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Response of INM, Spacing and Cycocel on Quality Attributes of Cabbage [*Brassica oleracea* (L.) var. *capitata*] in Bundelkhand

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ABSTRACT

Background: The significance of stabilized use of fertilizers is more populous between the farmers to get higher quality of produce. In integrative agricultural system, integrated nutrient management (INM) provide best way to solve numerous issues regarding sustainability, improving quality, boosting yield and keeping good soil fertility in efficient and economical way. Cabbage is one of the most valued crop among *cole* group vegetables and it is rich in vitamins and minerals like vitamin A, vitamin C, vitamin B_1, B_2 and B_3, sulphur, phosphorus, calcium, magnesium, iron, potassium, sodium *etc.*

Methods: Field experiments were conducted to study the effect of vermicompost, inorganic fertilizers and growth retardant (cycocel) with different spacing in cabbage and carried out in factorial randomized block design at Experimental Farm Bundelkhand University, Jhansi (U.P.) during *rabi* season 2017-18 and 2018-19. Fertilizers with cycocel treatment increases the accumulation of various minerals and vitamins.

Result: Result indicated that quality attributes of cabbage were found to be highest and significant in the treatment where 50% RDF (Inorganic Fertilizer) + 50% Organic (vermicompost) were applied at wider crop geometry (45cm x 45cm spacing) along with spraying of 300 ppm cycocel (growth retardant). Head yield of cabbage was positively correlated with various quality attributes. Application of vermicompost along with inorganic in head of the cabbage. The experimental findings indicated that reduction in the amount of inorganic fertilizer was not detrimental to quality of cabbage while applying the vermicompost in proper amount that is 50% in combination with inorganic fertilizers. It is evident that integration of vermicompost and inorganic fertilizer at wider spacing under cycocel treatment enhances the quality of cabbage and also sustaining the fertility of soil.

Key words: Ascorbic acid, Cabbage, Cycocel, Fertilizer, Vermicompost.

INTRODUCTION

The significance of stabilized use of fertilizers is more populous among the farmers to get higher quality of produce. Cabbage is one of the most valued crops among *cole* group vegetables and it is rich in vitamins and mineral like vitamin A, vitamin C, vitamin B_1, B_2 and B_3, sulphur, phosphorus, calcium, magnesium, iron, potassium, sodium *etc*. The aggressive use of inorganic fertilizers has not only contaminated the soil and water but also affect the biospheres and human beings. So to eliminate more of inorganic fertilization, organic farming would be the best alternative. In the diversified farming system, integrated nutrient management under different crop spacing along with growth regulator is the most appropriate approach to solve various issues related to productivity, quality as well as sustainability. Cabbage is well known for its nutritive and health benefits. It has four distinct uses *viz*. salads, boiling, pickling and sauerkraut. Cabbage is grown during winter as a major vegetable crop and during summer it is taken as a minor crop or intercrop in Uttar Pradesh. This crops being a gross feeder, is always in need of high requirement of nutrients for producing best quality head in cabbage. On the other hand its productivity is very low in spite of showing great potential in the state. In Uttar Pradesh the production of cabbage is around 302.97 thousand MT from an area of 9.06 thousand hectares with the productivity of 33.44 t/ha (Anonymous, 2017). Therefore, keeping in view, a field experiment was conducted to study the effect of vermicompost, inorganic fertilizers and growth retardant (cycocel) with different spacing on quality of cabbage in Bundelkhand region.

