Assessment of organic and inorganic fertilization on soil micronutrient cations and qualitative parameters of cauliflower

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Received: 04.08.2022/Accepted: 31.08.2022

ABSTRACT

A field experiment was conducted to assess the organic and inorganic fertilization on soil micronutrient cations and qualitative parameters of cauliflower with nine treatments viz Control, 100 per cent FYM on N equivalent basis, 100 per cent N, 100 per cent NP, 100 per cent NK, 100 per cent PK, 100 per cent NPK, 100 per cent NPK + FYM and 150 per cent NPK + FYM replicated thrice in randomized block design in plot size of 3 m × 2.7 m on variety PSBK-1 during 2019-20 and 2020-21 at Dr YS Parmar University of Horticulture and Forestry, Solan, Himachal Pradesh. Highest available micronutrient cations (Fe, Zn and Mn) were recorded with application of FYM alone or in combination with NPK. Application of 100 or 150 per cent NPK along with FYM also recorded higher TSS and ascorbic acid content.

Keywords: Micronutrient cations; organic fertilizers; qualitative parameters; cauliflower

INTRODUCTION

Cauliflower (*Brassica oleracea* var *botrytis* L) is one of the most important vegetable crops of cole group grown extensively all over India under temperate to tropical climatic conditions. Cauliflower is a rich source of vitamin C (Keck and Finley 2004) which is about 48.2 mg/100 g besides minerals such as P, K, Ca, Na and Mg. A high intake of cauliflower has been associated with reduced risk of aggressive prostate cancer (Kushwaha et al 2013) as it contains potent anti-cancer compounds such as diindolylmethane, sulforaphane and selenium.

India is the second major cauliflower producing country after China in the world and contributes 32 per cent in area ie 4.60 lakhs ha and 36 per cent in production ie 9.17 million metric tonnes.

In Himachal Pradesh, it is grown in an area of 5,917 ha with a production of 1.30 million metric tonnes and productivity of 22.54 metric tonnes/ha (Anon 2020). In the state, it is grown commercially as an off-season crop during summer-rainy (March to November) season in Shimla, Mandi, Solan, Kullu and Kangra districts bringing lucrative returns to the farmers.

The crop yield and quality can be improved by combined application of inorganic and organic nutrient sources. Low and imbalanced use of chemical fertilizers is one of the major reasons for the low productivity of cauliflower. The farmers indiscriminately use N fertilizer while the application of P and K fertilizers is very limited and that of secondary and micronutrients is almost negligible. Thus an imbalanced fertilizer use has led to multi-nutrient deficiencies resulting in yield stagnation and deteriorated soil health. Farmyard manure improves soil physical, chemical and biological properties. Improvement in the soil structure due to application of farm yard manure leads to a better environment for root development (Prasad and Sinha 2000).

MATERIAL and METHODS

The field experiment with cauliflower (*Brassica oleracea* var *botrytis* L) variety PSBK-1 was conducted during 2019-20 and 2020-21at Dr YS Parmar University of Horticulture and Forestry, Solan, Himachal Pradesh (latitude 30° 52' N and longitude 77° 11' E, 1,175 m amsl) having average slope of 7-8 per cent. The site receives a mean annual rainfall of 1,100 mm of which 75 per cent is received during monsoon period (mid June–mid September). The soil of the study area belonged to Typic Eutrochrept and sandy loam in texture. The experiment was conducted with 9 treatments viz T_1 (Control), T_2 (100% FYM, N equivalent basis), T_3 (100% N), T_4 (100% NP), T_5 (100% NK), T_6 (100% PK), T_7 (100% NPK), T_8 [100% NPK + FYM (recommended practice)] and T_9 (150% NPK + FYM), replicated thrice in randomized block design in plot size of 3 m × 2.7 m. A recommended fertilizer dose of 150:100:54 kg of N, P_2O_5 and K_2O/ha represented NPK in cauliflower. The field was prepared during 2019 by ploughing and then in subsequent trials manual tilling operation was done to avoid the mixing of soils of different plots. Well decomposed FYM (250 q/ha recommended) was used and had a C:N ratio of 58.

