Effect of inorganic and biofertilizers on chilli

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ABSTRACT

An experiment was carried out at Horticulture Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, West Bengal during 2007-2008, to find out the efficacy of biofertilizers (Azospirillum and phosphate solubilizing bacteria) with different levels of inorganics on growth and yield of chilli (Arka Lohit and Arka Suphal). The experiment was laid out in Factorial RBD with two replications. Three levels (25%, 50% and 75%) of both inorganic N and P were included alongwith full dose of K and biofertilizer. There were altogether 12 treatment combinations. The biofertilizers were applied twice @ 15g/3 sq m during 30 and 60 days after transplanting (DAT) but inorganics were applied at 45 and 75 DAT. The results revealed that plants under treatment $N_{75\%}P_{75\%}K_{100\%}$ + biofertilizers and $N_{75\%}P_{50\%}K_{100\%}$ + biofertilizer recorded the maximum growth and yield in Arka Lohit and Arka Suphal respectively, indicating there is a chance of saving 25% both inorganic N and P in Arka Lohit and 25% N and 50% P in Arka Suphal through biofertilizer.

***Key words*:** Azospirillum, biofertilizers, chilli, growth, inorganics, phonphate solubilizing bacteria and yield.

Chilli is one of the important vegetable cum spice crops. It is grown over an area of about 758 ('000) ha with a production of 1234.10 ('000) tonnes and productivity 1628 (kg/ha) in 2006-2007 (IISR, Calicut). In India the most important chilli growing states are Andhra Pradesh, Karnataka, Tamil Nadu, Orissa, Maharashtra, Rajasthan and West Bengal. Continuous application of inorganic fertilizers has resulted in ecological imbalance with consequent ill effect on the soil and environment (Mondal *et al.* 2003). However, in recent years, biofertilizers has emerged as promising component of plant nutrient system. Hence, the experiment was designed with the objective to supplement the use of chemical fertilizers with biofertilizers that could ensure eco-friendly environment.

MATERIALS AND METHODS

The investigation was carried out at Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, West Bengal during the period from 2007 to 2008. The soil of experimental field was sandy loam having organic carbon content 0.35%, available phosphorus 22.61kg/hectare, available potassium 183.21 kg/hectare and pH of 6.8. The treatments were: T_1- full NPK, T_2- $N_{75\%}$ $P_{75\%}$ $K_{100\%}$+ biofertilizer, T_3- $N_{75\%}$ $P_{50\%}K_{100\%}$ + biofertilizer, T_4- $N_{75\%}$ $P_{25\%}K_{100\%}$+ biofertilizer; T_5- $N_{50\%}$ $P_{75\%}K_{100\%}$+ biofertilizer, T_6- $N_{50\%}$ $P_{50\%}K_{100\%}$+ biofertilizer, T_7- $N_{50\%}$ $P_{25\%}K_{100\%}$+ biofertilizer, T_8- $N_{25\%}$ $P_{75\%}K_{100\%}$+ biofertilizer, T_9- $N_{25\%}P_{50\%}K_{100\%}$+ biofertilizer, T_{10}- $N_{25\%}$ $P_{25\%}K_{100\%}$+ biofertilizer, T_{11}- biofertilizers (*Azospirillum* + PSB), T_{12}- Control (no fertilizer). The recommended dose of NPK was 90:60:50 kg/ha. The treatments were designed to substitute the both inorganic nitrogen and phosphorus with 25-75% substitution by biofertilizers. The experiment was laid out in two factor randomized complete block design with two replications. Two cultivars namely Arka Lohit and Arka Suphal were undertaken. Both *Azospirillum* and phosphate solubilizing bacteria (PSB) were applied @ 15g/3 sq.m. through water (1.5 litre) twice i.e. 30 and 60 days after transplanting. The seedlings were transplanted at 50 cm x 50 cm spacing i.e. 12 seedlings/plot (2m x 1.5m). FYM was applied at the basis of @10t/ha. The inorganic fertilizers were applied in two split doses *i.e.* 45 and 75 DAT. Observations on different growth parameters like plant height were taken during first harvesting, number of branches per plant were counted from the main stem at the time of last harvesting and yields were recorded. The analysis for the experimental data was done as per Panse and Sukhatme(1989).

