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EFFECT OF DIFFERENT TYPES OF MULCHING AND BIOFERTILIZERS ON GROWTH OF BRINJAL (*Solanum melongena* L.)

Ankit Bhadoriya*, Sachin Kumar Singh, Hirdesh Kumar, Arun Sahu, Arun Yadav and Naveen Kumar Singh

School of Agriculture Science Vikrant University Gwalior (M.P.), India
*Corresponding author E-mail: ankitbhadoriya52@gmail.com
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ABSTRACT

The present investigation entitled "Effect of different types of mulching and biofertilizers on growth and yield of brinjal (*Solanum melongena* L.)" was executed at Agriculture Research and development Centre, Sakatpura, Vikrant University, Gwalior (M.P.). Brinjal is a vegetable from *Solanaceae* family that has originated from warm India and China region. It is also known as eggplant, aubergine (French name), baigan or vankaya. Brinjal is a warm-weather crop mostly cultivated in tropical and subtropical regions of the world and their cultivars produce wide fruit diversity with different shapes, sizes and colors. The weather is hot and vegetables are sensitive to heat. This time mulching is an essential operation for achieving higher productivity. Mulches are covering material to the soil surface. It is mainly used to maintain the soil temperature. Mulches protect the root of plant from heat, check evaporation, conserve soil moisture, reduce weed infestation and modify the soil and air microclimate. Organic mulch improves physical, chemical and biological properties of soil, as it adds nutrients to the soil and ultimately enhances the growth and yield of crops. A balanced application of inorganic fertilizers, organic manures and biofertilizers appears to be an ideal proposition to meet nutrient requirements of a crop as compared to single application. Integrated Nutrient management has a great potential to set the growing heavy nutrient demands, to achieve maximum yield and to sustain the crop productivity on long term basis. The experiment was laid out in the Factorial Randomized Block Design (Factorial RBD) with three replications. Each replication was comprised of sixteen treatment combinations consisting of different types of mulch i.e. Plastic mulch, Paddy straw mulch and Soyabean mulch and different types of biofertilizers i.e. *Azotobacter*, PSB + KSB and *Azotobacter* + KSB were applied in Brinjal. Result concluded that the different mulching and biofertilizers treatments were significantly influenced the growth and yield parameters of brinjal. It was observed that the treatment M_2 - Plastic mulch and treatment B_4 - *Azotobacter* + KSB was found the best treatments for enhancing growth and yield of brinjal. The maximum net returns (Rs. 207357 /ha) was found in treatment combination T_8 - M_2B_4 - Plastic mulch x *Azotobacter* + KSB, while the maximum B:C ratio (3.8) was observed in treatment combination T_{12} - M_3B_4 - Paddy straw mulch x *Azotobacter* + KSB.
Keywords **:** Biofertilizers, Mulching, Brinjal, Organic mulch, *Azotobacter*, PSB, KSB.

Introduction

Brinjal (*Solanum melongena* L) is a vegetable from *Solanaceae* family that has originated from warm India and China region (Lawande, 1998). It is also known as eggplant, aubergine (French name), baigan or vankaya. Brinjal is a warm-weather crop mostly cultivated in tropical and subtropical regions of the world and their cultivars produce wide fruit diversity with different shapes, sizes and colors (Jose *et al*., 2016). In our country, generally organic mulches are used for moisture conservation and soil temperature moderation but it has partial control over these and have no reasonable control over weed growth. But now a day, plastic mulches have also gain acceptance in agriculture. Use of plastics in agriculture known as plasticulture is becoming popular in Indian agriculture for boosting crop production. The use of polyethylene as a mulch with irrigation is a widespread practice in commercial vegetable production systems. Organic mulch improves physical, chemical and biological properties of soil, as it adds nutrients to the soil and ultimately enhances the growth and yield of crops (Begum and Saikia, 2013). Bio-fertilizers are microbial inoculants. The complementary use of chemical fertilizers, organic manures, biofertilizers and other organics is important to maintain and sustain a higher level of soil fertility and crop productivity. Bio-fertilizers improve the quantitative and qualitative features of many plants (Yousefi *et al*., 2011). A balanced application of inorganic fertilizers, organic manures and biofertilizers appears to be an ideal proposition to meet nutrient requirements of a crop as compared to single application. Integrated Nutrient management has a great potential to set the growing heavy nutrient demands, to achieve maximum yield and to sustain the crop productivity on long term basis.

