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Effect of Optimum Levels of Fertilizer on Growth, Yield and Quality of Chilli (*Capsicum annuum* L.) cv Pant C 1

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ABSTRACT

A field study was conducted in the Village Sabli of district Tehri Garhwal to know the effect of optimum levels of fertilizer on growth, yield and quality of Chilli (*Capsicum annuum* L.) cv Pant C 1. To assess the effect of fertilizers on yield and yield parameters Randomize Block Design (RBD) in field and Com-Pletely Randomized Design (CRBD) in laboratory were used with 20 treatment combinations. In this study two levels of nitrogen (40 and 80 kg N ha^{-1}), one level of phosphorus (35 kg P_2O_5 ha^{-1}), two levels of potassium (35 and 60 kg K_2O ha^{-1}) and two levels of farmyard manure (20 and 25 tonns ha^{-1}) were taken. Among all treatment combinations, fertilizer dose of NPK and farmyard manure 80:35:35 kg and 25 t ha^{-1} (T_9 treatment) was found most suitable for cultivation of chilli. A significant increase in yield and yield parameters were recorded like number of fruits $plant^{-1}$, length of the fruit, 100 fruit weight, fruit yield kg $plot^{-1}$, fruit yield q ha^{-1} and dry fruit yield q ha^{-1}. The result found promising when 80 kg nitrogen, 35 kg phosphorus, 35 kg potassium and 25 tonns farmyard manure ha^{-1} respectively were used and was found significantly superior over other treatments. A significant effect of treatment on mean daily germination, highest value of relative growth index was recorded for T_9 treatment. The T_7 treatment had registered maximum mean germination time. The various treatments had significant effect on T_{50} and highest T_{50} value was observed in T_7 treatment. On the basis of above study it can be suggested that fertilizer ratio of N:P:K (80:35:35) with 25 t ha^{-1} of FYM give good yield and plant growth.

Keywords Chilli, Fertilizer, Growth, Yield.

INTRODUCTION

Chilli (*Capsicum annuum* L.) is an exceptional source of vitamins A, B_6, C, E and K with plenty of minerals like molybdenum, calcium, iron, copper, potassium, manganese, foliates and thiamin (Chakrabarty S *et al*. 2017), worldwide the percentage change in the area and production of chilli are consistently increasing but the productivity of chilli in India is 9.18 t ha^{-1} where as it is 14.4 t ha^{-1} of the world. The reduction trend in

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the last few decades seems to be due to some pathogenic agencies as well as seasonal fluctuations. Plant pathogens decreased fabrication crosswise the world annually by more than 20% on average, however, individual fields may sustain losses of 50 to 100% from one or more pests according to Dhaliwal and Koul. Chilli is being used in food and beverage industries for its oleoresin which imparts characteristic color and flavor to food. India is a leading country in the world with an area of 9.15 lakh hectares with production of 10.18 lakh tones of dry chilli. India is one of the leading countries in production of chilli however; its productivity is low as compare to other countries. Its productivity and quality can be enhanced by proper nutrient management. Nutrients plays a vital role in plant metabolism such as photosynthesis, translocation of photosynthates, regulation of plant pores, activation of plant enzymes and resistance against pests and diseases. It is also considered as a quality element as it improves quality parameters of many crops including chilli.

MATERIALS AND METHODS

The present investigation was carried out during *kharif*, 2013 and 2014 at the Sabli Village, tok Guryali district Tehri Garhwal which is located at 30.08730^0 N, 78.61422^0 E from 1503m from mean sea level and subsequent seed quality were evaluated at seed testing laboratory of Scientific and Applied Research Center (SARC), Meerut, Uttar Pradesh.

