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ORIGINAL RESEARCH ARTICLE



Effect of fertilizers and mulching on growth and yield of sweet pepper (*Capsicum annuum* L.)

Nusrat Jahan¹, Tatia Biswas², M.A. Rahim¹ and M. Ashraful Islam^{1*}

¹Department of Horticulture, Bangladesh Agricultural University (BAU), Mymensingh - 2202, BANGLADESH

²Department of Horticulture, Khulna Agricultural University (KAU), Khulna - 9100, BANGLADESH

*Corresponding author's E-mail: ashrafulmi@bau.edu.bd

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ABSTRACT

An experiment was carried out to evaluate the effects of fertilizers and mulching on growth and yield of sweet pepper at the Horticulture Farm, Bangladesh Agricultural University, Mymensingh during the period from October, 2018 to March, 2019. Two factors experiment was laid out in Randomized Complete Block Design (RCBD) with 3 replications. The experiment consisted four (4) levels of organic and inorganic fertilizers viz., F₁ (Vermicompost), F₂ (Recommended dose of NPKS), F₃ (50% Vermicompost + 50% Recommended dose of NPKS) and F₄ (75% Vermicompost + 25% Recommended dose of NPKS); and three mulch materials viz., M₀ (Control), M₁ (White polythene) and M₂ (Black polythene). Plot size was 1 m x 1 m. The growth and physio-morphological characters, yield attributes and yield were significantly influenced by different types of fertilizers application and mulching practices. F₄ treatment (75% Vermicompost + 25% Recommended dose of NPKS) produced maximum yield per hectare (40 t/ha) and F₁ (vermicompost) treatment produced minimum yield per hectare (23.07 t/ha). Fruit yield increased 12.49%, 20.01% and 28.44% higher using F₄, F₃ and F₂, respectively compared to control treatment. Mulching material influenced fruit yield where the maximum yield per hectare (40 t/ha) were observed from the M₂ (Black polythene). Fruit yield (t/ha) recorded 27.06% and 27.50% higher in M₂ and M₁, respectively compared to control. In case of combined treatment, the fresh weight of fruit and dry matter were found higher in M₂F₄ and the lowest in M₀F₁. The maximum yield per hectare (53.31 t/ha) was found in M₂F₄ and M₂F₄ treatment produce 201.75% higher yield (t/ha) compared to control treatment combination M₀F₁ (17.67 t/ha). The second and third highest was found from M₂F₃ and M₁F₄. The highest benefit cost ratio (BCR) was found in M₂ F₄ and it was 7.49. Black plastic mulch with combined fertilizer (vermicompost and chemical fertilizer) gives higher plant height, yield, dry matter and other yield contributing parameters. Control treatment (no mulch) with only vermicompost gives lowest result in all cases.

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INTRODUCTION

Sweet Pepper (*Capsicum annuum* L.) is a year-round international vegetable crop used in variety of ways for home consumptions, catering and industries (Obidiebube *et al.*, 2012). It is the second most important vegetable in the world after tomato. It has

introduced in Bangladesh for several years but not much familiar by the people or farmers. There is a good scope for its large-scale cultivation in Bangladesh for increasing vegetable diversification and to meet vegetable demand of the country's people. The nutritional quality of the fruits, especially as an excellent source of antioxidants- ascorbic acid, carotenoids and phenolic

compounds makes the daily intake of pepper a health protecting factor in the prevention of chronic human degenerative and systemic sicknesses including cancer, diabetes, liver cirrhosis and cardio-vascular diseases (Navarro et al., 2006). Sweet pepper is famous for its pleasant aromatic flavour, pungency and high colouring Substance. It is used very widely in culinary, pharmaceutical and beverage industries (Islam et al., 2017).

Fertilizer is the major source for growth and development of crop. Different types of fertilizers like organic and inorganic fertilizer influence the productivity of any crop. Excessive application of chemical fertilizers in crop field causes health hazards and create problem to the environment by polluting water, air and soil. Excessive use of chemical fertilizer increases insect pests and also hazardous for soil and environment. Farmers are highly dependent on inorganic fertilizers as a source of plant nutrients and the high cost of chemical fertilizers is associated with land and soil degradation as well as environmental pollution (Phiri, 2010). Organic farming practices are suitable way to decrease the negative environmental impact. Organic fertilizers are environmentally friendly and improve high cation exchange capacity, low bulk density, water holding capacity. Organic manures are helpful in improving the physical and nutritional status of the soil. Decomposition of organics in the soil leads to different types of biological reactions which are helpful in preventing various disease-causing pathogens (Ramesh et al., 2010). Organic agriculture can be used to obtain high-quality products and good productivity of sweet pepper. Organic manures play an important role in plant growth as a source of all necessary macro and micro nutrient. Alternatively, there are mixed fertilizers where organic fertilizer is combined with inorganic fertilizer for soil improvement and higher yield. Already, some researchers have applied the combined application of organic and inorganic fertilizer which promotes the sustainable production of vegetables like tomatoes, brinjal, cabbage, Indian spinach, carrots, and okra (Afrin et al., 2019; Farjana et al., 2019; Islam et al., 2017ab; Islam et al., 2020; Ullah et al., 2008). This reduces the need for a higher amount of inorganic fertilizer in crop production. Ultimately, application of reduced amount chemical fertilizer combined with judicious application of organic fertilizer sustain the quality of soil properties and product quality (Islam et al., 2017ab; Biswas et al., 2020) found that about 75% less amount inorganic fertilizer and judiciously incorporated vermicompost as organic fertilizer increased the 198% yield of tomato.