Materials and Methods

The experiment was laid out at Agriculture Research and development Centre, Sakatpura, Vikrant University, Gwalior (M.P.) in year 2025-26. The experiment was laid out in the Factorial Randomized Block Design (Factorial RBD) with three replications. Each replication was comprised of sixteen treatment combinations consisting of different types of mulch i.e. Plastic mulch, Paddy straw mulch and Soyabean mulch and different types of biofertilizers i.e. *Azotobacter*, PSB + KSB and *Azotobacter* + KSB were applied in Brinjal (*Solanum melongena* L.).

Treatment details:

Different types of Mulch:

M_1 - No mulch

M_2 - Plastic mulch

M_3 - Paddy straw mulch

M_4 - Soyabean mulch

Different types of Biofertilizers:

B_1 - No biofertilizers

B_2 - *Azotobacter*

B_3 - PSB + KSB

B_4 - *Azotobacter* + KSB

Growth parameters

Plant height (cm) at 30, 60 and 90 DAT

The height of the main stem from the ground level to the apical bud (leaf apex) was measured with the meter scale at 30, 60 and 90 DAT.

Number of branches per plant at 30, 60 and 90 DAT

The numbers of leaves arising from the stem of each tagged plant was counted at 30, 60 and 90 DAT.

Number of leaves per plant at 30, 60 and 90 DAT

The number of leaves on the selected plants were recorded and their mean was worked out and expressed as number of leaves per plant at 30, 60 and 90 DAT.

Phenological parameters

Days to first flowering

Number of days taken, beginning from the transplanting to the formation of flower bud on the five randomly selected plants in each germplasm was noted and average was calculated.

Days to 50% flowering

Number of days taken, beginning from the transplanting to the formation of 50 % flower bud on the five randomly selected plants in each germplasm was noted and average was calculated.

Number of flowers per plant

The total numbers of flowers on the selected plants were recorded and their mean was worked out and expressed as number of flowers per plant.

Leaf length (cm)

The length of three selected leaves of each five-tagged plant was taken with the help of centimetre scale and mean was worked out.

Leaf width (cm)

The width of three selected leaves of each five-tagged plant was taken with the help of centimetre scale and mean was worked out.

Leaf area (cm^2)

At random five plants form each germplasm and replication were uprooted and cleaned. The assimilatory surface area (A) was recorded by using electronic leaf area meter (Li Cor 3000).

Fruit setting (%)

Four branches are randomly selected and tagged on the plant and the number of flowers counted separately on each branch after that number of fruits counted. The fruit setting percent is calculated with following formula:

$$\text{Fruit set (\%)} = \frac{\text{Number of set fruits}}{\text{Number of flowers}} \times 100$$

Fruit drop (%)

The fruit drop percent is calculated with following formula:

Fruit drop (%) = fruit setting (%) – fruit retention (%)

Fruit retention (%)

The fruit retention per cent is calculated with following formula:

$$\text{Fruit retention}(\%) = \frac{\text{Number of fruits at harvest}}{\text{Number of flowers}} \times 100$$

Result and Discussion

Growth parameters

Mulching

The treatment M_2 - Plastic mulch was the best mulching treatment for enhancing growth parameters of brinjal and it gave the maximum growth parameters viz., plant height, number of branches and number of leaves at 30, 60 and 90 DAT, while the minimum growth parameters viz., plant height, number of branches and number of leaves at 30, 60 and 90 DAT were recorded with M_1 - No mulch. This may be also due to comparatively warm soil temperature and proper moisture availability (as influenced by mulches) that existed during entire growth stage of brinjal plant which provided the favourable conditions essential for plant growth processes resulting in efficient utilization of photosynthates for better growth, photosynthate substrates mobilization and development of the plants. Polythene mulch is also responsible for reduced fertilizer leaching, higher uptake of nutrients, increased water use efficiency, elevated soil carbon dioxide levels which improved the plant performance and ultimately vegetative growth. Findings are in agreement with those of Kumar *et al.* (2018), Kishore and Daniel (2018), Vidyasagar *et al.* (2018a) and Kamboj *et al.* (2019).

