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Short Communication

Nutrient content of Cauliflower (*Brassica oleracea* L. var. *botrytis*) as Influenced by Boron and Farmyard Manure in North West Himalayan Alfisols

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Chemical composition is the index of development of plant which determines the magnitude of yield potential (Cate and Nelson 1971). Among micronutrients, boron (B) is one of the essential micronutrients required for normal growth and development of crop plants. Boron in plants is reported to function at membrane level (Shelp *et al.* 1995) and is credited with maintaining membrane integrity (Cakmak *et al.* 1995) and enhanced ability of membranes to transport vital nutrients. The farmyard manure (FYM) itself contains reasonable amounts of nutrients which become available to plants upon decomposition besides enhancing availability of native as well as applied nutrients. The studies on the effect of B and FYM application on chemical composition of vegetables in general, and cauliflower in particular, are scanty. Therefore, greenhouse studies were conducted to investigate the effect of B and FYM on nutrient contents in cauliflower on two B-deficient soils collected from two varied agro-climatic conditions in North-West Himalayas of Himachal Pradesh.

Two locations, one in mid-hills sub-humid (Bajaura) and other in high-hills wet-temperate (Junga) conditions of Himachal Pradesh were chosen because of their low B content (0.30 mg B kg^{-1} soil in each). Bulk soil samples were collected from 0-0.15 m soil depth to conduct greenhouse studies at the Department of Soil Science, CSKHPKV, Palampur. Bajaura soils had higher exchangeable-Ca (1999 mg kg^{-1}) in comparison to Junga soils (933 mg kg^{-1}). The available N, P, K contents were 329, 6.7, 123 kg ha^{-1} in Bajaura soil and 329, 2.3 and 73 kg ha^{-1} in Junga soil, respectively. Bajaura soil was loamy in texture and neutral in reaction (pH 7.1), while Junga soil was sandy loam in texture and slightly acidic (pH 6.2). Organic carbon content was 11.3 g kg^{-1} in Bajaura soil and 12.9 g kg^{-1} in Junga soil.

Experiments were conducted in plastic pots filled with 10 kg of 2 mm sieved air-dried soil. The experimental design for each soil was a completely randomized design with twelve treatment combinations of four levels of B (0, 1, 2 and 3 mg kg^{-1} soil) and three levels of FYM (0, 10 and 20 g FYM kg^{-1} soil) with three replications. The FYM was incorporated on wet weight basis and contained 55.2% moisture and 21.5 mg kg^{-1} total B content. The Ca, N, P and K contents of the manure were 1.27, 0.80, 0.09 and 0.40%, respectively. Uniform application of N, P and K was made at the rate of 62.5, 25.0 and 15.0 mg kg^{-1}, respectively. Whole quantity of B, P and K was applied as basal while N was applied in three splits, *viz.* 50% at the time of transplanting and remaining in two equal splits at one month interval after transplanting of the crop. The sources of B, N, P and K application were borax, urea, single superphosphate and muriate of potash, respectively. One cauliflower (*cv.* Palam Uphaar) seedling was raised in each pot up to maturity. At harvest, the plants were separated into leaves, curd and root parts and dried in oven at 65±5 °C to a constant weight. For B estimation, the powdered plant parts were dry-ashed at 550 °C for 6 hours and ash was digested in 6 *N* HCl. Boron was then determined with the help of carmine method (Hatcher and Wilcox 1950). The available N, P, K and exchangeable Ca were determined following standard methods.

Cauliflower responded significantly to B application in terms of dry matter yield of leaves, curd

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Table 1. Effect of boron and FYM application on dry matter yield (g pot^{-1}) of cauliflower

Traetments	Bajaura soil			Junga soil		
	Leaves	Curd	Root	Leaves	Curd	Root
Boron levels						
B_0	24.90	5.86	3.57	22.10	4.32	2.82
B_1	26.70	6.44	4.02	23.70	6.13	3.53
B_2	27.50	6.94	4.41	22.50	6.31	3.60
B_3	27.80	7.02	4.51	21.80	6.13	3.22
CD (P=0.05)	0.80	0.50	0.39	0.80	0.53	0.37
FYM levels						
F_0	24.90	5.39	3.37	19.10	3.83	2.63
F_{10}	26.40	6.60	4.21	23.70	6.26	3.38
F_{20}	27.70	7.55	4.75	24.90	7.09	3.78
CD (P=0.05)	0.70	0.43	0.34	0.70	0.46	0.32

and roots up to 1 mg kg^{-1} in Junga soil and up to 2 mg kg^{-1} in Bajaura soil (Table 1). The promotive effect of B may be interpreted in terms of manufacturing more carbohydrates and proteins (Verma 1983) along with its role in enhancing their translocation from the site of synthesis to the storage organs (Sharma 2002). The differential response of cauliflower to B levels in two soils is probably due to the difference in Ca content of the soils. The soil high in Ca content (Bajaura) responded up to 2 mg kg^{-1} while soil with low Ca content (Junga) gave response only up to 1 mg kg^{-1}. Incorporation of FYM at 10 and 20 g kg^{-1} recorded a significant and consistent increase over the control in both the soils. Singh and Sharma (1990) have also observed similar results. Interaction between B and FYM application was not found to be significant on dry matter yield of cauliflower.