RESULTS AND DISCUSSION

The data presented in Table -1 revealed that Arka Lohit recorded significantly higher plant height (62.49 cm) as compared to Arka Suphal (51.87 cm). Among different treatments, the highest plant height (65.00 cm) was observed in T_3 ($N_{75\%}$ $P_{50\%}K_{100\%}$ + biofertilizer) as compared to lowest (49.50 cm) in T_{12} (control). In respect to variety the highest plant height (70.83 cm) was observed in T_2 ($N_{75\%}$ $P_{75\%}$ $K_{100\%}$+ biofertilizer) as compared to lowest (52.67 cm) in T_{12} (control) in Arka Lohit where as in Arka Suphal highest plant height (60.83 cm) was recorded in T_3($N_{75\%}$ $P_{50\%}K_{100\%}$ + biofertilizer) against lowest (46.33 cm) in T_{12} (control). These findings are in good agreement with Sankaranarayanan *et al* (1995) and Wange and Kale (2004). As per as the varietal effect Arka Lohit recorded maximum number of branches per plant (23.91) in comparison to Arka Suphal (19.95). The maximum number of branches was observed in Arka Lohit (30.17) and Arka Suphal (23.67) with T_2 ($N_{75\%}$ $P_{75\%}$ $K_{100\%}$+ biofertilizer) and T_3

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($N_{75\%}$ $P_{50\%}K_{100\%}$ + biofertilizer) respectively as compared to 18.93 and 16.00 under respective control. In respect to number of fruits per plant Arka Lohit produce more fruit (50.06) in comparison to Arka Suphal (43.56). The treatment $N_{75\%}$ $P_{75\%}$ $K_{100\%}$+ biofertilizer (T_2) recorded maximum number of fruits/plant (63.13) in Arka Lohit as compared to 44.35 in control but T_3 ($N_{75\%}$ $P_{50\%}K_{100\%}$ + biofertilizer) produced maximum (54.00) in Arka Suphal as compared to 35.24 in control. Like number of fruits per plant the same treatment combination recorded maximum number of seed per fruit, length of fruit, diameter of fruit, fresh weight of fruit in both the varieties and Arka Lohit showed superiority in all these five parameters as compared to Arka Suphal (Table-2).

Data recorded in Table-3 revealed that, the variety Arka Suphal significantly produced maximum fruit yield per plant (186.73 g) in comparison with Arka Lohit (147.94 g). The plant under treatment combination T_2 ($N_{75\%}$ $P_{75\%}K_{100\%}$+biofertilizer) recorded maximum fruit yield per plant (223.03g) as compared to control (110.00 g) where as maximum yield (291.60 g) was noticed with in T_3 ($N_{75\%}$ $P_{50\%}K_{100\%}$ + biofertilizer) in Arka Suphal as compared to only 123.33g under control. Though T_3 treatment gave maximum yield in Arka Suphal but there was no significant difference observed with T_2 treatment. The fruit yields under Full NPK were 178.20 and 235.80g in the respective varieties. Similar pattern of influence were observed in both varieties in respect of fruit yield per plot and projected yield (t/ha). The results of the study showed that combined application of biofertilizers and inorganic fertilizers had beneficial effect on growth and yield of chilli and there was a clear indication of substitution of 25% inorganic nitrogen and 25-50% phosphorus with biofertilizer. These findings are in good agreement with Sankaranarayanan *et al* (1995). Amirthalingam and Balakrishnan (1988) observed that the yield of chilli obtained with the inoculation on *Azospirillum* to seed, soil and seedlings at 75% N was at par with the yield obtained by 100% N with out inoculation.

The positive influence of biofertilizers on various growth and yield parameters observed in the present study were due to enhanced uptake of nutrients by the plants (Borea, 1991). *Azospirillum* aid in increased plant growth due to there nitrogen fixing capacity and also they are known to help in the synthesis of growth promoting substances like IAA and GA (Jackson and Brown, 1966). The present findings are also in good agreement with the observations of Gowda *et al* (2002) who observed the improved growth, yield and quality of chilli with 75% nitrogen, phosphorus plus 100% potassium in addition to the inoculation of biofertilizers. Application of biofertilizers along with reduced levels of chemical fertilizers has beneficial effects compared to application of recommended NPK. PSB enhances P availability, it is also known to produced amino acids, vitamins and growth promoting substances like IAA and GA, which help in better growth of plants.

