

Effect of Various Concentrations of Nitrobenzene on Bell Pepper (*Capsicum annuum* L.) Yield under Green House Condition

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Abstract

Bell pepper (*Capsicum annuum* L.) is grown extensively throughout the world especially in temperate countries. Poor fruit-set as well as loss of reproductive structures due to moisture stress is one of the major barriers to tropical adaptation of bell pepper. Hence the objective of the present study was to examine the effect of various concentration of nitrobenzene (flowering stimulant and yield booster) on bell pepper yield. The study was conducted at a farmer poly tunnel located in Pilimathalawa (WU1), Sri Lanka. The experiment was laid out in a Completely Randomize Design (CRD) with four treatments randomized in three replicates. The treatments were T₁ – Control (with out Nitrobenzene), T₂ – Nitrobenzene 15%, T₃ – Nitrobenzene 20%, T₄ – Nitrobenzene 25%. Plants were established in drip-fertigated bags in the Poly tunnel and standard crop management practices were applied throughout the study. Nitrobenzene was sprayed to the seedlings 40, 55, 80 and 105 days after planting. Albert solution, 6: 30: 30 fertilizer mixture 20: 20 fertilizer mixture and Ca (NO₃)₂ were used as recommended fertilizers. Measurements were taken on flowering, fruit setting, yield as well as the quality of the fruits. The data obtained were tabulated and analyzed subjected to the Analysis of Variance (ANOVA) procedure of Statistical Analysis System (SAS). Duncan's New Multiple Range Test (DNMRT) was performed to compare the differences among treatment means at p=0.05. The highest number of fruits and flowers/plant was observed in T3 and T4, i.e. 20% and 25% Nitrobenzene applied treatments. On the other hand the lowest number of flowers as well as fruits were recorded from T2 (15% nitrobenzene) and T1 (control of the experiment). Among different treatments tested, 25% nitrobenzene applied plants showed superior results in contrast to other nitrobenzene levels with enhancing flowering, fruit setting, yield quality as well as postharvest performances under greenhouse condition.

Keywords: Bell pepper; Nitrobenzene; Poly tunnel; Fruit setting; Yield; Quality

Introduction

Bell pepper (*Capsicum annuum* L.) is one of the most important vegetable crops grown extensively throughout the world especially in temperate countries. The crop is very sensitive to environmental factors [1]. The optimum temperature requirement for bell pepper growth ranged from 16-25°C [2]. High night temperature is more detrimental to fruit set than day temperature [3]. When large fruited bell peppers are exposed to environmental stresses during the flowering and fruiting period, abscission of flowers and flower buds may occur [4]. This loss of reproductive structures can result in serious yield decrease, and constitutes a major risk factor in pepper production. Nitrobenzene is a combination of nitrogen and plant growth regulators, extracted from sea weeds that act as plant energizer, flowering stimulant and yield booster [5]. Nitrobenzene produces best results in combination with plant growth regulators, which have capacity to increase flowering in plant and also prevent flower shedding. It is specially recommended for vegetable crops and flowering plants [6]. Nitrobenzene 20% w/w is a new generation plant energizer and yield booster of low cost PGRs compared to others. Nitrobenzene is quickly absorbed into the plants. It influences the bio chemical pathway of the plants to uptake more nutrients from the soil. It also increases the nutrient use efficiency thus improves the vegetative growth. Induces profuse flowering and helps in the retention of the flowers and fruits [7]. On the other hand, 'Flora' improves the organoleptic factors and keeping quality of the produce, which increases the harvestable yield of any crops [8]. As a further improvement step for greenhouse fruit set of bell pepper, Nitrobenzene can be adopted. Four sprays of nitrobenzene during 40, 55, 80 and 105 days after sowing (DAS) improve the yield up to 40%. Unfortunately, very limited researches have been carried out regarding the use of growth regulators on bell pepper varieties in Sri Lanka. Therefore, this

research was designed to study the effect of various concentrations of nitrobenzene on bell pepper yield and the quality. Furthermore it was expected to assess the most effective nitrobenzene concentration to reduce cost of production in order to improve the profit.

Materials and Methods

Experimental design and treatments

The experiment was laid out in a Completely Randomize Design (CRD) with four treatments randomized in three replicates. The treatments were four different concentrations of Nitrobenzene (%) applied to the seedlings to cover whole aerial parts of the plant as an aqueous spray by using a hand sprayer as given below

Treatments	Nitrobenzene levels (%)
T1	Control (without Nitrobenzene)
T2	Nitrobenzene 15%
T3	Nitrobenzene 20%
T4	Nitrobenzene 20%

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Planting materials and handling

The study was conducted at a farmer Poly tunnel located in Pilimathalawa (WU1- Wet Zone area in Up country), Sri Lanka. Plants were established in drip-fertigated bags in the Poly tunnel and standard crop management practices were done throughout the study. Nitrobenzene was sprayed at the 40, 55, 80 and 105 days after transplanting of seedlings in pots. Albert solution, 6: 30: 30 fertilizer mixture and Ca (NO₃)₂ were used as recommended fertilizers.

