



Yield quality response (YQR) of pepper under variable water application using micro-sprinkler system

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Received: 14 May 2012

Revised: 04 June 2012

Accepted: 05 June 2012

Key words: Pepper, yield quality, fruit length, fruit number, fruit width.

Abstract

Yield quality response of pepper (*Capsicum annum*) under variable water application was examined during two off-seasons of 2007/08 and 2008/09 at the Agricultural Engineering Research Farm of the Federal University of Technology, Akure, Nigeria. The crop was irrigated using micro-sprinkler system that allowed three treatments 1, 2, 3 at 0.5 WR (water requirements) of pepper, 0.75 WR, and 1 WR respectively. The experiment was repeated twice and irrigation was carried out at 3-day interval. Soil and agronomic measurements were carried out at each treatment during the experiments while moisture content was monitored weekly using gravimetric method. Measurements made included leaf area index (LAI) and crop yield (results not shown), plant height (PH), fruit number (FN), fruit length (FL) and Fruit Width (FW). Results showed that the growth of pepper were not statistically different among treatments at the 5% level of significance. Plant height responded positively to increased water application and thus influencing yield positively. Yield of pepper was highest at the highest water application, ranging from 20.1 t/ha (2007/08) to 21.1 t/ha (2008/09); fruit number ranged between 21 to 19 for the highest treatment in 2007/08 and 2008/09 respectively while fruit length and fruit width also increased with increasing water application. It was then concluded that variations in water application might significantly influence yield quality such as fruit number, fruit length and fruit width at harvest. Variable irrigation water application for field grown pepper is therefore recommended for higher and better quality yields.

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Introduction

Pepper (*Capsicum annum*) is a solanaceous vegetable crop. It is the second most important vegetable after tomato (AVRDC, 1989) in the world. It is also a foremost vegetable crop in Nigeria used as condiments in soups, can foods and as spices in many diets. As a tropical crop, it performs best under warm climate within a temperature range of between 25-35°C mostly under no frost condition especially during the growing seasons (Olalla and Valero, 1994). In general, pepper can be cultivated on a wide range of soil types, however, observance of good drainage ensures good harvest. Preparation of soil should be done to break up large clods and any hardpan in order to maintain good drainage while a soil pH of 5.5–7.0 is desirable. Where manure is applied, it is tilled into the soil during preparation for planting. General garden fertilizer, like NPK10-30-10, can be applied at the rate of 1.6 – 1.8kg per 30 square meters. One-third of the application is carried out at transplanting, one-third when flowers form, and one-third a month after flowering. Additional nitrogen may be applied after the first harvest to improve fruit size and vigour, however, excess nitrogen applied too early may cause flower drop.

Bell pepper plant requires large quantity of readily available soil nutrients with optimum soil moisture and favourable climatic conditions. Unfavourable temperature and water supply are likely causes of bud, flower and fruit drop. Sezen *et al.* (2006) reported that adequate water supply and relatively moist soil are required during the total growing period for high yields. The most sensitive stage to water shortage is the period when pepper begins to flower (Dagdelen *et al.*, 2004) and during this period water depletion in the root zone should not exceed 25 percent (Sezen *et al.*, 2006). No of fruits reduces if there is water shortage just prior and during flowering. As a rule, lighter soils need more frequent irrigation than do heavier soils, and peppers require more frequent irrigation after fruiting starts than before. Water and nutrients can

easily be lost from soils and as result, green pepper is grown on raised soil beds covered with plastic mulch. These beds help in conserving the soil moisture and reduce nutrient losses.

In turkey where wild flooding, furrow and basin irrigation methods were the common practice for bell pepper production, Tekinel *et al.* (1989) noted that drainage and salinity problems were created by the farmers owing to over-irrigation, resulting in high water losses and low irrigation efficiencies. As a result of the tropical humid climate of the South-Western Nigeria where this study was carried out, sprinkler irrigation systems are increasingly being used in crop production in the zone. Sprinkler irrigation systems apply water directly to the surface of the crop as well as the soil around the roots of the crop with high efficiency, thereby minimizing water loss, ponding and flooding. Studies have shown that sprinkler irrigation systems reduce the water use of crop by about 50% compared to that under seepage system (Pitts and Clark, 1991). The objective of this study was to determine the yield quality response of green pepper to variable water application under sprinkler irrigation system.

Materials and Methods

The study was carried out at the Research Farm of the Department of Agricultural Engineering, Federal University of Technology, Akure, in the South-Western part of Nigeria. It is located on latitude 7°16' N; longitude 5°13' E and lies within the tropical humid climate with two distinct seasons. Akure has a relatively dry season from November to March and a rainy season from April to October. Average annual rainfall ranges 1405 mm – 2400 mm of which raining season accounts for 90% and the month of April marks the beginning of rainfall. The field experiment was conducted during 2007/08 and 2008/09 dry seasons respectively. The physical and chemical properties of the soil were determined.

