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Impact of Various Organic Manures on Growth, Growth Attributes and Quality of Cabbage (*Brassica oleracea var. capitata* L.)

Arshpreet Kaur*

Department of Agriculture, Khalsa College, Amritsar, India

**Corresponding author*

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A B S T R A C T

An investigation entitled "Impact of different organic manures on performance of cabbage (*Brassica oleracea var. capitata* L.)" under field conditions was conducted in October 2017-2018 at Department of Horticulture, Khalsa College Amritsar (Punjab). The investigation was laid out in RBD with eleven treatments replicated three times with spacing 45×45 cm. The eleven treatments combinations were T_1- Recommended dose of fertilizers, T_2-100% N by Vermicompost, T_3- 100% N by Poultry manure, T_4- 100% N by Farmyard manure, T_5- 100% N by Vermicompost+ Azotobacter, T_6- 100% N by Poultry manure+Azotobacter, T_7- 100% N by Farmyard manure+Azotobacter, T_8- 75% N by Vermicompost+ Azotobacter, T_9- 75% N by Poultry manure+Azotobacter, T_{10}- 75% N by Farmyard manure+Azotobacter, T_{11}- Control. Among various treatments T_1 (RDF) proved to be significant over rest of the treatments as it registered maximum growth parameters. Maximum plant height at harvest was recorded to be (30.19cm), plant spread at harvest (46.74 cm), leaf length with petiole at harvest (32.34 cm), leaf breadth (24.37 cm), leaf area (147.65 cm^2), total number of leaves (31.85), total number of folded leaves (18.30), total number of unfolded leaves (13.56), stem length (NS), TSS content (4.94˚Brix), ascorbic acid content (44.05 mg/100g) was obtained in RDF. Among organic manures, poultry manure alone proved to be beneficial than Vermicompost and Farmyard manure, as it improved the growth and yield of cabbage and also gave maximum returns as compared. Among organic manures and biofertilizers, poultry manure along with Azotobacter performed better than Azotobacter combinations with Vermicompost and Farmyard manure. Among organic manure treatment T_6 (4 tonnes/ha poultry manure+Azotobacter) was found to be more economical as it solve the purpose both ways one being changing the trend of using more inorganic fertilizers towards organic manures and second being getting higher returns with B:C ratio (4.84).

Introduction

Cabbage (*Brassica oleracea var. capitata* L.) is one of the esteemed leafy vegetable, which is widely cultivated throughout the globe. It belongs to the family *Cruciferae* and genus *Brassica* which is consumed fresh as well as in processed form in different countries of the world (Haque *et al.*, 2015, Best, 2000). The Food and Agriculture organization has

identified cabbage among one of the top twenty vegetables (Olaniyi and Akanbi, 2008). In India the area under cabbage cultivation is around 4 lac hectare with 9039‘000 MT production during 2013-2014 (Anonymous, 2014). Cabbage is an important vegetable crop that grows well in climatic conditions of Punjab with good yield and productivity. Punjab produces 87.19 thousand tonnes from an area of 4.95 thousand ha with an average yield of 17.61 thousand MT/ha (Anonymous, 2014). Major cabbage producing districts include Amritsar, Patiala, Jalandhar and Ludhiana.

Nutrient management plays a crucial role for the improvement of cabbage yield and production. A remarkable effect on the physiological attributes after the incorporation of organic nutrients especially in the form of vermicompost, farmyard manure, poultry manure and biofertilizer has been noticed in various vegetables. Apparently, inorganic fertilizers impair the crop health due to of residual effect but such kinds of issues are not evident in case of organic fertilizer (Tindal 2000). The farmers supplement chemical fertilizer as a readily available source for nutrients but they do not apply it in balanced proportion (BARC, 2005). Despite of the balanced use of sole chemical fertilizer, high yield level could not be attained over years due to deterioration in soil physical, chemical and biological properties (Khan *et al.*, 2008). However, some studies have suggested that excessive use of those agrochemicals may actually aggravate pest problem in the long run (Altieri and Nocholls, 2003).

