Indian Journal of Agricultural Sciences **79** (8): 600–3, August 2009

Integrated nutrient management for better growth, yield and quality of green chilli (*Capsicum annuum*) in terai region of West Bengal

B TALUKDER[1] and J C JANA[2]

Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal 736 165

Received: 30 December 2008

ABSTRACT

An experiment was conducted during winter seasons of 2004–06 to study the effect of inoculation with biological nitrogen fixers on growth and yield of 'Suryamukhi' chilli (*Capsicum annuum* L.). The growth, yield and quality characters of green chilli crop increased with the inoculation of biological nitrogen fixers using *Azotobacter* and *Azospirillum*. Performance of *Azospirillum* was better as compared to *Azotobacter*. Dual inoculation gave a synergistic effect in increasing crop growth and yield. Dual inoculation with the biological nitrogen fixers, 100% recommended dose of N-fertilizer @ 80 kg N/ha and farmyard manure @ 15tonnes/ha recorded maximum growth, yield (7.43tonnes/ha) and quality parameters, and cost : benefit ratio of 1.55 and no significant difference was observed when N-fertilizer level was reduced to 75%. Thus associative nature of the above biofertilizers helped to save 25% nitrogenous fertilizer in chilli crop. There was increased content in plant nitrogen (84.10 mg/kg), phosphate (84.42 mg/kg) and potash (57.46 mg/kg), leaf chlorophyll (0.204 mg/100g) and residual available soil nitrogen (202.90 kg/ha), phosphate (67.10 kg/ha) and potash (70.50 kg/ha) with dual inoculation with the biological nitrogen fixers along with full dose of N-fertilizer.

Key words: *Azospirillum*, *Azotobacter*, Chilli, INM, N-fertilizer

Chilli (*Capsicum annuum* L.) is one of the important vegetable-cum-spice crops of India. According to FAO estimate (FAO 2003), globally the per cent change in the area and production of chilli is consistently increasing. The productivity of chillies in India is 9.18 tonnes/ha as compared to 14.4 tonnes/ha of the world, however, the potential productivity lies between 30 and 40 tonnes/ha (Rai *et al*. 2007). A good irrigated crop of chilli can be raised on red sandy to sandy loam soil with copious amount of organic manuring and fertilizer application. Organic sources of nutrients, like farmyard manure, compost and crop residues are widely used in vegetable crops. Under integrated nutrient management approach, the best available options lie in the complimentary use of biofertilizers and organic manures in suitable combinations with chemical fertilizers for good health of our soil and environment. Inorganic nitrogen of fertilizers occurs primarily as nitrate in arable soils and nitrate leaching from soils could be a major threat to environment in different agricultural situations. Biological nitrogen fixers help to enhance productivity by biological nitrogen fixation, producing hormones, vitamins and other growth factors required for plant growth and development, solubilization of phosphorus and suppression of growth of phyto-pathogenic fungi (Verma *et al*. 2000). Free-living nitrogen fixers belonging to *Azotobactor* and *Azospirillum* live in association with the root system of crop plants harvest atmosphere nitrogen, which in due course is made available to the plants or released in the soil. Biological nitrogen fixers are an ecologically sound, economically viable, partial substitute to costly and pollution-causing nitrogenous chemical fertilizers. In view of the above, the present investigation was undertaken, to study the effect of inoculation with biological nitrogen fixers using *Azotobacter* and *Azospirillum* on growth, yield and quality of 'Surjamukhi'chilli cv. under varying levels of nitrogenous fertilizer.

MATERIALS AND METHODS

A field experiment was conducted during two winter seasons of 2004–06 at the instructional farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch behar, West Bengal to asses the effect of inoculation of biological nitrogen fixers using *Azotobacter* and *Azospirillum* singly or in combination along with farmyard manure and graded levels of inorganic nitrogenous fertilizer on growth, yield and quality of 'Suryamukhi' green chilli under Terai agro-climatic region

Based on complete information of Ph D thesis of the first author submitted to UBKV, Pundibari during 2007.