The data presented in Table-4 clearly indicates the marked influence of different treatment combination on economics of chilli production. In Arka Lohit maximum net return per hectare (Rs. 70,668/-) with highest B:C ratio (2.37:1) was noticed in T_2 ($N_{75\%}$ $P_{75\%}K_{100\%}$+biofertilizer) but treatment combination of $N_{75\%}$ $P_{50\%}K_{100\%}$ + biofertilizer (T_3) recorded maximum net profit (Rs.101604/-) with B:C ratio (3.43:1) in Arka Suphal. The low and declining trend in T_7 to T_{11} were observed due to lower yield in these treatments. The experimental results clearly indicate that there is a chance of saving of 25% inorganic nitrogen in both variety and chance of saving 25% and 50% inorganic phosphate in Arka Lohit and Arka Suphal respectively.

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Table 1: Effect of biofertilizers with inorganic fertilizer on plant height, number of branches and fruits per plant.

Treatments	Plant height (cm)			Number of branches/plant			Number of fruits/plant		
	Arka Lohit	Arka Suphal	Mean	Arka Lohit	Arka Suphal	Mean	Arka Lohit	Arka Suphal	Mean
T_1-Full NPK	68.84	55.67	**62.26**	27.84	21.50	**24.67**	54.83	50.17	**52.50**
T_2-$N_{75\%}$ $P_{75\%}$ $K_{100\%}$ + BF	70.83	58.67	**64.75**	30.17	22.83	**26.50**	63.13	53.34	**58.24**
T_3-$N_{75\%}$ $P_{50\%}K_{100\%}$ + BF	69.17	60.83	**65.00**	28.50	23.67	**26.09**	57.84	54.00	**55.92**
T_4-$N_{75\%}$ $P_{25\%}K_{100\%}$ + BF	65.33	55.35	**60.34**	26.34	21.17	**23.76**	52.50	49.12	**50.81**
T_5-$N_{50\%}$ $P_{75\%}K_{100\%}$ + BF	64.67	50.00	**57.34**	24.34	21.17	**22.76**	48.50	46.67	**47.59**
T_6-$N_{50\%}$ $P_{50\%}K_{100\%}$ + BF	62.00	49.50	**55.75**	22.15	20.83	**21.49**	50.15	43.16	**46.66**
T_7-$N_{50\%}$ $P_{25\%}K_{100\%}$ + BF	63.17	47.30	**55.24**	23.83	19.50	**21.67**	47.84	40.67	**44.26**
T_8-$N_{25\%}$ $P_{75\%}K_{100\%}$ + BF	59.34	51.50	**55.42**	21.87	18.37	**20.12**	45.48	38.17	**41.83**
T_9-$N_{25\%}$ $P_{50\%}K_{100\%}$ + BF	60.66	48.50	**54.58**	22.60	19.52	**21.06**	45.91	38.00	**41.96**
T_{10}-$N_{25\%}$ $P_{25\%}K_{100\%}$ + BF	58.12	50.79	**54.46**	20.83	17.84	**19.34**	45.19	37.60	**41.40**
T_{11}-Biofertilizer	55.00	48.00	**51.50**	19.50	17.00	**18.25**	44.97	36.50	**40.74**
T_{12}-Control(no fertilizer)	52.67	46.33		18.93	16.00		44.35	35.24	**39.80**
Mean	**62.49**	**51.87**		**23.91**	**19.95**		**50.06**	**43.56**	
	SEm (±)	**LSD (P=0.05)**		**SEm (±)**	**LSD (P=0.05)**		**SEm (±)**	**LSD (P=0.05)**	
Variety(V)	**0.553**	**1.617**		**0.852**	**2.492**		**0.604**	**1.768**	
Treatment(T)	**1.354**	**3.962**		**2.086**	**N.S**		**1.480**	**4.331**	
V X T	**1.915**	**N.S**		**2.951**	**N.S**		**2.093**	**N.S**	

BF = Biofertilizer (*Azospirillum* + phosphate solubilizing bacteria)

Table 2: Effect of biofertilizers with inorganic fertilizer on number of seeds per fruit and dimension of fruit.

