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RESPONSE OF FARMYARD MANURE AND INORGANIC NITROGEN ON VEGETATIVE GROWTH, LEAF YIELD AND QUALITY OF KALE (*BRASSICA OLERACEA*VAR*ACEPHALA*) IN TEMPERATE REGION OF KASHMIR VALLEY

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ABSTRACT

A study was carried out with objectives of determining the effect of various levels of FYM and inorganic nitrogen on vegetative growth, yield and quality (total carotenoids, vitamin C and nitrate concentration) of kale in temperate region of Kashmir valley during 2010 and 2011.The experimental layout was a randomized complete block design with three replications. The treatments were four levels of FYM (0, 15, 30 and 45 t ha^{-1}) and four levels of inorganic nitrogen (0, 45, 90 and 135 kg ha^{-1}). The addition of various rates of FYM and inorganic nitrogen that were tested significantly improved vegetative growth and increased leaf yield of kale. The yield obtained from plant grown with inorganic nitrogen was generally higher than from those with FYM. The incorporation of either FYM or inorganic nitrogen increased total carotenoids during both the years. The Farm Yard Manure at high levels (45 t ha^{-1}) increased vitamin C while as application of Inorganic Nitrogen at 0 to 135 kg ha^{-1}decreased vitamin C content during both the years. Results revealed that Farm Yard Manure application produced quality vegetables in terms of low nitrate concentration as compared to inorganic nitrogen.

Key words: Kale, Farmyard manure, Inorganic nitrogen, Yield ,Growth, Quality
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INTRODUCTION

Kale (*Brassica oleracea* var. *acephala*) is a temperate vegetable which is grown for its tender leaf. It is often called "borecoles" which is taken from Dutch 'Borenkool'. It can withstand drought and temperature of -10 to -15^{o}C. It is highly nutritious vegetable, rich in vitamins, particularly vitamin C and provitamin A and minerals (Fadigas*et al*. 2010). Nowadays, kale attracted more attention due to its multifarious use and great nutritional value (Ahmad and Beigh, 2009).

In India, it is commercially grown in Kashmir and to a limited extent in Jammu regions, Assam and Himachal Pradesh.In Jammu and Kashmir, it is popular vegetable grown in almost all kitchen garden and also commercial crop around cities and towns. Its cultivation has picked up around metropolitan cities due to increased demand in hotels. Kale has a high nitrogen (N) requirement, so good nitrogen availability sustainable is a pre-requiste for economic yield. However, too much nitrogen can create problem. Plant supplied with an excess of nitrogen accumulate nitrate in their

vacuoles (Onyango*et al*., 2012). The nitrate content of plants increased with the increasing N application, but they found that the foliar nitrate content was lower when the plants were fertilized with manure than with mineral nitrogen. This study was therefore designed to evaluate the effect of FYM and inorganic nitrogen on vegetative growth, yield and quality (total carotenoids, vitamin C and nitrate concentration) of kale in temperate region of Kashmir valley.

MATERIALS AND METHODS

Field experiment was carried out at the experimental farm of Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar main campus.The study site lies on an altitude of 1587m above seas level and is within latitude 340°.8' N and longitude 74°83'E. The site receives an average rainfall of 812 mm per year. The mean monthly maximum temperature was 21.81°C and 21.40°Cand minimum temperature are 6.14°C and 7.53°C respectively, during the cropping season of 2010 and 2011.

The seeds were first placed in a seedbed for 4 weeks before transplanting. Seedlings were planted at a spacing of 30x15cm on slightly raised beds.The experimental layout was a randomized complete block design with 3 replicates. The treatments were four levels of FYM (0, 15,30and 45tons/ha) and four rates of inorganic nitrogen (0, 45, 90 and 135 kg/ha). The FYM was applied two week before planting as per treatments.Full quantity of P and K applied uniformly to plots as per package of practice and half dose of N applied to each plot as per treatment. Remaining dose of N was applied after 30 days of transplanting.

