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INFLUENCE OF PLANT DENSITY AND NITROGEN APPLICATION ON GROWTH AND QUALITY OF SWEET PEPPER (*Capsicum annuum*) IN UASIN GISHU COUNTY

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ABSTRACT

Sweet pepper an important export in Uasin Gishu had been facing a problem of rejection at the international market due to failure to meet the specified quality standards. The field experiment was conducted during the short rainy season between July 2009 January 2010 in Turbo and Kapseret aimed at determining the influence of plant density and nitrogen on the growth and quality of sweet pepper. Three plant densities; 23,809 plants / ha (70 × 60 cm), 31,746 plants / ha (70 × 45 cm), 47, 619 plants / ha (70 × 30 cm) and 4 nitrogen levels 0, 40.5, 81 , 121.5 (from CAN) and 80 kg N /ha (from farmyard manure) were combined in a factorial arrangement laid out in a randomized complete block design with three replications. Growth Parameters recorded included plant height, number of branches and number of days to attainment of 50% flowering. Quality parameters of fruit diameter, mechanical damage and pest incidence were captured during harvesting. The data was subjected to ANOVA using Genstat statistical package and means separated by Tukey's Studentized Range (HSD) at P≤0.05. Plant height and the number of branches increased at low plant density. The interaction effects of plant density and nitrogen were significant whereby, a treatment combination of 70 × 45 cm and 81 kg N / ha recorded low pests and disease incidence while producing fruits with the specified diameter size (40 – 44 mm). Turbo site produced vigorously growing sweet pepper plants which were tall, had the highest number of branches with no incidence of mechanical damage and blossom end rot recorded. The intermediate plant density (70 × 45 cm) and 81 kg N/ha produced fruits with the specified diameter size and recorded low pests and diseases incidence and should be adopted by the growers to meet the export market standard. Sweet pepper should be grown in lower altitude areas like Turbo for enhanced plant growth and high quality fruits in Uasin Gishu County.

INTRODUCTION

Sweet pepper (*Capsicum annuum*) originated from Tropical South America and Brazil prior to the 15th century (Khan *et al*., 2010). Production of sweet pepper is widespread in Kenya where it is used as a food colouring and flavoring agent. Food and Agricultural Organization (FAO) statistics estimate world production of capsicum peppers at 21.3 million tons from an area of 1.6 million ha (Anon, 2007). Approximately 9300 tons are produced annually in Kenya from an estimated acreage of 990 ha (HCDA. 2008). In 2007, Uasin Gishu County produced 40 tons valued at Kshs. 1.2 million. The targeted hactarage in Uasin Gishu that year was 10 ha although only 4 ha were achieved (MOA. 2007).

Studies on plant density for different types of pepper indicate that plant density and row arrangement have an influence on growth and marketable yield of peppers (Khasmakhi-Sabet *et al*., 2009). Plant density is a major factor determining the degree of competition for available resources between plants and hence has an influence on vegetative characters such as stem numbers and plant height. Jollife and Gaye (2000) reported that high population densities decreased absolute growth in sweet pepper plants. Dasgan and Abak (2003) reported that a spacing of 80 × 30 cm (41, 666 plants/ha) was more economical for sweet pepper cultivation as quality characteristics such as fruit weight, fruit length, fruit diameter and total soluble solids (TSS) were not significantly affected by plant density.

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Nitrogen being a constituent of many important compounds in the living cells is critical in growth of vegetable crops (Kirimi *et al*., 2011). Khan *et al*., (2010) reported that plant height and the number of branches increased significantly with increasing nitrogen doses up to 100 kg N / ha. Nitrogen when applied at 150 kg / ha increased leaf area enhancing photosynthesis which led to more vegetative growth in chilli plants (Neginahal *et al.*, 2008). Samin *et al.* (2008) observed that very little marketable fruit yield was achieved with nitrogen rates above 150 kg N / ha. Sweet pepper farmers in Uasin Gishu County had been varying nitrogen rates and spacing aiming at meeting the market standards. Unfortunately this resulted in about 70 % rejection after failure to meet the quality standards requiring the diameter of 40 – 44 mm with no blemishes. Despite the importance of sweet pepper as an export crop, there is very little information on the specific plant densities and nitrogen levels that would produce sweet pepper fruits having the specified export quality in Uasin Gishu County under field conditions. The objective of the field experiment was to improve sweet pepper quality in Uasin Gishu County by adopting plant density and nitrogen levels that would produce sweet pepper fruits with the specified export quality standards.