Materials and Methods

The field experiment was conducted at an experimental farm area of Department of Horticulture, Khalsa College, Amritsar during 2017-18 located 31º-38´ N latitude and 74 º-52´ E longitude with an elevation of 236 m MSL and represents the sub-tropical climate and humid zone of Punjab region in order to work impact of various sources of organic manures for obtaining higher head yield of cabbage. The soil of an experimental plot was sandy loam in texture with pH 8.40, organic carbon (0.40-0.75%), medium in available N (0.28%), available P (16 kg/ha) and available K (175 kg/ha). The experiment was laid in a randomized block design with three replications having 11 treatments comprising different combinations of organic sources and *Azotobacter viz*. 125:62.5:62.5 NPK per hectare through RDF (T_1), 8 tonnes/ha of N through vermicompost (T_2), 4 tonnes/ha of N through poultry manure(T_3), 25 tonnes/ha of N through farmyard manure (T_4), 8 tonnes/ha of N through vermicompost + *Azotobacter* (T_5), 4 tonnes/ha of N through poultry manure + *Azotobacter* (T_6), 25 tonnes/ha of N through farmyard manure + *Azotobacter* (T_7), 6 tonnes/ha of N through vermicompost + *Azotobacter* (T_8), 3 tonnes/ha of N through poultry manure + *Azotobacter* (T_9) and 18 tonnes/ha of N through farmyard manure (T_{10}) and control (T_{11}).

Cabbage seedling roots were inoculated with *Azotobacter* solution @ 4-5 ml per litre of water. The solution was dissolved in water and the seedlings of cabbage were dipped in the solution for 30 minutes before transplanting. Cabbage (Golden Acre) was transplanted at 45 × 45 cm spacing on 1st of October and harvested at fully matured stage. Selected and tagged plants were left in the field for head production during winter. All other cultural practices were followed as per standard recommendations. Absolute growth rate (AGR) was calculated using the formula (Wareing and Philips, 1981):

$$\text{Absolute growth rate} = \frac{H_2\text{-}H_1}{T_2\text{-}T_1}$$

The data was analyzed as per the standard procedure for Analysis of Variance

(ANOVA). The difference in the treatment mean was tested by using critical difference (CD) at 5% level of probability.

