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Organic Nutrient Management for Improved Plant Growth and Head Yield of Chinese Cabbage (*Brassica rapa* L. var pekinensis)

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A B S T R A C T

A field experiment was conducted during Rabi 2014-2015 at Experimental Farm of Division of Vegetable Science SKUAST-K Shalimar to find out the suitable nutrient management practices for enhanced growth and yield attributes of Chinese cabbage. Based on VC, FYM, SM, and BDC, the experiment was comprised of 13 treatments (including RDF) with or without biofertilizers and laid out in RCBD with three replications. Data revealed that VC @ 6.6t/ha + *AB* + PSB + KSB (T_4) recorded maximum plant height (30.33cm), fresh weight (1170.00 g plant^{-1}), dry weight (64.37 g plant^{-1}) and shoot/ root dry weight ratio (16.46) at 60 DAT against the minimum plant height (22.67cm), fresh weight (578.33g plant^{-1}), dry weight (31.59 g plant^{-1}) and shoot/ root dry weight ratio (10.93) in 50% nutrient application through inorganic + 50% through FYM (T_6). While talking about RGR, T_4 further verified its superiority by presenting higher RGRs (0.97 and 0.743 g.g^{1}day^{-1}), no. of folded leaves (30.33plant^{-1}), head diameter (6.50 cm), head length (21.16cm), head weight (613.33g) and head compactness of (1.89) coupled with least number of days taken to head initiation (19.33) in opposition to the significantly lowest values of folded leaves, head diameter, head length, head weight and head compactness (0.86) coupled with maximum number of days taken to head initiation in T_6 which was immaterially trailed by T_1 i.e. RDF.

Introduction

The importance of leafy vegetables for supply of proteins, vitamins and minerals is well recognized. Chinese cabbage (*Brassica rapa* L. var pekinensis) is an important leafy, herbaceous vegetable crop originated in China and belongs to the family Crucifereae (Rashid, 1999). It is low in calories, fats and carbohydrates but a good source of minerals, proteins and antioxidants (Singh *et al.*, 2004). There are two major types of Chinese cabbage, the heading and the non-heading. The non- heading type under its most common name *Bok Choy* is rather open rosette of dark green leaves with white celery like stalks. This plant is more heat tolerant but much more sensitive to cold which makes it bolt when it suddenly turns warm during winter or early spring. The heading types are known as *Napa* *cabbage* or *Michihili*. *Napa* is a short barrel-shaped head while the Michihili has a tall cylindrical or tapered head. Neither of these Chinese cabbages look or taste like ordinary cabbage. They both have large cover leaves that are trimmed off to reveal the compact head.

During recent years, Chinese cabbage is gaining popularity in India as potherb, salad as well as cooked vegetable and has become one of the important vegetable crops of eastern India. In J&K, Chinese cabbage is not so far grown by commercial farmers; however, it is being cultivated by innovative farmers and by agricultural research stations at small scale. With increase in people's preference towards diversified vegetable consumption, Chinese cabbage is gaining immediate attention in the Kashmir valley. However, the production package of Chinese cabbage is not much known in the valley. It requires considerable amount of nutrients for rapid growth in a short period of time and thrives well in a fertile clay loam soil (Islam and Haque, 1992). As such, for getting higher production and quality yield of Chinese cabbage it is necessary to ensure availability of essential nutrient components. Heavy use of inorganic fertilizer not only contaminates the ground and surface water but also disturb the harmony existing among the soil, plant and microbial population (Bahadur *et al.,* 2006). There has also been a growing concern about adverse impacts of pesticides and fertilizers on the environment and on the safety and quality of food. Sole use of organic manures, on the other hand, may not be able to give expected yield potential. The release of nutrients from soil organic matter is controlled by soil micro-organisms. Micro-organisms containing preparations having the capability of mobilize nutritive elements from non-usable to usable form through biological processes is called as biofertilizers. Therefore, an integrated approach by making judicious use of organic matters, bio-fertilizers combined with inorganic sources of nutrients is thought to be a better option for sustaining crop productivity and also maintaining soil health. Various studies indicated that organic manures and bio-fertilizers coupled with inorganic sources increase yield and influence quality attributes in vegetables (Tiwari, 2015). Keeping in view the above facts the present investigation has been carried out to find out the suitable nutrient management practices for enhanced growth and yield attributes of Chinese cabbage.

