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Effect of Varieties and Integrated Nutrient Management on Growth and Yield of Chilli (*Capsicum annuum* L.)

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ABSTRACT

The present study was carried out during 2012 rabi season at Research Farm, J.N.K.V.V. College of Agriculture, Tikamgarh, (M.P.), India with 10 treatment combinations (V_1I_1. V_1I_2, V_1I_3, V_1I_4, V_1I_5, V_2I_1, V_2I_2, V_2I_3, V_2I_4, V_2I_5, wheres V_1- Pusa Jwala, V_2- Garima -12 and INM facors, I_1- recommended dose of fertilizer (RDF) or Control (100:50:50 kg NPK ha^{-1}), I_2- RDF + FYM (10 t ha^{-1}), I_3 – RDF + Vermicompost (2.5 t ha^{-1}), I_4 – RDF + Vesicular arbuscular mycorrhiza (VAM) @ 2 kg ha^{-1}, I_5 – RDF + Azospirillum in factorial randomize block design with 3 replications. At 90 DAT application of RDF + Vermicompost 2.5 tonnes ha^{-1} showed significant increase in plant height (71.6 cm), number of branches $plant^{-1}$ (24.7), minimum days taken to 1^{st} flowering as well as 50% flowering (25.7 and 31.7 DAT, respectively), number of fruits $plant^{-1}$ (112.8), maximum fruit length (10.8 cm), fruit girth (2.38 cm), fruit yield $plant^{-1}$ (271.5 g) and fresh fruit yield of 6816 kg ha^{-1}. Significantly the lowest growth, yield attributes and fruit yield of chilli was noticed in recommended dose of fertilizer (RDF) or Control (100:50:50 kg NPK ha^{-1}).

Key words: *FYM, Vermicompost, VAM, Azospirillum, Chilli.*

INTRODUCTION

Chilli is one of the most important commercial spice crops of India. India is the major exporter of chilli, though; only 3-7 per cent of total produced is exported, contributing 25 per cent of the total world production. Area under chilli during the year 2011-12 in India was 805,000 ha, production 1276,000 MT and productivity was 1.6 MT/ha.[1] The crop is very important for agricultural economy and is used in processing industries. India is the largest producer, consumer and exporter of chilli, which contribute to 25% of total world's production. In India, chilli is grown in almost all the states across the length and breadth of the country. In India the most important chilli growing states are Karnataka, Tamil Nadu, Orissa, Maharashtra, Rajasthan and West Bengal.

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Andhra Pradesh is the largest producer of chilli in India, contributes about 30% to the total area under chilli. Chilli is an indispensable condiment of every Indian home. Chilli is consumed in both fresh as well as dried form. It is good choice for generating higher profit. It can be cultivated in many types of soils, well drained loamy soil having rich organic matter are best suited for its cultivation. On sandy loamy soil, crop can be grown successfully, provided, manuring is done heavily and crop is irrigated properly and timely[2]. A large number of constraint limit the production of chilli which include low yielding ability of genetic material, imbalanced supply of nutrient, pest and disease, etc., so screening of genotype / variety is most important for getting higher yield as well as higher income and international market. With respect to management, nutrient management is most important factor for higher productivity[3]. Higher cost of cultivation or chemical fertilizers is posing a major challenge to fully meet out the nutrient requirement of the crop. Use of organic manures to meet the nutrient requirements of crop would be an inevitable practice in the years to come for sustainable agriculture since organic manures not only improve the soil physical, chemical and biological properties[4] but also improves the moisture holding capacity of soil, thus resulting in enhanced crop productivity along with better quality of crop produce[5]. Hence fertilizers, manures and other amendments either alone or in combinations could be used to develop nutrient supplying capacity of the soil. The yield of chilli depends on adequate supply of the essential nutrients[6]. Chilli crop respond to addition of nutrients through FYM, green manuring and chemical fertilizers[7]. Particularly chilli needs heavy manuring for better plant growth and high yield. The growth parameters like plant height and number of branches plant^{-1} was found maximum with combined application of vermicompost and urea at 50% level. The yield attributes including fruit yield was found maximum with nitrogen received from vermicompost and urea at 50% level[8]. Use of judicious combinations of organic and inorganic fertilizer sources is essential not only to maintain the soil health but also sustain the productivity. Use of organic manures alone cannot fulfill the crop nutrients requirement. There is a proper ratio between the organic and chemical sources and it should be worked out to derive the best combination of the inputs for attaining quantity and quality in chilli. The integrated supply and use of plant nutrients from chemical fertilizers and organic manures has been shown to produce higher crop yields than when they are applied alone. Hence, an investigation was undertaken to study the effect of organic and inorganic sources of nutrients on growth, yield and economics of chilli in periurben areas to sustain the productivity. This problem can be managed through adoption of integrated nutrient management. Present investigation is carried out to identify / screening suitable variety with better management practices for getting good quality fruits and higher fruit yield of chilli.

