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Yugalkishor Lodhi
Department of Vegetable Science, Visva-Bharati, Sriniketan, West Bengal, India

Snehasish Chakravorty
Department of Vegetable Science, Visva-Bharati, Sriniketan, West Bengal, India

Jitendra Trivedi
Department of Vegetable Science, Indira Gandhi Krishi Viswavidyalaya, Krishak Nagar, Raipur, Chhattisgarh, India

Sangeeta Chandrakar
Department of Fruit Science, Indira Gandhi Krishi Viswavidyalaya, Krishak Nagar, Raipur, Chhattisgarh, India

Correspondence
Yugalkishor Lodhi
Department of Vegetable Science, Visva-Bharati, Sriniketan, West Bengal, India

Effect of different nutrients levels and mulches on fruit quality and chlorophyll content of bell pepper (*Capsicum annum* L.)

Yugalkishor Lodhi, Snehasish Chakravorty, Jitendra Trivedi and Sangeeta Chandrakar

Abstract
The field experiment was conducted to study the effect of nutrients and mulching on fruit quality and chlorophyll content of Bell pepper at Horticulture farm, Institute of Agriculture, Visva-Bharati, Sriniketan (West Bengal) during *Rabi* season 2014-15. The experiment was laid out in Completely Randomized Block Design (CRBD) consisting of nine treatments. The treatment comprising of different combinations of nutrients and mulches *i.e.* Nitrogen (150Kg ha^{-1}and 200 Kg ha^{-1}), Phosphorous (80 Kg ha^{-1} and 120 Kg ha^{-1}) and mulches (Paddy straw and water hyacinth each @ 7t ha^{-1}) with three replications. The statistical analysis indicated that the fruit quality of bell pepper was significantly influenced by different nutrients levels and mulches. The bio-chemical parameters *viz.* Highest total soluble solids (7.41^{0}Bx), chlorophyll content (63.28 SPAD) and Vitamin –C (197.64 mg/100g) were observed in treatment T_8 with 200kg N ha^{-1} + 120kg ha^{-1} P_2O_5 + Paddy straw mulch @ 7 t ha^{-1}. Control condition indicated significantly lowest result than all other treatment.

Keywords: Nutrients, mulches, bell pepper, fruit quality, bio-chemical parameters, chlorophyll content

Introduction
Bell pepper also known as Bell pepper or Sweet pepper or Green pepper or Shimla mirch is one of the popular solanaceous vegetable crops cultivated in most parts of the world, especially in temperate regions of Central and South America and European countries, tropical and sub-tropical regions of Asian continent mainly in India and China. India contributes one fourth of world production of Bell pepper with an average annual production of 0.9 million tons from an area of 0.885 million hectare with a productivity of 1266 kg per hectare from open as well as protected cultivation (Anonymous, 2005) [2]. It is extensively cultivated in hills of Himachal Pradesh, Uttar Pradesh, Jammu and Kashmir and Nilgiri hills during summer months. As an autumn crop, it extends up to winter months in Karnataka, Maharashtra, Tamil Nadu, Andhra Pradesh, Bihar, West Bengal and Madhya Pradesh (NHB, 2012-13).

Bell pepper can be consumed either by cooking or raw. The leaves are also consumed as salad, soups or eaten with rice (Love look, 1973) [5]. It was also used as folk medicine for black vomit, tome for gout and paralysis in Shimla hills. Nutritive value of sweet pepper is also very good as it is rich in vitamin A (3131IU), vitamin C (283 mg), protein (1.29 mg) and minerals like calcium (13.4mg), magnesium (14.9mg), phosphorus (28.3mg), potassium (263.0 mg) per 100 g of fresh weight. (Arya, P.S., 1999 and IIHR, 2000) [3].

Application of nutrients to support the crop plants for optimum production is well established through various research programmes, especially for the macronutrients like nitrogen, phosphorus and potassium. Crucial role of nitrogen for being main constituent of all amino acids in proteins and lipids, the structural compounds of cells and chloroplast made it the most essential macronutrient for good plant establishment and expected growth (Uddin and Khalequzzaman, 2003) [8]. Therefore, its deficiency shows negative impact on growth and development of plants which is ultimately reflected in reduced yield. Reports of various investigations indicated its significant role for application stimulating the plants for uptake of potassium and phosphorus through its synergistic effect (Qawasmi *et al*., 1999) [7]. Bell pepper requires heavy nitrogen application for higher yield as it imparts good vegetative growth necessary for good development of fruit.

Phosphorus (P) is another important macronutrient vital for plant growth as it is involved in several key plant cellular activities like energy transfer, photosynthesis, transformation of sugars and starches and transfer of genetic characteristics from one generation to the next. It also promotes root proliferation that increases root volume and improves soil nutrient exploration.