Measurements

Data were collected at 50, 65, 90 and 115 days after transplanting. Measurements were taken on growth, yield and yield determining parameters with postharvest quality. Bell peppers are harvested at an immature stage when they are in full size and green. The total yield was measured directly in the field by using a digital balance with four digits. Ten fruits were selected randomly from each treatment and kept in normal environmental conditions and at the same time remaining five fruit samples were kept in refrigerator to determine the shelf life (days). At the same time weight loss was recorded at five days intervals by using a digital balance.

Statistical analysis

The data obtained were tabulated and analyzed subjected to the Analysis of Variance (ANOVA) procedure of Statistical Analysis System (SAS). Duncan's New Multiple Range Test (DNMRT) was performed to compare the differences among treatment means at $p=0.05$. Correlation analysis was used to determine the strength of the relationships between measured parameters of Bell pepper.

Results and Discussion

Evaluation of plant growth parameters

Among different treatments tested the plant growth parameters did not show any significant differences ($p>0.05$) between T3 and T4, i.e. 20% and 25% Nitrobenzene applied treatments. But control treatment showed the lowest values when compared to other growth parameters in the experiment. On the other hand, the highest number of flowers per plant was observed from the treatment T4, i.e. 25% Nitrobenzene applied treatment whilst the lowest number of flowers was observed from the control (Table 1).

The highest concentration of Auxin and Gibberellins is present in 25% of Nitrobenzene which influences the elongation of cells so

that the plant height is increased dramatically. According to the study findings of Nickell [9] and Richard [10] that cell growth and elongation is influenced by Auxin and Gibberellins. Cytokinin and Auxin with higher ratios of Nitrobenzene influence the lateral growth of parenchyma cells in stem so that the plant girth was increased with higher concentrations of Nitrobenzene. The best concentration of Nitrobenzene is present in 20% and 25% Nitrobenzene which influence to increase flowering in plant, prevent flower shedding, enhance early flowering and plants take less time to flower so that the number of flowers is increased for the highest concentration of Nitrobenzene. The application of Nitrobenzene and their simultaneous transport to the auxiliary buds would have resulted in a better sink for the mobilization of photo-assimilates at a faster rate. This would have helped in the early transformation from the vegetative phase to reproductive phase. The induction of early flower bud initiation might be influenced by triggering of such metabolic processes and narrowing of the carbon: nitrogen ratio by the significant accumulation of carbohydrates. The result on earliness in flowering in this experiment goes with the study findings of Singh and Mukherjee.

Evaluation of yield determining parameters

The highest fruit weight was observed from 25% Nitrobenzene applied treatment and the lowest was recorded from control treatment. Nuruzzaman et al., [11] also found that the maximum fruit weight was provided by the foliar application of Nitrobenzene on strawberry. On the other hand the fruit length did not show any significant difference ($p>0.05$) among treatments tested. These results were supported by Sharma in bell pepper. The increase in fruit length may be attributed to increase in the number of cells as well as elongation of cells which is characteristic action of any auxinic group of chemicals.

The highest pericarp thickness was recorded from 25% Nitrobenzene applied treatment and lowest thickness was recorded from control treatment. On the other hand, T2 and T3, i.e. 15% and 20% Nitrobenzene did not show any significant difference ($p>0.05$) (Table 2). The enhanced concentration of Auxin in Nitrobenzene on the pericarp due to external application of Nitrobenzene would have diverted the photo-assimilates to develop the cell wall of the pericarp instead of the ovules. The similar results were reported by Lyngdon and Sanyal [12] in capsicum.

Total yield per plant (kg)

The highest yield was recorded for 25% of nitrobenzene applied treatment and lowest yield was recorded in control treatment. Total

Treatments	Plant height (cm)	Plant girth (cm)	Number of leaves per plant	Leaf Area Index	Number of flowers per plant	Number of fruits per plant
(T1)	63.92 ^b	3.55 ^b	38.44 ^b	0.26 ^a	7.22 ^b	4.67 ^b
(T2)	66.00 ^{ab}	3.61 ^b	41.21 ^a	0.27 ^a	7.66 ^b	6.17 ^a
(T3)	66.56 ^a	3.93 ^a	41.39 ^a	0.28 ^a	10.64 ^a	6.25 ^a
(T4)	67.65 ^a	3.97 ^a	41.27 ^a	0.31 ^a	10.89 ^a	6.92 ^a

Note: Means followed by the same letter/s along the column are not significantly different at $P=0.05$

Table 1: Effect of different concentrations of Nitrobenzene on growth parameters of Bell pepper.