Materials and Methods

The present investigation was carried out during Rabi 2014 at Experimental Farm, Division of Vegetable Science, SKUAST-Kashmir, Shalimar lies between 34.° North latitude and 74.89°East longitude at an altitude of 1587 meters above mean sea level and having temperate climate i.e. characterized by hot summers and very cold winters. The soil of the experimental field was low in available N and medium in available P and K. Chinese cabbage variety 'Solan band Chinese sarson' having short barrel-shaped head was used as experimental material. There were 13 (1+12) treatments comprised of four organic manures namely farmyard manure (FYM), biodynamic compost (BDC), sheep manure (SM) and vermicompost (VC), three types of bio-fertilizers candidly *Azotobacter* (*AB*), phosphorus solublizing bacteria (PSB) and potassium solublizing bacteria (KSB) plus recommended fertilizer dose (RDF - NPK @ 100:50:30 kg/ha) through urea, DAP and MOP as control. The experiment was laid in a randomized complete block design (RCBD) with three replications. Amount of nutrients in the organic manures was calculated on the basis nitrogen equivalence. Bio-fertilizers were applied as seedling root dip treatment (@ 2.5%) i.e. 25 ml of each of the bio-fertilizers was added in 1 litre of water and roots of the seedlings were kept for 10 minutes in the solution before transplanting in the experimental field. All organic manures and inorganic fertilizers were incorporated in the experimental field at the time of land preparation. Twenty five days old uniform and healthy seedlings were transplanted in well prepared plots with spacing of 45 cm × 30 cm. Plant height, fresh weight, dry weight, shoot/root ratio and relative growth rate (RGR) were measured periodically. Time taken to head initiation, no. of folded and unfolded leaves, head diameter, head length, head weight and head compactness in terms of Z value were recorded accordingly. Plant relative growth rate (RGR) and head compactness were measured by following the method Hoffmann and Poorter (2002) and Pearson (1931) using equation I and II, respectively.

$$RGR = \frac{\ln (W_2 - W_1)}{t_2 - t_1} \quad (I)$$

Whereas ln = natural logarithm and w_1 and w_2 are plant weights at corresponding time t_1 and t_2.

Head compactness (Z) = C/W3 x 100 (II)

Where, Z = index of compactness; C = net weight of head; W = average of equatorial and polar diameter of head

Results and Discussion

Data presented in table 1-3 revealed significant differences among different nutrient managements practices with respect to plant height (Table 1), plant dry and fresh weight (Table 2) and shoot-root ratio (Table 3) wherein VC @ 6.6t/ha + *AB* + PSB + KSB (T_4) recorded maximum plant height (15.33, 20.30, 24.23, and 30.3cm), fresh weight (36.18, 220.79, 570.66 and 1170.00g/plant), dry weight (1.9, 6.7, 28.9 and 38.3g/plant), shoot-root (S/R) ratio (32.50, 22.06, 18.68 and 16.46) at 15, 30, 45 and 60 DAT, respectively, which was closely related with FYM @ 20t/ha + *AB* + PSB + KSB (T_2), SM @ 16.6t/ha + *AB* + PSB + KSB (T_3) and BDC @ 8.3 t/ha + *AB* + PSB + KSB (T_5) with minor exceptions. In opposition to the maximum values of these parameters in T_4, treatment T_6 (50% NPK + 50% FYM) recorded the minimum plant height (9.66, 14.83, 19.73 and 22.63cm), fresh weight (16.87, 85.12,184.33 and 578.33g/plant), dry weight (1.9, 5.9, 27.1 and 31.6g/plant) and shoot-root (S/R) ratio (17.32, 12, 96, 11.79 and 10.93) at 15, 30, 45 and 60 DAT, respectively which were found to be closely trailed by the recommended dose of sole nutrients through inorganic fertilizers (T_1).

