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Effect of different plant spacings and fertigation levels on yield of chilli

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Abstract
The experiment entitled ‘‘Effect of different plant spacings and fertigation levels on yield of chilli’’ was carried at RFRS, Katol, District Nagpur in 2024-2025. Variety Keshori is studied under this experiment. The experiment was laid out in Factorial Randomized Block Design with twelve treatment combinations replicated thrice. The treatments comprised of four levels of plant spacing viz., S_1-60 cm × 60 cm, S_2-60 cm × 45 cm, S_3-60 cm × 30 cm and S_4-45 cm × 45 cm and three levels of fertigation viz., F_1-Application of RDF with traditional method, F_2-Application of 100% RDF through drip and F_3-Application of 80% RDF through drip.
Result of an experiment revealed that, maximum yield per plot and yield per hectare was recorded under the spacing S_3, while maximum number of fruits per plant, weight of fruit, average weight of 50 fruits and yield per plant were recorded under the spacing S_1. All the yield parameters were recorded maximum under fertigation level F_2. The interaction effect of plant spacing and fertigation on yield per plot and yield per hectare was recorded maximum under treatment combination S_3F_2. Maximum number of fruits per plant, weight of fruit, average weight of fruit 50 fruits and yield per plant was recorded under treatment combination S_1F_2. Maximum B:C ratio recorded in the treatment combination of S_3F_3.

Keywords: Spacing, fertigation, chilli, yield, keshori, *Capsicum annuum*, nutrient management, plant density, irrigation, fertilizer, crop yield, fruit yield

Introduction
Chilli (*Capsicum annum* L.) belongs to the family Solanaceae, and chromosome no. is 2n = 24. Chilli is grown for its fruits; it is one among India's most valued crops. Widely grown in warm, temperate, tropical, and subtropical regions, it is one of the most significant spices and vegetable crops in the world. It grows best in a warm, humid environment with well-drained loamy soil that is rich in organic matter. It is cultivated all year round and utilized for its colour and pungency in green and red mature dried stages. The tropics and subtropics of the New World are where the genus Capsicum first appeared.
In 1584, the Portuguese introduced capsicum to India from Brazil. However, it may be assumed that the spread of capsicum in the northeastern states is distinct from that of other parts of India due to the unique variety that exists there. It is believed that South American capsicum was directly brought by Christian missionaries.
Chilli is mostly used in cooking to give pungency, flavour, colour, and adding vitamins (A, C, E, and P). As a result, they are essential to many South Americans, Africans, Asians, and Indians. Indian cooks use dry chillies, powdered or ground into a paste, and even green chillies on a daily basis to add pungency, colour, and taste to curries, sambar, rasam, and other meals. It is widely used in the production of curry paste, curry powder, and various pickles as well as in the making of sauces, soups, salads, and other dishes.
Chilli has a great medicinal benefit. Its paste is used externally as a rubefacient and a local stimulant to the tonsils in tonsillitis. In the case of diphtheria, it is supposed to speed up the separation of fake membranes. It works particularly well against cholera when combined with asafoetida and camphor. Chilli extracts are utilized in pharmaceuticals, cosmetics, paints, and chili sprays.
"Keshori" is a locally cultivated variety in Maharashtra, particularly in the eastern Vidarbh zone. The intense variety may be consumed as green or processed into a chilli powder. Keshori chilli is a local, pungent variety of chilli grown in the eastern Vidarbha region of

Maharashtra, India. It's known for being consumed both as green chillies and after processing into chilli powder. Keshori chilli has a high pungency and is valued for its colour.

Plant density and plant arrangement can affect plant development, growth, and the marketable yield of peppers, according to studies on plant density for various pepper types, such as bell, cayenne, pepperoncini, and jalapeño (Khasmakhi-Sabet *et al.*, 2009) [7].

Fertigation makes it possible to evenly apply the proper amounts of plant nutrients to the wetted root volume zone, which is where the majority of the active roots are located. This improves the efficiency of nutrient usage. As a result, during a growing season, it is feasible to dispense a sufficient amount of nutrients at the right concentration to satisfy crop need (Jat *et al.* 2011) [6].