Water is a natural resource and essential for crop production. Production of vegetable is hampered in winter due to lack of irrigation as well as minimum rainfall. Most determinate crops are sensitive to water stress especially at the time of floral initiation, during flowering, and to a lesser extent, during fruit development (Hegde, 2008). In the winter season, the conservation of soil moisture may help in preventing the loss of water through evaporation from the soil facilitating maximum utilization of moisture by the plants. Mulching practices help to conserve soil moisture by reducing evaporation and control weeds effectively

by reducing physiological functions of weed like germination, root, shoot and stem growth (Farzana et al., 2019) found 63.92% higher cabbage yield using black polythene mulch materials compared to control. The use of plastic mulch reduces weed populations, soil evaporation, fertilizer leaching, improves greater water use efficiency. In the era of climate change, mulching should be used for soil moisture conservation, temperature moderation, soil health maintenance, weed management and finally increased productivity. They also influence plant growth and yield when added to the soil surface by reducing evaporation, increasing water infiltration, controlling soil erosion, and improving soil structure (Pramanik et al., 2015; Arun, 2016). By using plastic mulch, it lowers the cost of irrigation as well as cost of production and can ensure the best use of natural resources like water. Use of more organic fertilizers like vermicomposting reduces the use of chemical fertilizers. It also lessens the cost of chemical fertilizers as the market prices of chemical fertilizers are high. Organic fertilizers improve the soil health, increase water holding capacity of soil, do not cause any harm for environment. This study finds out how efficiently organic fertilizers and water can be used in agriculture without hampering the natural environment. Overall growth and development is highly influenced by different management practices like fertilizer, mulching practices and others. Therefore, the present piece of work has been undertaken to find out the appropriate dose of organic and inorganic fertilizers, and to identify the effective mulch material on growth and production of sweet pepper.

MATERIALS AND METHODS

Experimental site and soil

An experiment was conducted at the Horticulture Farm of Bangladesh Agricultural University, Mymensingh during the period from October 2018 to March 2019 to study the effect of different types of fertilizers and mulching on growth and yield of sweet pepper. The experiment was carried out to the soil series of Old Brahmaputra Flood Plain Alluvial Tract (UNDP, 1988) of AEZ-9. The texture of the soil was silty loam with pH 6.6. Soil series was sonatola series which was non-calcareous dark grey. Information regarding monthly maximum, minimum and average temperature, relative humidity was recorded by Weather Yard of Bangladesh Agricultural University, Mymensingh during the experimental period (Table 1).

Experimental design

The two factors experiment was laid out in the Randomized Complete Block Design (RCBD) with three replications. Factor A is the fertilizer treatments (4) and factor B were mulch materials (3). So, total treatment combinations were 12. Here, recommended dose of fertilizer was applied followed by KPH (2018). The total numbers of plots were 36 in the experiment which were placed randomly.

Treatments:

Factor A: Fertilizers application	F ₁ (Vermicompost)
	F ₂ (Recommended dose of NPKS)
	F ₃ (50% Vermicompost + 50% Recommended dose of NPKS)
	F ₄ (75% Vermicompost + 25% Recommended dose of NPKS)
Factor B: Mulch materials	M ₀ (Control)
	M ₁ (White polythene)
	M ₂ (Black polythene)

Raising of seedlings and transplanting

Hybrid sweet pepper seeds were used for this experiment named "Mollika seed". The seeds of this variety were sown in the seedbed (3 m×1 m) for raising seedlings. Weeding, mulching and watering in seedbeds were done as needed. Seedlings germinated within a week. Healthy and uniform size 25 days old seedlings were uprooted separately from the seed bed and transplanted on 10th December so as to minimize damage to the roots. Nine seedlings were transplanted in one experimental plot in the afternoon. Plant spacing was 30 cm × 30 cm in the area of 90 cm × 90 cm plot. Light irrigation was given immediately after transplanting by using a watering can.

Application of manures and fertilizers

Organic and Inorganic fertilizers were applied to the field as per treatment of the experiment. Full dose of TSP and Gypsum and

half dose of vermicompost were applied during land preparation. Urea and MoP were applied in three installments. The first installment of fertilizer was applied 10 days after transplanting. The second and third installments were applied after 30 and 50 days of transplanting according to guidelines of KPH (2018) (Table 2).

Mulching

Mulching was done after 10 days of transplanting. It prevents water evaporation from soil so that it maintains soil moisture for long time and also helps to suppress weed growth that's why plants can get proper nutrient. Mulching was done by black and white polythene.

Intercultural operations

After transplanting, very few seedlings were damaged. Gap filling was done with healthy seedlings having ball of earth and watering was done for 5 days for their proper establishment. Weeding was done, when necessary, throughout the growth period. Several irrigations were given throughout the growing season.