Treatment	Fruit weight (g)	Fruit length (cm)	Fruit girth (cm)	Pericarp thickness (mm)
(T1)	240 ^c	14.6 ^b	28.2 ^b	10.0 ^b
(T2)	246 ^{bc}	15.5 ^a	28.7 ^a	11.6 ^{ab}
(T3)	252 ^{ab}	15.6 ^a	28.8 ^a	12.4 ^{ab}
(T4)	256 ^a	16.1 ^a	28.8 ^a	13.6 ^a

Note: Means followed by the same letter/s along the column are not significantly different at $P=0.05$

Table 2: Effects of different concentrations of Nitrobenzene on yield parameters.

	PH	PG	LAI	NFLO	NFUPP	TYLD	SL
PH	-	-	-	-	-	-	-
PG	0.71624**	-	-	-	-	-	-
LAI	-0.08192 ^{ns}	0.21027 ^{ns}	-	-	-	-	-
NFLO	0.61762*	0.87982**	0.35235 ^{ns}	-	-	-	-
NFUPP	0.91320***	0.65674*	0.02409 ^{ns}	0.70117*	-	-	-
YYLD	0.75055**	0.87640**	0.28498 ^{ns}	0.86007**	0.81251**	-	-
SL	0.59750*	0.57419*	0.29882 ^{ns}	0.60661*	0.68439*	0.61555*	-

Note: ns- non significant at p=0.05; * significant at p<0.05; ** significant at; p<0.01; *** significant at p<0.0001

Table 3: Linear correlation coefficients between Plant Height (PH), Plant Girth (PG), Leaf Area Index (LAI), Number of Flowers per Plant (NFLO), Number of Fruits per Plant (NFUPP), Total yield per Plant (TYLD) and Shelf Life (SL) of Bell pepper.

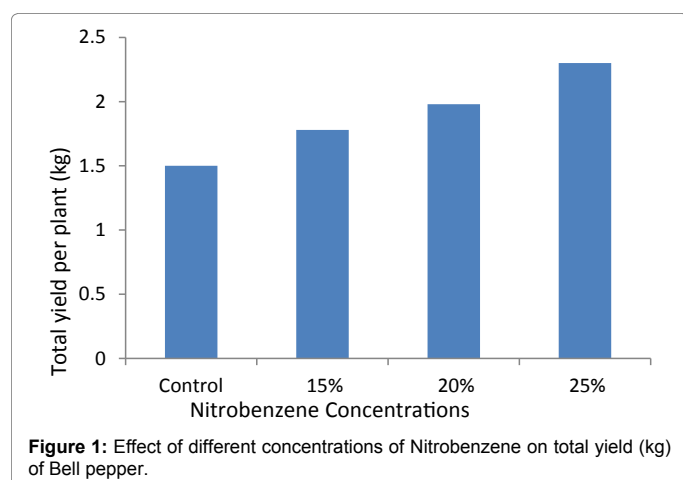


Figure 1: Effect of different concentrations of Nitrobenzene on total yield (kg) of Bell pepper.

yield for the rest of the concentrations was in between these limits (Figure 1).

Nitrobenzene is quickly absorbed into the plants, which has capacity to increase flowering in plants and maximum number of fruits per plant [7]. The highest yield per plant was recorded for 25% of nitrobenzene applied treatment and lowest yield per plant was recorded in control treatment. Nitrobenzene increase the fruit weight as well as bigger fruits is produced thus the total yield increase due to its application compare to control [13]. Nitrobenzene can be used as spray or in granular form, which increases flower forming substances by altering auxin, cytokinin, gibberellic acid and Ethylene ratio favourably tilting to a higher level of flower forming substances, thereby increasing flowers by more than 40 to 45% and yield [14].

Correlation analysis

When linear correlation analysis was performed for the overall data set, there was a highly significant (p<0.0001) positive correlation between plant height and number of fruits per plant. On the other hand there was a significant (p=0.05) positive correlation among shelf life of bell pepper fruits, total yield per plant, number of flowers per plant as well as number of fruits per plant. Leaf area index showed a non-significant (p>0.05) correlation amongst yield parameters. Furthermore, there was a highly significant positive correlation apparent amongst number of flowers per plant, number of fruits per plant as well as total yield of Bell pepper (Table 3).

Conclusion

Results enumerated that the application of nitrobenzene had a

significant (p<0.05) effect on growth, yield and quality parameters of bell pepper. Among different treatments tested, 25% Nitrobenzene showed optimum results to ensure the yield as well as the postharvest performance of bell pepper. However, 20% (T3) and 25% (T4) Nitrobenzene applied treatments did not show much difference on growth and yield parameters tested. A long shelf life was observed in T4 i.e. 25% Nitrobenzene applied treatment. Furthermore high Nitrobenzene levels showed a significant positive impact on postharvest quality of bell pepper with extending the shelf life. In the light of this situation application of 25% Nitrobenzene can be considered the most effective treatment to get better yield from bell pepper under greenhouse condition.

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