The fields were manually maintained weed-free. Harvesting of kale leaves was at once after planting while samples for analysis of qualityattributes were taken at harvest stage. Total carotenoids, Vitamin C and nitrates were determined using methods outlined inArnon (1949), AOAC (1984) and AOAC (1980) for vitamins and nitrates, respectively. The experimental data were analyzed statistically by using analysis of variance technique as discussed by Gomez and Gomez (1984).

RESULTS AND DISCUSSIONS

Vegetative growth:

Incorporation of various concentrations of FYM and inorganic N fertilizer, significantly improved the vegetative attributes of plant height, plant spread and number of leaves per plant (Table 1).The above attributes improved with increasing levels of FYM and inorganic N incorporated into the soils, with inorganic nitrogen being generally

Table 1. Effect of FYM and inorganic nitrogen on growth parameters of and yield of kale during 2010 and 2011

FYM Levels	Plant Height (cm)		Plant Spread(cm)		No of leaves /plant		Leaf yield (q ha^{-1})	
	2010	**2011**	**2010**	**2011**	**2010**	**2011**	**2010**	**2011**
F_0	41.03	42.09	48.65	49.02	11.38	11.22	433.38	431.81
F_{15}	43.98	44.40	50.82	52.06	12.42	12.53	486.14	491.29
F_{30}	45.98	46.93	53.57	54.51	13.34	13.50	522.67	532.77
F_{45}	47.30	48.02	55.13	56.19	13.78	13.96	552.42	562.46
CD(p≤0.05)	**0.57**	**0.63**	**0.80**	**0.85**	**0.43**	**0.44**	**12.56**	**13.01**
Inorganic N levels								
	2010	**2011**	**2010**	**2011**	**2010**	**2011**	**2010**	**2011**
N_0	37.79	38.15	41.99	42.89	9.71	9.76	379.19	376.30
N_{45}	43.85	44.84	51.88	52.69	12.59	12.73	490.37	495.50
N_{90}	47.41	48.26	56.27	57.20	13.95	13.99	548.18	556.42
N_{135}	49.25	50.19	58.03	58.98	14.67	14.73	576.86	589.72
CD(p≤0.05)	**0.57**	**0.63**	**0.80**	**0.85**	**0.43**	**0.44**	**12.56**	**13.01**

Figure-1. Effect of FYM and inorganic nitrogen on total carotenoids (mg/100g) during 2010 and 2011 of kale