Harvesting

Mature fruits at proper size were harvested at intervals of seven days. As the fruits attained harvesting stage at different times depending upon the size, harvesting was continued for a

Table 1. Monthly record of temperature, relative humidity, rainfall and sunshine during the period from October, 2018 to March, 2019 at BAU campus.

Year	Month	**Air Temperature (°C)			**Relative humidity (%)	*Rainfall (mm)	*Sunshine (hours)
		Maximum	Minimum	Average			
2018	October	35.0	19.0	27	83.7	78	205.9
	November	32.0	15.0	23.5	82.9	04.3	200
	December	28.5	09.0	18.75	86.8	00.0	117.9
2019	January	29.9	09.4	19.45	83.3	18.2	84.7
	February	31.2	11.0	21.1	80.14	8.4	137.8
	March	33.5	16.5	25	74.04	104.8	190.2

*Monthly total; **Monthly average; Source: Weather yard, Department of Irrigation and Water Management, Records of Climatologically observation, Bangladesh Agricultural University, Mymensingh-2202.

Table 2. Manures and fertilizer doses for different treatments.

Treatments	Fertilizer amount (dose/ha)	Fertilizer amount per plot (g)
F ₁	10 ton	
F ₂	Urea=250kg, TSP=350kg, MoP=250kg, Gypsum=110kg	100g
F ₃	5 ton vermicompost + Urea=125kg, TSP=175kg, MoP=125kg, Gypsum=55kg	Urea=2.5g, TSP=2.0g, MoP=1.4g, Gypsum=0.70g
F ₄	7.5 ton vermicompost + Urea=62.5kg, TSP=87.5kg, MoP=62.5kg, Gypsum=27.5kg	70 g vermicompost + Urea=0.84g, TSP=0.67g, MoP=0.47g, Gypsum=0.25g

F₁ = Vermicompost; F₂ = Recommended dose of NPKS; F₃ = 50% Vermicompost + 50% Recommended dose of NPKS; F₄ = 75% Vermicompost + 25% Recommended dose of NPKS.

period of one month. Harvesting was started in 1st week of March and continued up to 1st week of April 2019. Harvesting was done usually by hand picking and seeds from them were collected for next season.

Data collection

The plant height was measured from the sample plants in cm from the ground level to the tip of the longest stem. It was recorded at 15 days interval starting from first day of transplanting. Lastly, the plant height was recorded at 75 DAT (days after transplanting). Number of branches per plant, number of leaves per plant, the number of fruits/plant was recorded. Fruit diameter (cm) and fruit length (cm) was measured by a slide calipers. The mature fruits were harvested and number of seeds was calculated manually. Weigh of fruits (g) were taken by using digital balance and fruit yield was recorded. Production cost was calculated from input cost and overhead cost. Fresh sweet pepper was cut into pieces and kept in an oven for drying at 65°C until a constant mass reached then total dry matter (DM) was calculated.

Statistical analysis

The data in respect of growth, yield and yield components were statistically analyzed to find out the significance of the experimental results. The data were analyzed by analysis of variance (General Linear Model procedure) and Tukey's pair wise comparison test by Duncan's Multiple Range Test (DMRT) at 5% level of probability using Minitab Version 17 (Minitab Inc., State College, PA, USA). The means of all the treatments were calculated and the analysis of variance for each of the characters under study was performed by F test.

RESULTS AND DISCUSSION

Effect of different types of fertilizers on growth and yield of sweet pepper

There was a significant variation shown on different level of fertilizers in respect of plant height, number of leaves per plant, number of primary branches, number of fruits per plant, fruit length, fruit diameter, number of seeds per plant, fresh weight of individual fruit, percent dry matter content, yield per plant, yield per plot and yield per hectare on sweet pepper production. Significant doses of organic and inorganic fertilizers are applied on sweet pepper under study at different days after transplanting. The maximum plant height (22.96 cm) was recorded from the application of F₄ (75% Cow dung+ 25% Recommended dose of NPKS) treatment and the lowest (20.62 cm) was obtained from the F₁ (Vermicompost) treatment at 75 DAT (Figure 1). The maximum number of primary branches per plant (2.95) and leaves per plant (38.04) was noted from F₄ treatment (Table 3). Similar reports also published by Islam *et al.* (2017b). The maximum number of fruits per plant (3.93) was acquired from F₄ and the lowest (2.67) was found from F₁ at maximum vegetative stage (Table 3). The highest yield per plant 360.38 g, per plot 3.24 kg and per ha. 40 t were obtained from F₄ treatment and

the lowest yield per plant 207.82 g, per plot 1.87 kg and per ha.23.07 t was noted from F₁ treatment (Table 3 and Figure 2). Fruit yield was found 70.20% higher (40 t/ha) in F₄ treatment compared to F₁ treatment. Joshi and Pal (2010) also found similar result in case of tomato fruit yield per plant, per plot and per hectare. The higher growth and yield were found from the combined application of vermicompost and recommended dose of chemical fertilizer. This might be the reason of inorganic fertilizers supply the nutrient quickly for the crop production and organic fertilizer release the nutrient slowly for the crop. It gives the opportunity to supply the all nutrients to crop during their production period.