Materials and Methods

A field experiment titled "Effect of different plant spacings and fertigation levels on yield of chilli" was conducted at the field of Regional Fruit Research Station, Katol, District Nagpur during late kharif season of 2024-2025. The experiment will be conducted using a Factorial Randomized Block Design (FRBD) comprising 12 treatment combinations with three replications. The treatments comprised of four levels of plant spacing viz., S_1-60 cm × 60 cm, S_2-60 cm × 45 cm, S_3-60 cm × 30 cm and S_4-45 cm × 45 cm and three levels of fertigation viz., F_1-Application of RDF with traditional method, F_2-Application of 100% RDF through drip and F_3-Application of 80% RDF through drip.

In the Nagpur district Katol tehsil is located at 21.27°N and 78.58°E. It has an average elevation of 417 metres (1368 ft). Katol has a tropical wet and dry climate with dry conditions prevailing for most of the year. The soil selected for experiment was classified as medium black in colour, featuring adequate natural drainage capacity and being notably rich in organic matter.

Keshori seeds were collected from a farmer in village Keshori, Tah. Arjuni Morgaon, District Gondia. Keshori seeds were planted in protrays. Forty-day old, healthy, disease-free seedlings were selected and transplanted into experimental plots. Seedlings are transplanted as per the spacing of treatment.

As per treatments, the nutrients NPK are applied as per Recommended dose of fertilizer (RDF)-150:50:50 NPK Kg/ha. FYM is added in the soil at the time of field preparation @ 25 tonnes/ha. For the treatment of application of RDF with traditional method, fertilizers were applied in the soil through straight fertilizers like Urea, SSP and MOP. Fertigation was performed at 10-day intervals, in eight 8 equal split doses. The recommended fertilizer doses at various levels were applied using water-soluble fertilizers 19:19:19 NPK and urea (46% N) through fertigation using a drip irrigation technique.

Results and Discussion

Yield parameters

The data regarding the number of fruits per plant, weight of fruit, average weight of 50 fruits, yield per plant of chilli was significantly influenced by plant spacing and fertigation levels during the year of experiment and are indicated in Table 1.

The treatment S_1-60 cm × 60 cm recorded significantly maximum number of fruits per plant, weight of fruit, average weight of 50 fruits, yield per plant of chilli, which found significantly superior over rest of the treatments. However, the significantly minimum value for these observations was noticed with the treatment S_3-60 cm × 30 cm.

The data regarding to the number of fruits per plant, weight of fruit, average weight of 50 fruits, yield per plant of chilli which was affected by different levels of fertigation was clearly indicated that, the treatment F_2-Application of 100% RDF through drip recorded significantly maximum value for these observations, which was found at par with F_3-Application of 80% RDF through drip. However, the significantly minimum value for these observations was noticed with the treatment F_1-Application of RDF with traditional method.

The data regarding to the interaction effect of plant spacing and fertigation on number of fruits per plant, weight of fruit, average weight of 50 fruits, yield per plant of chilli was clearly indicated that, the treatment combination S_1F_2-60 cm × 60 cm spacing + Application of 100% RDF through drip was recorded significantly maximum value for these observations, which was found at par with treatment combination S_1F_3-60 cm × 60 cm spacing + Application of 80% RDF through drip. However, significantly minimum value for these observations was noticed with treatment combination S_3F_1-60 cm × 30 cm spacing + Application of RDF with traditional method.

Wider spacing reduces intra-plant competition, allowing each chilli plant to access more sunlight, water, and nutrients. This spatial advantage promotes a more extensive canopy development, leading to increased photosynthetic activity and, consequently, greater assimilate production. The enhanced photosynthate availability supports the development of larger and heavier fruits. When combined with a higher RDF supplied through fertigation, which delivers nutrients directly to the root zone, plants can absorb nutrients more effectively, leading to improved fruit development and increased fruit weight.

Similar results were found by Usha *et al.* (2018) [15] in tomato, Ganjare *et al.* (2013) [5] in capsicum, Ramakrishna (2002) [12] in chilli, Amit and Sharma (2018) [2] in capsicum, Priya and Shalini (2024) [11] in bell pepper.

The data regarding the yield per plot and yield per hectare of chilli was significantly influenced by plant spacing and fertigation levels during the year of experiment and are indicated in Table 1.