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MATERIALS AND METHODS

The present study was conducted at Experimental Farm Bundelkhand University Jhansi (U.P.) during *rabi* season 2017-18 and 2018-19.Geographically, the research farm of the university is located at 25.45°N latitude and 78.61°E longitude at an altitude of 285 m from mean sea level having a sub-tropical climate. The experiment was laid out in factorial randomized block design (FRBD) with 27 treatment combinations and three replications. The treatments comprised of three different factors such as 1. Cycocel *viz.* C_1 (0 ppm), C_2 (300 ppm) and C_3 (600 ppm); 2. Fertilizer application *viz.* F_1 (100% RDF Inorganic Fertilizer 120:80:60 NPK kg/ha), F_2 [75% RDF (Inorganic Fertilizer) + 25% Organic (Vermicompost)] and F_3 [50% RDF (Inorganic Fertilizer) + 50% Organic (Vermicompost)]; 3. Plant spacing *viz.* S_1 (30 x 30 cm), S_2 (45 x 30 cm) and S_3 (45 x 45 cm). The observation recorded on moisture percentage, dry weight of cabbage head, ascorbic acid (Mukherjee and Chaudhary, 1983), phosphorus (Olsen *et al*., 1954), calcium (Derderian, 1961), magnesium (Derderian, 1961), chlorophyll A (µg/g fresh weight), chlorophyll B and total chlorophyll (Iosob *et al.,* 2019). All the agronomic practices were followed as per recommendations to the crop. One month old cabbage seedlings of Pusa Drum Head were transplanted in the main field at different spacing. Biometrical observations of five randomly samples were taken from each treatment with standard procedures and techniques. Data recorded were analyzed with the help of statistical programme- STPR- 3 developed by Department of Mathematics and Statistics, College of Basic Science and Humanities, GBPUAT, Pantnagar, Uttarakhand, India.

RESULTS AND DISCUSSION

The statistically analysed pool data of two year experiments (Table 1) revealed that different levels of integrated nutrient management, crop geometry and cycocel treatments brought out significant response in quality attributes of cabbage. The highest moisture content (92.56%) was recorded in treatment $C_2F_3S_3$ which was statistically at par with $C_3F_3S_2$ while lowest moisture content (85.39%) was observed in treatment $C_1F_1S_2$. Manure and fertilizers in the form of 50% vermicompost and inorganic fertilizers (50% RDF) at wider spaced geometry make good soil environment that insist the higher uptake of water which ultimately increase the higher percentage of moisture in cabbage head. The results are in the line of findings of Hatano *et al.* (2003) and Islam (2011). As per dry matter content the inorganic source of fertilizers responded higher dry matter content in cabbage heads irrespective of spacing. Thus the maximum dry matter content (14.40%) was observed in treatment $C_1F_1S_1$ which was statistically at par with $C_1F_1S_2$ and $C_1F_1S_3$ while lowest dry matter content (7.44%) was recorded in treatment $C_2F_3S_3$. Dry matter of head cabbage was markedly enhanced by inorganic fertilizer irrespective of plant spacing under different doses of cycocel treatment. The possible reason for increase in dry matter might be due to more contribution of minerals through the matured leaves and stem for the development of head by supplying higher carbohydrate to head contributing to higher dry matter content. Increase of cycocel dose suppressed gibberellic acid synthesis leading to clear reduction in dry weight. These finding are in the line of the results reported by Sorenson (1999), Loncaric, *et al.* (2003), Carter *et al*. (1997) and Choudhary and Choudhary (2005).

On perusal of data in Table 1 revealed that the different levels of integrated nutrient management, crop geometry and cycocel treatments brought out non-significant response in ascorbic acid content in cabbage heads. However, the highest ascorbic acid content was recorded in treatment $C_2F_3S_3$ (40.31mg/100g wet weight) followed by $C_2F_3S_2$ whereas, lowest ascorbic acid content (23.37 mg/100g wet weight) was found in treatment $C_2F_1S_1$. The maximum ascorbic acid content in cabbage was recorded in the treatment having 50% Vermicompost + 50 % RDF in combination with 300 ppm cycocel at wider crop geometry (45 cm x 45 cm). This might be due to physiological response of vermicompost with inorganic sources of nutrients for activation of various enzymes and due to more transport of energy to the head. Similar findings were also observed by Mehandran and Kumar (1998), Sharma and Chandra (2003), Upadhyay *et al*. (2007), Wang *et al*. (2010) and Rai *et al.* (2013), in cabbage.

In terms of phosphorus content the highest phosphorus content (89.82µg/ml) was observed in treatment $C_2F_3S_3$ followed by $C_3F_3S_3$ and $C_3F_3S_2$ while the lowest content was recorded in treatment $C_2F_2S_1$ (40.12 µg/ml). The increase in available phosphorus content in plants by combination of vermcompost and RDF under cycocel treatment at wider crop geometry might be attributed to greater mineralization of native soil phosphorus by reducing ability of soil mineral to fix phosphorus and increased its availability through liberation of organic acid. The organic material as a protective covering on sesquioxide reduced the phosphate fixation capacity of soil and hence increased the phosphorus status in plants. The similar finding has also been reported by Sharma *et al*. (2005).