Basal application of ½ dose of N (nitrogen) in the form of urea, full dose of phosphorus in the form of S.S.P (Single Super Phosphate) and potassium in the form of MOP (Murate of Potash) and FYM (Farm Yard Manure) with broad cast method was done, rest half of nitrogen was applied in two split doses i.e. 30 and 50 days after transplanting. Urea (46% nitrogen), single super phosphate (18% P_2O_5), muriate of potash (60% K_2O) and farm yard manure (0.4 - 0.5% nitrogen, 0.25% phosphorus and 0.50% potassium) were applied as sources of nitrogen, phosphorus and potassium, respectively. The spacing which was maintained for planting for this study was 60 cm between row to row and plant to plant 45 cm. Gap filling was done at the time of thinning to ensure optimum plant population. Three hand weeding along with hoeing was done to manage the weeds in the field. Since crop was raised in summer season, however in the absence of rain, beds were irrigated as and when required. Plant protection measures as per in package of practices were taken up during experimentation in order to control insect pests and diseases in the corps. The chilli seedling transplanting on 29th May 2013 and 20th May 2014 in Randomized Block Design with twenty treatments and three replications at the farmer's field. Five plants of chilli were selected randomly and tagged in each plot and replication for the observations was recorded on the plant height (cm), number of branches per plant, days to first flowering, root length (cm), shoot length (cm), days taken to 50% flowering, days taken to fruit setting, total green fruit yield plant^{-1}, number of fruits plant^{-1}, length of the fruit, 100 fruit weight, average fruit weight, fruit yield kg plot^{-1}, fruit yield q ha^{-1}, dry fruit yield q ha^{-1}, seed germination percent, seed vigour parameters first count test, standard germination seedling length, seedling fresh weight, seedling dry weight, seedling vigour index I and II, speed of germination, relative growth index (RGI), mean germination time (MGT), time to 50% germination (T_{50}) and mean daily germination.

RESULTS AND DISCUSSION

Chilli is an exhaustive crop and removes a good amount of nitrogen (N), phosphorus (P_2O_5), potassium (K_2O) and FYM from the soil. The N, P, K nutrients are responsible for better growth, yield and quality of the crop. Keeping these things in view, the present investigation was carried out to study the consequence of optimum levels of fertilizer on growth, fruit yield and quality of chilli (*Capsicum annuum* L.) cv Pant C 1. Reduction in plant growth, yield and its contributing character through accelerated ageing under field condition were observed. High quality seed that provides adequate plant stand is the basis for profitable production and expansion of chilli crop, in order to increase the production of chilli, a source of high quality; disease free seed must be established and maintained. In case of many crop seeds loss of viability and vigour could be seen due to high temperature and RH conditions but this phenomenon is well marked in chilli.

A significant effect of different treatments of fertilizers was found on different parameters which were considered for this study viz., Plant height, Number of branches plant^{-1}, Days to 50 % flowering, Days taken to fruit setting, Number of fruits per plant, Fruits length (cm), 100 Fruits weight, Fruit yield kg plot^{-1}, Green fruit yield q ha^{-1} and Dry fruit yield q ha^{-1}, Germination (%) at first count, Standard germination (%), Seedling root length (cm), Vigour Index I and II, Speed of Germination, Relative Growth Index (RGI), Mean Daily Germination (MDG), Mean Germination Time (MGT) and Time to 50% Germination (T_{50}). The first parameter was plant height which showed a significant increment in T_9 treatment attaining a maximum value of 65.64 and 70.75 cm in the year 2013 and 2014 respectively produced membrane integrity leading to deterioration of plant height. Similar results were reported by Bahuguna *et al*. (2015) in sweet pepper and Bahuguna *et al*. (2016) in Tomato. The other parameters like Number of branches plant^{-1}, Days to 50 % flowering and Days taken to fruit setting the least number of branches which were recorded in the study was 8.73 and 9.26 found under T_2 and T_{17} treatment, however the maximum number of branches was seen in case of T_9 treatment. The maximum number of branches found on 13.86 and 13.33 was found under T_9 treatment in both years. The maximum 50% flowering time recorded to 41.26 and 39.86 days was found under T_9 treatment. Such type of findings showed a broad agreement with Bahuguna *et al*. (2016) in tomato. The maximum days for fruit setting were found 50.86 days in T_{16} in the year 2013 and 46.46 days in T_7 for year 2014. However, a minimum day was counted 45.86 and 41.20 days in T_9 for the year 2013 and 2014 respectively. The parameters which are mentioned above are shown in Table 1.

The minimum numbers of fruits per plant was seen in control and were 50.26 and 55.06 for the consecutive years, while maximum number of fruits per plant was recorded for 63.00 and 62.40 in the year 2013 and 2014 in T_9. Such types of findings were also related to Bahuguna *et al*. (2015) in sweet pepper and Bahuguna *et al*. (2016) in tomato. However, the fruit length through accelerated ageing exhibited a maximum length of per fruit 3.86 and 4.06 cm and

Table 1. Consequence of optimum levels of fertilizer on plant height and number of branches per plant of chilli (Pant C 1).