MATERIALS AND METHODS

The present investigation was carried out at Research Farm, J.N.K.V.V. College of Agriculture, Tikamgarh, (M.P.) during 2012 with an objective to study the effect of varieties and integrated nutrient management on growth and fruit yield of chilli. The experimental site was clay loam, low in available N (266 kg N ha^{-1}) and high in available P_2O_5 (25.9 kg ha^{-1}) and K_2O (255 kg ha^{-1}). The experiment was laid out in factorial randomized block design with three replications comprised of 10 treatment combinations viz; V_1I_1. V_1I_2, V_1I_3, V_1I_4, V_1I_5, V_2I_1, V_2I_2, V_2I_3, V_2I_4, V_2I_5 where's, V_1- Pusa Jwala, V_2- Garima -12 and INM facors, I_1- recommended dose of fertilizer (RDF) or Control (100:50:50 kg NPK ha^{-1}), I_{2-} RDF + FYM (10 t ha^{-1}), I_3 – RDF + Vermicompost (2.5 t ha^{-1}), I_4 – RDF + Vesicular arbuscular mycorrhiza (VAM) @ 2 kg ha^{-1}, I_5 – RDF +

Azospirillum. Organic manures were applied (on equal N basis) as per the treatment and incorporated into the soil before sowing. 1/3 nitrogen were given to the plot before sowing as basal dose. Remaining 2/3 quantity of nitrogen was applied in two split doses i.e., 30 and 60 DAT. The seedlings were planted in the plots with spacing of 60×45 cm^2. Five plants were randomly selected from each treatments and replication for the study. Daily observations were made on the five randomly selected and tagged plants for first flower and 50 per cent flowering. The day on which first flower and 50 per cent of plants showed flower initiation was considered as days to first flower and 50 per cent flowering, respectively. Immediately after harvesting their fresh yield was recorded. The weight of each picking was added to get the total green chilli yield. Observations were recorded on plant height (cm), number of branches $plant^{-1}$, minimum days taken to 1^{st} flowering as well as 50% flowering (DAT), number of fruits $plant^{-1}$, maximum fruit length (cm), fruit girth (2.38cm), fruit yield $plant^{-1}$ (g) and fresh green fruit yield (kg ha^{-1}). The required amount of N, P and K fertilizers was applied through urea, DAP and muriate of potash, respectively. Other cultural operations and plant protection measures were followed as per the recommendations.