Biofertilizers

The treatment B_4 - *Azotobacter* + KSB was significantly superior treatment as compared to rest of treatments for improving the growth parameters of brinjal and it recorded the maximum growth parameters viz., plant height, number of branches and number of leaves at 30, 60 and 90 DAT, whereas the treatment B_1 - No biofertilizers was observed the minimum growth parameters viz., plant height, number of branches and number of leaves at 30, 60 and 90 DAT. The reason for the increase in vegetative growth may be due to the availability of the necessary nutrients in the chemical fertilizer N, P and K added to the soil close to the root zone, its transfer to the vegetative system and its exploitation in the biological and physiological processes inside the plant such as carbon assimilation, respiration and the processes involved in the synthesis of nuclear acids necessary in the division of cells and new tissues that help the growth of different parts of the plant This statement is justified in light of research carried out by Jaishwal *et al.* (2019), Nisar *et al.* (2019), Sherpa *et al.* (2019), Hossain and Akter (2020), Padhiary and Dubey (2020) and Baboo *et al.* (2024).

Phenological parameters

Mulching

Result reported that the minimum days to first and 50% flowering was found in treatment M_2 - Plastic mulch and it was significantly superior treatment as compared to rest of treatments. However, the maximum days to first and 50% flowering was appended with treatment M_1 - No mulch, among in mulching. This might be due to silver polythene mulches provide favourable environmental conditions for brinjal growth and development and thus inducing early flowering. Similar results for most of the characters were also reported by Das *et al.* (2016), Kishore and Daniel (2018) and Kamboj *et al.* (2019).

The treatment M_2 - Plastic mulch was the statistically best treatment for enhancing the phenological parameters in brinjal and it recorded the maximum phenological parameters viz., number of flowers per plant, leaf length, leaf width, leaf area, fruit setting, retention and drop percent, whereas the minimum phenological parameters viz., number of flowers per plant, leaf length, leaf width, leaf area, fruit setting, retention and drop percent were found with treatment M_1 - No mulch. Findings are in agreement with those of Kumar *et al.* (2018), Kishore and Daniel (2018) and Král *et al.* (2020).

Biofertilizers

It was recorded that the minimum days to first and 50% flowering was observed with treatment B_4 - *Azotobacter* + KSB and it was the best treatment for improving the flowering in brinjal. However, the maximum days to first and 50% flowering was noted with treatment B_1 - No biofertilizers, among in biofertilizers. This might be attributed to certain growth promoting substances secreted by the biofertilizers which in turn might have led to better root development, better transportation of water, uptake and deposition of nutrients. This statement is justified in light of research carried out by Almammory and Matloob (2019), Jaishwal *et al.* (2019), Sherpa *et al.* (2019) and Baboo *et al.* (2024).

The treatment B_4 - *Azotobacter* + KSB was significantly best treatment as compared to rest of treatments and it also gave the maximum phenological parameters viz., number of flowers per plant, leaf length, leaf width, leaf area, fruit setting, retention and drop percent, whereas the treatment B_1 - No biofertilizers was noted the minimum phenological parameters viz., number of flowers per plant, leaf length, leaf width, leaf area, fruit setting, retention and drop percent in brinjal. This might be attributed to certain growth promoting substances secreted by the biofertilizers which in turn might have led to better root development, better transportation of water, uptake and deposition of nutrients. The results are in confirmation with the results achieved by Jaishwal *et al.* (2019), Hossain and Akter (2020) and Padhiary and Dubey (2020).

Conclusion

Result concluded that the different mulching and biofertilizers treatments were significantly influenced the growth parameters of brinjal. It was observed that the treatment M_2 - Plastic mulch and treatment B_4 - *Azotobacter* + KSB was found the best treatments for enhancing growth of brinjal.

