GROWTH, YIELD AND FRUIT QUALITY OF CAPSICUM HYBRIDS *(Capsicum annuum)* AS AFFECTED BY INTEGRATION OF INORGANIC FERTILIZERS AND ORGANIC MANURES (FYM) IN PROTECTED CONDITION

ABSTRACT

A trial was conducted at Horticulture Research Farm, Department of Horticulture, during the year 2022-23. Five *Capsicum* ~~V~~varieties: ~~Names~~ Nemalite, Cebrail, Bungi, Volante, and Shehzadi. were evaluated at SHUATS, Prayagraj in randomized block design with three replications during Jan-April 2023-24 to evaluate the best performing variety in terms of growth, yield, and quality. The ~~V~~variety Cebrail performed best in terms of plant height (68.97 cm), ~~N~~number of branches (4.89), days to first flower initiation (42.89), ~~C~~chlorophyll content (°Brix) (45.71 cm), ~~N~~number of fruits per plant (8.11), ~~F~~fruit length (9.2 cm), individual fruit weight (160.44 g), fruit yield per plant (1.15 kg), ~~M~~maximum fruit yield per plot(6.90 kg).The highest ~~cost~~benefit-cost ratio was found at 2.88 in the same variety.

Keywords: Capsicum; Performance;Varieties

1. Introduction

Capsicum (*Capsicum annuum L.*) moreover called Simla Mirch in India is one of the most important vegetables grown in open situations further to beneath managed situations. Its financial significance as ~~a~~ an excessive-fee vegetable crop both in home and remote places markets. due to more consumer alternatives and use in diverse culinary products, satisfactory production of capsicum is the need of the day.

1.1. Why Integrated Nutrient Management?

It is the combined application of chemical fertilizers and organic manures for crop manufacturing. it's miles ecologically, socially, and economically feasible. It will increase crop yield and first-rate, ~~I~~it minimizse the quantity of synthetic and natural fertilizsers you use, It reduce ammonia emissions and enhances air first-class and human health, It lessen damage to sensitive habitats due to extra nutrients carried in the air or via water, It lessen greenhouse fuel emissions and assists lessen the outcomes of climate alternate.

Importance of Integrated Nutrient M~~m~~anagement

- Nutrient management helps to reduce the contamination ~~t~~of waterways by plant nutrients.
- Improve soil fertility.
- Enhance plant productivity.
- Reduce the cost of chemical fertilizers.
- Providing balanced nutrition to crops.
- Promotes carbon sequestration and prevents the deterioration of soil, water, ecology, and also leaching of nutrients from the soil.
- Help to check the emerging deficiency of nutrients other than NPK.

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Comment [HG1]: The title of the research is very interesting however, there is a misunderstanding when explaining/writing the methodology and results. The result is explained in terms of varietal effect only by ignoring the influence of inorganic and organic fertilizer on growth, yield and yield components of the five varieties.

Comment [HG2]: Chlorophyll content is typically not measured in degrees Brix (°Brix), as Brix is a unit of measurement primarily used to quantify the sugar content in a solution, such as fruit juices or plant sap. Chlorophyll content is usually measured using methods specific to chlorophyll analysis, such as spectrophotometry or fluorometry.

Comment [HG3]: The introduction part should be revised and include:A brief overview of Capsicum cultivation, highlighting its economic importance, nutritional value, and global production trends.
Importance of Growth, Yield, and Fruit Quality: Discuss the key factors influencing the growth, yield, and fruit quality of Capsicum hybrids. Highlight the importance of optimizing these factors to enhance productivity and marketability in Capsicum cultivation.
Role of Fertilizers and Manures: Explain the role of fertilizers and organic manures in modern agricultural practices, focusing on their contributions to soil fertility, nutrient uptake, and crop performance. Discuss the advantages and disadvantages of inorganic fertilizers and organic manures, including their impact on soil health, environmental sustainability, and crop nutrition.
Need for Integrated Nutrient Management: Describe the concept of integrated nutrient management (INM) and its relevance in optimizing nutrient availability for crop growth and development. Emphasize the potential benefits of integrating inorganic fertilizers and organic manures, such as synergistic nutrient effects, improved soil structure, and enhanced crop resilience.
Research Gap and Objectives: Identify the knowledge gap or research gap that motivates the current study. Clearly state the objectives of the research, which may include evaluating the effects of integrating inorganic fertilizers and organic manures on the growth, yield, and fruit quality of Capsicum hybrids in protected conditions.
Significance of the Study: Highlight the potential contributions of the study to the agricultural sector, including improved crop management practices, enhanced resource use efficiency, and sustainable production of high-quality Capsicum crops. Discuss the relevance of the findings for farmers, researchers, policymakers, and other stakeholders involved in Capsicum cultivation and horticultural production.