METHODOLOGY

Site description

The study was conducted in Turbo and Kapseret divisions in Uasin Gshu County, Kenya between July 2009 and January 2010. These were the areas where farmers were producing pepper for export and had suffered losses due to rejection. Turbo is located at (0^0, 31'N and 34^0, 75'E). Altitude ranges 1500 – 1900 m above sea level. The soils are mainly acrisols which are well drained, deep, and brown to dark sandy clay (MOA, 2007). Kapseret is located at (0^0, 29'N and 30^0, 25'E). Altitude ranges 1600 – 2030 m above sea level. Feralsols dominate the area which is low in fertility. The initial chemical properties of the soils as shown in (Table 1) were acidic (< P^H 5.5), low in N (< 0.2 %) and P (< 10mg /Kg) all below the critical values (indicated in the brackets) as described by Okalebo *et al.,* (2002). Phosphorus deficiency was compensated during transplanting through the application 250kg/ha of DAP (18:46:0). Olsen method was used in phosphorus determination.

Table 1 Chemical Soil properties and farmyard manure analysis

Parameters	Turbo	Kapseret	Farmyard manure
N (%)	0.14	0.12	0.32
P (mg/Kg)	5.8	5.2	6.5
O.C (%)	2.9	2.8	3.3
P^H	4.9	4.5	6.7
C: N	9.06: 1	9.33:1	10:1

Preparation for planting, pricking out and transplanting

Sweet pepper seeds of California wonder were pre-germinated on filter papers (whatman 125 mm) in the germination chambers at 30^0C - 35^0C and relative humidity 75% - 80% in University of Eldoret seed laboratory. The seedlings were transferred to polythene sleeves of size 6 × 4 cm in the glass house. A contact pesticide, mocap 10 GR (a.i ethoprophos) at a rate of 50 kg / ha was added during the infilling of the polythene sleeves to control soil borne pests especially nematodes. The seedlings were raised in the glass house for one month (August 2009) after which they were transplanted in the experimental sites. The size of the experimental plot was 20 × 13 m ($260m^2$) having 15 treatments replicated thrice.

Treatments

The treatments consisted of 3 plant densities (70 × 60 cm, 70 × 45 cm, 70 × 30 cm) and 5 nitrogen levels (0, 40.5, 81, 121.5Kg N / ha from CAN 27% and 80 Kg N /ha from farmyard manure). Randomized complete block design (RCBD) was used and the treatments were combined in a factorial arrangement, whereby 2 factors were investigated i.e. plant density and nitrogen at 3 and 5 levels respectively. The CAN was applied in 2 splits with first application 2 weeks after transplanting followed by another application 4 weeks later. The farmyard manure was applied during transplanting.

Data collection

Three plants were randomly picked in each row in an experimental unit and tugged. These were the plants used in taking data on plant height and the number of branches at vegetative, flowering and harvesting stages. Finally three mature fruit from the tugged plants were picked at random in each experimental unit and observed for mechanical damage and their diameter measured. Scoring for aphids, leaf spot and blossom end rot was done according to the procedure laid by Sutherland *et al., (*1996). During scoring qualitative aspects were assigned numerical values which were analysed.

Statistical analysis

The experimental data was subjected to Analysis of Variance (ANOVA) using GLM procedure in Genstat (2005) and means separated by Tukey's Studentized (HSD) at $P \leq 0.05$.

RESULTS AND DISCUSSION

Effects of plant density and nitrogen on plant height

Plant density had no significant effect on plant height throughout the experimental period (vegetative, flowering and harvesting stages) in Turbo (Table 2). Data taken during the flowering stage, indicated that an application of 121.5 kg N /ha resulted in significantly tall plants as compared to control in Turbo (Table 2). This increase in height resulting from increased nitrogen levels can be due to an increase in nitrogen uptake making it available for growth and development (Patil and Biradar, 2001). This was in agreement with (Bar *et al.,* 2001).

In Kapseret, Planting sweet pepper at high plant density (70 × 30 cm) resulted in significantly tall plants at vegetative stage as compared to low plant density (70 × 60 cm) (Table 2) while the intermediate plant density (70 × 45 cm) resulted in plants of medium height of 16.84 cm and was not significantly different from high plant density (Table 2). This difference can be attributed to competition for available space and light resulting in tall plants. Similar increase in height at increased plant densities were reported by (Umesh, 2008). Applying different levels of nitrogen in the form of farmyard manure or CAN had no effect on plant height.