The experimental design was a Randomized Complete Block Design (RCBD) with three

treatments and three replicates. Each treatment was subjected to different water applications of 0.5 WR as Low, 0.75 WR as Medium, and 1 WR as High irrigations respectively. A 10 m x 60 m portion of the farm site was ploughed and harrowed for effective seed bed formation and 10 m x 10 m part of the ploughed land was divided into nine seed beds (micro-sprinkler plots), 2.0 m long, 2.0 m wide and 0.15 m deep and leaving 0.5 m spacing between beds. The micro-sprinklers were installed at the centers of the nine 2.0 m x 2.0 m plots. Each treatment plot was connected to separate supplies (0.1 m³ capacity reservoirs) placed adjacent to each of the beds at uniform pressure head of 1.5m to ensure even distribution of water.

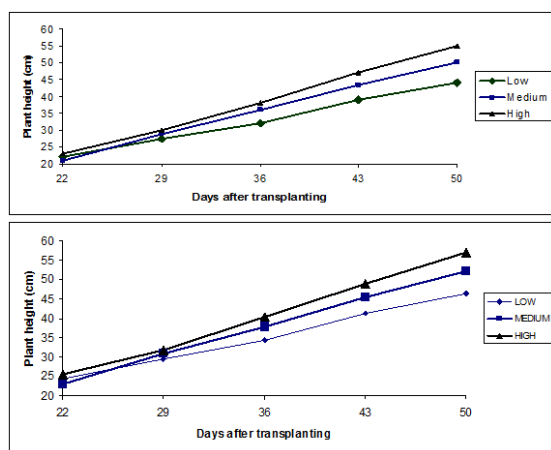


Fig. 1. Plant height response to variable water application (a) 2007/08 and (b) 2008/09.

Soil samples were collected at nine different locations on the experimental site to determine the soil physicochemical properties such as particle size distribution (i.e. sand, silt and clay contents), organic matter, soil pH, bulk density and percentage composition of nitrogen, phosphorus, potassium, calcium and magnesium using standard procedures. Soil moisture content were determined in each of the plot once a week at 10, 20, 30, 40, 50, and 60 cm soil depths in every plot using gravimetric method. Soil bulk density (gcm⁻³) was determined by the core method using a 6.2 cm long by 6.2 cm diameter cylindrical metal can. Samples were dried at 105°C for 24 hours in a forced air oven, weighed and density calculated as sample dry weight (g) divided by sample volume (cm³). The soil in the area

was generally sandy-loam with pH range of 5.95-6.40, rich in organic matter and important macro nutrients while the bulk density taken within 0.3 m depth of soil was 1.25g/cm³.

Leaf area index (LAI), crop yield and such yield quality parameters as plant height, fruits length, number of fruits and fruit width were measured on weekly basis beginning from the 29 days after transplanting (DAT) to the maturity stage i.e. 65 DAT when harvesting began. Harvestable yields of Pepper (*Capsicum annum*) were determined on weekly interval starting from the day harvesting began (65 DAT). Fresh peppers were manually harvested from the plots based on the respective treatments for ease of measurement of fresh biomass.

Results and Discussion

Plant height response to variable water application

The results of the response of plant height to variable water application for the two seasons are shown in Fig. 1(a and b). The more irrigation water applied, the higher the plant height (PH) obtained. However, there was no significant difference in plant height in all the treatments plots at 5% level. Sezen et al. (2011) had stated that a significant decrease in plant height resulted from decreasing amounts of irrigation water. However, increase in PH has the potential of increasing the fruit number, therefore, the fruit yield. This has perhaps made PH one of the most important vegetative parameters affecting fruit yield.

Increased fruit number was recorded as water application increased for both seasons (Fig. 2), however, there was no significant difference in fruit number at 5% level in both seasons. Increase in fruit number is one of the most significant factors affecting yield. Therefore, in order to prevent poor fruit size and shape and to increase yield, a uniform supply of soil water throughout the growing season is needed (Sezen *et al.*, 2011). While high irrigation treatments produced the highest fruit number of 19 in 2007/08 season, 21 were produced in 2008/09

season. 16 and 19 fruits were produced under treatment 2 (medium irrigation) in 2007/08 and 2008/09 seasons respectively. Low (0.5 WR) irrigation treatment produced the lowest fruit number of 15 and 16 in the two seasons respectively. Thus, there is positive response of fruit number to water application.