Treatment	Plant height (cm)		Number of branches per plant		Days to 50 % flowering		Days taken to fruit setting	
	2013	2014	2013	2014	2013	2014	2013	2014
T_1 Control	57.07	58.16	10.86	9.93	46.80	44.13	48.26	43.86
T_2 40 kg Nitrogen ha^{-1}	62.14	64.35	8.73	9.46	43.53	41.66	48.20	44.46
T_3 80 kg Nitrogen ha^{-1}	56.34	58.44	11.00	10.93	46.66	43.26	48.53	43.53
T_4 35 kg P_2O_5 ha^{-1}	61.57	58.67	11.13	11.46	47.66	43.66	49.60	43.86
T_5 35 kg K_2O ha^{-1}	59.41	60.57	11.06	12.40	46.46	42.60	49.13	44.20
T_6 60 kg K_2O ha^{-1}	58.10	63.93	10.73	11.60	47.93	43.26	48.40	44.73
T_7 25 t FYM ha^{-1}	58.28	58.36	10.13	10.66	43.53	43.53	49.20	46.46
T_8 40 kg : 35 kg : 35 kg : 25 t, N:P:K: FYM ha^{-1}	63.53	69.02	11.20	11.40	43.80	41.93	48.06	43.46
T_9 80 kg : 35 kg : 35 kg : 25 t, N:P:K: FYM ha^{-1}	**65.64**	**70.75**	**13.86**	**13.33**	**41.26**	**39.86**	**45.86**	**41.20**
T_{10} 35 kg : 35 kg : 25 t, P:K: FYM ha^{-1}	64.68	64.32	11.00	11.13	41.46	41.46	48.00	44.20
T_{11} 35 kg : 60 kg : 25 t, P:K: FYM ha^{-1}	61.09	61.08	9.53	9.80	46.46	42.80	48.46	43.06
T_{12} 40 kg : 35 kg : 25 t, N: P: FYM ha^{-1}	61.52	59.89	11.40	11.46	44.86	43.06	49.00	45.26
T_{13} 80 kg : 35 kg : 25 t, N: P: FYM ha^{-1}	60.00	61.43	10.53	10.33	44.66	42.46	48.80	44.33
T_{14} 80 kg : 35 kg , N: P ha^{-1}	65.54	63.48	9.26	9.46	47.20	41.53	49.53	44.13
T_{15} 80 kg : 35 kg , N: K ha^{-1}	59.27	63.88	10.46	11.33	46.73	42.80	49.33	45.66
T_{16} 80 kg : 60 kg , N: K ha^{-1}	60.25	63.40	13.13	12.53	43.93	42.46	50.86	44.46
T_{17} 40 kg : 25 t, N: FYM ha^{-1}	62.59	63.81	9.26	9.26	47.00	42.20	50.53	44.40
T_{18} 35 kg : 25 t, P: FYM ha^{-1}	60.62	60.95	12.00	11.73	47.13	42.40	47.20	43.53
T_{19} 60 kg : 25 t, K: FYM ha^{-1}	62.28	60.51	10.53	10.33	48.00	42.53	47.86	44.60
T_{20} 40 kg : 35 kg : 35 kg , N: P:K ha^{-1}	63.39	62.38	10.33	10.00	44.53	42.73	50.06	44.33
GM	**61.16**	**62.37**	**10.81**	**10.93**	**45.48**	**42.52**	**48.74**	**44.19**
Sem (±)	**3.24**	**2.60**	**0.99**	**0.78**	**3.18**	**1.26**	**2.60**	**0.69**
CD (0.05)	**9.27**	**7.45**	**2.85**	**2.25**	**9.11**	**3.60**	**7.45**	**2.00**
CV (%)	**9.17**	**7.22**	**15.95**	**12.46**	**12.12**	**5.13**	**9.25**	**2.74**

Table 2. Consequence of optimum levels of fertilizer on number of fruits per plant and fruits length of chilli (Pant C 1).