- It brings economy and efficiency ~~in~~ to fertilizer use and favourably affects the physical, chemical, and biological environment of soil.

2.MATERIALS AND METHODS

This experiment was carried out ~~during~~ in 2023 at Horticulture Research Farm, SHUATS, Prayagraj, UP, which is located at 25.28°N latitude, 81.54°E longitude, and 98 m altitude above the mean sea level. This area is situated on the right side of the river Yamuna by the side of Prayagraj Rewa Road about 5 km away from Prayagraj, city. The experiment was done in the polyhouse. The highest O_2 and CO_2 ~~C~~concentration was 20.2%. and 480 ppm respectively. In the polyhouse the maximum temperature was 34.7 °C. The maximum light intensity inside and outside the polyhouse was ~~were~~ 63600 lux and 110600 lux.

The temperature reache~~d~~s up to 48°C in summer and in winter it goes down to as low as 2-3 °C. The experiment was laid out in a randomized block design with 9 treatments and three replications. The crop was grown in a naturally ventilated polyhouse. 30 days old seedlings were used for transplanting. November was the first week that transplants were performed at 60 cm × 45 cm spacing on the raised bed. The plants were trained along a plastic thread tied to GI wire stretched over beds. The necessary recommended cultural practices like fertilizer application, irrigation, and weeding.

3. Experimental design should be included and stated very clearly,and the data should be checked for assumptions of ANOVA, ANOVA result should be included and it should be analysed in statistical methods used for posthoc analysis for those that showed a significant among/between treatments in ANOVA (Analysis of Variance)and then determine significant differences between group means

3.STATISTICAL ANALYSIS

The data recorded during the course of the investigation were subjected to statistical analysis as per the method of analysis of variance Fisher (1950). The significance and non-significance of the treatment effect were judged with the help of 'f' value (variance ratio), and ~~was~~ were compared with the table value at a 5% level of significance. If the calculated value exceed~~ed~~s then the value, the effect of considered to be significant. The significant difference between the means was tested against the critical difference at a 5% level of significance.

4.Results and Discussion

Observations were recorded for growth parameters which are Plant height (cm), Number of primary branches, Days taken for flower initiation, and Chlorophyll content. In Yield parameters are Number of fruits per plant, Fruit length (cm), Fruit diameter (cm), Average fruit weight (g), Fruit yield (kg plant^{-1}), Individual Fruit Weight(gm), Fruit yield (200sq. m). In q~~Q~~uality, parameters are Total soluble solids (°Brix), and Vitamin-C (mg/100g). In economicsparametersare c~~C~~ost of cultivation (Rs/200sq. m), Gross Return (Rs/200sq. m), Net Return (Rs/200sq. m), and Benefit Cost Ratio (Rs/200sq. m).

4.1 Growth Parameter

4.1.1 Plant height (cm)

The Maximum plant height at 90 DAP was recorded in the Variety Capsicum Cebrail (T2) (68.97 cm) given in (Table 1). This might be due to the genetic constitution of the varieties. The differential response of vegetative growth of the different may be due to differences in genetic constituents of the varieties.

4.1.2 Number of primary branches

The Maximum Number of branches was recorded in the Variety Capsicum Cebrail (T2) (4.89) given in (Table 1). It is due to the ~~O~~organic treatment of cebril (T2) was good consumption for those capsicum plants. The temperature can be controlled and regulated under protected conditions, therefore healthy and better growth of plants can be expected under protected conditions. The differential response of vegetative growth of the different varieties~~y~~ may be due to differences in genetic constituents of the varieties and microclimate conditions.