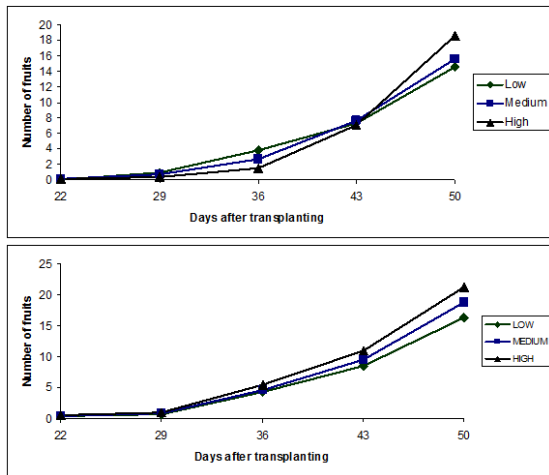


Fig. 2. Fruit Number response to variable water application (a) 2007/08 and (b) 2008/09.

Fruit length (FL) response to variable water application

There was a progressive increase in fruit length as irrigation level increased, and fruit yield increased in turn (Fig. 3). There was no significant difference in fruit length on all the treatment plots at 5% level. This was similar to the result obtained by Dagdelen *et al.* (2004) which stated that there was no significant difference in fruit length during the first year of a series of treatment carried out on pepper in Turkey. Inadequate water supply reduces the length and the weight of green pepper fruit; hence irrigation has increased the length of the green pepper fruit.

Fruits width (FW) response to variable water application

Fig. 4 below shows the results of the response of fruits width to varying water application for the three treatment plots. As earlier obtained for other parameters, at 5% level, there was no significant difference in fruits width in low and medium irrigation treatments, but differed significantly from

high irrigation treatment in both seasons. At 50 DAT, highest fruit widths of 1.31 cm and 1.82 cm were obtained under high irrigation treatments in 2007/08 and 2008/09 seasons, respectively, while the lowest value of 1.14 cm and 1.29 cm were observed at low irrigation treatment for both seasons.

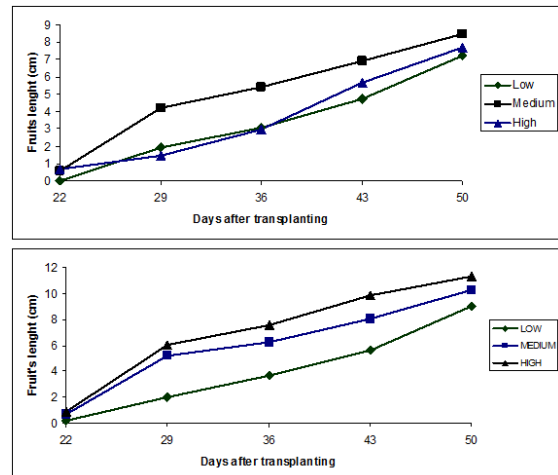


Fig. 3. Fruit Length (FL) response to variable water application (a) 2007/08 and (b) 2008/09.

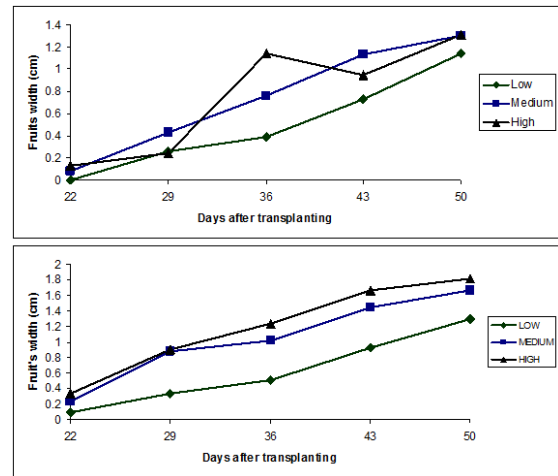


Fig. 4. Fruit Width response to variable water application (a) 2007/08 and (b) 2008/09.

Conclusion

From the foregoing, it can be concluded that yield quality parameters of pepper responded positively to varying irrigation water application. This is in line with the earlier finding of Ngouajia *et al.* (2008) that irrigation treatments were capable of influencing pepper fruit number, yield, and fruit size. Total yield of pepper was highest at the highest irrigation water application in the two seasons,

ranging from 20.1 t/ha (2007/08) to 21.1 t/ha (2008/09). Also, varying irrigation water application influenced positively pepper quality parameters such as the plant height, fruit number, fruit length and fruit width. The amounts of water applied using micro-sprinkler irrigation system were statistically different among treatments at the 5% level; however there was no significant difference in the agronomic parameters among the treatments. Therefore, it is recommended that variable irrigation water application should be adopted for field grown pepper for higher and better quality yields.

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