Treatment	Number of fruits per plant		Fruits length (cm)		100 fruits weight (g)		Fruit yield kg plot^{-1}	
	2013	2014	2013	2014	2013	2014	2013	2014
T_1 Control	50.26	55.06	3.13	2.73	227.93	232.18	5.06	4.99
T_2 40 kg Nitrogen ha^{-1}	54.26	59.33	3.46	3.53	247.73	240.56	5.45	5.56
T_3 80 kg Nitrogen ha^{-1}	59.59	56.53	3.13	3.40	243.82	238.61	5.16	5.31
T_4 35 kg P_2O_5 ha^{-1}	57.46	59.40	3.80	3.13	246.13	236.85	5.09	5.41
T_5 35 kg K_2O ha^{-1}	55.33	55.53	3.66	3.46	242.31	245.36	5.18	5.24
T_6 60 kg K_2O ha^{-1}	53.26	60.20	3.60	3.46	253.08	243.98	5.65	5.30
T_7 25 t FYM ha^{-1}	56.86	57.06	3.46	3.60	240.55	243.93	5.40	5.63
T_8 40 kg : 35 kg : 35 kg : 25 t, N:P:K: FYM ha^{-1}	57.80	57.06	3.53	3.80	245.91	247.03	5.50	5.48
T_9 80 kg : 35 kg : 35 kg : 25 t, N:P:K: FYM ha^{-1}	**63.00**	**62.40**	**3.86**	**4.06**	**273.60**	**251.08**	**6.00**	**5.75**
T_{10} 35 kg : 35 kg : 25 t, P:K: FYM ha^{-1}	56.13	59.60	3.60	3.33	265.95	243.34	5.64	5.39
T_{11} 35 kg : 60 kg : 25 t, P:K: FYM ha^{-1}	51.80	55.93	3.26	3.53	251.97	238.86	5.53	5.44
T_{12} 40 kg : 35 kg : 25 t, N: P: FYM ha^{-1}	51.26	61.73	3.40	3.40	234.62	238.59	5.33	5.49
T_{13} 80 kg : 35 kg : 25 t, N: P: FYM ha^{-1}	57.86	55.53	3.73	3.60	240.98	240.91	5.46	5.32
T_{14} 80 kg : 35 kg , N: P ha^{-1}	56.46	58.26	3.66	3.53	253.42	244.56	5.99	5.14
T_{15} 80 kg : 35 kg , N: K ha^{-1}	61.33	55.33	3.46	3.40	251.44	240.26	5.60	5.37
T_{16} 80 kg : 60 kg , N: K ha^{-1}	54.53	58.60	3.46	3.20	254.50	242.03	5.36	5.29
T_{17} 40 kg : 25 t, N: FYM ha^{-1}	52.40	59.60	3.20	3.20	230.81	241.27	5.98	5.29
T_{18} 35 kg : 25 t, P: FYM ha^{-1}	57.86	55.86	3.73	3.60	243.99	249.43	5.53	5.30
T_{19} 60 kg : 25 t, K: FYM ha^{-1}	55.20	58.13	3.26	3.20	263.76	241.28	5.32	5.26
T_{20} 40 kg : 35 kg : 35 kg , N: P:K ha^{-1}	56.40	61.13	3.40	3.40	242.53	241.00	5.36	5.48
GM	**55.95**	**58.11**	**3.49**	**3.43**	**247.75**	**242.05**	**5.48**	**5.37**
Sem (±)	**3.30**	**2.26**	**0.37**	**0.35**	**10.29**	**5.21**	**0.59**	**0.43**
CD (0.05)	**9.46**	**6.49**	**1.06**	**1.01**	**29.47**	**14.93**	**1.70**	**1.24**
CV (%)	**10.23**	**6.75**	**18.40**	**17.81**	**7.19**	**3.73**	**18.82**	**14.01**

was found under T_9 treatment in the year 2013 and 2014. Similar result was reported by Bahuguna *et al*. (2015) in sweet pepper. In chilli crop, yield is the cumulative consequence of yield components viz., number of fruits per plant, fruit length and 100 fruit weight. Similar results were reported by Bahuguna *et al*. (2015) in sweet pepper and Bahuguna *et al*. (2016) in tomato. Application of potassium significantly in-

Table 3. Consequence of optimum levels of fertilizer on green fruit yield q ha^{-1}, dry fruit yield q ha^{-1} and number of seeds fruit^{-1} of chilli (Pant C 1).