The data regarding to the yield per plot and yield per hectare of chilli which was influenced by different spacings was clearly indicated that, the treatment S_3-60 cm × 30 cm recorded significantly maximum yield, which found significantly superior over rest of the treatments. However, the significantly minimum yield was noticed with the treatment S_1-60 cm × 60 cm.

The data regarding to the yield per plot and yield per hectare of chilli which was affected by different levels of fertigation was clearly indicated that, the treatment F_2-Application of 100% RDF through drip recorded significantly maximum yield, which was found at par with F_3-Application of 80% RDF through drip. However, the significantly minimum yield was noticed with the treatment F_1-Application of RDF with traditional method.

The data regarding to the interaction effect of plant spacing and fertigation was clearly indicated that, the treatment combination S_3F_2-60 cm × 30 cm spacing + Application of 100% RDF through drip was recorded significantly maximum yield per plot and yield per hectare, which was found at par with treatment combinations S_3F_3, S_4F_2 and S_4F_3. However, significantly minimum yield per plot and yield per hectare was noticed with treatment combination S_1F_1-60 cm × 60 cm spacing + Application of RDF with traditional method.

The interaction of close spacing with higher Recommended Dose of Fertilizer (RDF) through fertigation results in increased yield per plot and yield per hectare in chilli due to enhanced nutrient uptake and efficient resource utilization.

Close spacing increases plant density, leading to a higher number of plants per unit area. When combined with higher RDF via fertigation, which ensures precise and timely nutrient delivery, each plant receives adequate nutrients despite the increased competition. This synergy promotes vigorous vegetative growth, higher leaf area index, and increased photosynthetic activity, culminating in a greater number of fruits and higher yield per plot and yield per hectare.

Similar results were found by Singh *et al.* (2019) [14] in chilli, Bharai and Leua (2022) [3] in brinjal, Agostinho *et al.* (2024) [1] in chilli and Khasmakhi-Sabet *et al.* (2009) [7] in bell pepper.

B:C Ratio

The data in respect of Benefit Cost ratio as influenced by different plant spacings and fertigation levels was calculated and results are presented in Table 2 and depicted in Fig. 2.

The data revealed that, there were significant differences in B:C ratio among the different plant spacing and fertigation levels. Maximum B:C ratio recorded in the treatment combination of S_3F_3-60 cm × 30 cm spacing + Application of 80% RDF through drip (2.22) and minimum B:C ratio noticed in the treatment combination of S_1F_1-60 cm × 60 cm spacing + Application of RDF with traditional method (1.38).

Table 1: Effect of plant spacing and fertigation on yield attributing characters of chilli

Treatment	Number of fruits per plant	Weight of fruit (g)	Average weight of 50 fruits (g)	Yield per plant (g)	Yield per plot (kg)	Yield per hectare (q)
Spacing (S)						
S_1	59.50	4.91	243.78	292.53	5.01	75.29
S_2	55.44	4.51	225.89	251.70	5.47	88.54
S_3	53.65	4.06	207.67	225.18	7.10	112.33
S_4	54.55	4.28	214.98	236.21	6.82	110.97
'F' test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE±	0.66	0.09	2.29	3.80	0.08	2.49
CD at 5%	1.95	0.28	6.71	11.16	0.24	7.31
Fertigation (F)						
F_1	51.81	4.13	209.85	221.13	5.10	81.97
F_2	58.50	4.69	231.80	270.58	6.69	106.90
F_3	57.05	4.51	227.58	262.52	6.51	101.48
'F' test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE±	0.58	0.08	1.98	3.29	0.07	2.16
CD at 5%	1.69	0.24	5.81	9.66	0.21	6.33
Interaction effect (S×F)						
S_1F_1	56.70	4.37	219.33	249.83	4.07	65.33
S_1F_2	62.67	5.47	261.67	324.37	5.57	84.83
S_1F_3	59.13	4.90	250.33	303.40	5.40	75.70
S_2F_1	53.67	4.43	220.33	236.63	5.07	80.67
S_2F_2	57.20	4.63	232.67	266.67	5.83	95.33
S_2F_3	55.47	4.47	224.67	251.80	5.50	89.63
S_3F_1	48.37	3.53	188.67	188.33	5.73	85.40
S_3F_2	56.67	4.28	216.33	240.67	7.87	127.67
S_3F_3	55.92	4.37	218.00	246.53	7.70	123.93
S_4F_1	48.52	4.17	211.07	209.70	5.53	96.47
S_4F_2	57.47	4.37	216.53	250.60	7.50	119.77
S_4F_3	57.67	4.32	217.33	248.33	7.43	116.67
'F' test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE±	1.41	0.20	4.85	8.07	0.17	5.29
CD at 5%	4.13	0.59	14.23	23.67	0.50	15.50