4.1.3 Days taken for flower initiation

Comment [HG4]: All treatments (variety, organic and inorganic fertilizer levels(rates), and their combination should be mentioned here. Moreover, how is an experiment with three factors arranged in CRD? It should be factorial CRD.

Comment [HG5]: Please also specify the country name(for instance, Prayagraj, Nepal, or Bangladesh.

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The Early days to first flower initiation ~~was~~ werecorded in the Variety Capsicum Cebrail (T2) (42.89) given in (Table 1). This may be due occurrence of early flowering is basically a genetic character of each variety. However, favourable temperature regimes in protected conditions for alonger period showed a great impact on the genetic constitution of plants to express its full genetic potential. Better environmental conditions and available nutrients seem~~s~~ to have brought quick changes in plant growth and development.

Table 1 Height of Plant (cm), number of primary branches, days taken for flower initiation, and chlorophyll as affected by inorganic fertilizers and Organic manures in Capsicum varieties in protected condition.

Treatment	Treatment Combination	Plant height (cm)	Number Of Branches	Days to First Flower Initiation
T0(Nemalite)	100% NPK+15t FYM	67.76	4.56	43.56
T1(Nemalite)	100% NPK + 15t FYM + AZOTOBACTER (10 g)	65.86	4.44	43.44
T2(Cebrail)	100% NPK+15t FYM	68.97	4.89	42.89
T3(Cebrail)	100% NPK + 15t FYM + AZOTOBACTER (10 g)	67.91	4.22	43.33
T4(Bungi)	100% NPK+15t FYM	61.34	3.89	48.56
T5(Bungi)	100% NPK + 15t FYM + AZOTOBACTER (10 g)	61.30	4.33	48.67
T6(Volante)	100% NPK+15t FYM	62.78	4.56	46.67
T7(Volante)	100% NPK + 15t FYM + AZOTOBACTER (10 g)	62.67	4.22	47.00
T8(Sehezadi)	100% NPK+15t FYM	63.00	4.67	49.22
T9(Sehezadi)	100% NPK + 15t FYM + AZOTOBACTER (10 g)	63.18	4.44	49.00
	F test	S	NS	S
	S.E (d) (±)	0.89	0.47	1.21
	CD 0.05	1.87	0.99	2.55
	C.V	1.69	13.11	3.21

4.2 Yield parameters

4.2.1 Number of Fruits Per Plant

The Maximum Number of fruits per plant was recorded in the Variety Capsicum Cebrail (T2) (8.11) given in (Table 2). This might be due to the favourable climatic conditions, and sufficient accumulation of photosynthesis in the polyhouse condition.

4.2.2 Fruit length (cm)

The Maximum Fruit length (cm) was recorded in the Variety Capsicum Cebrail (T2) (9.2 cm) given in (Table 2). Increased fruit size in different hybrids, might be due to enhanced photosynthesis accumulation of carbohydrates and favourable effect on vegetative growth which increased the fruit variety besides increasing fruit size.

4.2.3Fruit diameter (cm)

The Maximum Fruit diameter was recorded in the Variety Capsicum Volante (T6) (8.04 cm) given in (Table 2). It might be increased fruit size attributed in different hybrids might be due to enhanced photosynthesis, accumulation of carbohydrates, and favourable effect on vegetative growth which increased the fruit variety besides increasing the fruit size.

4.2.4 Individual fruit weight (g)

The Maximum individual fruit weight was recorded in the Variety Capsicum Cebrail (T2) (160.44 g) given in (Table 2). Due to increased fruit weight may be attributed to the favourable microclimate that prevailed in the polyhouse compared to other structures.

4.2.5 Fruit yield per plant (kg)

The Maximum fruit yield per plant was recorded in the Variety Capsicum Cebrail (T2) (1.15 kg) given in (Table 2). It might be due to the organic condition of Cebril (T2) was higher number of flowers per plant, fruits per plant, more pollination, lesser flower drop, maximum percent fruit set, maximum mean fruit weight, and fruit volume.

4.2.6 Fruit yield (kg/m2)

The Maximum fruit yield per plot was recorded in the Variety Capsicum Cebrail (T2) (6.90 kg) given in (Table 2). The higher fruit yield under this condition may be attributed to the favourable climatic conditions that prevailed under polyhouse and also due to its protective ability against major ~~a~~ biotic stress, which reduces the effect of the excess rainfall, waterlogging, and providesa controlled environment to the crop.

