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The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(8): 560-563

www.thepharmajournal.com
Received: 20-06-2021
Accepted: 23-07-2021

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Changes in biochemical properties of sprouting broccoli [*Brassica oleracea* (L.) Plenck var. *italica*)] curd by micronutrients and organics

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Abstract
Experiments were conducted in *rabi* season 2019-20 and 2020-21 at Horticulture Farm, S.K.N. College of Agriculture, Jobner (Jaipur). Experiments laid out in RBD having twenty five treatments with three replications. The treatment consisted of five micronutrients (control, Borax at 15 kg/ha, Zinc sulphate at 25 kg/ha, Ammonium molybdate at 1.5 kg/ha and Manganese sulphate at 10 kg/ha) and five organics (control, Cow urine 10%, *Panchagavya* 5%, Vermiwash 10% and *Azotobacter*). The results indicated that soil application of zinc sulphate to the sprouting broccoli significantly increased biochemicals in curd *i.e*. TSS (10.88 ^{0}Brix), protein (2.30 %) content, nitrogen (0.368 %), potassium (0.266 %) and zinc (44.22 ppm) content. Similarly, foliar application of *Panchagavya* at 5% also increased the biochemicals in curd upto the level of significance *viz*., TSS (11.69 ^{0}Brix), protein (2.40 %) content, nitrogen (0.376 %), phosphorus (0.073 %), potassium (0.282 %), boron (16.99 ppm), zinc (38.89 ppm), molybdenum (1.97 ppm) and manganese (66.82 ppm) content in pooled analysis of both years. The findings were in conclusion that soil application of zinc sulphate at 25 kg/ha and foliar application of *Panchagavya* at 5% have the potential effect to improve quality parameters in sprouting broccoli.

Keywords: Micronutrients, organics, sprouting broccoli, TSS and protein

Introduction
Sprouting broccoli [*Brassica oleracea* (L.) Plenck var. *italica*)] is close relative to cauliflower having longer flower stalks composed of differentiated flower buds and green in colour rather than white (Gray, 1982). Its curd is rich source of Sprouting broccoli curd contains carbohydrates (5.5%), protein (3.3%), vitamin-A (137 mg), vitamin- B_1 (.05%), vitamin-B_2 (0.12%), calcium (0.80 mg) and phosphorus (0.79 mg) (Thamburaj and Singh, 2001) [19]. It is recognized as powerful antioxidant due to its high levels of riboflavin, calcium and ascorbic acid contents which are 4.0, 2.5 and 2.0 times more as compared to cauliflower, respectively. The high calcium content just makes it good as milk, source of nutrition for osteoporosis or calcium deficient patients. Broccoli isa rich source of vitamin C which help the body make collagen, a tissue needed for healthy bones, teeth, gum and blood vessels (Anonymous, 2007) [2]. Broccoli also contains the glucoraphan and sulphoraphane compound leading to an anticancer property (Kalia, 1995) [8].

Presently sprouting broccoli cultivation depends on bulky organic manure like farmyard manure, vermicompost and in some cases poultry manure with less use of micronutrients. As these manures contain very low amount of plant nutrients and their mineralization rate is also very low. Therefore, cultivators are not able to get desired quality in produce. Hence, foliar application of liquid organic manures like *panchagavya* in addition to normal bulky organic manure and soil application of specific micronutrients are cheaper, eco-friendly and stimulate plant growth that enhances the biological efficiency of crops (Chaudhary *et al*., 2017) [3].

Keeping these in view, the present investigation was conducted to know the effect of micronutrients and organics on the biochemical properties of sprouting broccoli variety Pusa KTS-1.

Materials and Methods
The experiments entitled "Effect of micronutrients and organics on quality of sprouting broccoli" were conducted in *rabi* season 2019-20 and 2020-21 at Horticulture Farm, S.K.N. College of Agriculture, Jobner (Jaipur) to execute the present study.

In Rajasthan (India), this region falls under agro-climatic zone-IIIA (Semi-Arid Eastern Plains). The experiment was laid out in factorial randomized block design with three replications consisting of twenty five treatment combinations including five micronutrients (control, Borax at 15 kg/ha, Zinc sulphate at 25 kg/ha, Ammonium molybdate at 1.5 kg/ha and Manganese sulphate at 10 kg/ha) and five organics (control, Cow urine 10%, *Panchagavya* 5%, Vermiwash10% and *Azotobacter*). The micronutrients (B, Zn, Mo and Mn) were applied as soil application just before transplanting and organics (cow urine, vermiwash and *Panchagavya*) as foliar spray at 30 DAT and *Azatobacter* as seed treatment at the time of nursery raising and transplanting of seedling by root dipping. Recommended dose of inorganic fertilizers applied uniformly in whole experimental area. The plot size was 2.7 × 1.8 m^2(4.86 m^2) and seedlings transplanted at spacing of 45 cm x 45 cm. All the cultural operations were followed continuously during crop growth. The observations were recorded for different biochemical parameters like TSS (A.O.A.C., 1960) [1], protein content (A.O.A.C., 1960) [1], N (Snell and Snell, 1949) [18], P (Jackson, 1967) [7], K (Metson, 1956) [11] and Zn, B, Mo and Mn content (Lindsay and Norvell, 1978) [9] by following standard methodology as advocated by different scientists. Data obtained from consecutive two years were statistically analyzed as per procedure given by Gomez and Gomez (1984) [5].

