. Among fertilizer, plants treated with the rate of 200kg NPS+100kg urea produced the highest (252.9) leaf number plant -1. Whereas, the minimum (231) leaf number plant-1 was recorded from control (Table 1). According to the finding of Simon and Tesfaye (2014) varieties differed significantly in number of leaves, both Mareko Fana and Melka Shote recorded the highest mean number of leaves per plant four months after transplanting. The reason might be due to the increased vegetative growth with increasing NPS and this could be due to increase in N supply leads utilization of carbohydrate to form protoplasm and more cells to enhance growth. Plants deprived of N show decreased cell division and expansion (Tesfaw et al. 2013). N is known to promote both cell division and elongation which may explain way treatments with high N had high mean plant height and number of leaves. Similarly, AL-Shooke (1985) reported that the vegetative growth significantly improved through N fertilization. The minimum values were recorded from the control (Table 1). That is due to the increase in leaf number with NPS may be increased the growth parameters since it promotes plant growth (Mengel and Kirkby, 1987). Similarly, Simon and Tesfaye (2014) reported that plants suffering from P deficiency produced low lateral shoots which result in to developed low number of leaves.

Number of primary and secondary branches: The two way interaction of NPS and variety affected the number of primary branches significantly (P<0.001) but there is no significance (P<0.05) on number of secondary branch (Table 1).The main factor Varieties showed significance (P<0.05) effect between Gojeb local and Bako local varieties but there is highly significantly (P<0.001) the number of primary and secondary branch of Mareko fana variety as compared to the two local varieties. An increase in the number of primary branches in response to varietal differences and the applied NPS +Urea is due to the accumulation of assimilates in the growing seedlings that initiates the rise of new primary branches. Variety is also the major factor that is responsible to determine the number of primary and secondary branches. The highest number of primary branches (9.62, 9.31), secondary branch (8.78, 8.76) respectively was recorded in Mareko fana variety with fertilizer combination of 150NPS +100 U kg ha-1, 200 NPS +100 U kg ha-1. The minimum number of primary and secondary branches (5.91,5.49) respectively was also observed in variety Bako and Gojeb local variety with fertilizer rates of 0 kg NPS + U kg ha-1. However, the number of primary and secondary branches in Bako and Gojeb local (Figure 1) varieties treated with combination of 150NPS +100 U kg ha-1 and 200NPS +100 U kg ha-1 levels did not show significant variation. Obviously, N and S application also involve in protein synthesis and meristematic tissues initiation through hormonal synthesis which initiates a greater number of buds and hence more number of branches per plant (Tucker, 1999). Mebratu (2011) found that branch numbers were highly significantly and positively influenced by N. Furthermore, Ashebre (2016) obtained significantly highest number of secondary branches through application of 82 kg N ha-1 + 92 kg P2O5 ha-1+2.5 t ha-1 FYM. Seleshi (2011) indicated that variety is one of the major factors determining the number of primary and secondary branches in hot peppers.

Days to 50% flowering and Fruiting (Phenology): The analysis of variance showed that the interaction effect NPS blended fertilizer and variety caused significant (P<0.001) effect on the number of days required for 50% of the plants in a plot to start flowering and fruiting . The variation in days to 50% flowering and fruiting in response to the two way interaction of factors is attributed to the rationale that time of flowering and fruiting in pepper is governed by genetic factors responsible for earliness or prolonged start of blooming and fruiting (varietal differences) and the type and rate of nutrient supply rather than due to the individual or two way interaction effects of the two factors.