Perusal of the data presented in table 4 unveiled significant influences of the different sources of nutrients on plant RGR of Chinese cabbage. Among different treatments, T_4 (VC@ 6.6t/ha.+ *AB*+ PSB+ KSB) again recorded maximum RGR value of 0.97 and 0.74g/g/day during 15-30 and 30-45 DAT and was found statistically at par with T_5 (BDC @ 8.3 t/ha + *AB* + PSB + KSB) and T_3 (SM @ 16.6t/ha + *AB* + PSB + KSB) which showed a relative growth rate of 0.94g/g/day and 0.93g/g/day, respectively during 15-30 and 30-45 DAT. The minimum value of RGR i.e. 0.10 and 0.30g/g/day during 15 to 30 and 30-35 DAT was obtained in T_6 (50%NPK+ 50% FYM) which was statistically at par with T_1.

The data pertaining to days taken to initiation of head after transplanting (Table 4) notify that T_4 (VC @ 6.6t/ha + *AB* + PSB + KSB) starts early head initiation and took only 19.33 days along with T_2 (FYM @ 20t/ha + *AB* + PSB + KSB), T_3 (SM @ 16.6t/ha + *AB* + PSB + KSB) and T_5 (BDC @ 8.3 t/ha + *AB* + PSB + KSB) as they have taken 19.66 days to initiation of head. Application of recommended doses of nutrients through inorganic sources taken longer period (22.33 days) to initiate the head formation in Chinese cabbage. As depicted from table 4 treatment T_4 (VC@ 6.6t/ha. + *AB* +PSB+KSB) recorded maximum number of folded leaves (31.33/plant) followed by T_5 (30/plant), T_3 (29.66/plant) and T_2 (29.33/plant) but were found statistically at par with T_4. The minimum number of folded leaves (22.67/plant) was obtained with T_6 (50% NPK+ 50% FYM) followed by T_7&T_{10} (26.33), T_8 and T_9 (26.00) while as no. of leaves recorded in T_{11}, T_{12} and T_{13} were 29.00 and 27.00/plant, respectively.

Like number of folded leaves different treatments also influenced number of unfolded leaves plant^{-1} (Table 4) significantly. Among different treatments, treatment T_4 (VC (VC) @ 6.6t/ha + *AB* + PSB + KSB) resulted a significant increase in number of unfolded leaves (16.33 per plant) and was found superior to all other treatments followed by T_5 (BDC @ 8.3 t/ha + *AB* + PSB + KSB) (13.00cm) and T_2. The minimum number of unfolded leaves of 09.00/plant were observed in control (treatment T_1) and T_6 (50%NPK+ 50%FYM). While as T_{11}(50% NPK + 50% (VC) + *AB* + PSB + KSB) and T_{13}(50% NPK+50% BDC+ *AB* + PSB + KSB) were at par with each other with 12.66 number of leaves plant^{-1} but significant with T_1(Recommended dose of fertilizers (RDF) i.e NPK @ 100:50:30 kg/ha), T_6 (50%NPK+ 50% FYM) and T_8 (50% NPK + 50% SM (SM). Middling of like treatments also showed significant variation and followed the patterns of exhibited under folded leaves.

The data pertaining to head diameter, head length, head compactness (Z value) and head weight presented in table 5 revealed significant influence of various treatments applied. Treatment T_4 (VC @ 6.6t/ha + *AB* + PSB + KSB) recorded significantly maximum head diameter (6.50cm), head length (21.16cm), head compactness (1.89) and individual head weight (613.33g) which were at par with treatment T_5 (BDC @ 8.3 t/ha + *AB* + PSB + KSB) and T_3 (SM (SM) @ 16.6t/ha + *AB* + PSB + KSB). The minimum head diameter (3.40cm), head length (17.5), head compactness in terms of Z value (0.86) and individual head weight (275.00g) were noticed in treatment T_6 (50%NPK+ 50%FYM) followed by the treatment T_1 (Recommended dose of fertilizers (RDF).