The highest calcium content (1192.88µg/g wet weight) was observed in treatment $C_2F_3S_3$ which was found statistically at par with treatment $C_3F_1S_2$, $C_3F_2S_2$, $C_1F_3S_2$, $C_1F_3S_3$, $C_3F_3S_1$ and $C_3F_3S_2$ whereas, lowest content of calcium (614.89 µg/g wet weight) was noted in treatment $C_1F_1S_1$. The higher amount of Ca observed by the integrated nutrient management through organic and inorganic sources might be due to mineralization of micronutrients in the soils which exerted the more root pressure flow to carry adequate amounts of water-soluble Ca to the cabbage head. Calcium also helps in formation of new tissue such as meristematic tips, young leaves and often exhibit distorted growth from improper cell wall formation. It is also activating certain enzymes and to send signals that coordinate certain cellular activities. Similar findings were also reported by Kuo *et al.* (1981), Tetsuo and Sonoda (1981) and Padamwar and Dakore (2010).

The data shown in Table 1 revealed that the different levels of integrated nutrient management, crop geometry and cycocel brought out significant responses for magnesium and chlorophyll content in cabbage. The highest content of magnesium (0.0497µg/g wet weight) was recorded in plants treated with $C_2F_3S_3$ which was statistically at par with treatments $C_1F_3S_1$, $C_1F_3S_2$ and $C_2F_3S_1$ whereas,

Table 1: Effect of integrated nutrient management, cycocel and crop geometry on dry matter (%), moisture (%), ascorbic acid, phosphoru, calcium, magnesium, chlorophyll A, chlorophyll B and total chlorophyll content in cabbage.

Treatments	Treatment combination	Moisture percentage (%)	Dry weight of cabbage head (%)	Ascorbic Acid	Phosphorus (µg/ml)	Calcium (µg/g wet weight)	Magnesium (µg/gwet weight)	Chlorophyll A (µg/g fresh weight)	Chlorophyll B (µg/g fresh weight)	Total Chlorophyll (µg/g fresh weight)
		Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
$C_1F_1S_1$	0 ppm CCC + 100% RDF Inorganic Fertilizer (120:80:60 NPK kg/ha) with 30x30 cm spacing.	85.60	14.40	28.38	59.03	614.89	0.0253	0.34	0.44	1.21
$C_1F_1S_2$	0 ppm CCC + 100% RDF Inorganic Fertilizer (120:80:60 NPK kg/ha) with 45x30 cm spacing.	85.39	14.61	27.21	58.93	811.45	0.0270	1.08	0.29	1.51
$C_1F_1S_3$	0 ppm CCC + 100% RDF Inorganic Fertilizer (120:80:60 NPK kg/ha) with 45x45 cm spacing.	86.31	13.69	26.69	56.93	788.80	0.0373	0.37	0.43	1.62
$C_2F_1S_1$	300 ppm CCC + 100% RDF Inorganic Fertilizer (120:80:60 NPK kg/ha) with 30x30 cm spacing.	87.03	12.97	23.37	67.20	920.92	0.0387	0.81	0.88	2.40
$C_2F_1S_2$	300 ppm CCC + 100% RDF Inorganic Fertilizer (120:80:60 NPK kg/ha) with 45x30 cm spacing.	87.88	12.12	29.45	64.78	934.44	0.0407	1.81	0.98	2.34
$C_2F_1S_3$	300 ppm CCC + 100% RDF Inorganic Fertilizer (120:80:60 NPK kg/ha) with 45x45 cm spacing.	86.79	13.22	32.29	46.46	949.73	0.0410	1.05	1.33	2.11
$C_3F_1S_1$	600 ppm CCC + 100% RDF Inorganic Fertilizer (120:80:60 NPK kg/ha) with 30x30 cm spacing.	87.43	12.57	30.64	55.92	804.44	0.0443	1.96	0.97	2.05
$C_3F_1S_2$	600 ppm CCC + 100% RDF Inorganic Fertilizer (120:80:60 NPK kg/ha) with 45x30 cm spacing.	87.79	12.21	25.99	72.67	1059.60	0.0347	2.34	0.45	4.15
$C_3F_1S_3$	600 ppm CCC + 100% RDF Inorganic Fertilizer (120:80:60 NPK kg/ha) with 45x45 cm spacing.	87.85	12.15	31.42	76.38	953.47	0.0330	1.44	1.01	2.50
$C_1F_2S_1$	0 ppm CCC + 75% RDF Inorganic Fertilizer + 25% Organic (Vermicompost) with 30x30 cm spacing	88.00	12.00	33.29	59.35	766.95	0.0343	1.86	1.55	3.30
$C_1F_2S_2$	0 ppm CCC + 75% RDF Inorganic Fertilizer + 25% Organic (Vermicompost) with 45x30 cm spacing	88.01	11.99	29.09	66.65	1040.43	0.0447	1.61	0.66	3.09
$C_1F_2S_3$	0 ppm CCC + 75% RDF Inorganic Fertilizer + 25% Organic(Vermicompost) with 45x45 cm spacing	88.14	11.87	31.95	49.96	813.89	0.0403	2.27	0.60	3.12
$C_2F_2S_1$	300 ppm CCC + 75% RDF Inorganic Fertilizer + 25% Organic (Vermicompost) with 30x30cm spacing	87.79	12.21	31.25	40.12	542.63	0.0433	2.41	0.88	3.23
$C_2F_2S_2$	300 ppm CCC + 75% RDF Inorganic Fertilizer + 25% Organic(Vermicompost) with 45x30 cm spacing	88.46	11.55	30.45	52.08	669.16	0.0450	2.55	0.58	3.11
$C_2F_2S_3$	300 ppm CCC + 75% RDF Inorganic Fertilizer + 25% Organic(Vermicompost) with 45x45 cm spacing	88.05	11.95	37.14	57.08	727.55	0.0417	2.40	0.96	3.92
$C_3F_2S_1$	600 ppm CCC + 75% RDF Inorganic Fertilizer + 25% Organic(Vermicompost) with 30x30 cm spacing	88.41	11.60	28.49	69.27	1009.74	0.0440	3.78	0.66	4.31