The result indicated that the maximum number of days for fifty percent of the plants in a plot to flower and fruit was taken by variety Bakolocal variety (79,11 days) respectively to 50% flowering and fruiting in plots treated with 200 kg NPS+ 100 kg U ha-1. On the other hand, Gojeb local was the earliest to flower and fruiting taking 66 and 96 days respectively in plots treated with 0 kg NPS+U kg ha-1. This is in line with the findings in his study of hot pepper variety trial at Jimma, who reported that the variety Melka zala took longer period (71) days for 50% the plants in a plot to start flowering. For this study, the extra number of days required by Bako local to flower and fruit might have been caused by environmental factors which may have resulted in extended and continuous vegetative growth of the variety as it was grown in a relatively higher altitude as compared to the place where it was particularly adapted (Melkasa). According to Lemma (2008), the nutrient supply is also responsible for earliness or late start of blooming and fruiting. The result showed that plots that received higher levels of NPS fertilizers exhibited prolonged time to commence blooming and fruiting.

Fresh pod Yield and Yield Components: Analysis of variances (ANOVA) revealed that varieties differed significantly (P ≤ 0.001) in fruit length, fresh pod yield and (P<0.01) fruit number per plant. Mareko Fana variety had significantly higher pod length, pod number per plant, higher fresh pod yield ha-1 than Bako local and Gojeb local varieties.

NPS + Urea fertilizer affected positively and significantly (P < 0.001) fresh pod yield, pod length, pod number per plant. In this study generally the highest fresh pod yield and pod length were recorded from 150,200 NPS + 100 kg ha-1 and highest pod number per plant, were recorded from 150NPS +100 kg U ha-1 while the lowest was from 0NPS + 0U kg ha-1 .This result suggests that NPS application to the soil is important to improve fresh pod yield and yield components of pepper significantly. This might be due to nitrogen is an integral component of many essential plant compounds like chlorophyll, proteins and it is a major part of all amino acids (Brady and Weil, 2002). It increases the vegetative growth and produces good quality foliage and promotes carbohydrate synthesis through photosynthesis and ultimately increased yield of plants. This result also agree with who reported that fruit setting in pepper was related to phytohormone activity and N nutrition. Similarly who reported that the highest fresh pod yield (13.0. t ha-1) was found with 150NPSBZ+44N kg ha-1 and the minimum (9.45 t ha-1) was from unfertilized plots. Fruit yield, fruit length, fruit number per plant of hot pepper responded positively and significantly (P < 0.001) to increasing phosphorous level. Generally in this study increasing NPS level increased pod yield, and yield (Figure 2) components. This result is in agreement with observation of who reported that vegetative growth Yield and quality of pepper significantly improved through nitrogen and phosphorous fertilization. This could be attributed to the important role of each nutrient affecting growth and yield. Nitrogen is an essential constitute of protein and enzyme which directly affects several biochemical process mainly the photosynthetic activity. Phosphorous is required for producing well developed and highly efficient rooting system. There was significant interaction between variety, NPS levels for number of pod plant-1 and pod length but no significant interaction on total fresh pod yield.

Marketable pod yield

The result indicated that there was a significant (P<0.001) difference in marketable yield in response to the interaction effect of NPS and variety. The marketable yield is a good indicator of the performance of the variety for undertaking economic analysis and to choose the best options (highest benefit cost ratio). The result showed that the highest marketable pod yield of (1.18 t ha-1) was obtained from variety M. fana in plots treated with fertilizer rates of 200 kg NPS ha-1. On the other hand, from plots treated with 0 kg NPS ha-1 the minimum marketable pod yield of 0.66 t ha-1 was recorded. This shows that by applying 200 kg NPS +100 kg U ha-1, the marketable pod yield can be increased by 55.9% compared with the control plots. The variation in marketable yield among pepper varieties might be due to the genetic makeup (variety), varying levels of fertilizer treatments and the nutrient status of the growing environment reported that the influence of genetic variability and heritability are necessary in systematic improvement of hot pepper varieties for fruit yield and related traits. Marketable pod yield increase in response to addition of nutrients in nutrient deficient soils which agrees with the results of this study that 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.