RESULTS AND DISCUSSION

Integrated nutrient management practices exerted significant influence on growth parameters like plant height (cm), number of branches $plant^{-1}$, minimum days taken to 1^{st} flowering as well as 50% flowering (DAT). Chilli variety Garima-12 showed significantly higher in plant height at 30, 60 and 90 DAT (26.7, 61.3 and 77.6 cm respectively), maximum number of branches $plant^{-1}$ at 30, 60 and 90 DAT (6.6, 18.9 and 22.6 respectively) and minimum days taken to 1^{st} flowering and 50% flowering (28 and 33.8 DAT respectively). Combined application of RDF (100:50:50 kg NPK ha^{-1}) + Vermicompost (2.5 t ha^{-1}) showed significantly higher in plant height at 30, 60 and 90 DAT (29.9, 59.4 and 71.6 cm respectively), highest number of branches $plant^{-1}$ at 30, 60 and 90 DAT (9.1, 21.2 and 24.7 respectively) and minimum days taken to 1^{st} flowering as well as 50% flowering (25.7 and 31.7 DAT respectively). While, minimum plant height at 30, 60 and 90 DAT (21.7, 46.9 and 56.9 cm respectively), lowest number of branches $plant^{-1}$ at 30, 60 and 90 DAT (4.4, 14.4 and 17.3 respectively) and highest days taken to 1^{st} flowering and 50% flowering (30.9 and 36.9 DAT respectively) with the application of 100:50:50 kg NPK ha^{-1} (RDF or control) (Table-1,2,3). Among the varieties, Garima-12 recorded significantly higher plant growth over var. Pusa Jwala. The increase in growth components of Garima-12 was due to genetic makeup of the variety. Ramakrishna[9] and Shashidhara and Shivamurthy[10] (2008) also reported varietal differences for growth components in chilli. Treatment of RDF + Vermicompost @ 2.5 t ha^{-1} (I_3) resulted in significantly greater plant growth as compared to RDF + FYM @ 10 t ha^{-1} (I_2), RDF + Azospirillum (I_5), RDF + Vesicular arbuscular mycorrhiza @ 2 kg ha^{-1} (I_4) and control (I_1).

The increase in growth parameters may be due to the application of organic manure which facilitates quick and greater availability of plant nutrients for longer period and continuous supply of nutrients and thus provides a better environment for root growth and proliferation and also highest level of primary nutrients, which promoted the axillary buds in to new shoots. It also creates more adsorptive surface for uptake of nutrients. Results also in conformity with results recorded by Shashidhara and Shivamurthy[10] reported that maximum growth characters in chilli were recorded under integrated nutrient supply system. These results are in conformity with the findings of Chumyani et *al*.[11] in tomato, Vimera et *al*.[12] in king chilli and Chumei et *al*.[13] in brinjal, who found maximum growth characters under integrated nutrient supply system. However, interaction effect of integrated nutrient management treatments and varieties was found non significant at all the growth stages. All the treatments viz., varieties and INM treatments were failed to influence days to first flower and days taken to 50 per cent flowering significantly.

Among the genotypes, Garima-12 recorded significantly higher fruit number plant^{-1} (110.8), higher fruit length (9.9 cm), higher fruit girth (2.39 cm), higher fruit yield plant^{-1} and yield ha^{-1} (259.6 g and 6193 kg ha^{-1}, respectively) over Pusa Jwala. Among the integrated nutrient management treatments, RDF + Vermicompost 2.5 tonnes ha^{-1} recorded significantly higher number of fruits plant^{-1} (112.5), higher fruit length (10.8 cm), higher fruit girth (2.38 cm), higher fruit yield plant^{-1} and yield ha^{-1} (271.5 g and 6816 kg ha^{-1}, respectively) while, significantly lower fruit number plant^{-1} (92.5), lower fruit length (8.7 cm), lower fruit girth (1.67 cm), lowest fruit yield plant^{-1} and yield ha^{-1} (227.8 g and 4218 kg ha^{-1}, respectively) was recorded with control. Interaction due to treatments and varieties for fruit length, fruit girth and total green fruit yield was found non-significant. Fruit yield plant^{-1} and interaction was found significant and highest fruit yield plant^{-1} (282.2 g) was recorded under the treatment combination of RDF + Vermicompost 2.5 tonnes ha^{-1} with variety Garima-12 and was closely followed by combination of RDF + FYM 10 tonnes ha^{-1} with variety Garima-12 (255.7 g) (Table-4,5).