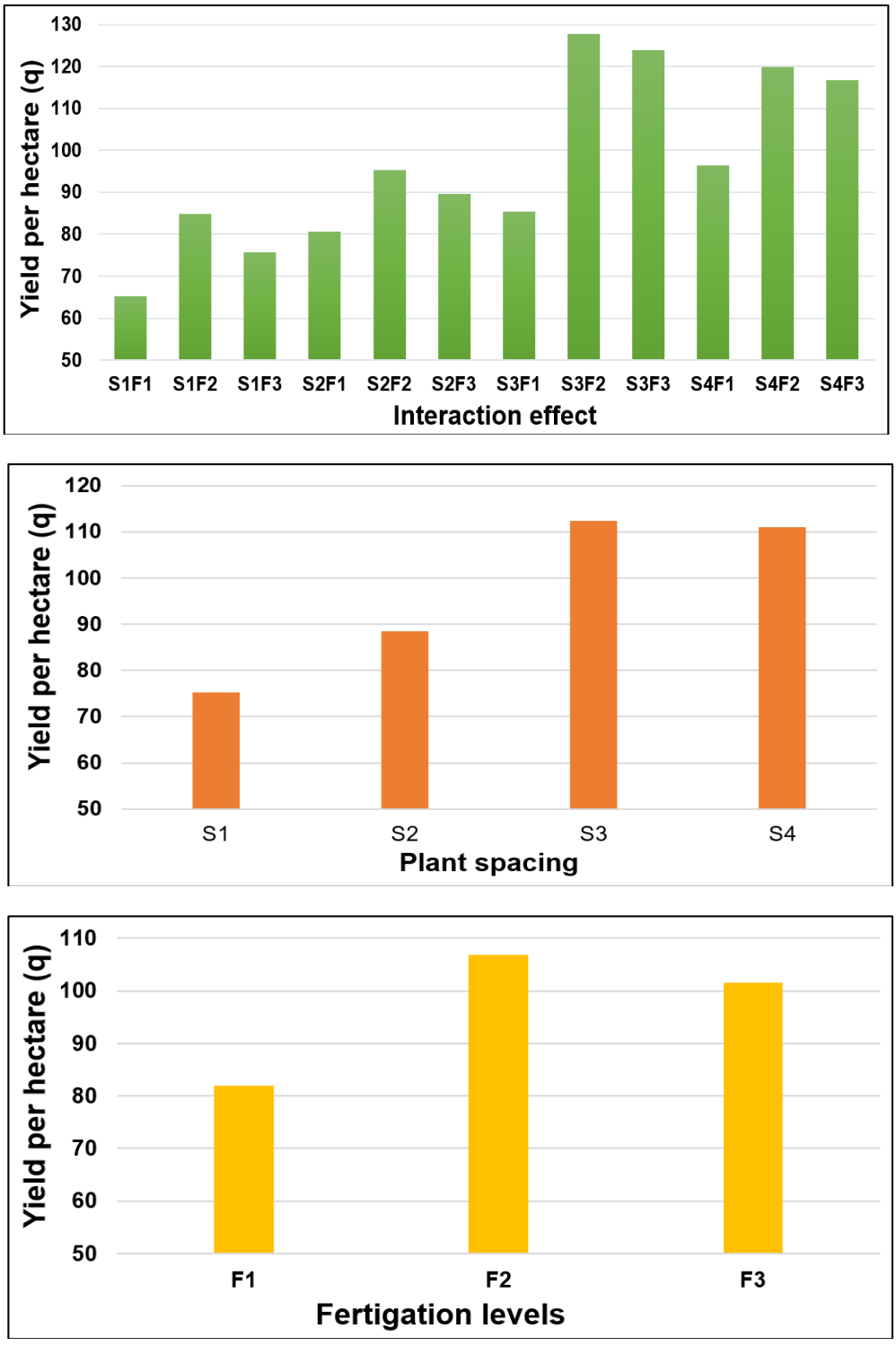

Fig 1: Effect of plant spacing and fertigation on yield per hectare

Table 2: Effect of plant spacing and fertigation on B:C ratio

Treatment	B:C Ratio
S_1F_1	1.38
S_1F_2	1.48
S_1F_3	1.39
S_2F_1	1.74
S_2F_2	1.65
S_2F_3	1.63
S_3F_1	1.83
S_3F_2	2.19
S_3F_3	2.22
S_4F_1	2.06
S_4F_2	2.06
S_4F_3	2.09

