International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(4): 773-775

Received: 21-05-2019
Accepted: 25-06-2019

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Effect of micronutrients and bio inoculants (*Trichoderma viride* and PGPR) on yield parameters of chilli (*Capsicum annum* L.)

Pragya Singh and DP Sharma

Abstract
An experiment was carried out at Horticulture Complex, JNKVV Jabalpur (M.P.) during the year 2017-18. The present investigation entitled "Effect of Micronutrient and Bio inoculants (*Trichoderma viride* and PGPR) on yield parameters of chilli (*Capsicum annuum* L.)" the experiment was laid out with three replications along with twenty treatments. Application of micronutrients significantly increase yield parameters such as a number of fruits per plant, fruit yield per plot, fruit yield per hectare. Bio inoculants application was also significantly better for yield attributes same as interaction effects of micronutrients and bio inoculants was significantly for yield attributing traits of chilli. The maximum number of fruit per plant, fruit yield per plot and fruit yield per hectare was recorded in treatment combination M5B3 (ZnSO4 (0.2%) + *Trichoderma viride* (TV) + *Pseudomonas fluorescens* (PF) + *Azotobacter chroococcum* (AC) (2.5 kg/ha +2.5 kg/ha+ 5.0 kg/ha) followed by M4B3. So from the result it can be concluded that application of micronutrients and bio inoculants in combination recommended for increasining fruit yield of chilli.

Keywords: Chilli, micro-nutrients, bio inoculants, yield

Introduction
Chilli (*Capsicum annuum* L., 2n=24) is one of the most important vegetables as well as spice and a cash crop of India and belongs to the family Solanaceae. India is the second in vegetable production next to China by sharing 15.38% of total world production of vegetable. Chilli is grown all over the country under varying agro-climatic zones but the area under dry chilli is concentrated in southern states. Chilli grew extensively throughout the country, both rainfed and irrigated conditions. Chilli is a very rich source of vitamin A and C. Chilli fruits are rich in ascorbic acid and known for two important quality parameters, the pungency is due to the presence of capsaicin present in placenta and pericarp of the fruit which has high diverse prophylactic and therapeutic uses in medicine. The red colour is due to the presence of pigment capsanthin. Chilli is one of the important spice crops of India.
Micronutrients and their application in different vegetables give a positive response on growth, yield and quality. In the present scenario, it is observed that the application of micronutrients plays a role in improving the yield and quality of chillies. Micronutrients are present in lower concentrations in soil than macronutrients but are equally significant in plant nutrition, since, plants grown in micronutrient-deficient soils show similar reductions in productivity as those grown in macronutrient-deficient soils (Havlin *et al*., 2005) [1].
Biofertilizers are also known as microbial inoculants or bio inoculants. Biofertilizers are products of selected live microorganisms. They help to improve plant growth and productivity mainly through the supply of plant nutrients. This study was clearly indicated that the combined effect of micronutrients with bio inoculants could ensure eco-friendly environment and enhance the growth and yield parameters when compared to control.

Materials and Methods
The experiment was conducted at Horticulture complex, Maharajpur, Department of Horticulture. J.N.K.V.V. Jabalpur (M.P.) during *Rabi* season of 2017- 2018. The soil of the experimental field was medium black with pH 6.5 and good drainage uniform texture. The experiment was laid out in Randomized Complete Block Design (RCBD-factorial) with three replications. The field experiment consisted of 20 treatments involving the interaction of

micronutrients and bio inoculants. Micronutrients applied were Ferrous sulphate (FeSO4) (0.2%), Calcium nitrate (CaNO3) (0.2%), Borax (Na2B2O7.2H2O) (0.1%), Zinc sulphate (ZnSO4) (0.2%) as foliar spray at 30, 60 and 90(DAT) days after transplanting. Different bio inoculants like *Trichoderma viride* (2.5kg/ha), *Pseudomonas fluorescence* (2.5kg/ha) and *Azotobacter chroococcum* (5kg/ha) were applied. The observations were recorded in each plot from randomly selected five tagged plant with respect to the biometric observation of yield parameters like a number of fruits per plant, fruit yield per plot, fruit yield hectare.