Treatment	Green fruit yield q ha^{-1}		Dry fruit yield q ha^{-1}		Number of seeds fruit^{-1}	
	2013	2014	2013	2014	2013	2014
T_1 Control	70.01	71.33	11.22	11.44	71.46	61.33
T_2 40 kg Nitrogen ha^{-1}	83.33	72.84	12.53	13.19	73.73	62.33
T_3 80 kg Nitrogen ha^{-1}	71.66	72.57	14.37	11.78	72.40	63.60
T_4 35 kg P_2O_5 ha^{-1}	71.66	72.72	12.27	12.56	72.80	63.40
T_5 35 kg K_2O ha^{-1}	81.56	72.50	11.45	12.52	72.40	62.53
T_6 60 kg K_2O ha^{-1}	81.47	73.32	11.48	12.78	73.33	62.40
T_7 25 t FYM ha^{-1}	81.57	71.46	12.11	12.55	72.60	62.46
T_8 40 kg : 35 kg : 35 kg : 25 t, N:P:K: FYM ha^{-1}	80.82	73.48	12.59	13.53	72.00	64.13
T_9 80 kg : 35 kg : 35 kg : 25 t, N:P:K: FYM ha^{-1}	**85.28**	**74.48**	**15.55**	**15.40**	**77.20**	**66.40**
T_{10} 35 kg : 35 kg : 25 t, P:K: FYM ha^{-1}	83.84	72.60	11.85	11.65	72.60	63.40
T_{11} 35 kg : 60 kg : 25 t, P:K: FYM ha^{-1}	83.38	73.46	11.80	12.46	73.86	62.40
T_{12} 40 kg : 35 kg : 25 t, N: P: FYM ha^{-1}	82.94	73.53	12.72	11.61	75.13	62.33
T_{13} 80 kg : 35 kg : 25 t, N: P: FYM ha^{-1}	83.98	74.35	11.46	12.66	72.66	62.20
T_{14} 80 kg : 35 kg , N: P ha^{-1}	82.65	73.60	11.60	12.35	74.40	62.20
T_{15} 80 kg : 35 kg , N: K ha^{-1}	82.04	72.52	13.52	13.33	69.53	63.53
T_{16} 80 kg : 60 kg , N: K ha^{-1}	84.37	72.64	11.48	12.58	73.66	64.40

Table 3. Continued.

Treatment	Green fruit yield q ha^{-1}		Dry fruit yield q ha^{-1}		Number of seeds fruit^{-1}	
	2013	2014	2013	2014	2013	2014
T_{17} 40 kg : 25 t, N: FYM ha^{-1}	84.49	73.62	11.62	11.45	71.60	64.06
T_{18} 35 kg : 25 t, P: FYM ha^{-1}	83.48	72.17	12.25	12.60	72.80	62.26
T_{19} 60 kg : 25 t, K: FYM ha^{-1}	73.64	74.12	12.29	12.76	71.56	62.33
T_{20} 40 kg : 35 kg : 35 kg , N: P:K ha^{-1}	83.31	72.42	12.61	13.45	76.00	64.40
GM	**80.77**	**72.98**	**12.34**	**12.63**	**73.08**	**63.10**
Sem (±)	**6.86**	**1.08**	**0.59**	**0.62**	**5.94**	**0.57**
CD (0.05)	**19.65**	**3.10**	**1.71**	**1.79**	**17.02**	**1.63**
CV (%)	**14.71**	**2.57**	**8.39**	**8.61**	**71.46**	**61.33**

creased the number of fruits plant^{-1}, fruit length and 100 fruit weight compared to control. The increase in yield components of chilli with different levels of potassium might be due to mobility of photosynthates from the source to sink (Suryakumari *et al*. 2015). The treatments attain a fruits weight range of 227.93 to 273.60 and 232.18 to 251.08 g was found for T_9 treatment (6.00 and 5.75 kg) in the year 2013 and 2014. Table 2 clearly exhibits the above discussed parameters. However, the green fruit yield recorded to maximum value 85.28 and 74.48 q ha^{-1} (T_9) and significant interaction was recorded lower value for 70.01 q ha^{-1} and 71.33 q ha^{-1} for 2013-2014. While the maximum dry fruit yield (15.55 and 15.40) q ha^{-1} was found under T_9 treatment and the minimum dry fruit yield (11.22 and 11.44) q ha^{-1} was found under T_1 (control) treatment in the year 2013 and 2014 as shown in Table 3. Similar results were obtained by Bahuguna *et al*. (2015) in sweet pepper and Bahuguna *et al*. (2016) in Tomato.

Table 4. Consequence of optimum levels of fertilizer on germination (%) at first count, final count, seedling root length and seedling shoot length of chilli (Pant C 1).