Application of RDF + Vermicompost @ 2.5 t ha^{-1} (I_3) resulted into 61.1%, 3.79%, 13.3% and 7.44% increased in fruit yield (kg ha^{-1}) over control (I_1), RDF + FYM @ 10 t ha-1 (I_2), RDF + Vesicular arbuscular mycorrhiza @ 2 kg ha^{-1} (I_4) and RDF + Azospirillum (I_5), respectively. The increase in fruit yield with application of RDF + Vermicompost @ 2.5 t ha^{-1} (I_3) may be attributed to better growth in terms of plant height and number of branches, which reflected into improved yield components viz., number of fruits plant^{-1}, fruit length, fruit girth and fruit yield plant^{-1} as compared to other INM treatments. The increased yield in I_3 was due to significantly more number of fruits plant^{-1} and fruit yield plant^{-1} respectively. These parameters also showed the similar trend as that of final green fruit yield. Increase in number of fruits plant^{-1} is due to production of more number of flowers, higher percentage of fruit set and reduced shedding of flowers and fruits and resulted in increased fruits. Similar increase in fruit yield was observed in gangetic alluvial plain soils with 50% nitrogen received from vermicompost and 50% from urea[8]. Improved growth components under application of RDF + Vermicompost @ 2.5 t ha^{-1} (I_3) may be attributed to increasing in availability of nutrients for longer period and continuous supply of nutrients. This might have attributed to more availability and subsequent nutrient uptake by the crop, thus increasing the yield. The reasons for increased fruit yield in chilli was attributed to the increased solubilization effect and availability of nutrients by the addition of vermicompost and increased physiological activity leading to the build-up of sufficient food reserves for the developing sinks and better portioning towards the developing fruits. This higher translocation was possible perhaps due to better sink capacity as indicated by the higher number of fruits and weight of fruits per plant. The results are in accordance with the findings of Patil et *al*.[14]. Similar results were also reported by Subbaiah et *al*.[15] in Chilli. In the present study increase in growth and morphological parameters in the early stages of crop growth, indicate the efficiency of the plant to trap the available solar radiation efficiently which resulted in the increased rates of assimilates which inturn used in the fruit formation, thus ultimately increased the yield per unit area. The results of the present investigation are in conformity with the findings of Swamy and Subba Rao[16].

Table 1: Plant height (cm)

Treatments	Plant height (cm)								
	30 DAT			60 DAT			90 DAT		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
I_1	20.2	23.1	21.7	39.2	54.6	46.9	43.7	70.2	56.9
I_2	25.8	28.4	27.1	47.1	63.2	55.2	53.3	81.1	67.2
I_3	28.3	31.7	29.9	49.6	69.2	59.4	56.5	86.7	71.6
I_4	23.6	24.2	23.9	44.3	58.1	51.2	46.9	73.4	60.1
I_5	24.2	26.1	25.2	45.2	61.2	53.2	48.6	76.8	62.7
	24.4	26.7		45.1	61.3		49.8	77.6	
	S.Em±	CD at 5%		S.Em±	CD at 5%		S.Em±	CD at 5%	
Variety (V)	0.46	1.38		0.35	1.76		0.30	0.90	
Treatment (I)	0.73	2.17		0.55	2.78		0.48	1.43	
Interaction (V x I)	1.03	NS		0.78	NS		0.67	NS	