Table 2. Number of Fruits Per Plant, Fruit Length (cm), Fruit Diameter (cm),Individual Fruit Weight (gm), Fruit Yield Per Plant (kg), and Fruit yield per plot (kg/m2) as affected by inorganic fertilizers and Organic manures in Capsicum varieties in protected condition.

Treatment	Treatment Combination	Number of Fruits Per Plant	Fruit Length (cm)	Fruit Diameter (cm)	Individual Fruit Weight (gm)	Fruit Yield Per Plant in(kg)	Fruit yield per plot (200 kg/m2)
T0(Nemalite)	100% NPK+15t FYM	7.12	8.7	7.03	141.56	0.94	12.53
T1(Nemalite)	100% NPK + 15t FYM + AZOTOBACTER (10 g)	7.89	8.7	7.04	144.44	0.91	12.13
T2(Cebrail)	100% NPK+15t FYM	8.11	9.2	6.98	160.44	1.15	15.33
T3(Cebrail)	100% NPK + 15t FYM + AZOTOBACTER (10 g)	7.44	8.9	7.00	158.56	0.96	12.80
T4(Bungi)	100% NPK+15t FYM	7.56	6.3	5.97	102.11	0.85	11.33
T5(Bungi)	100% NPK + 15t FYM + AZOTOBACTER (10 g)	7.67	6.2	6.26	99.00	0.98	13.06
T6(Volante)	100% NPK+15t FYM	7.00	8.8	8.04	139.00	1.06	14.13
T7(Volante)	100% NPK + 15t FYM + AZOTOBACTER (10 g)	7.11	8.9	8.00	132.22	1.01	13.46
T8(Sehezadi)	100% NPK+15t FYM	7.33	5.6	5.38	85.67	0.82	10.93
T9(Sehezadi)	100% NPK + 15t FYM + AZOTOBACTER (10 g)	7.67	5.5	5.34	88.11	0.81	10.80
	F test	S	S	S	S	NS	
	S.E (d) (±)	0.84	0.14	0.35	3.34	0.12	
	CD 0.05	1.77	0.30	0.74	7.02	0.25	
	C.V	13.78	2.28	6.41	3.27	15.68	

4.3 Qualityparameters

4.3.1 TSS Content (°Brix)

The Maximum Tss (°Brix) was recorded in the Variety *Capsicum* Volante (T7) (9.34) ~~are~~ isgiven in (Table 3). TSS is an important quality attribute of capsicum fruit. An ~~I~~increase in this parameter improves the flavour and increases the palatability. Since capsicum is used for salad making, fruits with high TSS are highly preferred.

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4.3.2 Vitamin C (mg/100g)

The Maximum Vitamin C content (mg/100g) was recorded in the Variety Capsicum Sehezadi (T8) (154.66)~~are~~ isgiven in (Table 3).Generally, the higher ascorbic acid content would increase the nutritive value of capsicum, which would help better retention of colour and flavour. Capsicum varieties and hybrids possessing high ascorbic acid content are ~~of~~ ingreat demand in export markets ~~it~~ whichmay be due to differences in genetic constituents of the varieties and microclimate conditions.

4.3.3 Chlorophyll (mg/cm^{-2})

The Maximum Chlorophyll content (mg/cm^{-2}) was recorded in the Variety Capsicum Cebrail (T2)~~are~~ given in (Table 3). This means that less photosynthesis would occur in the leaves of the plant, so less glucose is made as a result. Therefore there is less energy released for growth as glucose is needed for respiration.

Comment [HG6]: All findings (starting from 4.1.1 to 4.3.3. should be supported by previous findings whether the current result is in harmony or contrast with previously reported results.