Unmarketable pod yield: Unmarketable pod yield was significantly (P < 0.001) affected by NPS fertilizer rate. The highest unmarketable yield was obtained at 200 kg N ha-1, which was higher by about 32.14% than the unmarketable yield obtained at control level. There were no significant differences in unmarketable yield at control and in150NPS + 100 kg ha-1. The highest unmarketable pod yield was obtained at the highest level of NPS + U, which could be attributed to the production of more number of branches and other vegetative organs that may have increased competition for photoassimilate among the pods and the vegetative matter, which may have resulted in more number of small-sized pods (< 1 cm3 in volume). The increased unmarketable pod yield at this level of nitrogen could be also be ascribed to the production of high proportion of pods affected with white and yellowish pod spots. This result is in conformity with earlier result of who reported that colour spot incidence increased with nitrogen application and more pronounced in densely planted peppers due to shading effect. Moreover the highest unmarketable yield obtained from the control treatment, while the least unmarketable yield was recorded from plots treated with application of 69 kg N ha-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 the inherent characters of the varieties, 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.

Total dry pod yield: Total dry fruit yield is the sum of the marketable and unmarketable yield of the dry pod taken at each successive harvest. The result indicates that the two way interaction effect of NPS and varieties significantly (P<0.001) influenced the parameter. The highest total dry pod yield (1.36, 1.39 t ha-1) respectively was obtained from plots that received the maximum (150 +100 and 200 +100 kg ha-1) of NPS + U respectively. On the other hand, with 0NPS+ U kg ha-1, the least total dry pod yield of (0.85 t ha-1) was recorded. A general linear increasing trend of total dry fruit yield was observed in response to increasing level of both fertilizers. For example, by increasing the level of fertilizers from 0 kg NPS to 200 kg NPS +100 U kg ha-1, there were an increase in total dry pod yield by 0.54 t ha-1. Fruits are sites of sinks of nutrients. The main nutrients supplied (nitrogen, phosphorus and sulfur) are taken easily by the plants and are being utilized for the growth and development of the fruits. This results in formation of fruits which are bigger in size and number. Thus, the acquisition of fruits with the above characteristics is attributed to the combined influence of nitrogen, phosphorus and sulfur. The linear relationship between total dry fruit yield and fertilizer rates indicates that with increasing level of NPS blended fertilizer, (Figure 3) the nutrient sink (especially phosphorus) in fruits will be high thereby increasing the size fruits. This finding is agreed with the report of that Backo local bears a total yield of 1.231 ton/ha and 1.17 ton/ha from two experimental sites. The differences among treatment means may be due to varietal differences in nutrient absorption efficiency, especially nitrogen and phosphorus which have enhancing effect on vegetative growth by increasing cell division and elongation thereby create the possibilities of flowering and fruit bearing. Increasing P level increased pod yield of hot pepper cultivar. The other decisive factor is also the ability to adapt the existing environmental factors; such as soil type, rain pattern, temperature and light intensity.

CONCLUSIONS

Results of the present experiment indicated that the highest marketable (1.18 t ha-1) and total dry pod yield (1.39 t ha- 1) were recorded when Mareko fana is combined with 200 NPS +100 urea Kg ha-1. The overall experiment indicated, the growth characters, phenological and yield of Mareko fana ,Bako local and Gojeb local cultivars significantly influenced by blended fertilizer (NPS) + urea rates whereby the highest marketable dry pod yield (1.18 t ha-1) and the most economically profitable yield was recorded when Mareko fana was applied with 150 NPS +100 urea kg ha-1. Which was by 55.55 % higher than the control? Therefore, Mareko Fana variety with application of 150 kg NPS+100 kg U ha-1could be appropriate for hot pepper production in the test area. However, further testing is required in different locations and on different soils

