GROWTH AND YIELD RESPONSE OF CHILLI (*Capsicum annum* L) FOR THE COMBINED ORGANIC AND INORGANIC FERTILIZER APPLICATION

Ruhunuge I.J.A.[1]*, Wijeratne A.W.[2] and Wimalasiri E.M.[3]

[1]Faculty of Agriculture, Aquinas College of Higher Studies, Colombo 8, Sri Lanka
[2]Department of Agribusiness Management, Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka
[3]Department of Export Agriculture, Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka

*Corresponding Author: isuriruhunuge999@gmail.com (https://orcid.org/0000-0001-8761-5996)
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ABSTRACT

It is well known that the overuse of inorganic fertilizers has catastrophic impacts on forms of life and the environment. In chemical fertilizers, Nitrogen is one of the main elements that has a high leaching potency which leads to pollute both surface and groundwater resources. This study was carried out to identify the best organic and inorganic fertilizer combination that gives the highest yield in MI-Green. The treatments are 3 kg/pot cow dung (control 1), (T1), 2 kg/pot cow dung (control 2) (T2), 2 kg/pot cow dung + foliar urea spray (T3), 2 kg/pot cow dung + urea soil application (T4), 3 kg/pot cow dung+ foliar spray (T5) and 3 kg/pot cow dung + Urea soil application (T6). Results disclosed a significant effect ($p<0.05$) on growth and yield in T5. Hence, it can be concluded that 3kg/pot cow dung+ foliar spray combination can be used to improve the growth and yield of MI-Green chilli.

Keywords: Cow dung, Growth and yield parameters, Urea foliar spray

INTRODUCTION

The Sri Lankan government banned the import of synthetic fertilizers and agrochemicals recently (Beillard et al., 2021). Hence there is a growing trend for organic farming within the country. Organic farming recycles and mineralizes nutrients from organic matter to ensure sustainable production and reclaiming the degraded soil (Are et al., 2017). There was low soil fertility is in a large part of the lands in Sri Lanka too; mainly because of the high yielding varieties, the application of excessive inorganic fertilizers and inadequate nutrient replacement; while over-fertilization results in the accumulation and leaching of nitrate residuals that directly contribute to the pollution of ground water apart from the low soil fertility (Biosci et al., 2012). Consequently, the application of inorganic fertilizers to the soil should be shifted to the application of inorganic compounds in liquid form which is known as foliar-feeding. The foliar spray is absorbed through the plant leaf surface (Manasa et al., 2015). In foliar fertilization, urea is the most broadly used nitrogen source due to its non-polar nature. Hence, foliar-feeding is needed to introduce in every possible vascular plant which has a reasonable leaf area with appropriate concentrations and timing. There is a high probability of reducing the arable lands due to soil infertility and soil degradation in the distant future if current fertilizer practices are not changed in an environment-friendly way. The importance of foliar spraying of water-soluble fertilizers to overcome micro and macronutrient deficiencies in the soil is immensely felt these days because of the adaptation to high chemical inputs (Garhwal et al., 2007). Beneficial activities of soil microbes can be improved by organic manure through the supply of carbon-rich organic compounds (Knapp et al. 2010). The organic matter added to the soil is a favourable remedy to enhance soil fertility and reclamation of the already degraded soil. Considering the above facts; the objectives of this study were meant to identify the best combination of urea and soil application of cow dung as an amendment on MI-Green chilli growth and yield indices, as well as the best combination to produce a better yield.

METHODOLOGY

The experiment was carried out at Aquinas farm in Ragama which belongs to the WL3agro-ecological zone. The experiment was conducted during the period from September 2019 to January 2020 in the Maha season. The MI-Green variety was used in this study which performs well in all chilli growing areas and it has broad and long leaves. The soil media for the pots has a pH of 6.3 and available Na, Ca, K and Mg are 86, 1260, 1520 and 484 mg/Kg respectively which were determined according to AOAC 2006.03., (2009) and the official analysis method (Hall William., 2006). For the potting mixture of topsoil, sand, coir dust and compost, 5 parts from each were applied for all treatments (Mudalagiriyappa et al., 2016). The cow

dung sample was analyzed by wet oxidation by nitric–sulphuric-perchloric acid and then the filtrate was used to determine N, P, K Ca and Mg. Nitrogen was determined by the Micro-Kjeldahl method, Potassium was determined by flame photometer while calcium and magnesium were determined by AAS (Atomic absorption spectroscopy).