The highest fresh weight of individual fruit 89.33g was recorded from F₄ treatment whereas the lowest fresh weight of individual fruit 61.33g was observed from the F₁ treatment (Table 4). Similarly, Biswas *et al.* (2020) found highest yield at this treatment in tomato. F₄ treatment gives the highest dry matter content (4.94%) and lowest was found from the F₁ treatment. The highest length and diameter of fruits 7.01cm and 6.69cm were recorded from F₄ treatment whereas the lowest length and diameter of fruits 6.19cm and 5.76cm were observed from the F₁ treatment (Table 4). In tomato, similar results were reported by Islam *et al.* (2017b). The maximum number of seeds per fruit (280) was acquired from F₄ and the lowest (141.89) was found from F₁ at maximum vegetative stage.

Effect of mulching on growth and yield of sweet pepper

Plant height is one of the most important growth parameters for growth of plant. There was significant difference among different mulching for plant height. The tallest plant (23.15 cm) was recorded from M₂ (Black polythene) and the shortest (20.35 cm) one was recorded from M₀ (Control) at 75 DAT (Figure 3). The maximum number of leaves per plant (38.33) and the maximum number of primary branches per plant (2.9) was noted from M₂. Similar results were reported by Mahadeen (2014) in okra and summer squash. The effect of different mulching on the yield of sweet pepper per plant, per plot and per hectare was found to be significant. The maximum number of leaves per plant (38.33), number of primary branches per plant (2.90), the highest yield per plant 356.13g, per plot 3.24 kg and per ha. 40 t were audited from M₂ (Black polythene) and the lowest 222.4g per plant, 2 kg per plot and 24.69 t/ha were recorded from M₀ (Control) treatment (Table 5 and Figure 4). M₂ performed 59.12% higher yield (40 t/ha) compared to control. The present result corresponds with that of Aprodia and Maina (2018). Mulch materials absorb the heat from the solar radiation, increase the soil temperature and help to increase the crop production especially in the winter season. Also, it reduces the cost through reducing the weed infestation in the field and moisture conservation (Chakraborty *et al.*, 2008).

The higher fruit length (6.75) and diameter (6.52) were found from the M₂ treatment while the lowest were observed from control treatment (Table 6). The maximum number of seeds per fruit (253.25) was acquired from M₂ and the lowest (146.83) was found from M₀ treatment. The highest fresh weight of individual

Table 3. Effect of fertilizer doses on number of leaves per plant, primary branches per plant, number of fruits per plant, fruit weight per plant, fruit wt. per plot of sweet pepper.

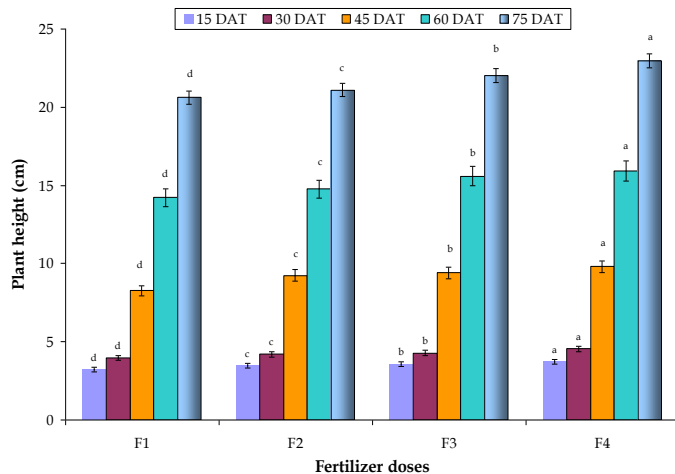
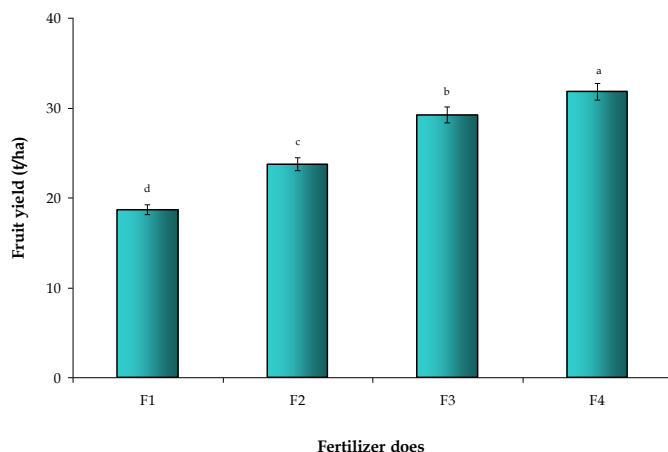
Fertilizer doses	No. of leaves/ plant	No. of Primary branches	No. of fruits/plant	Fruit weight /plant (g)	Fruit wt. /plot (kg)
F ₁	36.07±0.07 c	2.69±0.01 c	2.67±0.03 d	207.82±1.66 d	1.87±0.04 d
F ₂	36.53±0.05 b	2.73±0.03 bc	3.16±0.03 c	261.16±1.48 c	2.40±0.11 c
F ₃	36.76±0.05 b	2.78±0.05 b	3.53±0.03 b	319.64±4.98 b	2.88±0.08 b
F ₄	38.04±0.17 a	2.95±0.02 a	3.93±0.00 a	360.38±3.03 a	3.24±0.09 a
P-value	0.01	0.01	0.01	0.01	0.01

F₁ = Vermicompost, F₂ = Recommended dose of NPKS, F₃ = 50% Vermicompost + 50% Recommended dose of NPKS, F₄ = 75% Vermicompost + 25% Recommended dose of NPKS.