Putting up the various treatments into four different sets revealed that full application of nutrients given through organic manures plus biofertilizers (T_2 – T_5) resulted in maximum plant height, dry weight, S/R ratio, folded leaves, head earliness (Fig. 1), fresh weight, head weight (Fig. 3), head length and diameter (Fig. 5), plant RGR, head compactness (Fig. 7) followed by the nutrients applied as half through inorganic fertilizers and half through organic manures plus biofertilizers (T_{10} – T_{13}) against the poor values of these attributes when half of the nutrients given through inorganic fertilizers and half through organic manures (T_6 – T_9).

Further, if we consider the source of organic nutrients (Fig 2, 4 and 6) it can be stated in general that VC resulted in maximum plant growth and head quality followed by BDC, SM and FYM.

Considerable increase in plant height, fresh weight as well as dry weight due to different organic manures over the use of inorganic form of nutrients has also been reported through earlier workers (Pant *et al.*, 2009; Rai *et al.*, 2013; Getnet and Raja, 2013; Joshi *et al.*, (2014); Eswaran and Mariselvi (2016); Islam *et al.*, (2017). The increased plant height and weight (fresh and dry) of Chinese cabbage due to organic sources of nutrients might have resulted from the increased rate of plant growth in terms of RGR (in the present study).

Table.1 Effect of different sources of nutrients and biofertilizers on plant height in Chinese cabbage cv. 'Solan Band Chinese Sarson'

Treatment combinations	Plant height (cm)			
	15 DAT	**30 DAT**	**45 DAT**	**60 DAT**
RDF (NPK @ 100:50:30 kg/ha) – T_1	9.66	14.90	20.57	25.00
FYM @ 20t/ha + *AB* + PSB + KSB – T_2	13.66	19.00	23.17	29.33
SM @ 16.6t/ha + *AB* + PSB + KSB – T_3	14.00	19.07	23.90	29.67
VC @ 6.6t/ha + *AB* + PSB + KSB – T_4	15.33	20.30	24.23	30.33
BDC @ 8.3 t/ha + *AB* + PSB + KSB – T_5	15.00	20.30	20.67	30.00
50%NPK+ 50%FYM – T_6	9.66	14.83	19.73	22.67
50% NPK + 50% VC – T_7	11.00	16.67	20.93	26.33
50% NPK + 50% SM – T_8	10.33	15.56	20.80	26.00
50% NPK + 50% BDC – T_9	10.66	16.33	20.83	26.00
50% NPK + 50% FYM + *AB* + PSB + KSB – T_{10}	11.66	17.90	21.73	26.33
50% NPK + 50% VC + *AB* + PSB + KSB – T_{11}	13.66	18.67	22.83	29.00
50% NPK + 50% SM + *AB* + PSB + KSB – T_{12}	12.00	18.67	21.73	27.00
50% NPK + 50% BDC + *AB* + PSB + KSB – T_{13}	12.66	18.67	22.83	27.00
CD ($p \leq 0.05$)	**2.071**	**1.79**	**1.94**	**3.58**

Table.2 Effect of different sources of nutrients and biofertilizers on fresh and dry weight in Chinese cabbage cv. 'Solan Band Chinese Sarson'