Treatment	Number of seeds/ fruit			Length of fruit (cm)			Diameter of fruit (mm)		
	Arka Lohit	Arka Suphal	Mean	Arka Lohit	Arka Suphal	Mean	Arka Lohit	Arka Suphal	Mean
T_1-Full NPK	55.15	52.00	**53.58**	5.66	6.39	**6.03**	8.12	9.57	**8.85**
T_2-$N_{75\%}$ $P_{75\%}$ $K_{100\%}$ + BF	61.25	55.75	**58.50**	6.01	6.66	**6.34**	8.55	10.20	**9.38**
T_3-$N_{75\%}$ $P_{50\%}K_{100\%}$ + BF	58.35	62.75	**60.55**	5.90	6.68	**6.29**	8.42	10.88	**9.65**
T_4-$N_{75\%}$ $P_{25\%}K_{100\%}$ + BF	54.92	50.75	**52.84**	5.76	6.15	**5.96**	8.20	9.32	**8.76**
T_5-$N_{50\%}$ $P_{75\%}K_{100\%}$ + BF	54.12	52.30	**53.21**	5.45	5.99	**5.72**	8.04	9.47	**8.76**
T_6-$N_{50\%}$ $P_{50\%}K_{100\%}$ + BF	52.85	52.00	**52.43**	5.51	5.70	**5.61**	7.91	8.94	**8.43**
T_7-$N_{50\%}$ $P_{25\%}K_{100\%}$ + BF	50.85	48.17	**49.51**	5.24	5.81	**5.53**	7.78	9.15	**8.47**
T_8-$N_{25\%}$ $P_{75\%}K_{100\%}$ + BF	49.67	47.80	**48.74**	5.36	5.63	**5.50**	7.84	8.98	**8.41**
T_9-$N_{25\%}$ $P_{50\%}K_{100\%}$ + BF	48.9	44.32	**46.61**	5.48	5.27	**5.38**	7.42	9.13	**8.28**
T_{10}-$N_{25\%}$ $P_{25\%}K_{100\%}$ + BF	47.90	45.85	**46.88**	5.26	5.40	**5.33**	7.17	8.54	**7.86**
T_{11}-BF	46.65	43.65	**45.15**	4.95	5.12	**5.04**	6.95	7.98	**7.47**
T_{12}-Control(no fertilizer)	42.67	41.17	**41.92**	4.87	5.01	**4.94**	6.67	7.83	**7.25**
Mean	**51.94**	**49.71**		**5.46**	**5.82**		**7.76**	**9.17**	
	SEm (±)	**LSD(P=0.05)**		**SEm (±)**	**LSD(P=0.05)**		**SEm(±)**	**LSD (P=0.05)**	
Variety(V)	**0.816**	**N.S**		**0.083**	**0.243**		**0.084**	**0.246**	
Treatment(T)	**2.000**	**5.851**		**0.203**	**0.595**		**0.206**	**0.602**	
V X T	**2.828**	**N.S**		**0.288**	**N.S**		**0.291**	**N.S**	

BF = Biofertilizer (*Azospirillum* + phosphate solubilizing bacteria)

Table 3: Effect of biofertilizers with inorganic fertilizer on weight of ftuits and yield of chilli.