Results and discussion

Effect of micronutrients

Data pertaining to the effect of various micronutrients on biochemical properties of sprouting broccoli revealed that all the treatments significantly influenced the TSS, protein, nitrogen, phosphorus, potassium, B, Zn, Mo and Mn content of broccoli (Table 1, 2 and 3) during both the years and in pooled mean analysis. The significantly higher TSS (10.91, 10.85 and 10.88 ^{0}Brix), nitrogen content (0.376, 0.359 and 0.368 %), protein content (2.35, 2.24 and 2.30 %), potassium content (0.269, 0.262 and 0.266 %) and Zn content (44.42, 44.02 and 44.22 ppm) was found in treatment M_2 (Zinc sulphate-25 kg/ha) during the year 2019-20 and 2020-21 as well as in pooled mean analysis, respectively. The maximum phosphorus content (0.071 %) and boron content (18.40 ppm) were recorded with the application of treatment M_1 (Borax-15 kg/ha) in pooled mean analysis. However, treatment M_1 was found statistically at par to M_2 (zinc sulphate- 25 kg/ha). The maximum Mo content (2.18 ppm) was recorded with the treatment M_3 (Ammonium molybdate-1.5 kg/ha) and Mn content (64.50 ppm) with $MnSo_4$ at 10 kg/ha (M_4) in pooled mean analysis. This might be due to magnificent role of zinc in increasing the metabolic and physiological activity of the plant as it influences the nitrogen metabolism, chlorophyll formation and auxin concentration in the plants. Application of zinc also play a role to increase the activity of nitrate reductase enzyme and enhanced synthesis of certain amino acids and protein (Ramesh *et al*., 2006) [14]. The reduction in phosphorus content in plant under treatment of zinc sulphate might be due to antagonism relationship of zinc and phosphorus (Olsen, 1972) [13]. The application of zinc created hindrance in absorption and translocation of P from the roots to the plant parts (Reddy and Yadav, 1994) [15]. The results are also supported by Singh *et al*. (2017) [16] and Singh *et al*. (2018) [17] in broccoli.

Effect of organics

Data indicated that application of various organics also had significant effect on the biochemical properties of sprouting broccoli during both the years and in pooled mean analysis (Table 1, 2 and 3). The foliar spray of *Panchagavya* at 5 % (O_2) registered maximum TSS (11.69 ^{0}Brix), nitrogen content (0.376 %), protein content (2.40 %) of curd, phosphorus content (0.074 %), potassium content (0.282 %), boron content (16.99 ppm), Zn content (38.89 ppm), Mo content (1.97 ppm) and Mn content (66.82 ppm) which were significantly higher over rest of the treatments in pooled mean analysis. This might be due to faster absorption of nutrients like urea present in *panchgavaya* through cuticle of leaves and better stimulation of the phytohormones which increased the NR activity in functional leaves of the plants by increasing the synthesis of enzyme or protein by affecting the basic processes of translation. Similar observation was recorded earlier by Meerabai *et al.* (2007) [10], Muhammad *et al*. (2015) [12] and Gajjela and Chatterjee (2019) [4] in bitter gourd.

Conclusion

On the basis of two years experiment results, it may be concluded that the soil application of zinc sulphate-25 kg/ha and foliar spray of *Panchagavya*-5 per cent were better to improve biochemical properties in sprouting broccoli.

Table 1: Effect of micronutrients and organics on TSS, nitrogen and protein content in curd of sprouting broccoli

Treatments	TSS (^{0}Brix)			N content (%)			Protein content (%)		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
A. Micronutrients									
M_0 – Control	8.96	8.83	8.90	0.278	0.265	0.272	1.74	1.66	1.70
M_1 - Borax- (15 kg/ha)	10.50	10.70	10.60	0.345	0.336	0.341	2.16	2.09	2.12
M_2 -Zinc sulphate- (25 kg/ha)	10.91	10.85	10.88	0.376	0.359	0.368	2.35	2.24	2.30
M_3 - Ammonium molybdate- (1.5 kg/ha)	10.22	9.89	10.06	0.309	0.322	0.316	1.93	2.01	1.97
M_4 -Manganese sulphate- (10 kg/ha)	9.66	9.05	9.36	0.293	0.281	0.287	1.83	1.76	1.79
SEm±	0.24	0.24	0.17	0.007	0.008	0.005	0.05	0.05	0.03
CD (P=0.05)	0.68	0.69	0.48	0.021	0.022	0.015	0.13	0.14	0.09
B. Organics									
O_0 - Control (Water spray)	8.12	8.22	8.17	0.273	0.267	0.270	1.61	1.65	1.63
O_1 - Cow urine -10%	9.17	8.91	9.04	0.281	0.283	0.282	1.76	1.77	1.76
O_2 - *Panchagavya* - 5%	11.93	11.46	11.69	0.383	0.370	0.376	2.47	2.33	2.40
O_3 - Vermiwash -10%	10.97	10.74	10.86	0.350	0.345	0.347	2.19	2.15	2.17
O_4–*Azotobacter*	10.06	9.99	10.03	0.314	0.298	0.306	1.98	1.86	1.92
SEm±	0.24	0.24	0.17	0.007	0.008	0.005	0.05	0.05	0.03
CD (P=0.05)	0.68	0.69	0.48	0.021	0.022	0.015	0.13	0.14	0.09