Treatment combinations	Fresh weight (g/plant) Days after transplanting				Dry weight (g/plant) Days after transplanting			
	15	**30**	**45**	**60**	**15**	**30**	**45**	**60**
RDF (NPK @ 100:50:30 kg/ha) – T_1	17.1	88.12	327.7	615.0	1.9	6.7	28.9	38.3
FYM @ 20t/ha + *AB* + PSB + KSB – T_2	29.6	147.1	553.3	940.0	3.2	12.5	37.5	55.3
SM @ 16.6t/ha + *AB* + PSB + KSB – T_3	31.0	155.7	559.7	943.3	4.0	12.6	41.2	62.4
VC @ 6.6t/ha + *AB* + PSB + KSB – T_4	36.2	220.8	570.7	1170.0	4.9	16.1	42.8	65.4
BDC @ 8.3 t/ha + *AB* + PSB + KSB – T_5	32.4	171.7	560.0	1146.7	4.6	13.2	42.3	64.4
50%NPK+ 50%FYM – T_6	16.9	85.1	184.3	578.3	1.9	5.9	27.1	31.6
50% NPK + 50% VC – T_7	19.8	98.6	410.0	645.0	2.1	8.6	30.5	49.4
50% NPK + 50% SM – T_8	18.5	91.8	374.0	628.3	2.0	7.5	29.3	43.3
50% NPK + 50% BDC – T_9	19.5	98.2	388.3	630.0	2.0	7.7	30.4	44.6
50% NPK + 50% FYM + *AB* + PSB + KSB – T_{10}	24.0	99.7	427.7	681.7	2.5	8.9	32.6	51.7
50% NPK + 50% VC + *AB* + PSB + KSB – T_{11}	29.4	130.5	525.0	851.7	2.9	11.9	37.3	53.5
50% NPK + 50% SM + *AB* + PSB + KSB – T_{12}	28.4	101.1	433.3	695.0	2.5	10.8	33.4	52.4
50% NPK + 50% BDC + *AB* + PSB + KSB – T_{13}	29.3	119.1	503.3	740.0	2.9	11.3	36.1	52.7
CD ($p \leq 0.05$)	**2.00**	**26.00**	**27.36**	**101.7**	**1.0**	**1.5**	**1.3**	**0.97**

Table.3 Effect of different sources of nutrients and biofertilizers on shoot dry weight to root dry weight (S/R) ratio of Chinese cabbage cv. 'Solan Band Chinese Sarson' at different days after transplanting (DAT)

Symbol	Treatment combination detail	Shoot dry weight to root dry weight ratio (S/R)			
		15 DAT	**30 DAT**	**45 DAT**	**60 DAT**
RDF (NPK @ 100:50:30 kg/ha) – T_1		18.61	13.35	12.52	10.96
FYM @ 20t/ha + *AB* + PSB + KSB – T_2		26.24	21.04	16.78	13.50
SM @ 16.6t/ha + *AB* + PSB + KSB – T_3		27.10	21.33	17.32	13.76
VC @ 6.6t/ha + *AB* + PSB + KSB – T_4		32.50	22.06	18.68	16.46
BDC @ 8.3 t/ha + *AB* + PSB + KSB – T_5		29.37	21.69	17.33	14.39
50%NPK+ 50%FYM – T_6		17.32	12.96	11.79	10.93
50% NPK + 50% VC – T_7		22.33	17.31	14.75	11.64
50% NPK + 50% SM – T_8		18.80	15.23	14.38	11.27
50% NPK + 50% BDC – T_9		21.51	16.54	14.66	11.37
50% NPK + 50% FYM + *AB* + PSB + KSB – T_{10}		22.60	18.29	15.62	12.34
50% NPK + 50% VC + *AB* + PSB + KSB – T_{11}		25.32	19.42	16.67	12.80
50% NPK + 50% SM + *AB* + PSB + KSB – T_{12}		24.46	18.37	15.97	12.59
50% NPK + 50% BDC + *AB* + PSB + KSB – T_{13}		24.85	18.48	16.65	12.65
CD ($p \leq 0.05$)		**1.11**	**0.59**	**0.77**	**0.39**

Table.4 Effect of different sources of nutrients and biofertilizers on plant RGR and folded versus unfolded leaves in Chinese cabbage cv. 'Solan Band Chinese Sarson'