Results and Discussion

Growth parameters

Plant height is a reliable index of plant growth that indicates the vigor, strength and adaptability of the crop to the existing environment. It is evident from the Table 1 that plant height was significantly affected by different manure and fertilizer combinations under the present study. It is evident that plant height was highest with recommended dose of nutrients (T_1) i.e. 30.19 cm at 60 DAT. On the other hand lowest plant height at 60 DAT was recorded to be 26.23 cm with control treatment. The second highest plant height was recorded 29.66 cm at 60 DAT in T_6 (4t/ha poultry manure + *Azotobacter*) which was statistically similar with T_1. At harvesting T_3, T_5, T_6, T_8 and T_9 are at pat to T_1. Present findings on plant height are also in conformity with Souza *et al.,* (2008), Hasan and Solaiman (2012). The data in Table 1 reveal that the maximum plant spread at 60 DAT was recorded in T_1 (RDF) i.e. 46.74 cm at 60 DAT. Whereas the second highest plant spread was obtained in T_6 (4 tonnes/ha poultry manure + *Azotobacter*) i.e. 45.33 cm at 60 DAT. At 60 DAT T_3, T_5, T_6 and T_9 are significantly at par to T_1. Whereas, the lowest plant spread was recorded in T_{11} i.e. 32.73 cm at harvesting. The results in respect of this character are in complete agreement with the findings of Bhagavantagoudra and Rokhade (2002) and Choudhary and Choudhary (2005) for cole crops. Table 1 describe that significant variation was observed for leaf length with petiole at different stages after transplanting. It was observed that the highest leaf length with petiole was recorded with recommended dose of fertilizers (T_1) i.e. 32.34 cm at 60 DAT followed by treatment of poultry manure @4 tonnes along with *Azotobacter* (T_6). At 60 DAT T_2, T_3, T_5, T_6, T_7 andT_9 are statistically identical to T_1. The lowest leaf length with petiole was 20.71 cm at 60 DAT in control. The results obtained under the present experiment were also supported by Souza *et al.,* (2008), Hasan and Solaiman (2012). Leaf breadth significantly varied with different organic manures at different days after transplanting (DAT) as described in Table 1. It was measured that highest leaf breadth was obtained with the use of recommended dosage of nutrients (T_1) and that was 24.37 cm at 60 DAT respectively. T_1 was followed by T_6 (poultry manure @4 tonnes + *Azotobacter*). On the other hand lowest leaf breadth i.e. 18.24 cm at 60 DAT was obtained with control treatment (T_{11}). At 60 DAT T_2, T_3, T_5, T_6, T_7 and T_9 are statistically identical to T_1. The results obtained under present experiment were also supported by Souza *et al.,* (2008), Hasan and Solaiman (2012). Leaf area is an important plant growth indices determining the capacity of plant in trapping solar energy for photosynthesis and has marked influence on growth and yield of cabbage crop. Table 1 represents the leaf area at various growth stages. The highest leaf area at 60 DAT was 147.65 cm^2, which was obtained due to application of RDF (T_1). It was followed by T_6 which recorded leaf area of 137 cm^2 at 60 DAT. However, least leaf area was recorded in T_{11} i.e. absolute control which was 106.33 cm^2 at 60 DAT. At 60 DAT T_3, T_5 and T_6 are statistically identical to T_1. It was observed from Table 1 that no significant effect was seen in stem length at 60 DAT. Islam (2011), Sajib *et al.,* (2015) also supported the same results in their study. The number of leaves per plant is an important parameter considering the highest performance of cabbage yield. It is evident from Table 2 that the highest number of leaves per plant was obtained by the use of recommended dose of fertilizer (T_1) and the

highest number of leaves was 31.85 at harvest respectively. T_1 was statistically identical with T_6 comprising treatment of 4 tonnes/ha poultry manure and *Azotobacter*. The total number of leaves measured at harvest were 30.00 in T_6 (4 tonnes/ha poultry manure and *Azotobacter*). The lowest number of leaves was found to be 24.56 at harvest respectively with control treatment (T_{11}). The result obtained from the experiment on total number of leaves per plant was in conformity with Vimla (2006), Pankaj (2006) and Muhammad and Javed (2001).

The number of folded leaves per plant is an important parameter considering the highest performance of cabbage yield. It is evident from Table 1 that the highest number of leaves per plant was obtained by the use of recommended dose of fertilizer (T_1) and the highest number of folded leaves was 18.30 at harvest. T_1 was statistically identical with T_6 comprising treatment of 4 tonnes/ha poultry manure and *Azotobacter*. The total number of folded leaves measured at harvest were 17.96 in T_6 (4 tonnes/ha poultry manure and *Azotobacter*). The lowest number of folded leaves was found to be 14.00 at harvest in control treatment (T_{11}). This finding was in agreement with those reported by Singh *et al.*, (2009) and Kumar *et al.*, (2010) in cauliflower, Choudhary *et al.*,., 2012 and Mohanpatra *et al.*,., 2013. The data from Table 1 reveal that no significant effect was observed in number of unfolded leaves in cabbage at harvest due to various organic amendments. Absolute Growth Rate (AGR) is the change in actual growth over time. As clear from the Chart 1, treatment combination (T_7) recorded highest growth. It might be due to slow decomposition of farmyard manure at initial stages which later became available to plants leading to increased growth over time. Hence, low initial growth due to FYM lead to lower yield than other manures.