Table 1 : Effect of different types of mulching and biofertilizers on growth parameters of brinjal

Plant height (cm) at 30 DAT					
	B_1	**B_2**	**B_3**	**B_4**	**Mean**
M_1	18.40	19.59	21.31	23.92	**20.81**
M_2	19.53	20.83	23.22	25.30	**22.22**
M_3	19.10	20.64	22.29	24.76	**21.70**
M_4	18.91	20.18	21.81	24.19	**21.27**
Mean	**18.99**	**20.31**	**22.16**	**24.54**	
	M	**B**	**M*B**		
S.E.(m)	0.345	0.345	0.690		
C.D.(at 5%)	0.997	0.997	NS		
Plant height (cm) at 60 DAT					
	B_1	**B_2**	**B_3**	**B_4**	**Mean**
M_1	50.40	53.45	56.32	58.39	**54.64**
M_2	53.11	55.56	58.06	60.40	**56.78**
M_3	52.27	54.54	57.44	59.08	**55.83**
M_4	51.03	53.72	56.83	58.93	**55.13**
Mean	**51.70**	**54.32**	**57.16**	**59.20**	
	M	**B**	**M*B**		
S.E.(m)	0.467	0.467	0.934		
C.D.(at 5%)	1.349	1.349	NS		
Plant height (cm) at 90 DAT					
	B_1	**B_2**	**B_3**	**B_4**	**Mean**
M_1	67.40	69.91	74.28	78.08	**72.42**
M_2	69.06	72.38	77.45	80.40	**74.82**
M_3	68.98	71.07	75.47	79.22	**73.68**
M_4	67.82	70.73	75.26	78.14	**72.99**
Mean	**68.32**	**71.02**	**75.61**	**78.96**	
	M	**B**	**M*B**		
S.E.(m)	0.600	0.600	1.199		
C.D.(at 5%)	1.731	1.731	NS		

Number of branches per plant at 30 DAT					
	B_1	**B_2**	**B_3**	**B_4**	**Mean**
M_1	3.90	4.46	5.00	5.43	**4.70**
M_2	4.32	4.85	5.42	5.93	**5.13**
M_3	4.17	4.74	5.31	5.90	**5.03**
M_4	4.10	4.60	5.20	5.67	**4.89**
Mean	**4.12**	**4.66**	**5.23**	**5.73**	

	M	B	M*B		
S.E.(m)	0.109	0.109	0.217		
C.D.(at 5%)	0.314	0.314	NS		
Number of branches per plant at 60 DAT					
	B_1	**B_2**	**B_3**	**B_4**	**Mean**
M_1	10.11	11.56	13.74	14.72	**12.54**
M_2	11.45	13.11	14.13	15.40	**13.52**
M_3	10.87	12.59	14.05	15.19	**13.18**
M_4	10.21	12.58	13.82	15.09	**12.93**
Mean	**10.66**	**12.46**	**13.94**	**15.10**	
	M	**B2**	**M*B**		
S.E.(m)	0.236	0.236	0.472		
C.D.(at 5%)	0.681	0.681	NS		
Number of branches per plant at 90 DAT					
	B_1	**B_2**	**B_3**	**B_4**	**Mean**
M_1	18.40	19.69	20.80	21.96	**20.21**
M_2	19.66	20.20	21.84	23.40	**21.28**
M_3	19.24	20.00	21.82	22.21	**20.82**
M_4	18.48	19.97	21.36	22.14	**20.49**
Mean	**18.95**	**19.96**	**21.45**	**22.43**	
	M	**B2**	**M*B**		
S.E.(m)	0.251	0.251	0.503		
C.D.(at 5%)	0.726	0.726	NS		

Number of leaves per plant at 30 DAT					
	B_1	**B_2**	**B_3**	**B_4**	**Mean**
M_1	4.90	5.31	5.95	6.75	**5.73**
M_2	5.31	5.88	6.74	7.10	**6.26**
M_3	5.22	5.71	6.32	6.88	**6.03**
M_4	5.07	5.40	6.17	6.83	**5.87**
Mean	**5.12**	**5.58**	**6.30**	**6.89**	
	M	**B**	**M*B**		
S.E.(m)	0.113	0.113	0.226		
C.D.(at 5%)	0.326	0.326	NS		
Number of leaves per plant at 60 DAT					
	B_1	**B_2**	**B_3**	**B_4**	**Mean**
M_1	25.10	28.87	31.13	34.77	**29.97**
M_2	28.40	30.97	33.35	37.10	**32.46**
M_3	27.21	30.00	32.21	36.18	**31.40**
M_4	26.13	29.84	31.80	35.24	**30.75**
Mean	**26.71**	**29.92**	**32.12**	**35.83**	
	M	**B**	**M*B**		
S.E.(m)	0.581	0.581	1.162		
C.D.(at 5%)	1.678	1.678	NS		
Number of leaves per plant at 90 DAT					
	B_1	**B_2**	**B_3**	**B_4**	**Mean**
M_1	40.20	43.32	49.66	53.56	**46.68**
M_2	42.26	48.03	52.33	57.20	**49.96**