Table 2 Effects of plant density and nitrogen on plant height

Treatments	Vegetative		Flowering		Harvesting	
Plant Density	**Turbo**	**Kapseret**	**Turbo**	**Kapseret**	**Turbo**	**Kapseret**
70 cm x 60 cm	19.22a	15.60b	30.00a	21.60a	60.60a	24.60a
70 cm x 45 cm	18.67a	16.84a	32.07a	22.71a	62.16a	25.93a
70cm x 30 cm	19.49a	17.82a	32.20a	22.56a	61.96a	25.20a
HSD $_{0.05}$	2.11	2.16	3.42	2.2 9	4.56	2.52
Nitrogen						
0 kg N/ha	18.52ab	17.70a	29.11c	22.52 ab	58.75a	25.85 ab
40.5 kg N / ha	18.41ab	16.22a	30.07bc	20.93b	59.56a	22.67b
81 kg N / ha	18.15b	15.52a	28.89c	21.44 ab	63.48a	25.63 ab
121.5 kg N / ha	19.07a	15.78a	35.56a	21.85 ab	61.44a	25.30 ab
80KgN/h a (farm yard manure)	21.48a	18.56a	34.82ab	24.70	64.63a	26.78a
HSD $_{0.05}$	3.19	3.25	5.15	3.46	6.87	3.80
CV (%)	2.0	4.5	5.3	4.7	8.6	6.9

Effects of plant density and nitrogen on the number of branches

Plant density had no significant effect on the number of branches throughout the experimental period (vegetative, flowering and harvesting) in Turbo (Table 3). Data taken at vegetative stage indicated that an application of 81 kg N / ha resulted in sweet pepper plants with more branches as compared to control (Table 3). Nitrogen is an essential nutrient as it a major component of amino acids and enzymes and so is very necessary during the vegetative stage (Basela and Mahadeen, 2008). The reduced branching in the control treatment at this particular stage could be attributed to the absence of nitrogen.

In Kapseret at vegetative stage, low plant density (70 × 60 cm) produced sweet pepper plants with more branches as compared to high plant density (70 × 3 0cm) (Table 3). The widely spaced plants were able to utilize the available space and resource for more branching. These results were in agreement with the findings of Law-Ogbomo and Egharevbe (2009). The intermediate plant density (70 ×45 cm) resulted in moderately branched sweet pepper plants (Table 3).

Table 3 Effects of plant density and nitrogen on the number of branches

	Vegetative		Flowering		Harvesting	
Treatments	**Turbo**	**Kapseret**	**Turbo**	**Kapseret**	**Turbo**	**Kapseret**
Plant Density						
70 cm x 60 cm	7.00a	2.00a	13.00a	6.00a	32.00a	13.00a
70 cm x 45 cm	7.00a	2.00 ab	13.00a	6.00a	31.00a	13.00a
70 cm x 30 cm	8.00a	1.00b	12.00a	5.00a	29.00a	12.00a
HSD $_{0.05}$	0.93	0.57	1.58	1.10	3.90	2.31
Nitrogen						
0 kg N / ha	7.00b	1.00a	13.00a	6.00a	29.00a	13.00 ab
80kgN/ha(fym) /ha	7.00ab	2.00a	12.00a	6.00a	30.00a	13.00 ab
40.5 kg N / ha	7.00ab	1.00a	12.00a	6.00a	30.00a	10.00b
81 kg N / ha	8.00a	2.00a	14.00a	5.00a	33.00a	11.00ab
121.5 kg N /ha	8.00a	2.00a	14.00a	6.00a	33.00a	15.00a
HSD $^{0.05}$	1.41	0.85	2.39	1.66	5.88	3.47

Interaction effects of site, plant density and nitrogen on the height of sweet pepper

Sweet pepper plants grown in Turbo were taller than those grown in Kapseret (Table 4). The conditions in Turbo enhanced plant growth as Soether *et al*., (2008) reported that in the tropics, Above ground Net Primary Productivity (ANPP) usually increase with decreasing altitude mainly due to increased photosynthesis and direct impact of high temperature on plant growth. This difference can also be due to the soil properties in Turbo which were deep, well drained with slightly higher levels of N and P. A treatment combination of 121.5 Kg N/ha and 70 × 60 cm produced the tallest plants in Turbo while the shortest plants came from 40.5 Kg N/ha and 70×45cm in Kapseret (Table 4). The increase in height at high nitrogen level and low plant density can be attributed to availability of nitrogen and adequate space.