Table 2: Effect of micronutrients and organics on P, K and B content in sprouting broccoli

Treatments	P content (%)			K content (%)			B content (ppm)		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
A. Micronutrients									
M_0 – Control	0.053	0.049	0.051	0.218	0.207	0.213	11.31	11.12	11.22
M_1 - Borax- (15 kg/ha)	0.072	0.069	0.071	0.251	0.244	0.248	18.67	18.12	18.40
M_2 -Zinc sulphate- (25 kg/ha)	0.069	0.066	0.068	0.269	0.262	0.266	15.71	15.05	15.38
M_3 - Ammonium molybdate- (1.5 kg/ha)	0.062	0.057	0.060	0.247	0.241	0.244	13.61	13.23	13.42
M_4 -Manganese sulphate- (10 kg/ha)	0.058	0.054	0.056	0.233	0.228	0.231	13.97	13.56	13.77
SEm±	0.001	0.001	0.001	0.006	0.006	0.004	0.35	0.36	0.25
CD (P=0.05)	0.004	0.004	0.003	0.016	0.017	0.011	1.01	1.03	0.71
B. Organics									
O_0 - Control (Water spray)	0.051	0.051	0.051	0.200	0.203	0.202	12.02	11.91	11.96
O_1 - Cow urine -10%	0.055	0.053	0.054	0.214	0.211	0.213	13.81	12.71	13.26
O_2 - *Panchagavya* - 5%	0.076	0.071	0.074	0.287	0.278	0.282	17.22	16.76	16.99
O_3 - Vermiwash -10%	0.069	0.064	0.067	0.266	0.258	0.262	16.02	15.55	15.78
O_4–*Azotobacter*	0.063	0.056	0.059	0.252	0.231	0.241	14.20	14.16	14.18
SEm±	0.001	0.001	0.001	0.006	0.006	0.004	0.35	0.36	0.25
CD (P=0.05)	0.004	0.004	0.003	0.016	0.017	0.011	1.01	1.03	0.71

Table 3: Effect of micronutrients and organics on Zn, Mo and Mn content in sprouting broccoli

Treatments	Zn content (ppm)			Mo content (ppm)			Mn content (ppm)		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
A. Micronutrients									
M_0– Control	26.39	26.04	26.22	1.04	1.01	1.03	40.17	38.05	39.11
M_1 - Borax- (15 kg/ha)	34.17	33.92	34.05	1.76	1.54	1.65	56.31	51.03	53.67
M_2 -Zinc sulphate- (25 kg/ha)	44.42	44.02	44.22	1.79	1.65	1.72	61.39	58.89	60.14
M_3- Ammonium molybdate- (1.5 kg/ha)	31.74	31.24	31.49	2.32	2.04	2.18	48.82	43.56	46.19
M_4 -Manganese sulphate- (10 kg/ha)	29.52	29.11	29.32	1.43	1.14	1.29	65.45	63.54	64.50
SEm±	0.79	0.81	0.57	0.04	0.04	0.03	1.28	1.28	0.91
CD (P=0.05)	2.26	2.32	1.60	0.11	0.11	0.07	3.65	3.65	2.55
B. Organics									
O_0 - Control (Water spray)	28.81	28.31	28.56	1.25	1.18	1.22	39.17	36.26	37.71
O_1 - Cow urine -10%	29.94	29.47	29.70	1.41	1.31	1.36	49.05	45.40	47.22
O_2 - *Panchagavya* - 5%	39.24	38.55	38.89	2.09	1.85	1.97	67.82	65.82	66.82
O_3 - Vermiwash -10%	37.13	37.52	37.32	1.88	1.64	1.76	64.15	61.47	62.81
O_4–*Azotobacter*	31.13	30.47	30.80	1.70	1.41	1.56	51.95	46.13	49.04
SEm±	0.79	0.81	0.57	0.04	0.04	0.03	1.28	1.28	0.91
CD (P=0.05)	2.26	2.32	1.60	0.11	0.11	0.07	3.65	3.65	2.55

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