Treatments	Fresh weight of fruits (g)			Fruit yield/plant (g)			Projected yield (t/ha)		
	Arka Lohit	Arka Suphal	Mean	Arka Lohit	Arka Suphal	Mean	Arka Lohit	Arka Suphal	Mean
T_1-Full NPK	3.25	4.70	**3.98**	178.20	235.80	**207.00**	5.35	7.08	**6.22**
T_2-$N_{75\%}$ $P_{75\%}$ $K_{100\%}$ + BF	3.53	5.28	**4.41**	223.03	281.64	**252.34**	6.70	8.45	**7.58**
T_3-$N_{75\%}$ $P_{50\%}$$K_{100\%}$ + BF	3.45	5.40	**4.43**	199.55	291.60	**245.58**	5.98	8.75	**7.37**
T_4-$N_{75\%}$ $P_{25\%}$$K_{100\%}$ + BF	3.10	4.60	**3.85**	162.75	225.95	**194.35**	4.88	6.78	**5.83**
T_5-$N_{50\%}$ $P_{75\%}$$K_{100\%}$ + BF	3.00	4.20	**3.60**	145.50	196.01	**170.76**	4.38	5.88	**5.13**
T_6-$N_{50\%}$ $P_{50\%}$$K_{100\%}$ + BF	2.93	4.15	**3.54**	146.94	179.11	**163.03**	4.40	5.38	**4.89**
T_7-$N_{50\%}$ $P_{25\%}$$K_{100\%}$ + BF	2.80	3.90	**3.35**	133.95	158.61	**146.28**	4.04	4.75	**4.40**
T_8-$N_{25\%}$ $P_{75\%}$$K_{100\%}$ + BF	2.68	3.74	**3.21**	122.85	142.87	**132.86**	3.68	4.28	**3.98**
T_9-$N_{25\%}$ $P_{50\%}$$K_{100\%}$ + BF	2.65	3.62	**3.14**	121.67	137.50	**129.59**	3.64	4.13	**3.89**
T_{10}-$N_{25\%}$ $P_{25\%}$$K_{100\%}$ + BF	2.60	3.61	**3.11**	117.50	135.83	**126.67**	3.52	4.08	**3.80**
T_{11}-Biofestilizer	2.52	3.63	**3.08**	113.33	132.50	**122.92**	3.40	3.98	**3.69**
T_{12}-Control (no fertilizer)	2.48	3.50	**2.99**	110.00	123.33	**116.67**	3.30	3.70	**3.50**
Mean	**2.92**	**4.20**		**147.94**	**186.73**		**4.44**	**5.61**	
	SEm (±)	**LSD (P=0.05)**		**SEm (±)**	**LSD (P=0.05)**		**SEm(±)**	**LSD (P=0.05)**	
Variety(V)	**0.087**	**0.254**		**1.639**	**4.797**		**0.031**	**0.090**	
Treatment(T)	**0.212**	**0.621**		**4.016**	**11.749**		**0.075**	**0.220**	
V X T	**0.300**	**N.S**		**5.679**	**16.616**		**0.106**	**0.311**	

BF = Biofertilizer (*Azospirillum* + phosphate solubilizing bacteria)

Table 4: Economics of chilli as influenced by biofertilizers and inorganic fertilizer.

Treatments	Cost of cultivation (Rs ha^{-1})		Gross return (Rs ha^{-1})		Net return (Rs ha^{-1})		Benefit cost ratio	
	Arka Lohit	Arka Suphal	Arka Lohit	Arka Suphal	Arka Lohit	Arka Suphal	Arka Lohit	Arka Suphal
T_1-Full NPK	27776	27776	80250	106200	52474	78424	1.89:1	2.82:1
T_2-$N_{75\%}$ $P_{75\%}$ $K_{100\%}$+ BF	29831	29831	100500	126750	70668	96918	2.37:1	3.24:1
T_3-$N_{75\%}$ $P_{50\%}K_{100\%}$ +BF	29645	29645	89700	131250	60054	101604	2.03:1	3.43:1
T_4-$N_{75\%}$ $P_{25\%}K_{100\%}$+ BF	29615	29615	73200	101700	43584	72084	1.47:1	2.43:1
T_5-$N_{50\%}$ $P_{75\%}K_{100\%}$+ BF	29783	29783	65700	88200	35916	58416	1.21:1	1.96:1
T_6-$N_{50\%}$ $P_{50\%}K_{100\%}$+ BF	29598	29598	66000	80700	36401	51101	1.23:1	1.72:1
T_7-$N_{50\%}$ $P_{25\%}K_{100\%}$+ BF	29568	29568	60600	71250	31031	41681	1.05:1	1.40:1
T_8-$N_{25\%}$ $P_{75\%}K_{100\%}$+ BF	29303	29303	55200	64200	25896	34896	0.88:1	1.19:1
T_9-$N_{25\%}$ $P_{50\%}K_{100\%}$+ BF	29360	29360	54600	61950	25239	32589	0.86:1	1.11:1
T_{10}-$N_{25\%}P_{25\%}K_{100\%}$+BF	29333	29333	52800	61200	23466	31866	0.80:1	1.09:1
T_{11}- Biofestilzer	28575	28575	51000	59700	22425	31125	0.78:1	1.08:1
T_{12}-Control (no fertilizer)	26200	26200	49500	55500	23300	29300	0.89:1	1.12:1

BF = Biofertilizer (*Azospirillum* + phosphate solubilizing bacteria)