Table 4 Interaction effects of site, plant density and nitrogen on plant height

Spacing (cm)		Nitrogen rates (Kg N / ha).				
Site		**0**	**40.5**	**81**	**121.5**	**80**
Turbo	70 × 60	54.65	51.17	57.33	73.31	67.37
	70 × 45	55.24	63.61	54.75	65.18	62.02
	70 ×30	50.55	62.32	59.16	51.09	61.00
Kapseret	70 × 60	27.03	27.02	26.01	26.38	22.02
	70 × 45	25.76	21.31	27.51	25.28	25.02
	70 × 30	27.23	27.05	26.23	22.57	22.02
HSD	Site × spacing × nitrogen			4.512		
CV%				2.30		

Interaction effects of site, plant density and nitrogen on the number of branches

Plants grown in Turbo had more branches as compared to those grown in Kapseret (Table 5). This can be attributed to the soil characteristics in the two sites. Turbo soils are well drained, deep and thus able to provide the plants with the nutrients required for growth and development. The mean temperature in Turbo (23^0C - 25^0C) favor sweet pepper growth while Kapseret records very low minimum temperature of 9^0C which is unfavorable for sweet pepper growth and development (MOA, 2007). A treatment combination of 121.5 Kg N/ha and 70 × 60 cm produced sweet pepper plants with the highest number of branches while the least number of branches came from a combination of 0KgN/ha and 70× 30cm (Table 5).This increase in the number of branches at high nitrogen levels can be attributed to increased nutrient uptake associated with increased nutrient levels. Neginahal *et al., (*2009) showed that nitrogen when applied at the highest level 150 kg N /ha increased leaf area enhancing the process of photosynthesis which led to more vegetative growth. Similar results were reported by Ekwu and Okporie (2006) who had the highest number of branches with the highest nitrogen levels. The widely spaced plants were highly branched as they had enough nutrients and light for maximum vegetative growth. These results concurred with the findings of Umesh (2008).

Table 5 Interaction effects of site, plant density and nitrogen on the number of branches

Spacing(cm)		Nitrogen rates (Kg/ha)				
Site		**0**	**40.5**	**81**	**121.5**	**80**
Turbo	70×60	30.00	31.00	31.00	36.00	31.00
	70×45	30.00	35.00	32.00	30.00	30.00
	70×30	26.00	25.00	35.00	26.00	34.00
Kapseret	70×60	17.00	12.00	15.00	14.00	11.00
	70×45	14.00	10.00	14.00	14.00	13.00
	70×30	9.00	10.00	14.00	13.00	10.00
HSD	Site× Spacing × nitrogen			3.143		
CV%				2.30		

Interaction effects of plant density and nitrogen on aphids and leaf spot incidence in Turbo

In Turbo, an interaction of 81Kg N/ha and 121.5KgN/ha with high (70×30cm) and intermediate (70×45cm) plant densities recorded the lowest aphids and leaf spot incidence (Table 6). The highest pest and disease incidence was observed in a combination of 40.5KgN/ha and 70× 60cm. Similar findings whereby the number of pests reduced at high plant density were reported by Yamamura (2002) who observed that increasing the number of collard plants per hectare reduced the number of pests per leaf surface thereby reducing the damage on the crop. Further observations were that the number of insect pests per plant decreased with increased plant density as a result of dilution of colonies among the plants. Accordingly incidences of insect borne viral diseases decrease with increasing plant densities. Application of 121.5 kg N/ha and 81 Kg N / ha led to low pest incidence probably due increased nitrogen uptake leading to the availability of other nutrients for growth and development. Patil and Biradar (2001) observed that increased nitrogen rates enhanced the uptake of potassium and phosphorus. Warner *et al*., (2004) stated that maximum marketable fruit yield was achieved with nitrogen rate of 150kg/ha, whereby marketable fruits were those with fruit size greater than 40mm, without cracks, blemishes, diseases and other physiological disorder