Chemical fertilizers containing N, P and K were applied as urea, SSP and muriate of potash respectively. The fertilizer was broadcast and mixed in soil before transplanting. Manual weeding was done as an intercultural operation. Curd shape was determined by the curd shape index as suggested by Odland and Noll (1954) ie ratio of polar and equatorial diameter was used to work out the curd shape index. Curd compactness was calculated as per the formula suggested by Pearson (1931):

$$Z=\frac{c}{w^3}\times 100$$

where Z= Index of compactness, c= Weight of curd in grams, w= Average of polar and equatorial diameter

Total soluble solids (TSS) of roots were determined by crushing and extracting juice with the help of muslin cloth. The TSS was observed by placing small quantity of juice on prism of hand refractrometer and results were expressed as °Brix (Ranganna 1986). Ascorbic acid content was determined as per the procedure given by Anon (1980) using 2,6-dichlorophenol indophenols dye. Representative soil samples from 0-15 cm depth were collected at the time of harvesting of cauliflower and available micronutrient cations (available Fe, Cu, Zn and Mn) were analysed by DTPA extractant method (Lindsay and Norvell 1978).

The data recorded were analyzed by using MS-Excel and OPSTAT. The mean values of data were subjected to analysis of variance as described by Panse and Sukhatme (1967).

RESULTS and DISCUSSION

Data presented in Table 1 depict the effect of nutrient management on soil micronutrient cations (available Fe, Cu, Zn and Mn). On pooling the data for two years, it was found that highest Fe, Zn and Mn content was recorded with the application of T_9 (150% NPK + FYM) (22.4, 3.46 and 15.99 ppm respectively), T_8 [100% NPK + FYM (recommended practice)] (21.2, 2.94, 3.40 and 15.65 ppm respectively) and T_2 (100% FYM, N equivalent basis) (20.3, 2.93, 3.43 and 15.99 ppm respectively), all three being at par while T_1 was at par with all other treatments. Cu content was found higher in T_9 (3.02 ppm), T_8 (2.94 ppm), T_2 (2.93 ppm), T_7 (100% NPK) (2.75 ppm) and T_3 (100% N) (2.52 ppm), all being at par and control was at par with rest of the treatments. Years and the interaction of years with treatments had non-significant effect on soil micronutrients.

The Fe content was more in plots receiving FYM either alone or in combination with inorganic fertilisers. The increase in Fe content may be due to contribution of substantial amount of Fe by SSP (Dhiman et al 2019). Higher content of Cu in FYM treated plots may be due to formation of organic chelates which decreased their susceptibility to adsorption, fixation and precipitation leading to their enhanced availability in soil. Addition of organic matter to soil encourages proliferation of microorganisms which aids in the liberation of micronutrients. It may be attributed to the fact that microbial decomposition of organic matter releases micronutrients as well as complexing agents such as organic acids and humic substances that facilitate the movement of micronutrients from the solid phase into solution. Zhang et al (2015) and Rajneesh et al (2017) have also reported similar findings.

Table 1. Effect of nutrient management on soil micronutrient cations (available Fe, Cu, Zn and Mn)

Treatment	Available Fe (ppm)			Available Cu (ppm)			Available Zn (ppm)			Available Mn (ppm)		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
T_1 (Control)	13.9	12.7	13.3	2.22	2.10	2.16	3.02	2.95	2.99	13.01	12.45	12.73
T_2 (100% FYM, N equivalent basis)	18.5	22.1	20.3	2.86	2.99	2.93	3.34	3.53	3.43	15.48	16.51	15.99
T_3 (100% N)	12.9	15.8	14.4	2.45	2.58	2.52	3.17	3.15	3.16	13.12	13.38	13.25
T_4 (100% NP)	13.7	13.5	13.6	2.38	2.12	2.25	3.08	3.12	3.10	13.17	13.12	13.14
T_5 (100% NK)	14.9	14.3	14.6	2.53	2.22	2.37	3.05	3.22	3.13	13.65	13.59	13.62
T_6 (100% PK)	15.2	13.9	14.5	2.25	2.37	2.31	3.12	3.05	3.08	13.86	13.69	13.78
T_7 (100% NPK)	15.9	14.4	15.2	2.72	2.79	2.75	3.25	3.19	3.22	14.07	13.50	13.79
T_8 (100% NPK + FYM)	18.4	23.9	21.2	2.82	3.05	2.94	3.33	3.46	3.40	15.28	16.01	15.65
T_9 (150% NPK + FYM)	19.5	25.3	22.4	2.90	3.14	3.02	3.36	3.55	3.46	15.51	16.47	15.99
Mean	15.9	17.3		2.57	2.59		3.19	3.25		14.13	14.30	
$CD_{0.05}$	NS	4.3		NS	0.28		NS	0.09		NS	0.58	

$CD_{0.05}$	Available Fe	Available Cu	Available Zn	Available Mn
T	3.1	0.50	0.23	1.33
Y	NS	NS	NS	NS
T × Y	NS	NS	NS	NS