Treatment	Germination (%)				Seedling			
	First count		Final count		Root length (cm)		Shoot length (cm)	
	2013	2014	2013	2014	2013	2014	2013	2014
T_1 Control	41.00	39.67	58.33	57.00	6.64	6.55	7.10	7.17
T_2 40 kg Nitrogen ha^{-1}	32.00	32.33	57.00	57.67	6.86	6.26	7.12	7.02
T_3 80 kg Nitrogen ha^{-1}	28.33	28.67	56.67	56.33	6.99	6.41	7.16	7.06
T_4 35 kg P_2O_5 ha^{-1}	23.67	24.00	57.00	56.67	7.03	7.00	7.13	7.03
T_5 35 kg K_2O ha^{-1}	18.67	19.33	55.67	55.33	7.04	7.02	7.03	7.04
T_6 60 kg K_2O ha^{-1}	15.33	15.33	54.00	53.33	7.16	7.07	7.15	7.06
T_7 25 t FYM ha^{-1}	12.67	12.67	56.33	55.67	7.09	7.01	7.03	7.01
T_8 40 kg : 35 kg : 35 kg : 25 t, N:P:K: FYM ha^{-1}	41.33	39.33	58.33	57.67	7.21	7.18	7.23	7.13
T_9 80 kg : 35 kg : 35 kg : 25 t, N:P:K: FYM ha^{-1}	**50.67**	**48.67**	**58.67**	**58.00**	**7.87**	**7.68**	**7.35**	**7.27**
T_{10} 35 kg : 35 kg : 25 t, P:K: FYM ha^{-1}	38.00	37.67	57.00	56.33	7.04	7.03	7.18	7.17
T_{11} 35 kg : 60 kg : 25 t, P:K: FYM ha^{-1}	34.33	33.33	56.67	55.33	7.04	7.01	7.04	7.03
T_{12} 40 kg : 35 kg : 25 t, N: P: FYM ha^{-1}	32.67	32.00	55.33	54.67	6.91	6.74	7.02	7.01
T_{13} 80 kg : 35 kg : 25 t, N: P: FYM ha^{-1}	35.67	35.00	54.67	54.00	6.94	6.85	7.01	7.00
T_{14} 80 kg : 35 kg , N: P ha^{-1}	43.33	42.67	55.67	54.67	6.99	6.86	7.09	7.06
T_{15} 80 kg : 35 kg , N: K ha^{-1}	45.33	43.67	57.33	56.67	7.01	7.00	7.09	7.06
T_{16} 80 kg : 60 kg , N: K ha^{-1}	39.33	38.67	56.00	55.67	6.93	6.95	7.02	7.04
T_{17} 40 kg : 25 t, N: FYM ha^{-1}	33.33	32.33	56.33	55.67	7.03	7.01	7.03	7.01
T_{18} 35 kg : 25 t, P: FYM ha^{-1}	39.33	36.67	55.33	54.67	6.99	6.87	7.08	7.07
T_{19} 60 kg : 25 t, K: FYM ha^{-1}	43.33	41.67	54.00	53.67	7.08	7.07	7.05	7.03
T_{20} 40 kg : 35 kg : 35 kg , N: P:K ha^{-1}	38.33	38.00	53.33	52.67	7.01	7.03	7.00	7.01
GM	**34.33**	**33.58**	**56.61**	**55.58**	**7.04**	**6.93**	**7.09**	**7.06**
Sem (±)	**0.67**	**0.89**	**0.85**	**0.98**	**0.01**	**0.05**	**0.01**	**0.01**
CD (0.05)	**1.94**	**2.56**	**2.44**	**2.78**	**0.04**	**0.17**	**0.04**	**0.03**
CV (%)	**3.42**	**4.62**	**2.61**	**2.94**	**0.42**	**1.49**	**0.37**	**0.29**

Table 5. Consequence of optimum levels of fertilizer on vigour index I and vigour index II of chilli (Pant C 1).

Treatment	Vigour index I		Vigour index II	
	2013	2014	2013	2014
T_1 Control	801.50	781.86	8.95	10.83
T_2 40 kg Nitrogen ha^{-1}	797.24	765.81	9.12	9.61
T_3 80 kg Nitrogen ha^{-1}	801.46	758.55	9.82	9.95
T_4 35 kg P_2O_5 ha^{-1}	806.95	795.22	10.45	10.58
T_5 35 kg K_2O ha^{-1}	783.24	777.62	10.76	11.07
T_6 60 kg K_2O ha^{-1}	772.95	753.96	11.35	11.56
T_7 25 t FYM ha^{-1}	795.06	780.28	11.45	11.69
T_8 40 kg : 35 kg : 35 kg : 25 t, N:P:K: FYM ha^{-1}	842.73	825.59	14.00	14.41
T_9 80 kg : 35 kg : 35 kg : 25 t, N:P:K: FYM ha^{-1}	**892.91**	**867.51**	**15.25**	**15.28**
T_{10} 35 kg : 35 kg : 25 t, P:K: FYM ha^{-1}	810.34	800.12	14.07	14.46
T_{11} 35 kg : 60 kg : 25 t, P:K: FYM ha^{-1}	797.60	776.88	11.72	12.17
T_{12} 40 kg : 35 kg : 25 t, N: P: FYM ha^{-1}	771.09	751.29	12.17	12.58
T_{13} 80 kg : 35 kg : 25 t, N: P: FYM ha^{-1}	762.41	747.88	10.57	10.80
T_{14} 80 kg : 35 kg , N: P ha^{-1}	783.58	760.78	12.25	11.30
T_{15} 80 kg : 35 kg , N: K ha^{-1}	808.37	796.50	11.85	11.52
T_{16} 80 kg : 60 kg , N: K ha^{-1}	781.26	778.79	10.65	11.34
T_{17} 40 kg : 25 t, N: FYM ha^{-1}	792.06	780.45	9.95	9.65
T_{18} 35 kg : 25 t, P: FYM ha^{-1}	778.54	762.05	11.80	11.11
T_{19} 60 kg : 25 t, K: FYM ha^{-1}	762.83	756.70	12.59	11.09
T_{20} 40 kg : 35 kg : 35 kg , N: P:K ha^{-1}	747.02	739.60	11.56	10.88
GM	**794.45**	**777.87**	**11.51**	**11.59**
Sem (±)	**10.30**	**8.37**	**0.35**	**0.31**
CD (0.05)	**29.46**	**23.92**	**1.01**	**0.89**
CV (%)	**2.24**	**1.86**	**5.33**	**4.66**