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications with the total number of unit pots was 18 in a block. There were 6 treatment combinations as follows. 3kg/pot cow dung (control 1)(T1), 2kg/pot cow dung(control 2)(T2), 2 kg/pot cow dung + foliar urea spray (T3), 2 kg/pot cow dung + urea soil application (T4), 3 kg/pot cow dung+ foliar spray (T5) and 3 kg/pot cow dung + Urea soil application (T6).According to (Biosci et al., 2012); (3 kg/pot), organic manure with NPK exhibited a significant effect on growth parameters in chilli.The dimension of each pot was approximately 23 cm (diameter) × 38 cm (height). Spraying was carried out every 15 days of the interval as it was the standard foliar treatment practice (Deore et al., 2010). In this study, 2% (v/v) urea solution (Venkatesh et al., 2011), was applied and it was prepared by using 20g of urea dissolved in one-litre water (2g urea/100 ml). In treatments 4 and 6, fertilizer was applied to the soil as urea 35kg/ha as basal dressing before sowing seeds and as top dressing urea, 30 kg/ha applied at flowering (Mudalagiriyappa et al., 2016). Two plants/pots were maintained 2 weeks after sowing. In this study, Glycerin was used as the surfactant and applied before applying foliar treatments (Fernandez et al., 2013). Water/glycerin spray was prepared by mixing water with glycerin in a 10:1 ratio. The growth parameters, yield and yield-related parameters were taken as response variables in this study. The canopy size was taken by measuring the diameter of the plant which was taken from north to south and east to west directions of the above-ground part of plants at 90 DAS. Plant volume (cm^3) was measured using the formula (V) = 1/6× π × height × D2) where, D was the average value of north-south and east-west spreading of the canopy at 90 DAS (Mandal et al., 1984). The data obtained on these various parameters were analyzed by using ANOVA at $p<0.05$. The significance of the difference between pairs of means was tested by the Least Significant Difference Test (LSD) at the level of 0.05 whereas Pearson correlation and R-sq were also calculated to identify the degree of relationship among the specified variables.

RESULTS AND DISCUSSION

Cow dung sample

Nutritional composition of cow dung was used in this study had 18.6% organic matter, 2.8% Nitrogen, 0.34% Phosphorus, 0.48% Potassium, 0.21% Calcium and 0.26% Magnesium.

Plant height

The highest average plant height 18.6 cm at 30 DAS was recorded in T5 whereas the least average plant height 9.7cm was in T2. There is a significant ($P < 0.05$) difference in plant height at 30 DAS between T2 and T4 (Difference between two different treatment mean (τ_1-τ_2) = 6.5> LSD = 3.2). Ahmed et al., (2007) stated that nitrogen application resulted in maximum plant height which was identified in the present study too. The highest average plant height of 53.5cm at 90 DAS was recorded in T5 whereas the least average plant height 36.7cm was in T2. There is a significant ($P< .05$) difference in plant height at 90 DAS between T5 and T6 (τ_1-τ_2 =13.2 >LSD =7.1) (*Table 1*). When applying urea as a foliage application it can facilitate the good provision of nitrogen to soil while minimizing nitrogen leached to the environment (Witte et al. 2002). Therefore a significant difference can be identified among T5 and T6.

Number of branches

The highest number of branches (4) at 30 DAS was recorded in T3, T4 and T5 whereas the least number of branches (2) was in T1 and T2. There is no significant ($p>0.05$) difference among treatments on 30 DAS. The highest number of branches (7) at 60 DAS was recorded in T5 whereas the least number of branches (4) was in T1 and the highest number of branches at 90 DAS was recorded in T5 whereas the least number of branches was in T1.There is a significant ($p< 0.05$) difference in plant height at 90 DAS between T5 and T1 (τ_1-τ_2 =8>LSD =3.6) (*Table 1*).Nitrogen has a considerable effect on the number of branches/plants during the vegetative stage where, these findings were agreed with the findings of (Sarker et al., 2018).

Plant volume (cm^3)

The highest plant volume (1309 cm^3) was recorded in T5 where the lowest spreading (693.2 cm^3) was in T2. There was a significant ($p <0.05$) difference in plant volume in T5 and control 1(τ_1-τ_2 =555.9 >LSD = 223.7) whereas T3 and control 2 (τ_1-τ_2

=304.3>LSD = 223.7)(*Table 2*).Nitrogen increases the vegetative growth of the plants (Baloch, 2008). As stated by Aliyu et al. (2000); plants with a wider crown yielded more than those with a smaller crown whereas wider canopy diameter could produce more pods, due to the increased number of secondary and tertiary branches which result in high plant volume at last.

Days to 50% of flowering

The earliest number of days (51 days) to reach 50% flowering was observed in T5. While the longest days (83 days) to attain 50% flowering was recorded in T2 which is statistically different ($p < 0.05$) from T3 (τ_1-τ_2 = 2.1> LSD = 8.1)(*Table 2*). This might be due to the improvement in soil physical condition for the plant growth along with the increased availability of nitrogen.