Table 1: continue...

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$C_3F_2S_2$	600 ppm CCC + 75% RDF Inorganic Fertilizer + 25% Organic(Vermicompost) with 45x30 cm spacing	89.37	10.63	39.26	70.59	1145.13	0.0423	2.74	1.12	3.39
$C_3F_2S_3$	600 ppm CCC + 75% RDF Inorganic Fertilizer + 25% Organic (Vermicompost) with 45x45 cm spacing	90.06	9.94	32.35	81.85	932.76	0.0427	3.68	1.32	4.03
$C_1F_3S_1$	0 ppm CCC + 50% RDF Inorganic Fertilizer + 50% Organic(Vermicompost) with 30x30 cm spacing	89.14	10.86	35.44	81.34	994.57	0.0460	3.60	0.56	4.13
$C_1F_3S_2$	0 ppm CCC + 50% RDF Inorganic Fertilizer + 50% Organic (Vermicompost) with 45x30 cm spacing	88.35	11.65	33.82	78.31	1152.80	0.0450	3.39	0.65	4.03
$C_1F_3S_3$	0 ppm CCC + 50% RDF Inorganic Fertilizer + 50% Organic (Vermicompost) with 45x45 cm spacing	88.56	11.44	31.03	76.74	1163.87	0.0400	3.76	1.95	5.71
$C_2F_3S_1$	300 ppm CCC + 50% RDF Inorganic Fertilizer + 50% Organic (Vermicompost) with 30x30 cm spacing	88.36	11.64	35.12	73.22	1002.44	0.0450	6.38	1.19	7.86
$C_2F_3S_2$	300 ppm CCC + 50% RDF Inorganic Fertilizer + 50% Organic (Vermicompost) with 45x30 cm spacing	89.20	10.80	39.99	68.36	911.99	0.0383	5.09	1.08	5.71
$C_2F_3S_3$	300 ppm CCC + 50% RDF Inorganic Fertilizer + 50% Organic (Vermicompost) with 45x45 cm spacing	92.56	7.44	40.31	89.82	1192.88	0.0497	8.55	2.17	9.84
$C_3F_3S_1$	600 ppm CCC + 50% RDF Inorganic Fertilizer + 50% Organic (Vermicompost) with 30x30 cm spacing	91.29	8.71	31.22	67.62	1142.39	0.0400	8.03	1.39	9.42
$C_3F_3S_2$	600 ppm CCC + 50% RDF Inorganic Fertilizer + 50% Organic (Vermicompost) with 45x30 cm spacing	92.12	7.88	38.78	87.17	1143.96	0.0387	5.93	1.99	6.95
$C_3F_3S_3$	600 ppm CCC + 50% RDF Inorganic Fertilizer + 50% Organic (Vermicompost) with 45x45 cm spacing	89.67	10.33	36.42	88.46	838.45	0.0353	5.16	1.61	6.68
SEm$\pm$		0.34	0.34	4.43	10.903	48.85	0.003	0.064	0.042	0.084
CD at 5% or1 %		0.95	0.95	NS	NS	138.66	0.008	0.183	0.120	0.239