M_3	42.21	47.63	51.32	57.07	**49.56**
M_4	41.18	44.35	50.49	56.72	**48.18**
Mean	**41.46**	**45.83**	**50.95**	**56.14**	
	M	**B**	**M*B**		
S.E.(m)	0.590	0.590	1.180		
C.D.(at 5%)	1.704	1.704	NS		

Table 2 : Effect of different types of mulching and biofertilizers on phenological parameters of brinjal

Days to first flowering					
	B_1	**B_2**	**B_3**	**B_4**	**Mean**
M_1	52.40	49.72	46.50	44.38	**48.25**
M_2	50.36	47.59	45.37	40.40	**45.93**
M_3	51.12	48.04	45.48	42.27	**46.73**
M_4	51.30	49.02	45.85	43.30	**47.37**
Mean	**51.30**	**48.59**	**45.80**	**42.59**	
	M	**B2**	**M*B**		
S.E.(m)	0.570	0.570	1.141		
C.D.(at 5%)	1.647	1.647	NS		
Days to 50% flowering					
	B_1	**B_2**	**B_3**	**B_4**	**Mean**
M_1	61.72	58.79	56.50	54.38	**57.85**
M_2	59.72	56.91	55.23	49.79	**55.41**
M_3	60.82	57.09	55.37	52.10	**56.35**
M_4	61.12	58.00	55.48	53.68	**57.07**
Mean	**60.85**	**57.70**	**55.65**	**52.49**	
	M	**B2**	**M*B**		
S.E.(m)	0.597	0.597	1.195		
C.D.(at 5%)	1.725	1.725	NS		
Number of flowers per plant					
	B_1	**B_2**	**B_3**	**B_4**	**Mean**
M_1	2.40	3.10	3.82	4.70	**3.51**
M_2	3.00	3.74	4.66	5.53	**4.23**
M_3	2.83	3.47	4.47	5.14	**3.98**
M_4	2.62	3.21	4.05	4.90	**3.70**
Mean	**2.72**	**3.38**	**4.25**	**5.07**	
	M	**B2**	**M*B**		
S.E.(m)	0.092	0.092	0.183		
C.D.(at 5%)	0.264	0.264	NS		
Leaf length (cm)					
	B_1	**B_2**	**B_3**	**B_4**	**Mean**
M_1	12.10	13.80	14.91	15.67	**14.12**
M_2	13.69	14.72	15.44	17.10	**15.24**
M_3	13.53	14.53	15.20	16.81	**15.02**
M_4	12.33	14.12	15.05	16.51	**14.50**
Mean	**12.91**	**14.29**	**15.15**	**16.52**	
	M	**B2**	**M*B**		
S.E.(m)	0.247	0.247	0.493		
C.D.(at 5%)	0.712	0.712	NS		
Leaf width (cm)					
	B_1	**B_2**	**B_3**	**B_4**	**Mean**
M_1	9.20	10.20	11.00	11.79	**10.55**