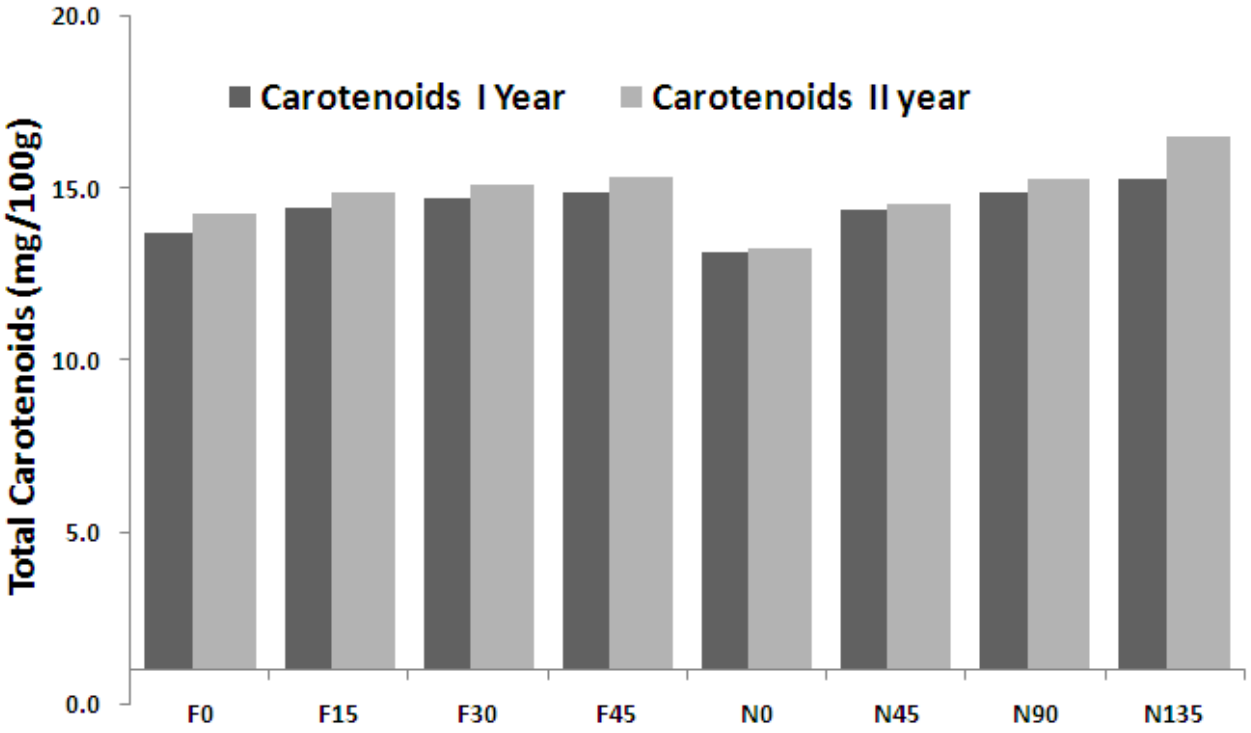
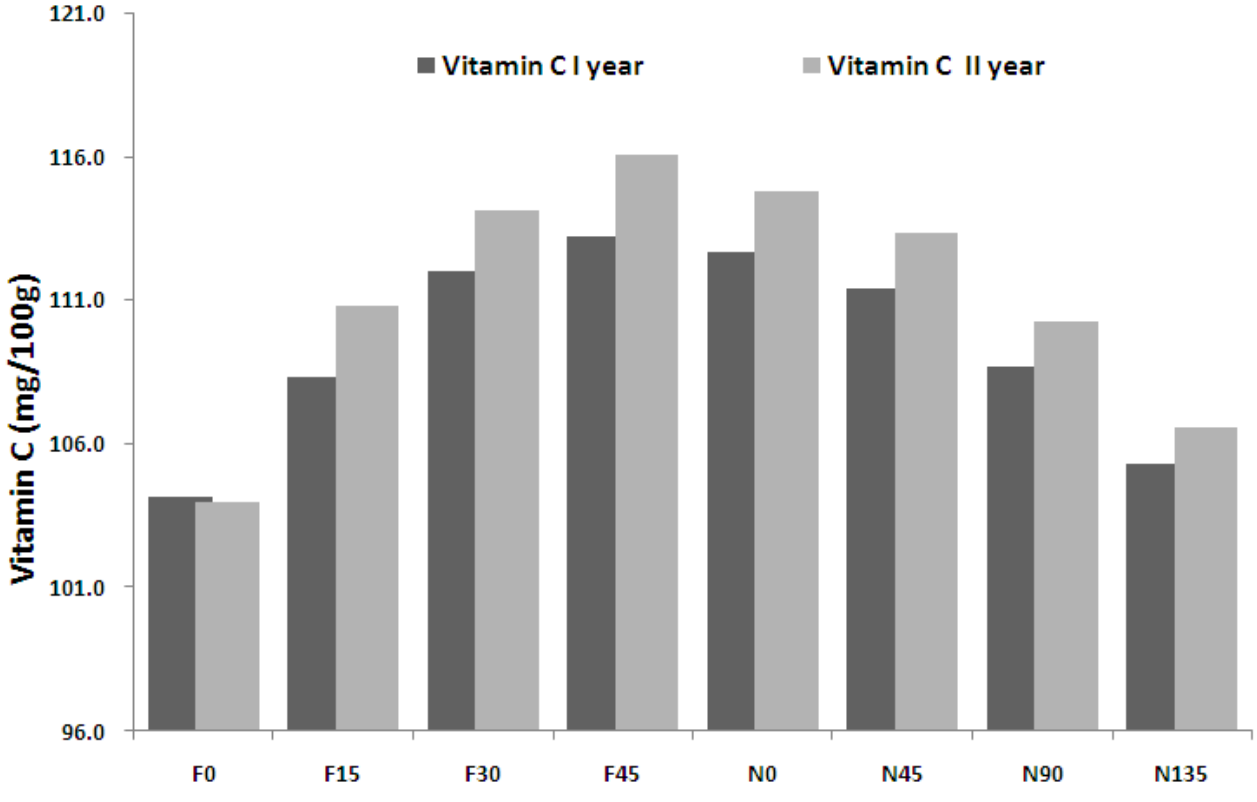