Table 4. Effect of fertilizer doses on fruit length, fruit diameter, number of seeds per fruit, fresh weight of individual fruit, dry matter content of sweet pepper.

Fertilizer doses	Fruit length (cm)	Fruit diameter (cm)	No. of seeds/fruit	Fresh weight of individual fruit (g)	Dry matter (%)
F ₁	6.19±0.02 c	5.76±0.01 d	141.89±2.7 d	61.33±0.19 d	3.11±0.01 d
F ₂	6.23±0.02 c	6.08±0.05 c	184.67±3.00 c	69.44±0.89 c	3.34±0.02 c
F ₃	6.39±0.03 b	6.31±0.02 b	229.67±1.20 b	76.78±0.48 b	4.56±0.04 b
F ₄	7.01±0.09 a	6.69±0.02 a	280.00±2.64 a	89.33±0.39 a	4.94±0.01 a
P-value	0.01	0.01	0.01	0.01	0.01

F₁ = Vermicompost, F₂ = Recommended dose of NPKS, F₃ = 50% Vermicompost + 50% Recommended dose of NPKS, F₄ = 75% Vermicompost + 25% Recommended dose of NPKS.

**Figure 1.** Effect of fertilizer doses on plant height of sweet pepper plant. Vertical bars represent the mean value ± SE (standard error). F₁ = Vermicompost, F₂ = Recommended dose of NPKS, F₃ = 50% Vermicompost + 50% Recommended dose of NPKS, F₄ = 75% Vermicompost + 25% Recommended dose of NPKS.**Figure 2.** Effect of fertilizer doses on yield of sweet pepper per hectare. Vertical bars represent the mean value ± SE (standard error). F₁ = Vermicompost, F₂ = Recommended dose of NPKS, F₃ = 50% Vermicompost + 50% Recommended dose of NPKS, F₄ = 75% Vermicompost + 25% Recommended dose of NPKS.

fruit 83.83 were found from the M₂ (Black polythene) treatment while the lowest fresh weight of individual fruit 61.42 was observed from M₀ (Control) treatment. M₂ treatment gives highest dry matter content (4.35) and lowest was found from the M₀ treatment. The present result corresponds with that of Bogevska *et al.* (2021). They found the highest plants (58.8 cm), the highest number of marketable fruits per plant (8.45), the longest and widest fruits (16.00 and 8.25 cm, respectively), the highest fruit mass (113.79 g) and the highest yield (63.15 t ha⁻¹) were obtained from plants grown with black foil as mulching material.

Combined effect of different types of fertilizers and mulching on growth and yield of sweet pepper

The combined effect of fertilizers and mulching had significant effect on plant height. The maximum plant height (24.20 cm) was obtained from the treatment combination of M₂F₄ (Black polythene and 75% Vermicompost + 25% Recommended dose of NPKS) and lowest (19.40 cm) one was recorded with the treatment combination of M₀F₁ (Control mulch and vermicompost) at maximum vegetative stage (Figure 5). These results are in conformity with the findings of Farjana *et al.* (2019) where highest yield obtained from the combined effect of fertilizer and mulch as black polythene (F3M3) compared to control (F0M0). The maximum number of leaves per plant (39) was obtained from the treatment combination of M₂F₄. The maximum number of primary branches was noted (3.25) from M₂F₄ and lowest (2.67) from M₀F₁, M₀F₂ and M₁F₁. These results are in close conformity with the study carried out by Akhter *et al.* (2018) in squash. The maximum number of fruits per plant (4.93) was obtained from the treatment combination of M₂F₄ and lowest (2.40) was recorded with the treatment combination of M₀F₁ at maximum vegetative stage (Table 7). These results are in close conformity with the study carried out by Mazed *et al.* (2015). The maximum number of fruit length, fruit diameter and number