The number of flowers / plant

The highest number of flowers at 60 DAS (19 flowers) was recorded in T5 whereas the least (7 flowers) was in T2. There was a significant ($p < 0.05$) difference in T5 and T1 (τ_1-τ_2 =9> LSD =4.7)(*Table 2*). These results were inagreement with those of (Natesh et al ., 2010)who reported that the number of fruit per plantincreased when organic manure was combined with nitrogen application.

The number of pods/ plants

The highest number of pods (15 fruits) at 90 DAS was in (T5) whereas the least (4fruits) was in T2. There was a significant ($p < 0.05$) difference in T5 and T1 (τ_1-τ_2 = 9> LSD = 3.4) (*Table 2*). Abid et al.,(2014), stated the highest number of fruits per plant might be due to the vigour of the plant and more number of leaves per plant.

Seed numbers/pod

The highest seed numbers (87 seeds) per pod were in T5 and the least (51 seeds) seeds number per pod was in T1. There was a significant ($p < 0.05$) difference in T5 and T6(τ_1-τ_2 = 30 > LSD = 14.9)(*Table2*).

Pod weight (g)

Among the treatments, T5 recorded the highest average pod weight (12.5g) and the lowest (6.2 g) was in T1. There was a significant ($p < 0.05$) difference in T5 and T6 (τ_1-τ_2 = 3.2 > LSD = 1.2) and also there was a significant ($p < 0.05$) difference in T1 and T6 (τ_1-τ_2 =3.1 > LSD = 1.2)(*Table 3*). Similarly, the highest pod weight was obtained by (Abid et al. 2014) inchilli plants treated with organic fertilizers.

Pod length (cm)

The highest pod length (6.8 cm) was in T5 and the least diameter (4.4cm) was in T4. There was a significant ($p < 0.05$) difference in T4 and T5 (τ_1-τ_2 =2.4 > LSD = 1.1) (*Table 3*).Correspondingly (Roychaudhury et al. 1997) observed an improvement in fruit size with increasing nitrogen contents in organic fertilizer.

Pod girth (cm)

The highest grith (2.6 cm) was in T5 and the least grith (1.5 cm) was in T1. There was a significant ($P<.05$) difference in T1 and T5 (τ_1-τ_2 =1.1 > LSD = 0.8) (*Table 3*). The effect of organic manure with various levels of inorganic fertilizer had a significant impact on fruit girth (Akanbi et al., 2007).

Pod pericarp weight (g)

The highest pod pericarp weight (4.7 g) was in T5 and the least pericarp weight (1.6g) was in T2. There was a significant ($p < 0.05$) difference in T1 and T5 *(τ_1-τ_2 =1.4> LSD = 0.2) (Table 3).*

Yield / Plant (g)

The highest yield per plant (3.1g) was in (T5) whereas the least (1.9g) was in (T2). There was a significant ($p < 0.05$) difference in T1 (control 1) and T5 (τ_1-τ_2 =0.9 > LSD = 0.6) and control 2 treatment *with T3(τ_1-τ_2 =0.8> LSD = 0.6) (Table 3).*

Final yield (t/ha)

The highest final yield (15. 2 t/ha) was in T5 whereas the least (9.7 t/ha) was in T2 and there was a significant difference ($p < 0.05$) in the final yield of control 1 treatment with T5 (τ_1-τ_2 =4< LSD = 3.8) and control 2 treatment with T3 (τ_1-τ_2 =4.1< LSD = 3.8)(*Table 3*). Hence it was obvious that urea foliar application combined with cow dung treatment had a significant effect on final yield.

According to the DOA, the average yield of the MI-Green variety during the Maha season was 15 t/ha. Laxman *et al.*, (2000), indicated that yield attributes of chilli were highly influenced by the foliar spray of urea. Similar to the present study; Chopra et al., (2005) observed that combining organic and inorganic nutrients increased the production of chilli genotypes. Azad (2000) claimed that using a combination of manures and chemical fertilizers resulted in the highest cabbage

plant height. In a similar study, Ashrafi et al. (2010) discovered that adding organic manure and NPKS to rice plants enhanced growth and yield parameters. Moreover, the results of this study also revealed the beneficial effect when combined organic manure with foliar urea application because organic fertilizers improve soil structure while increasing the performance of beneficial soil organisms (Ouda et al., 2008).

Table 1: Effect of different treatments on the plant height and number of branches at 30, 60, 90 (DAS) in MI-Green chilli.