Germination (%) at first and final count, Standard Germination (%), Seedling Root and Shoot Length (cm) with respects to time duration of ageing a significant decline in first count and standard germination was observed. While, standard germination was also influenced by the treatments higher value of first count 50.67 and 48.67 % was observed for T_9 treatment and the treatments attain a range of 53.33 to 58.67 and 52.67 to 58.00 % of standard germination at final count in the year 2013 and 2014. The least seedling root length was observed in T_1 (control) treatment 6.64 cm, followed by T_2 treatment 6.86 cm, however, maximum root length in T_9 treatment 7.87 cm in the year 2013. In the year 2014 the least seedling root length was observed in T_2 treatment 6.26 cm, followed by T_3 treatment 6.41 cm, however, maximum root length in T_9 treatment 7.68 cm in the year 2014. In case of shoot length maximum shoot length was observed in T_9 treatment 7.35 and 7.27 cm for the year 2013 and 2014 respectively. The parameters which are discussed above have been shown in Table 4.

The least value of vigour index I was observed for 762.41 and 739.60 and highest value was recorded for T_9 treatment (892.91 and 867.51) followed by T_8 treatment (842.73 and 825.59) in the year 2013 and 2014. The observed minimum mean value for vigour index II (8.95 and 9.61) in both years. The maximum value was found for T_9 treatment (15.25 and 15.28) followed by T_{10} treatment (14.07 and 14.46) as shown in Table 5. A similar result was obtained by Ahamed *et al*. (2014) in chilli.

The T_6 treatment seeds showed minimum mean value of speed of germination (6.77 and 6.69) while maximum speed of germination was found in case of T_9 treatment (10.96 and 10.75) followed by T_{15} treatment (10.46 and 10.20) the range of speed of germination from 6.77 to 10.96 and 6.69 to 10.75 in the year 2013 and 2014. The least relative growth index were found on T_7 treatment 22.49 and 22.74 while, highest value was recorded for T9 treatment (86.36 and 83.94) followed by T_{19} treatment 80.26 and 77.66 as shown in Table 6.

A significant effect of treatment on mean daily

Table 6. Consequence of optimum levels of fertilizer on speed of germination index, relative growth index, mean daily germination (MDG), mean germination time (MGT) and time to 50% germination (T_{50}) of chilli (Pant C 1).