Water is the critical factor for growth and development of any crop. Favorable water balance maintained through irrigations may result in better maintenance of cell turgidity, better translocation of photosynthates, greater availability of nutrients leading to better plant growth and yield (Ali and Kushwaha, 1987) [1]. Raising of crop during *Rabi* season in laterite belt of West Bengal has been threatened by various factors like low and erratic rainfall, deep ground water table and scarcity of alternative water resources. Bell pepper is a high value crop and it is susceptible to moisture stress and drought. Therefore, better water management through water conservation practices are necessary to maintain adequate soil moisture during critical periods of growth and development of the plants. Among all water conservation methods mulching is an important one and easy to adopt which reduces evaporation and increases availability soil moisture and thus enhances availability of nutrients to plants which ultimately affects yield and quality (Vanlalhluana and Sahoo 2011) [9]. Among mulches, organic mulches are an attractive option to improve soil organic matter through their biodegradation and easy availability. It improves vegetative growth, blooming and number of fruit per plant which leads to early maturity and early harvest (Gomez *et al.*, 1997) [4]. Use of organic materials for mulching provide opportunities for growers to recycle on-farm agricultural by-products and thus these are eco-friendly and economic as well.

Materials and Methods

The field experiment on capsicum was conducted at the Horticultural farm, Palli-Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, West Bengal during December, 2014 to March, 2015 to study the effect of nutrients and mulching on growth and yield of capsicum. The experimental field is in the red and lateritic belt of West Bengal, situated at about 23° 42′ N latitude and 87° 40′ 30″ E longitude with an average altitude of 40 m above mean sea level.

The soil of experimental field was sandy loam having pH 6.1. The main field was prepared by thoroughly ploughing and leveling and then divided into plots. The size of individual plots was 3m x 2m and the whole area was intercept by irrigation cum drainage channels of 0.5m wide. The bunds besides irrigation channel are 15 cm and border bunds & bunds in intra replication are 30 cm. Bell pepper cv. Bharat was taken for experiment. First seedling was raised in the nursery and then 35 days old healthy seedlings were planted at spacing of 60 X 40cm in the main field plot.

The experiment was laid out in a Randomized Block Design (RBD) with three replications of nine treatments. The treatment consisted 9 different combinations of nutrient levels and mulches *i.e.* T_1 -150kg N/ha + 80kg P_2O_5/ha + Rice chaff mulch @ 7t/ha, T_2-150kg N/ha + 80kg P_2O_5/ha+ Paddy straw mulch @7t/ha, T_3 - 150kg N/ha + 120 kg P_2O_5/ha + Rice chaff mulch @7t/ha, T_4 - 150kg N/ha + 120kg P_2O_5/ha + Paddy straw mulch @7t/ha, T_5 - 200kg N/ha + 80kg P_2O_5/ha + Rice chaff mulch @7t/ha, T_6 - 200kg N/ha + 80 kg P_2O_5/ha + Paddy straw mulch @7t/ ha, T_7 - 200kg N/ha + 120kg P_2O_5/ha + Rice chaff mulch @7t/ha, T_8 - 200kg N/ha + 120kg P_2O_5/ha + Paddy straw mulch @7t/ha, T_9 – Control. All the experimental plants were uniformly maintained and same cultured practices were provided *i.e.* Irrigation, manuring, fertilizer application, gap filling, earthing up, harvesting and plant protection measures during whole period of investigation. Data regarding total soluble solids, chlorophyll content and vitamin- C were recorded and statistically analyzed.

Results Findings and Discussion

Chlorophyll content (SPAD Units)

At 45 DAT the highest chlorophyll content (63.28 SPAD) was observed in the treatment T_8 (200kg N/ha + 120kg P_2O_5 /ha + Paddy straw mulch @ 7 t/ha) which was statistically *at par* with T_5 (62.69 SPAD) where 200kg N/ha, 80kg P_2O_5/ha and rice chaff mulch @ 7 t/ha were applied. Among all the treatments lowest chlorophyll content registered in the treatment T_9 (control).

At 90 DAT there was no significant difference among the treatments. However, the highest chlorophyll content (70.17 SPAD) was observed in T_7 (200kg N/ha + 120kg P_2O_5/ha + Rice chaff mulch @ 7t/ha), though, it was mere numerical.

The positive response of chlorophyll content at the early stage of plant growth might be attributed to availability of nutrients in sufficient quantity necessary for development of chlorophyll. Moreover, nitrogen is the main constituent of all amino acids in proteins and lipids which are also structural compounds of the chloroplast (Basela and Menhaden, 2008). Conserved moisture due to mulching also increased availability of nitrogen. On the other hand, deficiency of both moisture and nitrogen in control plots negatively affected chlorophyll content in the plants.