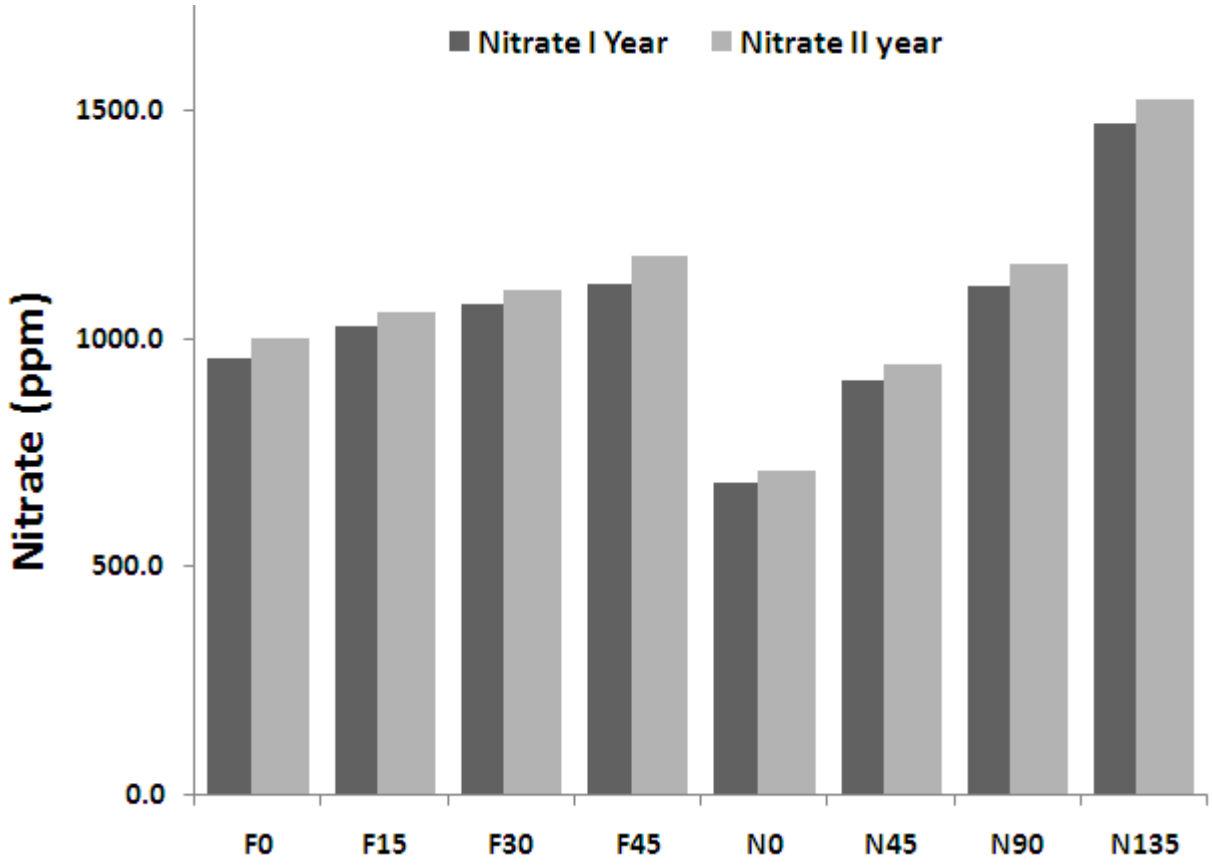
Figure-2. Effect of FYM and inorganic nitrogen on Vitamin C (mg/100g) during 2010 and 2011 of kale