[1]Research Associate, [2]Reader (E-mail: janajc@rediffmail.com), Department of Vegetable and Spice Crops.

of West Bengal. The soil was sandy loam in texture, having *p*H of 6.2 and 6.8, organic carbon 1.05 and 1.14% and available N, P and K of 137.4 and 189.54, 40.62 and 45.30 and 56.64 and 124.86 kg/ha, respectively, for the respective years. Seed treatment with *Azotobacter* and *Azospirillum* each @25 g/kg seed for 20 min. and then seedling root dip @ 2% for 30 min. at transplanting (Kavitha *et al.* 2003) as single and in dual inoculation were tested with 4 levels of N (0, 50, 75 and 100% of the recommended dose) and farmyard manure @ 15 tonnes/ha. Two additional treatments included were the full recommended dose of N @ 80 kg/ha and farmyard manure @ 15 tonnes/ha. These 14 treatments were replicated thrice in randomized block design. The planting of chilli seedlings at six weeks age was done at spacing 75 cm×45 cm in 3 m×2.70 m plots. Nitrogen was applied in the form of urea depending upon the treatments in split doses half as basal and another half was applied in two equal splits at 3 and 6 weeks after transplanting. Phosphate and potash each @ 60 kg/ha were applied in the form of single superphosphate as basal and muriate of potash in two equal splits, one as basal and rest at 6 weeks after transplanting to all the plots. Irrigation and other intercultural operations were completed as and when required. Matured green chillies were harvested in 5 pickings at 20 days interval to get the yield. Observations on various growth, yield and quality parameters were recorded during both the years. From the green chillies harvested at fourth picking ascorbic acid content was determined using 2, 6 dichlorophenol indophenol dye (AOAC 1980). Nitrogen content in plant and residual soil nitrogen content were determined in line with the method of IITA (1975). The data of both the years have been pooled and analyzed statistically using MSTAT-C procedures.

RESULTS AND DISCUSSION

Inoculation of the biological nitrogen fixers singly or in dual application had significant influence on growth, yield and quality parameters of green chilli independently in presence of different levels of inorganic nitrogen. The results revealed that plant height, number of primary branches, days to 50% flowering and days to 50% fruit maturity (Table 1) were significantly influenced by the treatments. In the treatment of dual inoculation of biological nitrogen fixers, like *Azotobacter* and *Azospirillum* along with 100% recommended dose of nitrogen and farmyard manure recorded highest plant height (73.90 cm) and number of primary branches (7). Application of 50% recommended nitrogen with *Azotobacter* and farmyard manure resulted early flowering (44 days after planting) and fruit maturity (55days after planting) over other treatments. Similar significant increase in growth parameters due to inoculation with biological nitrogen fixers have been reported by Sengupta *et al*. (2002) in tomato(*Lycopersicon esculentum* Mill. non.cons.) and Mondal *et al.* (2003) in chilli.

The number of fresh fruits plant, 100-green fruit weight, green fruit yield/plant, green fruit yield/ha (Table 1) were

Table 1 Plant growth and yield attributes of chilli as affected by different INM treatments

Treatment	Plant height (cm)	Number of primary branches/ plant	Days to 50% flowering	Days to 50% fruit maturity	Green fruits/ plant	100-green fruit weight (g)	Green fruit yield/ plant (g)	Green fruit yield (tonnes/ ha)
T_1,100% recommended N+ *Azotobacter* + FYM	67.81	7	45.0	61.0	81	261.01	200.50	6.99
T_2,75% recommended N + *Azotobacter* + FYM	66.70	6	47.0	59.0	77	252.82	195.16	6.95
T_3,50% recommended N + *Azotobacter* + FYM	64.90	6	44.0	55.0	74	247.49	181.01	6.49
T_4,100% recommended N + *Azospirillum* + FYM	68.94	7	46.0	62.0	83	268.18	201.53	7.08
T_5,75% recommended N + *Azospirillum*+ FYM	68.33	6	46.0	61.0	77	255.06	195.40	7.01
T_6,50% recommended N + *Azospirillum* + FYM	63.53	6	47.0	59.0	75	247.07	191.39	6.77
T_7,100% recommended N + *Azotobacter* + *Azospirillum* + FYM	73.90	7	48.0	61.0	85	281.20	213.63	7.43
T_8,75% recommended N + *Azotobacter* + *Azospirillum* + FYM	69.98	7	45.0	58.0	82	271.57	207.83	7.30
T_9,50% recommended N + *Azotobacter* + *Azospirillum* + FYM	67.78	6	44.0	58.0	77	248.80	193.22	6.87
T_{10}, *Azotobacter* + FYM	51.58	5	49.0	66.0	62	215.65	161.87	5.71
T_{11}, *Azospirillum* + FYM	50.64	5	49.0	64.0	65	225.93	164.69	5.78
T_{12}, *Azotobacter* + *Azospirillum* + FYM	56.76	5	50.0	65.0	67	235.27	168.41	5.84
T_{13}, FYM	49.77	5	48.0	64.0	57	184.89	149.94	5.60
T_{14},100% recommended NPK	65.63	6	47.0	63.0	77	239.20	188.76	6.56
CD (*P*=0.05)	5.69	0.3	1.2	4.4	8.0	11.05	18.22	0.15