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References

1. Alemu Haiylie, Ermias Abate (2000) Horticultural crops production and associated Constraints in North-west Ethiopia. Working paper. Agricultural Economics Research Division, Agricultural Research Centre, Adet 1: 18.
2. Aloni B, Karni L, Rylski I, Zaidman Z (1994) The effect of nitrogen fertilization and shading on the incidence of 'Colour spots' in sweet pepper (Capsicum annuumL.) fruit. Journal of Horticultural Science, 69 (4): 767-773.
3. Al-shooke RH (1985). The effect of spacing and fertilizer levels on growth and yield of bottle ground Lagenaria siceraria. Msc Thesis, Hort Department University of Bagdad, Iraq 5: 25 61.
4. Aminifard MH, Aroiee H, Nemati M. Aziz F, Khayyat M (2012) Effect of Nitrogen fertilizer on vegetative and reproductive growth of pepper under field Conditions. Journal of plant nutrition 35(2): 235-242.
5. 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. Journal of applied Science Research 2: 8-12.
6. Fekadu Marame, Dandena Galmesa (2006) Status of Vegetable Crops in Ethiopia.Ugandan. Journal of Agriculture 12(2): 26-30.
7. Gebremeskel H, Abebe H, Biratu W, Jaleto K (2015
8. Performance evaluation of hot pepper (Capsicum annum L.) cultivars for productivity under irrigation at Raya Valley, Northern Ethiopia Basic Res. J. Agric. Sci. Rev 4(7): 211-216.
9. Howard LR, Talcott ST, Brenes CH, Villalon B (2000) Changes in phytochemical and antioxidant activity of selected pepper cultivars (Capsicum sp.) as influenced by maturity. Journal of Agriculture and Food Chemistry 48: 1713-20.
10. Lemma Desalegn, Shimelis Aklilu (2008) Achievement and research experience on capsicum crop Melkasa Agricultural Research center. EIAR.
11. Lemma D, Fekadu M, Chemeda F (2008) Genetic Components and Heritability of Yield and Yield Related Traits in Hot Pepper. Research Journal of Agriculture and Biological Science. 4(6): 803-809.
12. Matta FR, Cotter DJ (1994) Chile production in North-Centeral New Mwxico. NM Cooperative Extension Circular. Las Cruces NM. 5(9): 765-975.
13. Mebratu A, Dechassa N, Mulualem T, Weldetsadik K (2014) Effect of Inorganic Fertilizers on Yield and Physical Quality Parameters of Hot Pepper (Capsicum annuum l.) in South-Eastern Ethiopia. Journal of Plant and Pest Science 1(3): 138-145.
14. Melkasa K (2003) Progress Report of melkasa agricultural Research center complete activity. Melkassa, Addis Ababa. 7: 1-9
15. Mengel K, Kirkby EA (1987) Principles of Plant Nutrition. 4th ed. International Potash Institute, Berne, Switzerland. 2: 12-16.
16. Nimona, Fufa (2018) Effects of blended Fertilizer Rates on yield and Yield components and Nutrient use Efficiencies of Hot peppet at Assosa,Western Ethiopia.Msc. Thesis, Hawasa university, Ethiopia. 5: 56-67.
17. Robi R, Sreelathakumary I (2004) Influence of maturity at harvest on capsaicin and ascorbic acid content in hot chilli (Capsicum chinense Jacq.). Capsicum and Eggplant Newsletter, 23: 13-16.
18. Sahlemedhin S, Taye B (2000) Procedures for Soil and Plant Analysis. Addis Ababa, Ethiopia 67:1738-1769.
19. SAS Institute Inc.Cray.2008.UsersGuide.Version 9.2. NC.USA.
20. Seleshi K, Deleleg N (2011) Evaluation of elite hot pepper Cultivars (Capsicum species) for growth, dry pod yield and quality under Jimma condition, South West Ethiopia.1-58.
21. Simon T, Tesfaye B (2014) Growth and Productivity of Hot Pepper (Capsicum annuum L.) as affected by Variety, Nitrogen and Phosphorous at Jinka, Southern Ethiopia. Journal of Biology, Agriculture and Health care. 4(17): 56-62.
22. Tesfaw A Dechassa NK Sadik T
23. (2013). Performance of hot pepper (Cupsicum annuum L.) cultivars as influenced by nitrogen and phosphorus fertilizers at Bure, Upper Watershed of the Blue Nile in Northwestern Ethiopia. Intern. Jour. of Agri. Sc. 3 (8): 599-608.
24. Wassie H, Shiferaw B (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.