Total Soluble Solids (^{0}Bx)

Significant variance was observed among all the treatments, the highest total soluble solids content (7.41°Bx) was observed in treatment T_8 (200kg N/ha + 120kg P_2O_5/ha + Paddy straw mulch @ 7 t/ha) which was followed by T_7 (7.28°Bx) treatment (200kg N/ha + 120kg P_2O_5/ha + Rice chaff mulch @ 7 t/ha). Among all the treatments lowest TSS content 5.86^{0}Bx was observed in controlled condition.

This might be due to better accumulation of photosynthates in the fruits due to availability of nutrients and moisture in the soil for the applied treatments comprising of nutrients and mulching. The results are in conformity with findings of Patil and Bojappa (1987) in muskmelon.

Vitamin-C (mg/100g)

Perusal of result has shown significant variation among the treatments with respect to Vitamin- C content. It was observed that plants treated with 200kg N/ha, 120 kg P_2O_5/ha and paddy straw mulch @ 7 t/ha in T_8 recorded the highest vitamin C content (197.64mg/100g) followed by T_6 (193.59mg/100g) comprising of 200kg N/ha, 80 kg P_2O_5/ha and paddy straw mulch @ 7 t/ha. Among all the treatments lowest Vitamin C content (166.89 mg/100g) was observed in controlled condition where the plants grown devoid of nitrogen, phosphorus and mulching.

As the data shows, application of nitrogen and phosphorus at their highest level along with paddy straw mulch increased

vitamin C content to the maximum level. This might be due to better growth and development of plants producing better fruits and yield. The results are in conformity with the findings of Randhawa *et al*., (1981) and Ananyan *et al.*, (1975) in tomato.

Table 1: Effect of Nutrients levels and Mulches on chlorophyll content of Bell Pepper

Treatments	Chlorophyll (SPAD Units)	
	At 45 Dat	At 90 Dat
T_1-150kg N/ha + 80kg P_2O_5/ha + Rice chaff mulch @ 7t/ha	60.04[b]	64.93
T_2-150kg N/ha + 80kg P_2O_5/ha + Paddy straw mulch @ 7t/ha	55.61[c]	64.37
T_3-150kg N/ha + 120 kg P_2O_5/ha + Rice chaff mulch @ 7t/ha	59.93[b]	65.09
T_4-150kg N/ha + 120kg P_2O_5/ha + Paddy straw mulch @ 7t/ha	57.58[c]	65.30
T_5-200kg N/ha + 80kg P_2O_5/ha + Rice chaff mulch @ 7t/ha	62.69[a]	64.75
T_6-200kg N/ha + 80kg P_2O_5/ha + Paddy straw mulch @ 7t/ha	61.28[ab]	60.73
T_7-200kg N/ha + 120kg P_2O_5/ha + Rice chaff mulch @ 7t/ha	61.79[ab]	70.17
T_8-200kg N/ha + 120kg P_2O_5/ha + Paddy straw mulch @ 7t/ha	63.28[a]	62.97
T_9-Control	47.63[d]	59.10
SEM(±)	0.78	NS
CD (5%)	2.34	NS
CV (%)	2.29	NS

The superscript letter indicates that the treatment means with same letters are at par at 5% level of significance, while the means with different letters are significantly different at 5% level of significance. These letters have been affixed based on CD-value comparison of treatment means.

Table 2: Effect of Nutrients and Mulching on fruit quality of Bell Pepper

Treatments	TSS (^{0}B)	Vitamin-C (mg/100g)
T_1-150kg N/ha + 80kg P_2O_5/ha + Rice chaff mulch @ 7t/ha	6.12[ef]	168.86[ef]
T_2-150kg N/ha + 80kg P_2O_5/ha + Paddy straw mulch @ 7t/ha	6.24[e]	165.52[ef]
T_3-150kg N/ha + 120 kg P_2O_5/ha + Rice chaff mulch @ 7t/ha	6.67[d]	169.66[ef]
T_4-150kg N/ha + 120kg P_2O_5/ha + Paddy straw mulch @ 7t/ha	6.88[cd]	171.33[e]
T_5-200kg N/ha + 80kg P_2O_5/ha + Rice chaff mulch @ 7t/ha	7.00[bg]	181.07[d]
T_6-200kg N/ha + 80kg P_2O_5/ha + Paddy straw mulch @ 7t/ha	7.16[abc]	193.59[b]
T_7-200kg N/ha + 120kg P_2O_5/ha + Rice chaff mulch @ 7t/ha	7.28[ab]	189.89[c]
T_8-200kg N/ha + 120kg P_2O_5/ha + Paddy straw mulch @ 7t/ha	7.41[a]	197.64[a]
T_9-Control	5.86[f]	166.89[f]
SEM(±)	0.10	1.05
CD (5%)	0.30	3.17
CV (%)	2.5	1.02

The superscript letter indicates that the treatment means with same letters are at par at 5% level of significance, while the means with different letters are significantly different at 5% level of significance. These letters have been affixed based on CD-value comparison of treatment means.

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