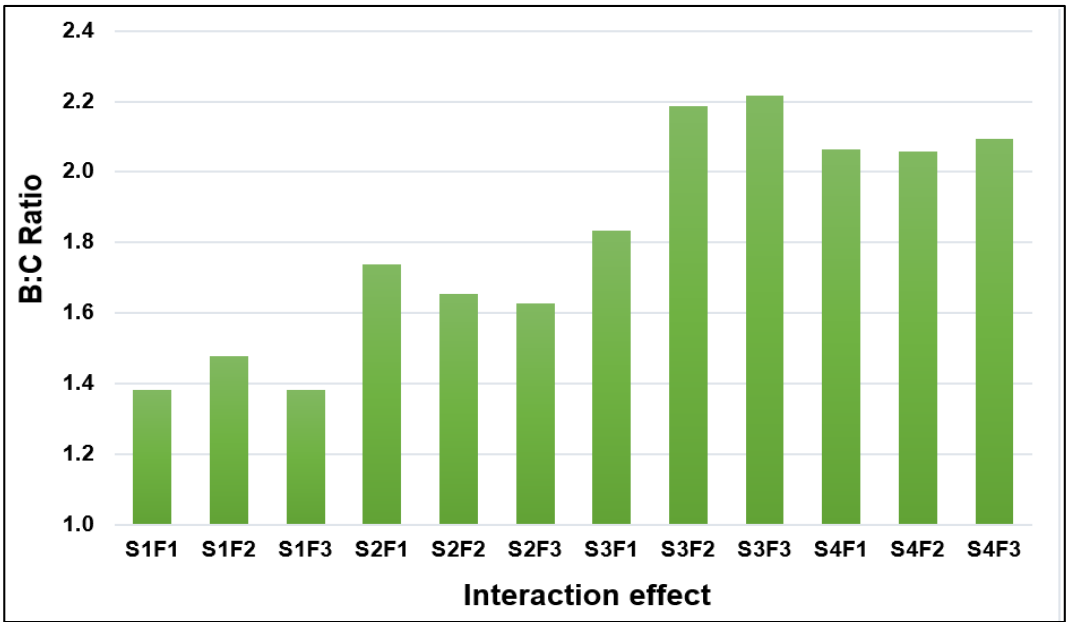

Fig 2: Effect of plant spacing and fertigation on B:C Ratio

Conclusion

Amongst the different plant spacing, the treatment S_3-60 cm × 30 cm was found to be the best treatment in respect to yield per plot and yield per hectare. In respect of number of fruits per plant, weight of fruit, average weight of 50 fruits and yield per plant S_1-60 cm × 60 cm was found to be the best treatment.

The fertigation level F_2-Application of 100% RDF through drip was found to be the best treatment in respect of the yield parameters viz., number of fruits per plant, weight of fruit, average weight of 50 fruits, yield per plant, yield per plot and yield per hectare was also found maximum under same treatment

Amongst the different combinations of interaction effect of plant spacing and fertigation, the treatment combination S_3F_2-60 cm × 30 cm spacing + Application of 100% RDF through drip was found to be the best treatment in terms of yield per plot and yield per hectare. In respect of number of fruits per plant, weight of fruit, average weight of 50 fruits and yield per plant S_1F_2-60 cm × 60 cm spacing + Application of 100% RDF through drip was found to be the best treatment.

From economic point of view, maximum B:C ratio recorded in the treatment combination of S_3F_3-60 cm × 30 cm spacing + Application of 80% RDF through drip and minimum B:C ratio noticed in the treatment combination of S_1F_1-60 cm × 60 cm spacing + Application of RDF with traditional method.

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