Table.1 Effect of different organic manures in AGR of cabbage

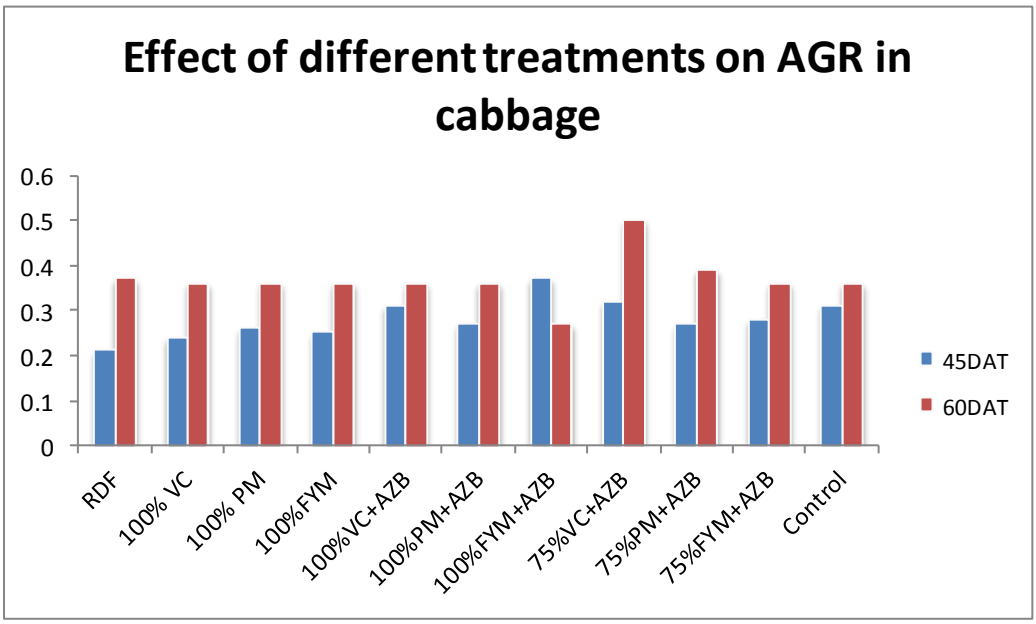
	Treatment	45DAT	60DAT
T_1	RDF	0.21	0.37
T_2	100% VC	0.24	0.36
T_3	100% PM	0.26	0.36
T_4	100%FYM	0.25	0.36
T_5	100%VC+AZB	0.31	0.36
T_6	100%PM+AZB	0.27	0.36
T_7	100%FYM+AZB	0.37	0.27
T_8	75%VC+AZB	0.32	0.50
T_9	75%PM+AZB	0.27	0.39
T_{10}	75%FYM+AZB	0.28	0.36
T_{11}	Control	0.31	0.36