Treatment combinations	RGR (g/g/day)		Head Initiation (day)	Leaves/ plant	
	0-30 DAT	**30-60 DAT**		**Folded**	**Unfloded**
RDF (NPK @ 100:50:30 kg/ha) – T_1	0.12	0.28	22.33	25.00	09.00
FYM @ 20t/ha + *AB* + PSB + KSB – T_2	0.89	0.64	19.66	29.33	13.00
SM @ 16.6t/ha + *AB* + PSB + KSB – T_3	0.93	0.65	19.66	29.67	13.00
VC @ 6.6t/ha + *AB* + PSB + KSB – T_4	0.97	0.74	19.33	31.33	13.33
BDC @ 8.3 t/ha + *AB* + PSB + KSB – T_5	0.94	0.72	19.66	30.00	13.00
50%NPK+ 50%FYM – T_6	0.10	0.30	23.00	22.67	09.00
50% NPK + 50% VC – T_7	0.74	0.54	21.66	26.33	10.33
50% NPK + 50% SM – T_8	0.54	0.60	21.66	26.00	09.33
50% NPK + 50% BDC – T_9	0.66	0.47	21.66	26.00	09.66
50% NPK + 50% FYM + *AB* + PSB + KSB – T_{10}	0.77	0.53	21.00	26.33	11.66
50% NPK + 50% VC + *AB* + PSB + KSB – T_{11}	0.84	0.45	20.00	29.00	12.66
50% NPK + 50% SM + *AB* + PSB + KSB – T_{12}	0.80	0.48	20.66	27.00	12.00
50% NPK + 50% BDC + *AB* + PSB + KSB – T_{13}	0.81	0.52	20.33	27.00	12.66
CD ($p \leq 0.05$)	**0.29**	**0.06**	**1.251**	**3.58**	**2.92**

Table.5 Effect of different sources of nutrients and biofertilizers on head physical quality in Chinese cabbage cv. 'Solan Band Chinese Sarson'

Treatment	Physical Quality of Head			
	Diameter (cm)	Length (cm)	Weight (g/head)	Z value
RDF (NPK @ 100:50:30 kg/ha) – T_1	4.63	17.83	323.33	0.90
FYM @ 20t/ha + *AB* + PSB + KSB – T_2	5.46	19.00	470.00	1.51
SM @ 16.6t/ha + *AB* + PSB + KSB – T_3	5.63	19.33	505.00	1.53
VC @ 6.6t/ha + *AB* + PSB + KSB – T_4	6.50	21.16	613.33	1.89
BDC @ 8.3 t/ha + *AB* + PSB + KSB – T_5	5.83	20.33	598.33	1.78
50%NPK+ 50%FYM – T_6	3.40	17.50	275.00	0.86
50% NPK + 50% VC – T_7	5.20	18.16	371.66	1.08
50% NPK + 50% SM – T_8	4.66	18.00	358.33	0.94
50% NPK + 50% BDC – T_9	4.83	18.00	363.33	1.01
50% NPK + 50% FYM + *AB* + PSB + KSB – T_{10}	5.20	18.16	391.66	1.16
50% NPK + 50% VC + *AB* + PSB + KSB – T_{11}	5.33	18.16	440.00	1.23
50% NPK + 50% SM + *AB* + PSB + KSB – T_{12}	5.23	18.33	395.00	1.16
50% NPK + 50% BDC + *AB* + PSB + KSB – T_{13}	5.26	18.66	398.33	1.23
CD ($p \leq 0.05$)	**0.96**	**1.31**	**47.79**	**0.11**

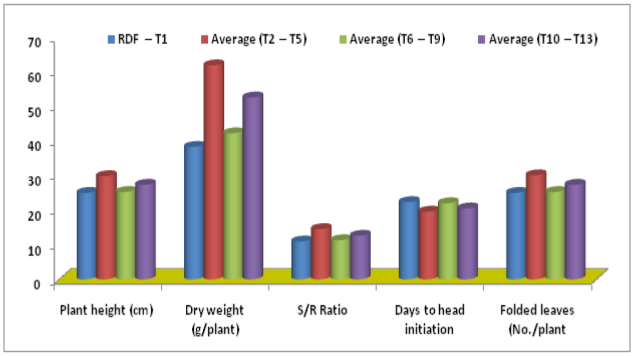

Fig.1 Effect of different set of organic amendments on plant growth and head formation in Chinese cabbage