Table 1: Details of treatments along with their symbols

	Micronutrients		**Bio inoculants**
M1	No micronutrient	B0	No bioinoculant
M2	FeSO4 (0.2%)	B1	*Trichoderma viride* (TV)
M3	CaNO3 (0.2%)	B2	(TV) *Trichoderma viride* + (PF) *Pseudomonas fluorescence*
M4	B (0.1%)	B3	(TV) *Tricoderma viride* + (PF)*Pseudomonas fluorescence* +(AC)
M5	ZnSO4 (0.2%)		*Azotobacter chroococcum*

Result and Discussion

The present investigation was carried out to study the combined effect of "Effect of Micronutrients and Bio inoculants (*Trichoderma viride* and PGPR) on yield parameters of chilli (*Capsicum annum* L.)". Different micronutrients and bio inoculants alone and in combination were applied.

The result of the present investigation is presented in Table 2. The analysis of variance showed a significant difference for all the characters. Foliar application of micronutrient affects the number of fruits per plant significantly. The maximum number of fruits per plant was obtained in treatment M5 (51.31) followed by M4 (50.17) and the minimum number of fruits per plant were recorded in treatment M1 (27.23). The application bio inoculants also significantly affects the number of fruits per plant. The highest numbers of fruits per plant were recorded in B3 (55.58) which were significantly followed by B2 (47.54). The Minimum number of fruits per plant was recorded in B0 (35.78).

Table 2 (Fig. 1) indicates that in case of interaction effects of micronutrients and bio inoculants (*Trichoderma viride* and PGPR), maximum number of fruits per plant was recorded in treatment combination of M5B3 (65.33) followed by M4B3 (64.99). While it was recorded minimum in combination for M1B0 (Control) (23.93). The maximum fruit yield per plot was obtained in treatment M5 (7.67 kg) followed by M4 (7.3kg) and the minimum number of fruit yield per plot was obtained in treatment M1 (5.66kg). The bio inoculants application also significantly affects the fruit yield per plot. The highest fruit yield per plot was recorded in B3 (8.47kg) which was significantly followed by B2 (6.97kg) and minimum fruit yield per plot was recorded in B0 (6.01kg). The treatment combination M5B3 produced significantly higher fruit yield per plot (9.82kg) While it was recorded minimum for M1B0 (Control) (5.31kg). Data presented in the table 2 revealed that maximum yield per hectare was obtained in treatment M5 (79.71q) followed by M4 (76.19q). In the application of bio inoculants, maximum fruit yield per hectare was recorded in B3 (88.08q) followed by B2 (72.50q) and the minimum fruit yield per hectare recorded in B0 (62.49q).But the interaction between the micronutrients and bio inoculants indicated maximum fruit yield per hectare and it was recorded for treatment combination M5B3 (102.03q) while it was recorded lowest in treatment combination for M1B0 (Control) (55.17q).

Table 2: Effect of different micronutrients and bioinoculants {*Trichoderma viride* (TV), *Pseudomonas fluorescence* (PF), *Azotobactor* (AC)} on number of fruits per plant, fruit yield per plot (kg) and fruit yield per hectare (q)

Treatment	**Number of fruits per plant**	**Fruit yield per plot(kg)**	**Fruit yield per hectare(q)**
Micronutrients			
M1	27.23	5.662	58.83
M2	46.83	7.091	73.67
M3	48.14	7.188	74.69
M4	50.17	7.333	76.19
M5	51.31	7.672	79.71
S.Em±	0.29	0.13	1.33
C.D.5% level	0.83	0.37	3.82
Bio inoculants			
B0	35.78	6.014	62.49
B1	40.05	6.488	67.41
B2	47.54	6.977	72.50
B3	55.58	8.477	88.08
S.Em±	0.26	0.11	1.19
C.D.5% level	0.75	0.33	3.42
Interaction effect of Micronutrients and Bio inoculants			
M1 B0	23.93	5.310	55.17
M1 B1	27.30	5.650	58.71
M1 B2	28.30	5.710	59.33
M1 B3	29.40	5.977	62.10
M2 B0	38.12	6.030	62.65
M2 B1	42.24	6.503	67.57
M2 B2	49.36	7.006	72.80
M2 B3	57.60	8.823	91.67
M3 B0	38.13	6.120	63.59
M3 B1	43.23	6.597	68.54
M3 B2	50.62	7.197	74.77
M3 B3	60.59	8.840	91.84
M4 B0	38.57	6.230	64.73
M4 B1	43.27	6.780	70.44
M4 B2	53.84	7.397	76.85
M4 B3	64.99	8.927	92.75
M5 B0	40.11	6.380	66.29
M5 B1	44.19	6.910	71.80
M5 B2	55.60	7.577	78.72
M5 B3	65.33	9.820	102.03
S.Em±	0.58	0.25	2.66
C.D.5% level	1.66	0.74	7.64