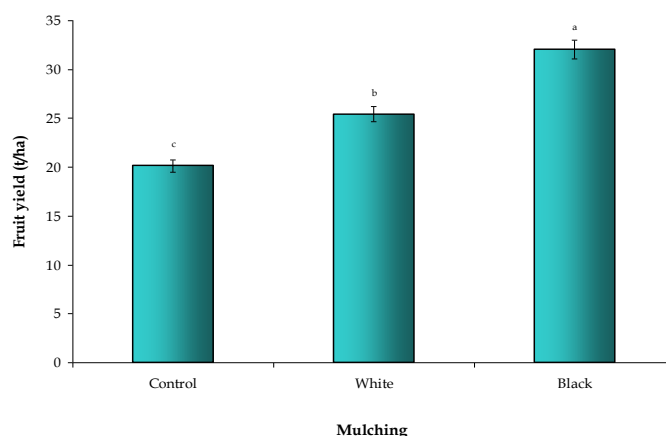
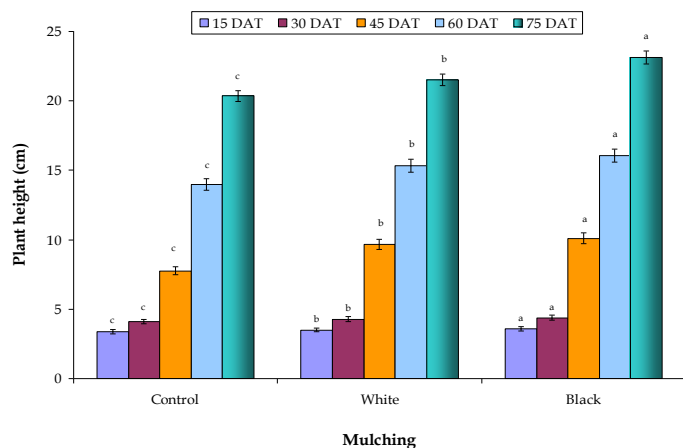


Figure 3. Effect of mulching on plant height of sweet pepper plant. Vertical bars represent the mean value \pm SE (standard error). M_0 = Control, M_1 = White polythene, M_2 = Black polythene.

Figure 4. Effect of mulching on yield of sweet pepper per hectare. Vertical bars represent the mean value \pm SE (standard error). M_0 = Control, M_1 = White polythene, M_2 = Black polythene.

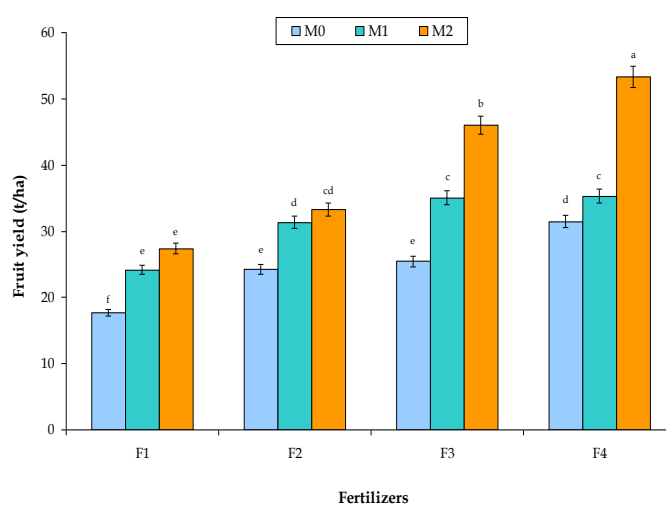
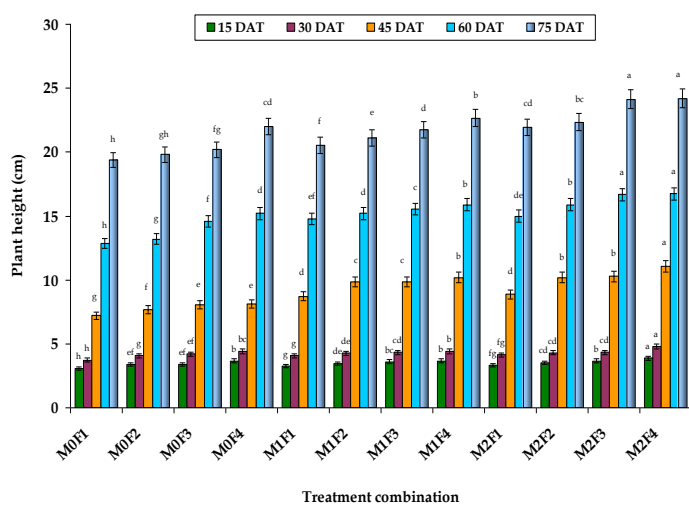


Figure 5. Combined effects of mulching and fertilizer doses on plant height at different days after transplanting of sweet pepper. Vertical bars represent the mean value \pm SE (standard error). M_0 = Control, M_1 = White polythene, M_2 = Black polythene and F_1 = Vermicompost, F_2 = Recommended dose of NPKS, F_3 = 50% Vermicompost + 50% Recommended dose of NPKS, F_4 = 75% Vermicompost + 25% Recommended dose of NPKS.

Figure 6. Combined effects of mulching and fertilizer doses on yield of sweet pepper per hectare. Vertical bars represent the mean value \pm SE (standard error). M_0 = Control, M_1 = White polythene, M_2 = Black polythene and F_1 = Vermicompost, F_2 = Recommended dose of NPKS, F_3 = 50% Vermicompost + 50% Recommended dose of NPKS, F_4 = 75% Vermicompost + 25% Recommended dose of NPKS

Table 5. Effect of mulching on number of leaves per plant, number of primary branches per plant, number of fruits per plant, fruit weight per plant, fruit wt. per plot of sweet pepper.