Table 2. Effect of nutrient management on curd shape, index of compactness of cauliflower, TSS and ascorbic acid content

Treatment	Curd shape index			Index of compactness (g/cm^3)			TSS (°B)			Ascorbic acid content (mg/100 g)		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
T_1 (Control)	0.56	0.63	0.59	82.5	85.8	84.2	4.70	4.67	4.68	47.12	48.20	47.66
T_2 (100% FYM, N equivalent basis)	0.64	0.64	0.64	63.7	65.1	64.4	5.27	5.50	5.38	51.93	52.33	52.13
T_3 (100% N)	0.56	0.52	0.54	79.7	65.3	72.5	4.80	4.83	4.82	49.90	49.03	49.47
T_4 (100% NP)	0.53	0.54	0.53	80.7	66.4	73.5	4.77	5.00	4.88	49.23	50.27	49.75
T_5 (100% NK)	0.53	0.56	0.54	66.9	77.1	72.0	4.80	5.03	4.92	49.73	53.47	51.60
T_6 (100% PK)	0.57	0.53	0.55	81.8	69.5	75.7	5.47	5.67	5.57	49.80	51.67	50.73
T_7 (100% NPK)	0.52	0.50	0.51	69.1	67.8	68.5	5.73	6.07	5.90	53.70	50.30	52.00
T_8 (100% NPK + FYM)	0.53	0.53	0.53	72.5	69.3	70.9	5.87	6.20	6.03	56.20	59.90	58.05
T_9 (150% NPK + FYM)	0.53	0.52	0.52	77.7	68.9	73.3	6.13	6.20	6.17	58.37	60.87	59.62
Mean	0.55	0.55		75.0	70.6		5.28	5.46		51.78	52.89	
$CD_{0.05}$	NS	0.08		NS	NS		0.32	0.46		5.81	7.13	

$CD_{0.05}$

	Curd shape insex	Index of compactness	TSS	Ascorbic acid content
T	0.06	NS	0.12	4.39
Y	NS	NS	NS	NS
T × Y	NS	NS	NS	NS

Qualitative parameters of cauliflower

The perusal of data given in Table 2 show that different treatments had a significant effect on curd shape index of cauliflower. Highest value for curd shape index was recorded under T_2 (0.64) and T_1 (Control) (0.59), the two being at par. All other treatments were statistically at par with one another for this trait. The effect of years and interaction of treatments with years was non-significant. Under all the treatments except T_2, the curd was drum-shaped.

Mean values for index of compactness ranged from 64.5 to 84.2 g/cm^3 under different treatments. However, there were no statistical differences among various treatments, years and their interacation.

The size of curd formed and the shape are important cultivar traits in cauliflower determined by genetics, but these traits can be greatly influenced by cultivation and management conditions including fertilization (Janco et al 2011).

Data show that TSS was maximum in treatment T_9 (6.17°B) and T_8 (6.03°B), the two being at par and minimum under control T_1 (4.68°B). There was significant variation among years but non-significant effect of interaction between treatments and years was noticed.

Higher TSS under T_9 and T_8 might be due to the fact that the combined application of FYM and inorganic fertilizers led to a balanced C:N ratio which resulted in satisfactory nutrient availability and increased plant metabolism which ultimately lead to increased carbohydrate accumulation in fruits resulting in higher TSS (Kaur and Rattan 2021). Similar findings were reported by Thriveni et al (2015) and Shree et al (2018) in bitter gourd.

Variation among treatments was significant for ascorbic acid content during both the years of study. Examination of pooled data reveal that significantly higher ascorbic content was observed in treatment T_9 (59.62 mg/100 g) and T_8 (58.05 mg/100 g) while control treatment was at par with all other treatments except T_2. Years and interaction of treatments with years had a non-significant effect on ascorbic acid content of cauliflower. Higher ascorbic acid content under T_9 and T_8 might be due to more availability of micronutrients like Cu, Zn, Mn and B etc with application of FYM (Kaur and Rattan 2021). These results are in accordance with the findings of Thriveni et al (2015), Das et al (2015) in bitter gourd.

CONCLUSION

Based on two years field experimentation, it can be inferred that soil micronutrient cations viz available Fe, Cu, Zn and Mn were significantly improved by conjoint application of inorganic and organic nutrients. Treatments comprising FYM recorded higher Fe, Zn and Mn content. TSS and ascorbic acid content was higher in treatments where FYM was applied with incorganic fertilizers. Therefore, 100 or 150 per cent NPK with FYM may be applied for enhancing nutrients and qualitative traits in cauliflower.

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