Table 6 Interaction effects of plant density and nitrogen on the quality of sweet pepper in Turbo

Treatment	Aphids	Leaf spot	Fruit diameter (mm)	Mechanical damage	Blossom end rot
0KgN/ha+70×60cm	0.22	0.33	46.10	0	0
0KgN/ha+70×45cm	0.56	0.55	50.00	0	0
0KgN/ha+70×30cm	0.56	0.44	41.00	0	0
40.5KgN/ha+70×60cm	1.50	1.33	46.10	0	0
40.5KgN/ha+70×45cm	0.33	0.33	43.30	0	0
40.5KgN/ha+70×30cm	0.22	0.22	41.66	0	0
81KgN/ha+70×60cm	1.33	0.40	52.00	0	0
81Kg/ha+70×45cm	0.11	0.11	42.00	0	0
81KgN/ha+70×30cm	0.11	0.11	39.37	0	0
121.5KgN/ha+70×60cm	1.00	1.00	47.00	0	0
121.5KgN/ha+70×45cm	0.11	0.11	53.00	0	0
121.5KgN/ha+70×30cm	0.11	0.11	40.00	0	0
80KgN/ha+70×60cm	0.99	0.77	47.20	0	0
80KgN/ha+70×45cm	0.44	0.56	45.55	0	0
80KgN/ha+70×30cm	0.33	0.33	40.50	0	0
HSD	0.608	O.529	6.363	0.	0

Interaction effects of plant density and nitrogen on aphids and leaf spot in Kapseret

Generally low plant densities resulted in low pest incidence while high plant densities recorded high incidence (Table 7). Plant density influences the interaction among pests and diseases and most fungal diseases increase with increasing plant densities due to the mode of transmission (Yamamura, 2002). The climatic conditions in this area did not produce vigorously growing plants as indicted by growth parameters. The closely spaced plants which experienced competition for available resources were weak and prone to pest and disease attack. Low and intermediate nitrogen levels led to reduced pest incidence. It was also observed that high nitrogen levels led to increased pest and disease incidence. This was in agreement with Warner *et al*. (2004) who reported that nitrogen application above 100kgN/ha increased yield of green fruits but little yield of marketable fruits was observed with rates above 150kgN/ha. High nitrogen levels produced very succulent fruits which were very susceptible to pest attack (Reiley and Shry, 2004). The difference in the climatic conditions in Turbo and Kapseret could have contributed to the contrasting results. In Kapseret the plants were stunted and those planted at low plant density and the intermediate plant densities were able to utilize the available space for growth and development and were able to tolerate pest and disease

Table 7 Interaction effects of plant density and nitrogen on the quality of sweet pepper in Kapseret

Treatment	Aphids	Leaf spot	Fruit diameter (mm)	Mechanical damage	Blossom end rot
0 Kg N/ha+70×60cm	1.00	1.00	54.00	0.66	0
0KgN/ha+70×45cm	0.88	1.00	48.00	0.44	0
0KgN/ha+70×30cm	0.33	0.33	46.10	0	0
40.5KgN/ha+70×60cm	0.11	0.11	41.60	0	0
40.5KgN/ha+70×45cm	0.11	0.20	40.00	0	0
40.5KgN/ha+70×30cm	1.33	1.20	38.88	0.20	0
81KgN/ha+70×60cm	0.11	0.11	50.00	0	0
81Kg/ha+70×45cm	0.33	0.77	38.00	0	0
81KgN/ha+70×30cm	0.11	0.11	43.00	0	0
121.5KgN/ha+70×60cm	0.67	0.66	48.30	0	0
121.5KgN/ha+70×45cm	0.77	0.33	46.60	0	0
121.5KgN/ha+70×30cm	1.00	1.00	37.00	0	0
80KgN/ha+70×60cm	0.11	0.67	47.77	0.20	0
80KgN/ha+70×45cm	0.11	0.11	41.11	0.10	0
80KgN/ha+70×30cm	1.10	1.20	31.00	0	0
HSD	0.784	0.748	6..354	0.077	0

Interaction effects of plant density and nitrogen on fruit diameter, mechanical damage and blossom end rot.