FYM, Farmyard manure

Table 2 Leaf chlorophyll, ascorbic acid of green fruits, plant NPK and residual soil NPK content in chilli as affected by different INM treatments

Treatment	Leaf chlorophyll content (mg/100g)	Ascorbic acid content in fresh fruit(mg/ 100g)	Nitrogen content in plant (mg/kg)	Phosphate content in plant (mg/kg)	Potash content in plant (mg/kg)	Residual soil nitrogen content (kg/ha)	Residual soil phosphate content (kg/ha)	Residual soil potash content (kg/ha)
T_1,100% recommended N+ *Azotobacter* + FYM	0.194	94.87	76.54	75.75	45.25	179.35	47.24	68.75
T_2,75% recommended N + *Azotobacter* + FYM	0.183	91.15	74.65	75.53	47.11	178.68	48.01	68.20
T_3,50% recommended N + *Azotobacter* + FYM	0.175	90.37	70.14	73.82	40.36	162.43	43.22	68.35
T_4,100% recommended N + *Azospirillum* + FYM	0.198	95.62	79.48	76.76	51.33	194.68	49.65	68.55
T_5,75% recommended N + *Azospirillum*+ FYM	0.187	94.25	75.81	76.74	49.01	178.99	48.63	67.35
T_6,50% recommended N + *Azospirillum* + FYM	0.172	90.62	71.29	74.61	41.53	163.27	44.56	67.40
T_7,100% recommended N + *Azotobacter* + *Azospirillum* + FYM	0.204	100.75	84.10	84.42	57.46	202.90	67.10	70.50
T_8,75% recommended N + *Azotobacter* + *Azospirillum* + FYM	0.190	93.62	80.64	81.43	54.81	194.83	50.74	70.35
T_9,50% recommended N + *Azotobacter* + *Azospirillum* + FYM	0.175	91.17	72.76	79.03	50.71	162.75	51.63	69.95
T_{10}, *Azotobacter* + FYM	0.164	89.50	56.80	72.11	36.15	148.41	42.50	68.35
T_{11}, *Azospirillum* + FYM	0.165	89.75	59.11	73.03	36.77	155.49	41.29	68.35
T_{12}, *Azotobacter* + *Azospirillum* + FYM	0.170	90.37	61.84	74.04	40.45	158.00	44.92	69.30
T_{13}, FYM	0.160	88.92	49.03	66.43	33.63	141.66	34.67	67.15
T_{14},100% recommended NPK	0.180	90.73	63.15	73.75	41.52	162.25	41.98	67.10
CD (*P*=0.05)	0.0016	4.43	3.55	2.46	3.19	9.45	5.14	2.41

FYM, Farmyard manure

markedly increased by the treatments. The treatment of combined application of *Azotobacter* and *Azospirillum* along with farmyard manure and 100% recommended nitrogen recorded higher fresh fruit/plant, 100-green fruit weight, green fruit yield. It recorded 13 and 33% more fruit yield/ha over sole application of inorganic nitrogen and farmyard manure, respectively and was statistically at par with the combined application of *Azotobacter* and *Azospirillum* along with farmyard manure and 75% recommended nitrogen. Among the single inoculations, application of *Azospirillum* along with farmyard manure and 100% recommended nitrogen produced more yield than that of *Azotobacter*. Similarly, it was also statistically at par when inorganic nitrogen level was reduced to 75% keeping others same. In the absence of inorganic nitrogen comparatively less green fruit yield was recorded from the plots treated with sole or dual inoculation of *Azotobacter* and *Azospirillum*. Dual inoculation of the biological nitrogen fixers always recorded better performance when compared with their single inoculation. The synergistic effect might have occurred when both were present. The increase in yield may be due to better root proliferation, more uptake of nutrients and water, higher plant growth, more photosynthesis and enhanced food accumulation. Thus associative nature of the above biofertilizers helped to save 25% nitrogenous fertilizer in chilli. The results are in conformity with the findings of Swain *et al*. (2003) and Wange and Kale (2003) in okra *hybiscus esculentum* L.

The leaf chlorophyll content, ascorbic acid content, plant nitrogen, phosphate and potash content and residual soil nitrogen, phosphate and potash content (Table 2) were also significantly influenced by the treatments. In the treatment T_7, i e dual inoculation of biofertilizers along with 100% recommended dose of nitrogen and farmyard manure highest leaf chlorophyll content, ascorbic acid content, plant nitrogen, phosphate and potash content and residual soil nitrogen, phosphate and potash content were recorded. Significantly higher available soil nutrients were observed in plots receiving organics and *Azospirillum* than those in inorganic fertilized plot in knolkhol cultivation (Shalini *et al*. 2002).