M_2	10.02	10.77	11.56	12.20	**11.14**
M_3	9.53	10.68	11.33	12.05	**10.90**
M_4	9.31	10.67	11.10	11.81	**10.72**
Mean	**9.52**	**10.58**	**11.25**	**11.96**	
	M	**B2**	**M*B**		
S.E.(m)	0.048	0.048	0.096		
C.D.(at 5%)	0.138	0.138	NS		
Leaf area (cm^2)					
	B_1	**B_2**	**B_3**	**B_4**	**Mean**
M_1	2354.35	2671.97	2992.12	3218.81	**2809.32**
M_2	2548.79	2797.65	3177.45	3905.46	**3107.34**
M_3	2542.13	2728.36	3149.91	3581.01	**3000.35**
M_4	2466.31	2703.94	3097.12	3411.91	**2919.82**
Mean	**2477.90**	**2725.48**	**3104.15**	**3529.30**	
	M	**B**	**M*B**		
S.E.(m)	49.428	49.428	98.856		
C.D.(at 5%)	142.739	142.739	NS		
Fruit setting (%)					
	B_1	**B_2**	**B_3**	**B_4**	**Mean**
M_1	62.35	70.53	74.73	79.66	**71.82**
M_2	69.15	74.67	77.59	85.84	**76.81**
M_3	67.76	71.40	76.19	83.72	**74.76**
M_4	65.23	70.59	75.25	80.68	**72.94**
Mean	**66.12**	**71.80**	**75.94**	**82.47**	
	M	**B**	**M*B**		
S.E.(m)	0.300	0.300	0.600		
C.D.(at 5%)	0.866	0.866	1.733		
Fruit drop (%)					
	B_1	**B_2**	**B_3**	**B_4**	**Mean**
M_1	26.23	30.55	29.77	31.29	**29.46**
M_2	29.63	31.30	29.59	35.74	**31.56**
M_3	28.71	29.37	29.72	34.30	**30.52**
M_4	27.61	29.04	30.17	31.47	**29.57**
Mean	**28.04**	**30.07**	**29.81**	**33.20**	
	M	**B2**	**M*B**		
S.E.(m)	0.406	0.406	0.812		
C.D.(at 5%)	1.172	1.172	NS		
Fruit retention (%)					
	B_1	**B_2**	**B_3**	**B_4**	**Mean**
M_1	36.12	39.98	44.97	48.37	**42.36**
M_2	39.52	43.37	48.00	50.10	**45.25**
M_3	39.05	42.02	46.47	49.42	**44.24**
M_4	37.62	41.55	45.09	49.20	**43.37**
Mean	**38.08**	**41.73**	**46.13**	**49.27**	
	M	**B2**	**M*B**		
S.E.(m)	0.281	0.281	0.563		
C.D.(at 5%)	0.813	0.813	NS		

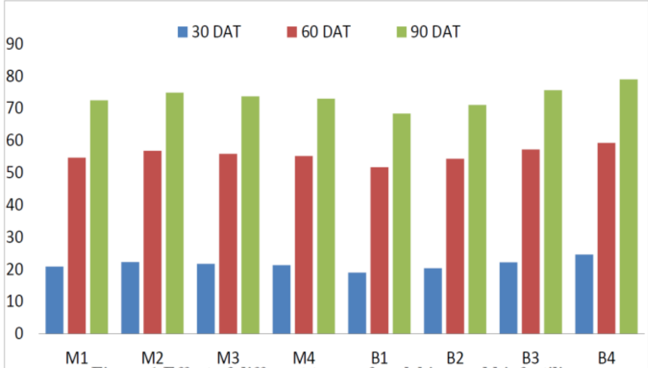

Figure 1 Effect of different types of mulching and biofertilizers on plant height (cm) at 30, 60 and 90 DAT of brinjal

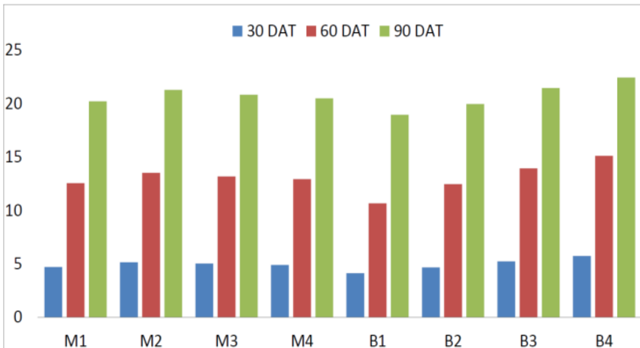

Figure 2 Effect of different types of mulching and biofertilizers on number of branches per plant at 30, 60 and 90 DAT of brinjal