The results of the present investigation are in conformation with the findings of Patra *et al.* (2016) [4] in chilli. Micronutrients like Zinc involved in the biochemical synthesis of phytohormone, Indole acetic acid (IAA) through

the pathway of conversion of tryptophan to IAA, which also improved a number of fruits per plant and different yield components. Similarly, rise in the number of fruits per plant in tomato have been reported by application of Zn and / Boron by (Hamsaveni *et al.*, 2003, Sivaiah and Swain, 2013) [2, 6]. Biofertilizers help in increasing the various endogenous hormonal levels, carbohydrate accumulation and translocation in the plant tissue, resulting in enhanced pollen germination, tube growth and fruit set. These results are in conformity with the reports of Sharma (2001) [5] in tomato.

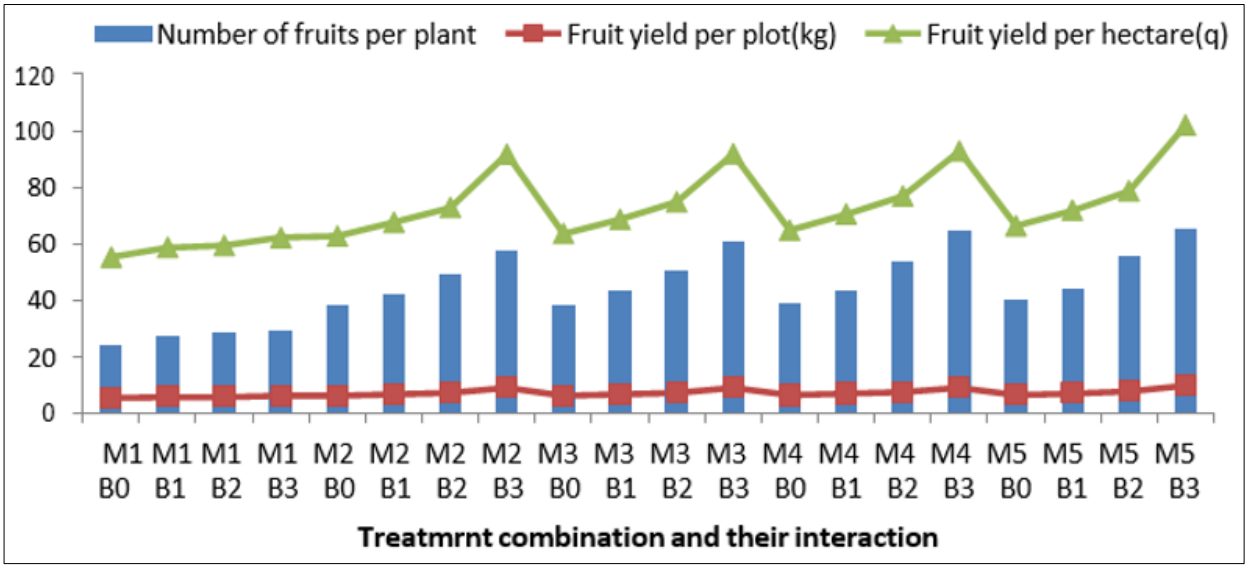

Fig 1: Interaction effect of different micro nutrients and bio inoculants [Trichoderma viride (TV), Pseudomonas fluorescence (PF), Azotobactor (AC)] on number of fruits per plant, fruit yield per plot (kg) and fruit yield per hectare (q).

Conclusion

From the above study, it is concluded that the combined effect of micronutrients and bio inoculants gave better yield as compared to control and could ensure eco-friendly environment. In all treatments, treatment combination M5B3 was better than the rest of the treatments and their combinations.

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