Treatment	Speed of germination index		Relative growth index		Mean daily germination		Mean germination time		Time to 50% germination (T_{50})	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
T_1 Control	9.47	9.26	70.28	69.58	4.86	4.75	6.71	6.70	3.19	3.16
T_2 40 kg Nitrogen ha^{-1}	8.44	8.52	56.13	56.07	4.38	4.43	7.35	7.37	3.72	3.72
T_3 80 kg Nitrogen ha^{-1}	8.08	8.16	50.00	50.87	4.72	4.70	7.57	7.52	4.00	3.96
T_4 35 kg P_2O_5 ha^{-1}	7.78	7.81	41.53	42.36	4.38	4.36	7.87	7.80	4.46	4.41
T_5 35 kg K_2O ha^{-1}	7.16	7.19	33.53	34.95	4.28	4.26	8.22	8.14	5.06	4.93
T_6 60 kg K_2O ha^{-1}	6.77	6.69	28.40	28.74	4.15	4.10	8.47	8.43	5.86	5.55
T_7 25 t FYM ha^{-1}	6.87	6.78	22.49	22.74	4.33	4.28	8.64	8.63	6.83	6.53
T_8 40 kg : 35 kg : 35 kg : 25 t, N:P:K: FYM ha^{-1}	9.59	9.35	70.86	68.22	4.86	4.80	6.65	6.76	2.85	3.06
T_9 80 kg : 35 kg : 35 kg : 25 t, N:P:K: FYM ha^{-1}	**10.96**	**10.75**	**86.36**	**83.94**	**5.33**	**5.27**	**5.89**	**5.96**	**1.85**	**2.07**
T_{10} 35 kg : 35 kg : 25 t, P:K: FYM ha^{-1}	9.48	9.32	66.66	66.87	4.75	4.70	6.76	6.77	3.08	3.08
T_{11} 35 kg : 60 kg : 25 t, P:K: FYM ha^{-1}	8.71	8.46	60.58	60.23	4.05	3.95	7.23	7.26	3.42	3.54
T_{12} 40 kg : 35 kg : 25 t, N: P: FYM ha^{-1}	8.15	8.04	59.00	58.53	4.26	4.21	7.35	7.36	3.62	3.64
T_{13} 80 kg : 35 kg : 25 t, N: P: FYM ha^{-1}	8.52	8.33	65.22	64.82	4.56	4.50	6.91	6.98	3.22	3.33
T_{14} 80 kg : 35 kg , N: P ha^{-1}	9.61	9.47	77.85	78.05	5.06	4.97	6.36	6.34	2.99	2.96
T_{15} 80 kg : 35 kg , N: K ha^{-1}	10.46	10.20	79.09	77.04	5.21	5.15	6.09	6.19	2.20	2.51
T_{16} 80 kg : 60 kg , N: K ha^{-1}	8.97	8.88	70.23	69.43	4.67	4.64	6.71	6.75	3.17	3.21
T_{17} 40 kg : 25 t, N: FYM ha^{-1}	8.37	8.26	59.18	58.09	4.70	4.64	7.20	7.23	3.64	3.66
T_{18} 35 kg : 25 t, P: FYM ha^{-1}	9.40	9.18	71.08	67.09	4.26	4.20	6.63	6.77	2.79	3.00
T_{19} 60 kg : 25 t, K: FYM ha^{-1}	9.58	9.47	80.26	77.66	4.50	4.47	6.26	6.33	2.51	2.52
T_{20} 40 kg : 35 kg : 35 kg , N: P:K ha^{-1}	8.74	8.67	71.87	72.16	4.45	4.39	6.64	6.64	3.11	3.10
GM	**8.75**	**8.64**	**61.03**	**60.37**	**4.58**	**4.53**	**7.07**	**7.09**	**3.57**	**3.59**
Sem (±)	**0.12**	**0.12**	**0.80**	**1.48**	**0.05**	**0.04**	**0.03**	**0.05**	**0.11**	**0.14**
CD (0.05)	**0.35**	**0.35**	**2.30**	**4.23**	**0.16**	**0.13**	**0.09**	**0.16**	**0.32**	**0.41**
CV (%)	**2.43**	**2.47**	**2.28**	**4.24**	**2.22**	**1.75**	**0.78**	**1.43**	**5.51**	**6.90**

germination, the least relative growth index was found on (4.05 and 4.10) while, highest value was recorded for T_9 treatment (5.33 and 5.27) followed by T_{15} treatment (5.21 and 5.15) the range of mean daily germination from 4.05 to 5.33 and 4.10 to 5.27 in the year 2013 and 2014. Both (2013 and 2014) year data revealed that the significant effect of treatment on mean germination time. The T_7 treatment had registered maximum mean germination time (8.64 and 8.63 days) while, minimum was found for T_9 treatment (5.89 and 5.96 days) followed by T_{15} treatment (6.09 and 6.19 days). The various treatments had significant effect on T_{50} and highest T_{50} value was observed in T_7 treatment (6.83 and 6.53) while, least T_{50} value was found in case of T_9 treatment (1.85 and 2.07) as shown in Table 6.

CONCLUSION

The above study provided promising outcomes when the fertilizers with FYM used in the ratio of 80:35:25 (N:P:K) with 25 t FYM ha^{-1}. All the parameters which were considered in this study showed significant relation in T_9 treatment. The observation depicted that the production of chilli can be more increased when the dose of fertilizer used in T_9 treatment over recommended dose of fertilizers would be used, which could be profitable for farmers as it would provide good quality and quantity of chilli and more returns. The findings of this study suggested that, there is further need to observe the adaptibility and quality production of chilli in different agro-ecological zones of India.

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