Table 3.TSS (°Brix)& Vitamin C (mg/100g) content as affected by inorganic fertilizers and Organic manures in Capsicum varieties in protected condition

Treatment	Treatment Combination	Tss (°Brix)	Vitamin C (mg/100g)	Chlorophyll (mg m^{-2})
T0(Nemalite)	100% NPK+15t FYM	7.56	152.00	42.32
T1(Nemalite)	100% NPK + 15t FYM + AZOTOBACTER (10 g)	9.26	153.22	43.03
T2(Cebrail)	100% NPK+15t FYM	8.70	152.03	45.71
T3(Cebrail)	100% NPK + 15t FYM + AZOTOBACTER (10 g)	8.74	152.15	43.31
T4(Bungi)	100% NPK+15t FYM	9.00	152.56	45.20
T5(Bungi)	100% NPK + 15t FYM + AZOTOBACTER (10 g)	9.08	154.10	43.86
T6(Volante)	100% NPK+15t FYM	7.59	154.48	42.40
T7(Volante)	100% NPK + 15t FYM + AZOTOBACTER (10 g)	9.34	152.56	44.39
T8(Sehezadi)	100% NPK+15t FYM	8.83	154.66	43.41
T9(Sehezadi)	100% NPK + 15t FYM + AZOTOBACTER (10 g)	8.68	154.05	43.07
	F test	S	NS	S
	S.E (d) (±)	0.05	1.19	1.48
	CD 0.05	0.12	2.50	3.11
	C.V	0.77	0.95	4.16

Table 4. Cost of agronomical practices of cultivation as affected by inorganic fertilizers and Organic manures in Capsicum varieties in protected condition

S. No	Particular	Requirement	Rate/unit Rs.	Cost
(A)	Land preparation			
I.	Soil Pulverization	4 labours	350 Rs/labours	1,400
II.	Layout of field	2 labours	350 Rs/labours	700
III.	Mulching (30 Micron) Silver black			6,000
(B)	Planting	1 labour	350 Rs/labour	350
(C)	Manures and fertilizer			
I.	FYM	300kg	10 Rs/kg.	3,000

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II.	Urea	60 Kg	10 Rs/Kg	600	Formatted: Font: Not Bold
III.	DAP	50 Kg	30 Rs/Kg	1,500	Formatted: Font: Not Bold
IV.	MOP	40 Kg	50 Rs/Kg	2,000	Formatted: Font: Not Bold
V.	Labour	1 labours X 3 time	350 Rs/labour	1,050	Formatted: Font: Not Bold
(D)	Irrigation	1 Labour X 3 time	350	1,050	Formatted: Font: Not Bold
(E)	Weed Management	1 labour X 3 time	350 Rs/labour	1,050	Formatted: Font: Not Bold
(F)	Harvesting	1 labours X 3 time	350 Rs/labour	1,050	Formatted: Font: Not Bold
	Total cost of cultivation			**19,750**	Formatted: Font: Not Bold

Table 5.Cost economics of growing different varieties of capsicum as affected by inorganic fertilizers and Organic manures in Capsicum varieties in protected condition

Treatments	Cost of cultivation (Rs/200sq. mt)	Total yield 200sq. mt	Selling Rate (Rs/q)	Gross return (Rs/200sq. mt)	Net return Rs./ 200sq. mt)	Benefit-cost ratio
T0(Nemalite)	19,750	12.53	5000	62,650	42,900	2.17
T1(Nemalite)	19,750	12.13	5000	60,650	40,900	2.07
T2(Cebrail)	19,750	15.33	5000	76,650	56,900	2.88
T3(Cebrail)	19,750	12.80	5000	64,000	44,250	2.24
T4(Bungi)	19,750	11.33	5000	56,650	36,900	1.86
T5(Bungi)	19,750	13.06	5000	65,300	45,550	2.30
T6(Volante)	19,750	14.13	5000	70,650	50,900	2.57
T7(Volante)	19,750	13.46	5000	67,300	47,550	2.40
T8(Sehezadi)	19,750	10.93	5000	54,650	34,900	1.76
T9(Sehezadi)	19,750	10.80	5000	54,000	34,250	1.73

5. Conclusion

From the present investigation,it is concluded that variety Cebrail (T2) performed best in terms of Growth parameters viz.,plant height (68.97 cm), Number of branches (4.89), Days to first flower initiation (42.89), Chlorophyll content (45.71). In terms of Yield Parameter number of fruits per plant (8.11), Fruit length (9.2 cm), individual fruit (160.44 g), fruit yield per plant (1.15 kg), fruit yield per plot (6.90 kg). Also,~~I~~in terms of Economics,Variety Cebrail (T2) recorded the highest Benefit-cost ratio (2.88)

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