Mulching	No. of leaves per plant	No. of Primary branches	No. of fruits/plant	Fruit weight /plant (g)	Fruit wt. per plot (kg)
M_0	35.42 \pm 0.05 c	2.72 \pm 0.21 b	2.78 \pm 0.01 c	222.40 \pm 2.76 c	2.00 \pm 0.05 c
M_1	36.80 \pm 0.16 b	2.75 \pm 0.03 b	3.45 \pm 0.04 b	283.22 \pm 1.33 b	2.55 \pm 0.10 b
M_2	38.33 \pm 0.15 a	2.90 \pm 0.02a	3.73 \pm 0.02 a	356.13 \pm 2.05 a	3.24 \pm 0.08 a
P-value	0.01	0.01	0.01	0.01	0.01

M_0 = Control, M_1 = White polythene, M_2 = Black polythene.

Table 6. Effect of mulching on fruit length, fruit diameter, number of seeds per fruit, fresh weight of individual fruit and dry matter content of sweet pepper.

Mulching	Fruit length (cm)	Fruit diameter (cm)	No. of seeds/fruit	Fresh weight of individual fruit (g)	Dry matter (%)
M_0	6.03 \pm 0.03c	5.96 \pm 0.04 c	146.83 \pm 2.13 c	61.42 \pm 0.33 c	3.64 \pm 0.04 c
M_1	6.58 \pm 0.04 b	6.15 \pm 0.03 b	227.08 \pm 3.10 b	77.42 \pm 0.42b	3.97 \pm 0.02 b
M_2	6.75 \pm 0.05 a	6.52 \pm 0.01 a	253.25 \pm 1.23 a	83.83 \pm 0.22 a	4.35 \pm 0.04 a
P-value	0.01	0.01	0.01	0.01	0.01

M_0 = Control, M_1 = White polythene, M_2 = Black polythene.

Table 7. Combined effects of mulching and fertilizer doses on number of leaves per plant, primary branches per plant, number of fruits per plant, fruit weight per plant, fruit wt. per plot of sweet pepper.

Treatment combination	No. of leaves per plant	No. of Primary branch	No. of fruits/plant	Fruit weight /plant (g)	Fruit wt. per plot (kg)
M ₀ F ₁	34.60±0.23 f	2.67±0.02 b	2.40±0.03 h	159.53±3.78 g	1.43±0.04 f
M ₀ F ₂	35.33±0.23 ef	2.67±0.08 b	2.80±0.06 f	218.20±5.80 f	1.96±0.11 e
M ₀ F ₃	35.53±0.02 de	2.73±0.02 b	2.80±0.023 f	228.47±3.57 f	2.06±0.05 e
M ₀ F ₄	36.20±0.12 cd	2.80±0.03 b	3.13±0.03 e	283.40±4.77 d	2.55±0.05 d
M ₁ F ₁	35.60±0.06 de	2.67±0.03 b	2.59±0.05 g	217.73±0.53 f	1.96±0.08 e
M ₁ F ₂	36.20±0.12 cd	2.73±0.02 b	3.13±0.02 e	282.20±6.11 d	2.54±0.23 d
M ₁ F ₃	36.47±0.02 c	2.80±0.06 b	4.33±0.12 b	315.40±2.83 c	2.84±0.04 cd
M ₁ F ₄	38.93±0.58 a	2.80±0.04 b	3.73±0.01 c	317.53±2.37 c	2.86±0.07 c
M ₂ F ₁	38.00±0.29 b	2.73±0.02 b	3.00±0.06 e	246.20±1.22 e	2.22±0.10 e
M ₂ F ₂	38.07±0.04 b	2.80±0.03 b	3.53±0.02 d	283.07±4.07 d	2.69±0.03cd
M ₂ F ₃	38.27±0.16 ab	2.80±0.07 b	3.47±0.05 d	415.07±8.59 b	3.73±0.17 b
M ₂ F ₄	39.00±0.46 a	3.25±0.05a	4.93±0.04 a	480.20±6.09 a	4.31±0.17 a
P-value	0.01	0.01	0.01	0.01	0.01

M₀ = Control, M₁ = White polythene, M₂ = Black polythene and F₁ = Vermicompost, F₂ = Recommended dose of NPKS, F₃ = 50% Vermicompost + 50% Recommended dose of NPKS, F₄ = 75% Vermicompost + 25% Recommended dose of NPKS.

Table 8. Combined effects of mulching and fertilizer doses on fruit length, fruit diameter, number of seeds per fruit, fresh weight of individual fruit, dry weight, percent moisture content, dry matter content of sweet pepper.