Total carotenoids.:
Total carotenoids was significantly influenced by the kind and rate of fertilizer applied (Figure 1). The incorporation of either organic or inorganic fertilizer increased Vitamin A content during both years.The content of total carotenoids increased significantly with increasing levels of FYM and inorganic nitrogen (Figure 1).Increased carotenoid content could be assigned to elevation in the content and activity of chlorophyll and associated light absorbing pigments (including carotenoids) following the application of FYM. Similar results were also reported byDufault (1987). Application of Inorganic Nitrogen has been reported to improve carotene content in other crops such as *solanumnigrum* in Kabeta, central Kenya (Murage,1989) and cabbage (Nillson,1979). Nitrogen facilitates formation of chloroplasts which are rich in carotenoids (Salisbury and Ross, 1991).

Vitamin C:
Increasing levels of FYM significantly increased while inorganic nitrogen decreased vitamin C content during both the years (Figure 2). The maximum Vitamin C was recorded with the application of 45 t FYM /ha and minimum was recorded with the application of 135 kg N/ha.Increasing levels of Farm Yard Manure and Inorganic Nitrogen had a varied effect on vitamin C content of kale (Figure 2). Farm Yard Manure significantly increased, while Inorganic nitrogen tended to decrease vitamin C content. This may be due to the fact that the greater amount of K present in FYM and higher levels of carbohydrates favored greater synthesis of ascorbic acid ((Salisbury and Ross, 1991).Application of nitrogen has been reported to decrease Vitamin C content results from the increase in protein production and decreased carbohydrate formation since vitamin C production is tightly linked to carbohydrate metabolism (Babik and Elkner, 2002 and Musa *et al*. 2010).

Figure 3 Effect of FYM and inorganic nitrogen on Nitrate content (ppm) during 2010 and 2011 of kale



Nitrate content:

Increments in the FYM and inorganic nitrogen increased the nitrate content of kale (Figure 3).Nitrate content in kale statistically increased with increasing doses of FYM and inorganic nitrogen application according to the statistical results. The highest nitrate content on fresh weight in kale for FYM and inorganic nitrogen were obtained as 1121.21 and 1181.7 (mg/kg)and 1474.16 and 1526.76mg /kg) during both the yearsrespectively, in the highest FYM level 45 t /ha and inorganic nitrogen 135 kg N / ha.Data presented in Figure 3 reported that nitrate content significantly increased with increasing levels of Farm Yard Manure and also increased with application of Inorganic Nitrogen at the rate of 135 kg ha^{-1} as compared to control. Increasing the available nitrogen in the soil by increasing the percentage of mineral N in fertilization led to a clear increase in nitrate accumulation in the plants. Nitrate content in the plots treated with 45 t FYM ha^{-1}decreased by 31percent compared to 135 kg N ha^{-1}. This was attributed to the supply of readily available nitrate from mineral N to the plants while, in the FYM treated plots, nitrate release was comparatively low (Esawy Mahmoud *et al*. 2009). The nitrate concentration increased with Inorganic nitrogen. Similar finding was obtained by Anga (2001) who found that nitrateconcentration in spinach leaves increased with biofertilizer and N fertilizer combinations. Williams (2002) reported lower nitrate content in organically fertilized crops, particularly leafy vegetables, and Vogtmann*et al*. (1993) showed lower nitrate concentration in cabbage with organic fertilization compared with mineral fertilized crops. The results are in consonance with that of Hammad*et al*. (2007); Mirjana*et al*. (2009) and Musa*et al*. (2010).

CONCLUSION

In summary, increasing nitrogen levels was more effective than FYM in increasing the vegetative growth, yield, carotenoids and the accumulation of nitrate in kale. With the application of FYM, quality of kale was improved which was indicated by higher concentration of vitamin C and lower accumulation of nitrate.

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