In Turbo an interaction of 121.5 Kg N/ha with 70×45cm produced the largest fruit while the smallest fruit came from 40.5 Kg N/ha and 70×30 cm (Table 6). The largest fruits in Kapseret came from a combination of 0KgN/ha and 70× 60 cm while a treatment combination of 80KgN/ha and 70×30cm produced the smallest fruits (Table 7).The interactions indicate that the fruit size increased at low plant densities. This can be attributed to more vegetation leading to more dry matter accumulation, more leaf area and ample sunlight under low plant density (Umesh, 2008). This was in agreement with the findings of Nagendraprasad (2001) in bell pepper. The competition for resources experienced by closely spaced plants resulted in lower weight and fruit volume (Aminifard *et al.,* 2012). However, fruits from widely spaced plants in Kapseret were not firm a factor which leads to deterioration in many fruits. The reduced firmness was probably due to low accumulation of assimilates. This was in agreement with the findings of Kirimi *et al*., (2011) who explained that the reduced firmness resulted from low assimilates as most of the radiation was lost through the wide space instead of being used for assimilate formation.

An application of 121.5 kg N / ha recorded the highest fruit diameter while the smallest fruit diameter was recorded in 40.5 kg N / ha in Turbo. Similar results were reported by (Bar *et al*., (2001), Devi *et al*., (2001) in egg plant production, Akambi *et al*., (2007) and Ajula *et al.,* (2007). This increase in fruit size with increased nitrogen rates can be attributed to its availability for biomass production which forms the basis for all production phases (Johnson and Decoteau, 1996). In Kapseret, the control

treatment produced the largest fruits which might have resulted from exogenous factors not quantified in the experiment.

Fruits produced in Turbo suffered neither mechanical nor blossom end rot (Table 6) probably due to careful handling and adequate soil moisture (Anon, 2007).

CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of the study, Plant density and nitrogen have an influence on growth and quality parameters and can be used to improve the quality and marketable yield of sweet pepper grown in Uasin Gishu County. Turbo site is suitable for sweet pepper production as indicated by the growth and quality parameters.

Sweet pepper should be grown in low altitude areas like Turbo in Uasin Gishu County for enhanced plant growth and high quality sweet pepper fruits. In addition the intermediate plant density (70×45 cm) and 81 kg N / ha from CAN should be adopted by growers. In this treatment combination the plants were able to utilize the available resources efficiently for the production of high quality sweet pepper fruits with the specified size in the export market (40-45mm diameter) thus recording high marketable fruits.

Suggestions for future research

The influence of the different types of manure on the growth, yield and quality of sweet pepper should be studied in Uasin Gishu County.

References

Ajula, M.S., Thind, H.S. and Buttar, G.S. Fruit Yield and Water Use Efficiency of Egg Plant (*Solanum melongena* L) as Influenced by Different Quantities of Nitrogen and Water Applied Through Drip and Furrow Irrigation. *Journal of Horticultural Science,* 112 *(2007*): 142 - 148.

Akambi, W.B., Togun, A.O., Olaniran, O.A., Akiniansore, J.O. and Tairu, F.M. Physio- chemical properties of Egg Plant (*Solanum melongena*) Fruit in Response to Nitrogen Fertilizer and Fruit size. *Agricultural Journal,* 2 (2007): 140- 148.

Aminifard, H.M., Aroiee, H., Ameri, A. and Fatemi, H. Effects of Plant Density and Nitrogen on Growth, Yield and Fruit Quality of Sweet Pepper (*Capsicum annuum*. L). *African Journal of Agricultural Research,* 7 (2012): 859- 866.

Anon. (2007) Annual Production by Crop Quick Reference.www.fao.stat.org.

Bar-tal, A., Atoni, B., Karin, l. and Rosenberg, R. Nitrogen Nutrition on Greenhouse Pepper. Effects of Nitrogen Concentration and Ammonium Nitrate Ratio on Growth, Transpiration and Nutrient uptake. *Journal of Horticultural Science,* 36 (2001): 1525-1529.

Basela, O. and Mahadeen, A. Effects of Fertilizes on Growth, Yield, Yield Components, Quality and Certain Nutrient Contents in Broccoli (*Brassica oleracea*) *Journal of Agricultural and Biology,* 10 (2008): 627-632.

Dasgan, Y.H. and Abak, K. Effects of Plant Densities and Number of Shoots on Yield and Fruit Characteristics of Pepper Grown in Glasshouse. *Turkish Journal of Agriculture and Forest,* 27 (2003): 29-35.