From the economic point of view (Table 3) the increased monetary benefits with B : C ratio of 1.55 and 1.53 were observed in 100% and 75% recommended dose of inorganic nitrogen, respectively with dual inoculation of biological nitrogen fixers like *Azotobacter* and *Azospirillum* and application of organic manure.

It is evident from the present study that a net saving of 25% of recommended dose of inorganic nitrogen and 13.26% yield increase in green chillies could be done in integrated nutrient management with dual inoculation of the biofertilizers and application of farmyard manure. Hence, dual inoculation of biological nitrogen fixers, like

Table 3 Economics of green chilli cultivation as affected by different INM treatments

Treatment	Yield (tonnes/ha)	Gross returns (Rs)	Cost of cultivation (Rs)	Net returns (Rs)	B: C ratio
T_1,100% recommended N+ *Azotobacter* + FYM	6.99	48 930	33 442	15 487	1.46
T_2,75% recommended N + *Azotobacter* + FYM	6.95	48 650	33 285	15 365	1.46
T_3,50% recommended N + *Azotobacter* + FYM	6.49	45 430	33 127	12 302	1.37
T_4,100% recommended N + *Azospirillum* + FYM	7.08	49 560	33 442	16 117	1.48
T_5,75% recommended N + *Azospirillum*+ FYM	7.01	49 070	33 285	15 785	1.47
T_6,50% recommended N + *Azospirillum* + FYM	6.77	47 390	33 127	14 262	1.43
T_7,100% recommended N + *Azotobacter* + *Azospirillum* + FYM	7.43	52 010	33 555	18 455	1.55
T_8,75% recommended N + *Azotobacter* + *Azospirillum* + FYM	7.30	51 100	33 397	17 702	1.53
T_9,50% recommended N + *Azotobacter* + *Azospirillum* + FYM	6.87	48 090	33 240	14 850	1.45
T_{10}, *Azotobacter* + FYM	5.71	39 970	31 162	8 807	1.28
T_{11}, *Azospirillum* + FYM	5.78	40 460	31 162	9 297	1.29
T_{12}, *Azotobacter* + *Azospirillum* + FYM	5.84	40 880	31 237	9 642	1.30
T_{13}, FYM	5.60	39 200	31 087	8 112	1.26
T_{14},100% recommended NPK	6.56	45 920	31 452	14 468	1.46

FYM, Farmyard manure

Azotobacter and *Azospirillum* with 75% recommended dose of N-fertilizer and farmyard manure can be recommended for integrated nutrient management of green chilli crop under terai agro-climatic region of West Bengal.

REFERENCES

AOAC. 1980. *Official Methods of Analysis*. Association of Analytical Chemists. 11 edn. Washington, D C.

FAO. 2003. *FAO Production Yearbook 2001*, Vol. 55, Statistics Series No. 170.

IIT A. 1975. *Selected Methods for Soils and Plant Analysis*. International Institute for Tropical Agriculture, Ibadan

Kavitha K, Meenakumari K S and Sivaprasad P. 2003. Effect of dual inoculation of native arbuscular mycorrhizal fungi and *Azospirillum* on suppression of damping off in chilli. *Indian Phytopathology* **56**: 112–3.

Mondal T, Ghanti P, Mahato B, Mandal A R and Thapa U. 2003. Effect of spacing and biofertilizer on yield and yield attributes of direct sown chilli (*Capsicum annuum* L. cv. *Bona Lanka*). *Environment and Ecology* **21**: 712–5.

Rai M, Kumar R and Rai A B. 2007. Chilli and Paprika. *(in)*: *Proceedings of National Symposium on Spices and Aromatic Crops* (SYMSAC IV), held during 25-26, November 2007 at OUAT, Bhubaneswar.

Sengupta S K, Dwivedi Y C and Kushwah S S. 2002. Response of tomato (*Lycopersicon esculentum* Mill.) to bioinoculation at different levels of nitrogen. *Vegetable Sciences* **29**: 186–8.

Shalini S B, Channal H T, Hebsur N S, Dharmatti P R and Sarangamath P A. 2002. Effect of integrated nitrogen management on nutrient uptake in knolkhol, yield and nutrient availability in soil. *Karnataka Journal of Agricultural Sciences* **15**: 43–6.

Swain A K, Pattanayak S K, Jena M K and Nayak R K. 2003. Effects of integrated use of bio-inoculant and fertilizer nitrogen on growth, yield and nitrogen economy of okra. *Journal of the Indian Society of Soil Science* **51**: 145–50.

Wange S S and Kale R H. 2003. Response of okra and bitter guard to diazotrophs with graded levels of nitrogen. *Journal of Soils and Crops* **13**: 271–4.