Treatments	Plant height (cm)			The number of branches per plant		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
$T1_{(Control\ l)}$	10.8	24.7	39.6	2	4	7
$T2_{(Control\ 2)}$	9.7	22.2	36.7	3	6	9
T3	14.5	29.9*	39.5*	4*	6*	10*
T4	16.2	31.6	41.3*	4*	6*	9*
T5	18.6	37.2	53.5	4*	7*	15
T6	11.7*	30.5*	40.3*	2*	6*	9*
$LSD_{(0.05)}$	3.2	8.4	7.1	2.9	4.7	3.6

**Value followed by the asterisk in the same columns is not significantly different with the respective control treatment at LSD test (p<0.05)*

Table 2: Effect of different treatments onplant volume, days to 50% flowering, flowers/plant, pods/plant and seeds/pod in MI-Green chilli.

Treatments	Plant Vol (cm^3)	Days to 50% of flowering	Flowers /plant	Pods/ plant	Seeds/ pod
$T1_{(Control\ l)}$	753.1	67	10	6	68
$T2_{(Control\ 2)}$	693.2	83	7	4	52
T3	997.5	62	8*	5*	80
T4	793.9*	72	17	10	60*
T5	1309	51	19	15	87
T6	787.1*	82	14*	8*	57*
LSD	223.7	8.1	4.7	3.4	14.9

**Value followed by the asterisk in the same columns is not significantly different with the respective control treatment at LSD test (p<0.05)*

Table 3: Effect of different treatments on, pod weight, pod grith and pod pericarp weight, yield/plant and final yield in MI-Green chilli.

Treatments	Pod Weight (g)	Pod Grith (cm)	Pod pericarp weight (g)	Yield/ plant (g)	Final Yield (t/ha)
$T1_{(Control\ l)}$	9.9	2.1	3.3	2.2	11.2
$T2_{(Control\ 2)}$	6.2	1.5	1.6	1.9	9.7
T3	8.8	2.4	2.7	2.7	13.8
T4	8.2	2*	2.8	2.4*	12.4*
T5	12.5	2.6	4.7	3.1	15.2
T6	9.3*	1.8*	3.0*	2.6*	12.8*
$LSD_{(0.05)}$	1.2	0.8	0.2	0.6	3.8

**Value followed by the asterisk in the same columns is not significantly different with the respective control treatment at LSD test (p<0.05)*

Control 1 = 3kg /pot Cow Dung, Control 2 =2 kg/pot cow dung,T3= 2 kg/pot cow dung + foliar urea spray, T4= 2 kg/pot cow dung + urea soil application, T5= 3 kg/pot cow dung+ foliar spray, T6= 3 kg/pot cow dung + Urea soil application. DAS= Days after sowing.

A positive correlation between plant volume (cm^3) and Yield (t/ha) was observed (*Figure1*). The relationship between plant volume (cm^3) and Yield (t/ha) was expressed by the regression equation Yield = 11.24 + 0.0025 Plant Volume. Pearson correlation of yield and plant volume = 0.249 and

P-Value = 0.142; therefore, there was no correlation between yield and plant volume (p> 0.05).

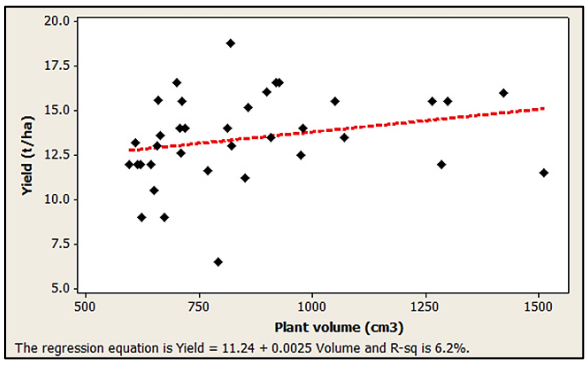

Figure 1: Relationship between plant volume with the average yield.

CONCLUSIONS

When considering growth parameters, the highest plant height, plant volume, the number of branches/ plant and early days to 50% flowering was reported in 3 kg/pot cow dung+ foliar spray (T5). Among yield and yield-related parameters, the highest number of pods/plant, pod weight, the highest yield/plant (g) and final yield (t/ha) were in 3 kg/pot cow dung+ foliar spray (T5). The highest pod length, pericarp weight, pod grith and the number of seeds per pod were also recorded in (T5).

Results disclosed that the best treatment combination to gain a high yield was 3 kg/pot cow dung+ foliar spray (T5). From the above results, it can be concluded that the tested 3 kg/pot cow dung+ foliar spray combination can be used to improve the growth and yield of MI-Greenchilli.

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