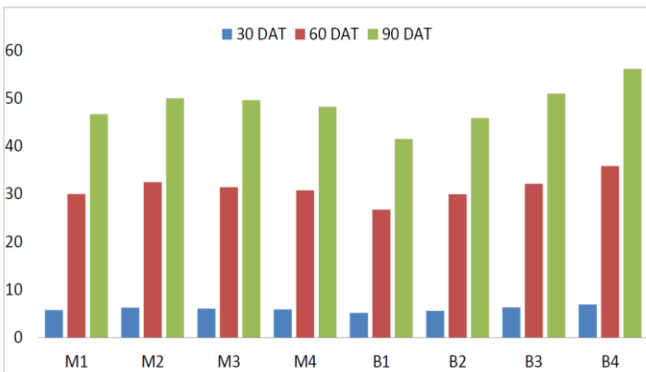

Figure 3 Effect of different types of mulching and biofertilizers on number of leaves per plant at 30, 60 and 90 DAT of brinjal

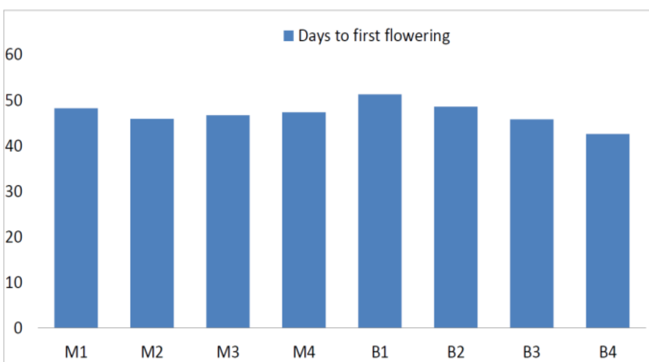

Figure 4 Effect of different types of mulching and biofertilizers on days to first flowering of brinjal

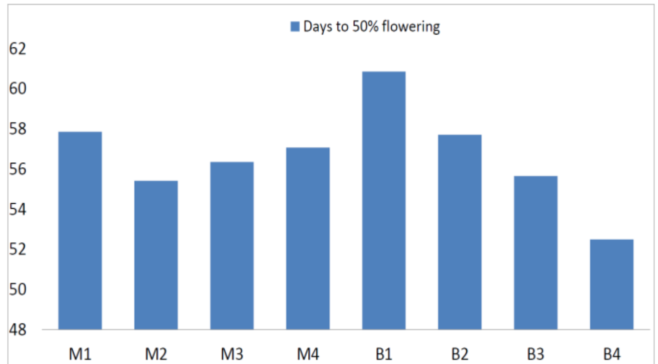

Figure 5 Effect of different types of mulching and biofertilizers on days to 50% flowering of brinjal

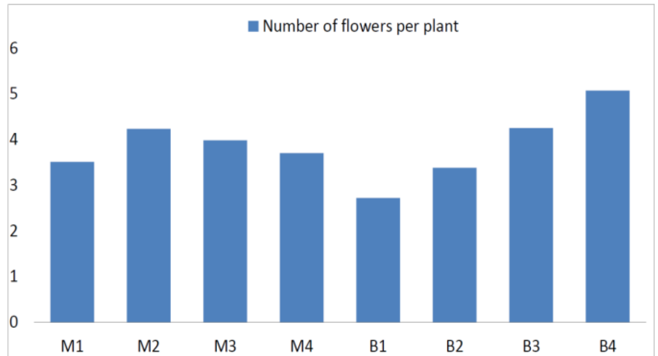

Figure 6 Effect of different types of mulching and biofertilizers on number of flowers per plant of brinjal

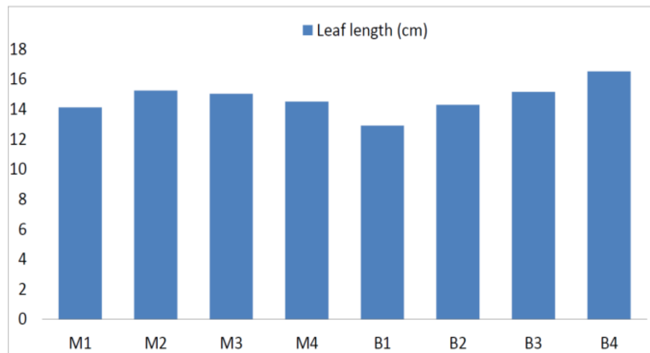

Figure 7 Effect of different types of mulching and biofertilizers on leaf length (cm) of brinjal