minimum magnesium content was observed in treatment $C_1F_1S_1$ (0.0253 µg/g wet weight). The magnesium content increased positively by the integration of vermicompost and inorganic fertilizers {50% RDF Inorganic Fertilizer + 50% Organic (vermicompost)} along with 300 ppm cycocel under wide spaced crop might be due to mineralization of nutrients leading to subsequent uptake of magnesium. It is worth to mention here that Mg is vital for biosynthesis of chlorophyll and cytochrome led to more activation of the photosystems as well as higher energy transfer from PS-I and PS-II. The increment in magnesium content in plant has positively boosted the relative rate of plant growth. The above findings are in the lines of Balakrishnan *et al.* (2000), Riga and Anza (2003) and Talat *et al.* (2014). In terms of chlorophyll content the highest Chlorophyll A content was found in treatment $C_2F_3S_3$ (8.55 µg/g fresh weight) followed by $C_3F_3S_1$ whereas, lowest content (0.338µg/g fresh weight) was recorded in plants treated under $C_1F_1S_1$. The highest Chlorophyll B content (2.17 µg/g fresh weight) was also observed in treatment $C_2F_3S_3$ while the lowest Chlorophyll B content (0.29 µg/g fresh weight) was recorded in treatment $C_1F_1S_2$.The increase in chlorophyll A and Chlorophyll B might be due to synergistic effect of organic, inorganic source of nutrients having 50% RDF (inorganic) + 50% vermicompost and particularly cycocel treatments which might be delaying the leaf senescence and hence keeping the green pigment from degradation. These results are in agreement with those reported by Emden and Cocks hull (1967) in cabbage.

In terms of total chlorophyll content in different treatments the highest total chlorophyll content (9.84 µg/g fresh weight) was observed in treatment $C_2F_3S_3$ followed by $C_3F_3S_1$ and $C_2F_3S_1$ while the least amount of total chlorophyll content was found in treatment $C_1F_1S_1$. The application of 50% vermicompost coupled with 50% inorganic fertilizer along with cycocel treatment under wider crop geometry (45 cm x 45 cm) was superior over rest of the treatments. Treatments in which inorganic sources were used without organic fertilizers the chlorophyll content was less. The organic fertilizer in combination with inorganic along with 300 ppm cycocel under wider crop geometry found better for enhancing the chlorophyll content. This might be due to significant enhancement of availability of macro and micro nutrients in the soil, as consequence of which the quality would have been increased. Application of plant growth retardant such as cycocel might have increases the content of cytokinin which resulted in enhancing the amount of leaf chlorophyll. These results are supported with the finding of Chinaswamy and Mariakulandi (1996), Mehaendran and Kumar (1998), Dole and Wilkins (2005) and Rosseni *et al.* (2005).

CONCLUSION

It may be concluded from above findings that treatment $C_2F_3S_3$ [300 ppm CCC + 50 % RDF (inorganic fertilizer) + 50% Organic (vermicompost) with 45 cm x45 cm spacing)] performed best in achieving higher amount of moisture percent, ascorbic acid, phosphorus, calcium and chlorophyll in cabbage as compare to other treatments under the present study. It is evident from the present findings that integration of vermicompost with inorganic NPK fertilizer under wider spacing along with spraying of growth retardant (cycocel) could be beneficial for increasing the qualitative attributes of cabbage and sustaining the fertility status of soil.

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