Table 2: Number of branches plant^{-1}

Treatments	Number of branches plant^{-1}								
	30 DAT			60 DAT			90 DAT		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
I_1	4.12	4.70	4.4	13.1	15.7	14.4	16.0	18.5	17.3
I_2	6.78	7.15	7.0	19.1	20.5	19.8	22.3	24.31	23.3
I_3	8.57	9.63	9.1	20.6	21.8	21.2	23.6	25.9	24.7
I_4	4.80	5.11	5.0	16.1	17.3	16.7	19.3	21.1	20.2
I_5	5.84	6.51	6.2	18.3	19.15	18.7	20.8	23.2	22.0
	6.0	6.6		17.5	18.9		20.4	22.6	
	S.Em±	CD at 5%		S.Em±	CD at 5%		S.Em±	CD at 5%	
Variety (V)	0.22	NS		0.26	0.79		0.33	0.99	
Treatment (I)	0.36	1.06		0.41	1.24		0.52	1.56	
Interaction (V x I)	0.50	NS		0.59	NS		0.74	NS	

Table 3: Flowering characters

Treatments	Flowering characters					
	Days to 1st flower (DAT)			Days to 50% flowering (DAT)		
	V_1	V_2	Mean	V_1	V_2	Mean
I_1	31.1	30.6	30.9	37.1	36.6	36.9
I_2	27.8	26.3	27.1	33.8	32.3	33.1
I_3	26.1	25.3	25.7	32.1	31.3	31.7
I_4	29.5	29.2	29.3	35.5	34.2	34.8
I_5	28.2	28.8	28.5	34.2	34.8	34.5
	28.6	28.0		34.6	33.8	
	S.Em±	CD at 5%		S.Em±	CD at 5%	
Variety (V)	0.35	NS		0.36	NS	
Treatment (I)	2.05	NS		2.17	NS	
Interaction (V x I)	0.77	NS		0.81	NS	

Table 4: Fruit characters

Treatments	Fruit characters								
	Number of fruits plant^{-1}			Fruit length (cm)			Fruit girth (cm)		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
I_1	84.4	100.6	92.5	8.5	8.9	8.7	1.39	1.95	1.67
I_2	94.6	116.3	105.4	9.8	10.2	9.1	1.71	2.45	2.08
I_3	103.1	121.9	112.5	10.3	11.3	10.8	1.82	2.95	2.38
I_4	87.1	106.2	96.6	9.2	9.5	9.3	1.51	2.32	1.92
I_5	90.4	109.1	99.8	9.4	9.8	9.6	1.51	2.26	1.88
	91.9	110.8		9.4	9.9		1.59	2.39	
	S.Em±	CD at 5%		S.Em ±	CD at 5%		S.Em ±	CD at 5%	
Variety (V)	0.42	1.26		0.25	NS		0.08	0.26	
Treatment (I)	0.67	2.00		0.40	1.17		0.14	0.41	
Interaction (V x I)	0.94	NS		0.55	NS		0.19	NS	

Table 5: Fruit yield

Treatments	Fruit yield					
	Fruit yield (g plant-1)			Fresh fruit yield (kg ha^{-1})		
	V_1	V_2	Mean	V_1	V_2	Mean
I_1	210.2	245.5	227.8	4123.00	4313.00	4218.00
I_2	240.2	255.7	247.9	6315.00	6819.00	6567.00
I_3	260.9	282.2	271.5	6526.00	7105.00	6816.00
I_4	220.7	235.9	228.3	5813.00	6217.00	6015.00
I_5	251.4	279.0	265.0	6177.00	6510.00	6344.00
	236.6	259.6		5791.00	6193.00	
	S.Em±	CD at 5%		S.Em±	CD at 5%	
Variety (V)	0.44	1.32		47.2	141.2	
Treatment (I)	0.70	2.09		74.6	223.2	
Interaction (V x I)	0.99	2.95		105.43	NS	

CONCLUSION

The treatments that combined RDF + Vermicompost @ 2.5 t ha^{-1} gave the best results in terms of all growth parameters measured and the yield, while the control (RDF, 100:50:50 kg NPK ha^{-1}) showed the lowest values. This indicates that provided that the problem of affordability and procurement of chemical fertilizer by resource poor farmers persists, the use of this chemical fertilizer with vermicompost (less expensive and affordable) should be a viable alternative.

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