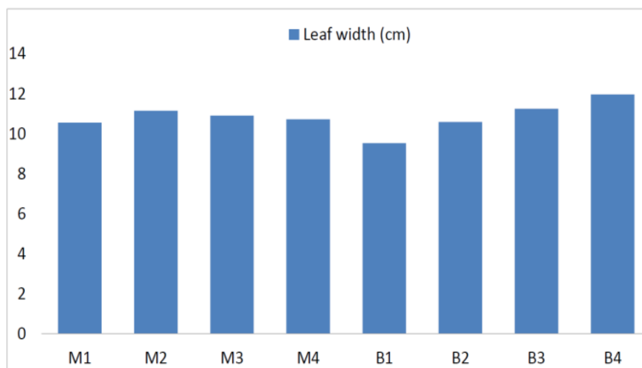

Figure 8 Effect of different types of mulching and biofertilizers on leaf width (cm) of brinjal

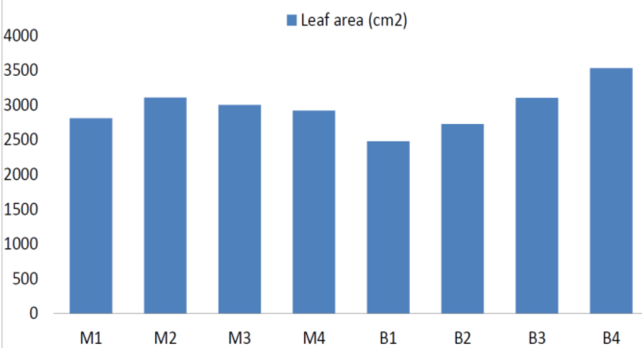

Figure 9 Effect of different types of mulching and biofertilizers on leaf area (cm^2) of brinjal

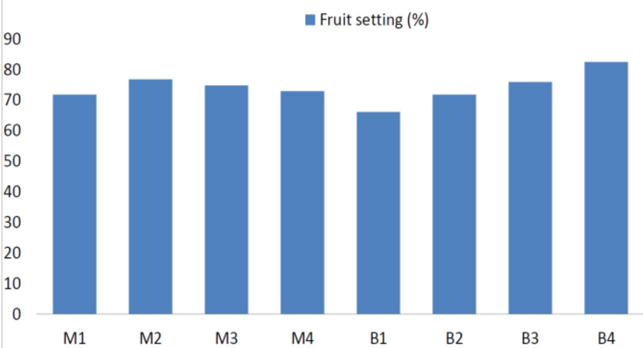

Figure 10 Effect of different types of mulching and biofertilizers on fruit setting (%) of brinjal

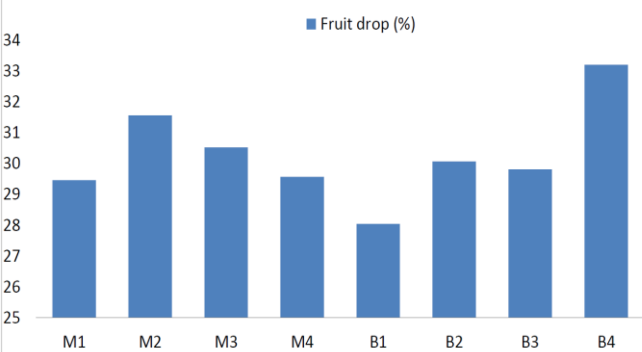

Figure 11 Effect of different types of mulching and biofertilizers on fruit drop (%) of brinjal

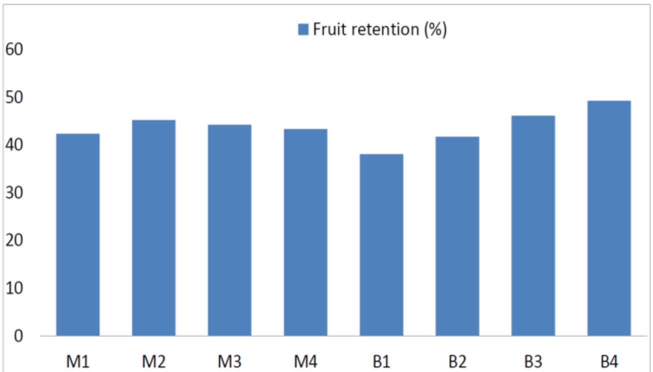

Figure 12 Effect of different types of mulching and biofertilizers on fruit retention (%) of brinjal

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