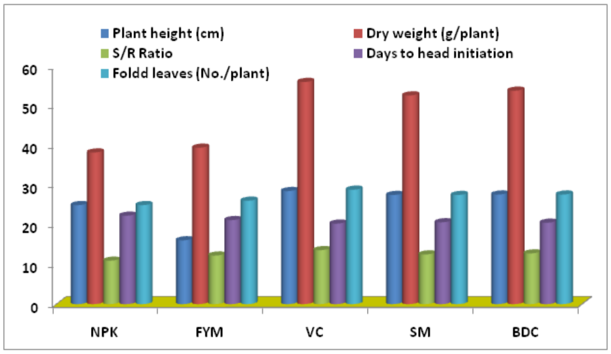

Fig.2 Effect of individual organic supplements on plant growth and head formation in Chinese cabbage

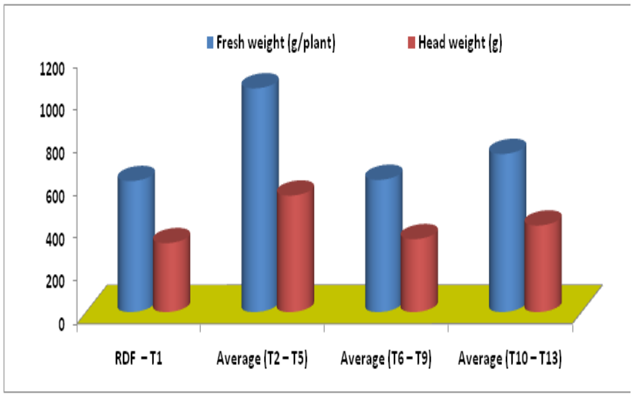

Fig.3 Effect of different set of organic amendments on fresh plant as well as head weight in Chinese cabbage

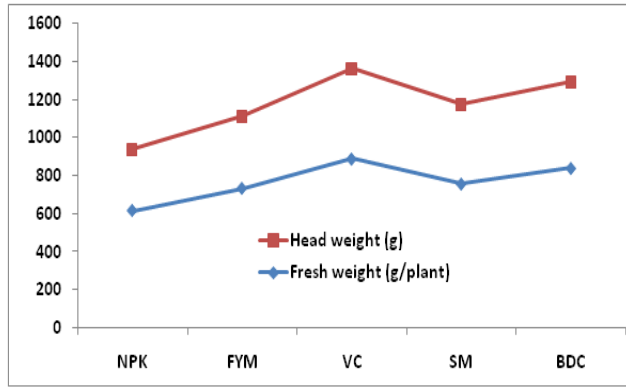

Fig.4 Effect of individual organic supplements on plant head fresh weight in Chinese cabbage

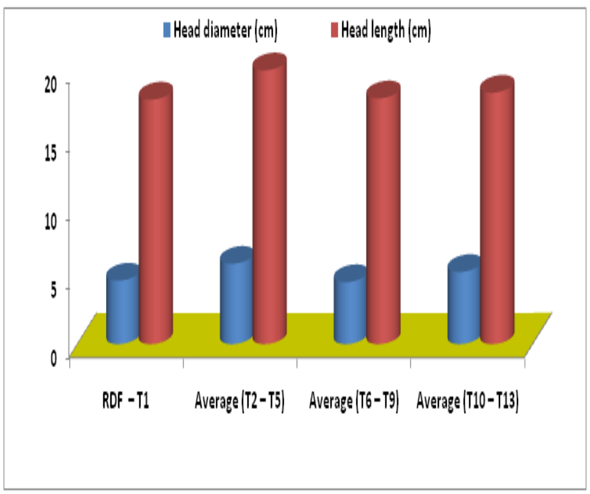

Fig.5 Effect of different set of organic amendments on head size (diameter and length) in Chinese cabbage