Table.2 Effect of different organic manures on growth and quality of cabbage

	Plant height (cm)	Plant spread(cm)	Leaf length with petiole (cm)	Leaf breadth (cm)	Leaf area (cm^2)	Stem length (cm)	Total number of leaves	No. of folded leaves	No. of unfolded leaves	TSS (˚Brix)	Vitamin C (mg/100g)
Treatments	**60DAT**	**60DAT**	**60DAT**	**60DAT**	**60DAT**	**60DAT**	**60DAT**	**60DAT**	**60DAT**		
T_1	30.19	**46.74**	32.34	24.37	147.65	2.44	31.85	18.30	15.22	4.94	39.92
T_2	27.98	41.45	28.62	21.23	119.49	2.22	27.00	14.78	13.89	4.17	42.92
T_3	29.26	43.51	30.48	23.83	131.35	2.27	28.48	15.56	14.59	4.67	43.88
T_4	26.74	38.29	25.69	20.22	114.61	2.15	25.00	13.67	13.00	3.24	42.67
T_5	29.47	42.55	29.67	23.04	133.47	2.33	29.04	16.70	14.00	4.70	43.86
T_6	29.66	45.33	31.50	24.07	137.00	2.41	30.00	17.96	14.78	4.83	44.05
T_7	27.27	39.35	29.96	21.90	120.40	2.17	28.00	15.89	13.78	4.50	43.02
T_8	28.91	39.04	27.59	20.86	116.96	2.17	27.15	15.15	13.67	3.60	42.52
T_9	29.38	42.89	30.34	21.09	130.07	2.22	29.41	16.37	14.70	3.67	43.74
T_{10}	26.46	37.11	24.71	20.48	111.96	2.02	26.07	14.29	13.45	3.20	42.19
T_{11}	26.23	32.73	20.71	18.24	106.33	1.95	24.56	14.00	12.22	2.98	42.15
CD(p=0.05)	**1.28**	**5.24**	**3.76**	**3.36**	**17.00**	**NS**	**2.76**	**0.54**	**NS**	**0.59**	**1.13**

T_1- Recommended doze of nutrients; T_2- 100% of N by VC; T_3- 100% of N by PM; T_4- 100% of N by FYM; T_5- 100% of N by VC+AZB; T_6- 100% of N by PM+AZB; T_7- 100% of N by FYM+AZB; T_8- 75% of N by VC+AZB; T_9- 75% of N by PM+AZB; T_{10}- 75% of N by FYM+AZB;T_{11}- Control

Fig.1 Effect of different organic manures in AGR of cabbage



Quality parameters

The use of different organic sources and inorganic sources showed disparities in TSS content of cabbage has been presented in Table 1. The highest TSS content 4.94˚Brix was recorded in T_1 (recommended dose of fertilizers) followed by 4.83˚Brix in T_6 (4 tonnes/ha poultry manure + *Azotobacter*) and 4.70˚Brix in T_5 (8 tonnes/ha vermicompost + *Azotobacter*). T_3, T_5, T_6 and T_7 are statistically at par with T_1. Whereas lowest TSS content 2.98˚Brix was recorded in control. Different nutrient sources affected the vitamin C content significantly in cabbage. Hiwale *et al.*, (2010), Yano *et al.*, (1981) also reported that the application of organic manures increased glucose and fructose content in cabbage. Data from Table 1 reveal that the maximum vitamin C content i.e. 44.05 mg/100g was recorded in T_6 (4t/ha poultry manure + *Azotobacter*) followed by 43.88 mg/100g in T_3 (4t/ha poultry manure), 43.86 mg/100g in T_5 (8t/ha vermicompost + *Azotobacter*), 43.02 mg/100g in T_7 and 43.74 mg/100g in T_9 (3t/ha poultry manure + *Azotobacter*). T_3, T_5, T_7 and T_9 are statistically at par with T_6. However, minimum vitamin C content was 39.86 mg/100g in RDF (T_1). Bahadur *et al.*, (2003) in broccoli and Shree *et al.*, (2014) in cauliflower also reported the similar results. Jaipal *et al.*, (2011) gave similar results that significantly higher ascorbic acid was recorded in integrated nutrient management in comparison to sole organic manures. Verma *et al.*, (2004) also concluded the same in their experiment in cabbage. Higher growth and growth characters due to RDF can be attributed to easy availability of nutrients required by plants leading to profuse growth. Among organic manures along with *Azotobacter*, superior results due to Poultry manure might be due to higher N content and quick availability.

From the experiment trial it can be concluded that:

Among various treatments, T_1 (RDF) was found to be better as it yielded maximum growth as well as other growth characters.

On the other hand, in case of organic manures and biofertilizers combinations, the treatment T_6 (100% N by poultry manure + *Azotobacter*) was found to be more economical as it solved the purpose both ways one being changing the trend of using more inorganic fertilizers towards organic manures and second being getting higher returns and B:C ratio (3.84).

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