Devi, H.H., Maity, T. K., Parin, N., Thapa, U. Response of Brinjal to Different Sources of Nitrogen. *Journal of Vegetable Science*, 29 (2002): 45-47.

Ekwu, L.G., Okporie, E.O. Effect of Plant Spacing and Nitrogen Fertilizer on the Growth and Yield of Sweet Pepper *(Capsicum annuum). Agro-Science,* 3 (2006): 22-26.

Genstat (2005). Genstat Release: 8.1 for Windows Lawes Agricultural Trust, Rotharmstead Experimental station, U.K.

HCDA. (2008). Horticultural Data 2005 – 2007 Validation Report. HCDA Nairobi Imaging Centre pp. 25–26.

Johnson, C.D. and Decoteau, D. R. Nitrogen and Potassium Fertility Affects Jalapeno Pepper Plant Growth, Pod Yield and Pungency. *Horticultural Science*, 31 (1996): 1119 –1123.

Jollife, P.A. and Gaye, M.J. (2000). Dynamics of Growth and Yield Component Responses of Bell Peppers *(Capsicum annuum L.)* to Row Cover Population Density. www.science.direct .com

Khan, M.S.I., Ray, S.S. and Pall, K.K. Nitrogen and Phosphorus Efficiency on the Growth and Yield Attributes of *Capsicum*. *Academic Journal of plant Sciences*, 3 (2010): 71-78.

Khasmakhi–Sabet, A., Sedaghathoor, S.M., Mohammady, I. and Olfati, A. Effect of Plant Density on Bell Pepper Yield and Quality *International Journal of vegetable Science*, 15 (2009): 264–271.

Kirimi, J.K., Itulya, F.M. and Mwaja, V.N. Effects of Nitrogen and Spacing on Fruit Yield of Tomato. *African Journal of Horticultural Science*, 5 (2011): 50-60.

Law–ogbomo, K. and Egharevba, E. Effects of Planting Density and NPK Fertilizer Application on Yield and Yield Components of Tomato (*Lycopersicum esculentum*) in Forest Location. *World Agriculture Science,* 5 (2009): 152 –158.

MOA. (2007). Annual Report 2007 Uasin Gishu District. Negendraprasad, H.N. (2001). Effect of Plant Density on Growth and Yield of *Capsicum* Grown Under Greenhouse and Open Conditions. *www.acta.org/books*.

Neginahal, B.P., Revannappa., Patil, M.G., Halepyati, A.S, and Bheemanna, M. Effect of Planting Methods and Nutrient Levels on Productivity and Nutrient Uptake of Chilly. *Karnataka Journal of Agricultural Science,* (2009): 392–394.

Okalebo, J.R., Gathua, K.W. and Woormer, P.L. (2002). Laboratory Methods of Plants and Soil Analysis: A Working Manual, Second Edition. TSBF- UNESCO, Nairobi.

Patil, K.B. and Biradar, D.P. Nutrient Uptake of Chili as Influenced by Plant population and Integrated Nutrient Levels in Vertisols. *Journal Maharashan Agricultural University*. 6 (2001): 337-339.

Reiley, E.H. and Shry, C.L. (2004). Introductory Horticulture 6th Edition. Delmar – pp 405, 410-420.

Samin, A. (2008). Effects of Plant Density on Flowering Date, Yield and Quality Attribute of Bush Beans (*Phaseolus vulgaris* L) under Centre Pivot irrigation System. *American Journal of Agriculture and Biological Science*. 3(4): 666-688.

Wileke, J., Homeier, J., Lehmann. and Engels, C. (2008). Plant Growth along Altitudinal Gradient-Role of Plant

Nutritional Status, Fine Root Activity and Properties. Guidelines on Tropical Mountain Ecosystem of Equador. Ecology.

Sutherland, J.A., Kibata, G.W. and Farnel, G. (1996. Field sampling methods for crop pests and disease in Kenya KARI PP. 8-31.

Umesh, Z.M. (2008). Investigation on Production Techniques in Capsicum under Protected Cultivation *www Agro-science.journal.com.*

Warner, J., Zhang T.Q. and Hao, X. Effects of Nitrogen Fertilization on Fruit Yield and Quality of Processing Tomatoes. *Canadian Journal of Plant Science*, 84 (2004): 865-871.

Yamamura, K. (2002). Encyclopedia of Pest Management. CRC Press pp 622

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