Treatment combination	Fruit length (cm)	Fruit diameter (cm)	No. of seeds/fruit	Fresh weight of individual fruit (g)	Dry matter (%)
M ₀ F ₁	5.80±0.023 e	5.57±0.02h	67.33±0.88j	52.00±0.58k	2.97±0.08e
M ₀ F ₂	5.87±0.02 e	5.80±0.06 g	90.00±3.22i	55.33±0.67j	3.04±0.02e
M ₀ F ₃	6.10±0.06 d	6.07±0.04 e	206.33±6.57 f	64.33±0.67i	3.88±0.06c
M ₀ F ₄	6.37±0.08 c	6.40±0.06 c	223.67±2.03 e	74.00±0.58f	4.69±0.02b
M ₁ F ₁	6.37±0.02 c	5.73±0.02 g	167.00±5.13 h	64.67±0.88i	2.97±0.06e
M ₁ F ₂	6.40±0.03 c	6.00±0.09ef	222.67±3.33 e	71.33±0.88g	3.16±0.10de
M ₁ F ₃	6.50±0.10 c	6.23±0.02 d	234.33±4.63de	78.33±0.88e	4.72±0.07b
M ₁ F ₄	7.07±0.04 b	6.63±0.02 b	284.33±7.06 b	95.33±0.88b	5.02±0.01a
M ₂ F ₁	6.40±0.05 c	5.97±0.02f	191.33±2.96 g	67.33±0.88h	3.38±0.05d
M ₂ F ₂	6.43±0.02 c	6.43±0.02 c	241.33±5.93cd	81.67±1.45d	3.80±0.17c
M ₂ F ₃	6.57±0.06 c	6.63±0.02 b	248.33±1.20c	87.67±0.88c	5.08±0.05a
M ₂ F ₄	7.60±0.17a	7.03±0.02 a	332.00±3.79 a	98.67±1.20a	5.12±0.03a
P-value	0.01	0.05	0.01	0.01	0.01

M₀ = Control, M₁ = White polythene, M₂ = Black polythene and F₁ = Vermicompost, F₂ = Recommended dose of NPKS, F₃ = 50% Vermicompost + 50% Recommended dose of NPKS, F₄ = 75% Vermicompost + 25% Recommended dose of NPKS.

Table 9. Benefit cost ratio of sweet pepper cultivation in one hectare of land with different mulching and fertilizer.

Treatments	BCR
M ₀ F ₁	2.44
M ₀ F ₂	4.33
M ₀ F ₃	3.97
M ₀ F ₄	4.62
M ₁ F ₁	3.26
M ₁ F ₂	5.42
M ₁ F ₃	5.30
M ₁ F ₄	5.03
M ₂ F ₁	3.64
M ₂ F ₂	5.65
M ₂ F ₃	6.86
M ₂ F ₄	7.49

M₀ = Control, M₁ = White polythene, M₂ = Black polythene and F₁ = Vermicompost, F₂ = Recommended dose of NPKS, F₃ = 50% Vermicompost + 50% Recommended dose of NPKS, F₄ = 75% Vermicompost + 25% Recommended dose of NPKS.

of seeds per fruit 7.60, 7.03 and 332 were obtained from the treatment combination of M₂F₄ respectively. The fresh weight of individual fruit (98.67 g), dry matter content (5.12) was highest at the treatment combination of M₂F₄ and lowest were found from the M₀F₁ treatment (Table 8).

The highest yield per plant 480.2 g, per plot 4.31 kg and per ha. 53.31 t were recorded from the treatment combination of M₂F₄ (Black polythene and 75% Vermicompost + 25% Recommended dose of NPKS) while the lowest yield per plant 159.5 g, per plot 1.43 kg and per ha. 17.67 t were observed from the treatment combination of M₀F₁ (Table 7 and Figure 6). M₂F₄ treatment showed 201.75% higher yield (53.31 t/ha) compared to M₀F₁ treatment. The higher yield with combined effect of fertilizers and mulching also reported by Reddy et al. (2018). In contrast, sweet pepper cultivation is very profitable production system under M₂F₄ (Black polythene and 75% Vermicompost + 25% Recommended dose of NPKS) treatment because mulching is very useful for soil moisture conservation, temperature moderation, soil health maintenance, weed management and finally increased productivity (Pramanik et al., 2015). Also included those applications of vermicompost in combination with other inorganic fertilizer have been proved effective to enhance growth and yield of fruit (Javed and Panwar, 2013; Chiezey and Odunze, 2009). Growth and yield of the vegetable crop is remarkably influenced by organic and inorganic nutrients management along with mulching to control weed and conserve soil moisture (Murungu et al., 2011).

Benefit cost ratio (BCR)

Among all the treatments highest BCR was found (7.49) from M₂F₄ (Black mulch and 75% Vermicompost + 25% Recommended dose of NPKS) and lowest was found (2.44) from M₀F₁ (control and vermicompost) (Table 9).

Conclusion

From the above experimental findings, it shows that different level of organic and inorganic fertilizers played an important role on yield contributing characters and yield of sweet pepper. Different mulching also significantly influenced all the parameters studied. The appropriate combination of fertilizers and mulching varies according to the system of land use, ecological, social and economic conditions. The system enhances nutrient use efficiency, maintains soil health, enhances yield and reduces cost cultivation. The study concluded that a judicious combination strategy of using fertilizers and mulching on sweet pepper may be helpful in increasing the vegetable productivity. It lowers the use of chemical fertilizers which save the environment. A great attention should be given to clean agriculture and application of eco-friendly practices. One of the most significant ways to achieve eco-friendly practices are using of organic fertilizers.

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