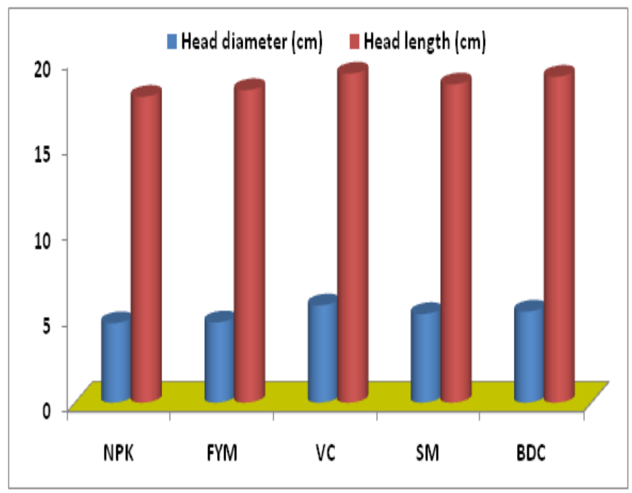

Fig.6 Effect of individual organic supplements on head diameter and length in Chinese cabbage

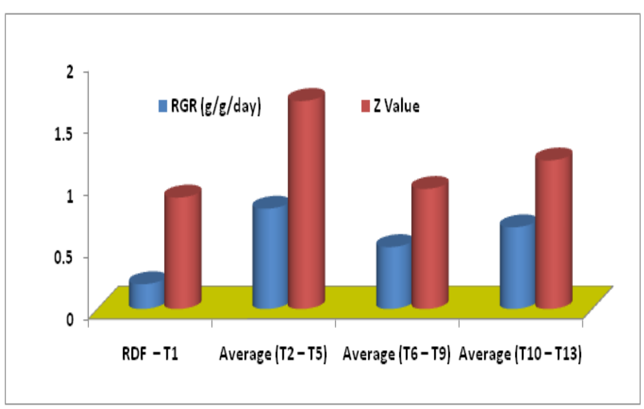

Fig.7 Effect of different set of organic amendments on plant RGR and head compactness in Chinese cabbage

The highest increase in plant growth of Chinese cabbage under VC treatment may be attributed to its ability to increase nutrient availability through mineralization and humification (Albanell *et al.*, 1988), improve soil health (Edwards and Burrows 1988) and availability of various microbiota particularly fungi, bacteria and actinomycetes which makes it suitable for plant growth (Tomati *et al.*, 1987). Further, increase in plant growth due to addition of biofertilizers namely PSB and KSB is obvious due to increased availability of major nutrients. Improved S/R ratio indicates that organic source of nutrients especially, VC has encouraged both root and shoot growth but shoot growth was more responsive than root growth. Our results corroborates with previous works (Xu and Mou, 2016). Kollar *et al.*, (1970) reported that an increase in RGR was the result of greater demand for assimilated in rapidly growing crop. Superiority of VC followed by FYM for accelerating the growth rate in terms of RGR has also been fixed by Sallaku *et al.*, (2009). In line with results regarding days taken to head initiation earlier workers also reported that high fertility levels and organic manure favors an early head initiation and maturity in cabbage (Wolde, 2015).

So far as head quality and yield in terms of length, breadth, compactness and weight is concerned our results confirm the reports notified by earlier workers (Haque *et al.*, 2015). In line with our results regarding superiority of VC, Chatterjee *et al.*, (2012) also found that VC was better source of nutrient than FYM. Greater head size and weight with the application of VC might be due to the supply of all essential nutrients and soil porosity as compared to other organic manures which provided favorable environment to

Finally, in light of the findings of the present study it may be concluded that recommended doses of nutrients (NPK @ 100:50:30 kg/ha) vermicompost along with biofertilizers (*Azotobacter* + PSB + KSB) should be applied on nitrogen equivalent basis to promote the plant growth and get the better head yield in Chinese cabbage.

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