The B, Ca, N, P and K contents in different cauliflower parts, in general, were found to increase significantly with increasing B and FYM application rates (Table 2). An increase in B content in plant tissues as a result of B application is obviously due to enhanced availability of B in soil and subsequently its uptake by plants. Further, according to Faust and Shear (1968), B has the property of catalyzing the uptake of more Ca to maintain a proper Ca:B ratio. Boron is also stated to play an important role in phosphate transport across membranes (Loughman 1977). Moreover, the application of B has a synergistic effect on P availability in soil attributed to borate-phosphate anion exchange mechanism (Saha and Haldar 1998). Boron is also involved in K uptake by plants which does not occur in the absence of B (Schon *et al.* 1991). Extensive studies have supported the idea that B in plants functions at the membrane level (Shelp *et al.* 1995) and is credited with maintaining membrane integrity (Cakmak *et al.* 1995) and hence enhanced ability of membranes to transport vital nutrients. An increase in nutrient content as a result of FYM may be due to the beneficial effect of FYM on nutrient availability in soil and improvement in soil physical and microbiological properties. The interaction effect of B and FYM on nutrient content was not found to be significant in any part of cauliflower.

Among parts of cauliflower, the highest content of B and Ca was found in leaves followed by roots and was least in curd, while the maximum amounts of N, P and K were found in curd followed by leaves and least in roots. The differential behaviour of nutrient distribution among different parts of cauliflower in the present study may be explained in terms of their retranslocation. In the literature, N, P and K are generally regarded as being retranslocated, whereas, B and Ca are not.

The B content in parts of cauliflower grown on Junga soil was more as compared to that grown on Bajaura soil. This may be due to higher availability of B in Junga soil due to its coarse texture (Keren *et al.* 1985). Besides this, higher exchangeable Ca in Bajaura soil might have depressed B content in cauliflower grown on this soil (Hill and Morril 1975). The Ca and K contents were more in parts of cauliflower grown on Bajaura soil as compared to Junga soil while N contents were comparable. However, inspite of higher available P in Bajaura soil, the P content in parts of cauliflower grown on Junga soil was more as compared to Bajaura soil. This could be because of the role of B in increasing P transport across the cell membranes (Loughman 1977). Further, higher amounts of exchangeable Ca in Bajaura soil might have depressed P absorption by cauliflower roots and subsequently lower content in cauliflower parts.

From the results of the present investigation, it can be inferred that the nutrient content in cauli-

Table 2. Effect of boron and FYM application on nutrient content in different parts of cauliflower in the experimental soils

Treatment	Nutrient contents														
	B (mg kg^{-1})			Ca (%)			N (%)			P (mg kg^{-1})			K (%)		
	Leaves	Curd	Roots	Leaves	Curd	Roots	Leaves	Curd	Roots	Leaves	Curd	Roots	Leaves	Curd	Roots
							Bajaura soil								
Boron levels															
B_0	17.28	3.44	5.06	2.11	0.17	0.49	2.63	5.09	1.74	689	1314	597	1.60	3.02	1.06
B_1	30.24	5.05	6.50	2.28	0.19	0.57	2.73	5.32	1.80	735	1327	614	1.88	3.56	1.25
B_2	40.50	5.55	7.94	2.48	0.21	0.61	2.91	5.35	1.92	764	1337	630	1.96	3.92	1.32
B_3	54.17	6.89	9.50	2.80	0.23	0.68	2.95	5.44	1.98	792	1354	697	2.01	4.11	1.49
CD (P=0.05)	2.65	0.62	0.77	0.13	0.01	0.03	0.05	0.04	0.04	39	NS	33	0.08	0.18	0.10
FYM levels															
F_0	35.17	4.58	6.88	2.31	0.18	0.55	2.88	5.15	1.67	653	1258	555	1.84	2.38	1.24
F_{10}	35.34	5.58	7.42	2.43	0.20	0.57	2.69	5.08	1.81	761	1356	655	1.79	4.10	1.26
F_{20}	36.14	5.54	7.46	2.51	0.21	0.64	2.85	5.67	2.11	820	1385	694	1.97	4.48	1.34
CD (P=0.05)	NS	0.54	NS	0.11	0.01	0.02	0.04	0.04	0.03	34	26	28	0.07	0.15	NS
							Junga soil								
Boron levels															
B_0	27.56	4.89	6.39	1.35	0.13	0.22	2.62	3.89	1.74	1158	1282	616	1.15	3.15	0.83
B_1	51.00	6.79	8.44	1.74	0.16	0.24	1.74	4.22	1.79	1245	1333	662	1.33	3.10	0.90
B_2	79.74	8.56	10.50	2.05	0.18	0.27	2.83	4.58	1.86	1405	1358	680	1.45	3.42	1.03
B_3	101.33	9.78	13.39	2.22	0.20	0.32	3.11	4.63	1.91	1499	1739	741	1.63	3.56	1.10
CD (P=0.05)	3.44	0.84	0.82	0.11	0.01	0.02	0.03	0.06	0.03	37	34	33	0.08	0.17	0.08
FYM levels															
F_0	58.89	6.67	8.67	1.32	0.13	0.20	2.88	4.15	1.63	1141	1339	585	1.29	2.55	0.87
F_{10}	67.79	7.88	10.13	2.09	0.19	0.28	2.75	4.35	1.90	1371	1348	696	1.36	3.54	0.87
F_{20}	68.04	7.92	10.25	2.12	0.19	0.31	2.85	4.49	1.94	1468	1373	744	1.52	3.82	1.17
CD (P=0.05)	2.98	0.73	0.71	0.10	0.01	0.02	0.03	0.05	0.03	32	NS	28	0.07	0.15	0.07

flower parts increased due to applied B and FYM in both the B-deficient soils of Bajaura and Junga and thus nutritional quality of the produce got improved.

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