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Response of nutrient and cutting management for quality and green yield of Palak (*Beta vulgaris* var. *bengalensis*)

P. K. NAYAK AND S. MAJI

Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow - 226025, Uttar Pradesh

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ABSTRACT

The present experiment was carried out to minimize the cost of production of Palak by more number of cuttings instead of repeated sowing and to get more yield from same piece of land during a short period of time. Different sources of nutrient Viz., Urea, Vermi-compost, FYM and Kitchen waste manure) were applied for feeding the crops after each cuttings viz., single, twice and thrice). The results from this experiment revealed that the two times cutting is beneficial for taking more yield as three times cutting showed a decrease in leaf yield and quality although, produced more number of leaves. Among the various sources of manuring vermicompost application was found to be the best for enhancing gworth, yield and quality of palak leves followed by kitchen waste manure prepared from composting of waste materials of kitchen which are mostly organic. Thus, repeated two times cutting in combination with vermicompost manuring may be suggested for getting more quality yield of palak from same land area without repeated sowing.

***Keywords*:** Green yield, manuring, multiple cutting, palak

According to Indian Council of Medical Research, New Delhi leafy vegetables 125 g, root vegetables 100 g and other vegetables 75 g are required per day per person for balance diet (Rao, 2013). Leafy vegetables are very important having good amount of iron, carotene, calcium, vitamin A, C, riboflavin and folic acid (Mohan ram and Ramadasmurty, 1984) and grown as potherbs, green vegetables, leafy green in short duration. High productivity of large green leaves with succulent stem almost throughout the year make it highly remunerative to the vegetable growers. Among the leafy vegetables, spinach beet (*Beta vulgaris* var. *bengalensis* L.) also known as Indian spinach, garden beet, Palongpalang, sag and Palak is one of the most commonly found leafy vegetables grown in India. It belongs to chenopodiaecae family. Spinach beet is most probably a native of Indo-Chinese regions (Salaria and Salaria, 2009) and was known in China as early as 647 AD. Spinach beet is one of the most common leafy vegetables of tropical and sub-tropical regions. The popular growing states in India are Uttar Pradesh, West Bengal, Rajasthan, Haryana, Punjab, Delhi, Madhya Pradesh and Bihar. It is rich in minerals and hence called as "Mines of Minerals" and cheap source of iron, vitamin A, calcium, protein, vitamin K, vitamin E, vitamin D, vitamin C, folic acid, thiamine, riboflavin, nicotinic acid, pyridoxine, antioxidants as carotene, flavones, indoles and Isothiocyanates, essential amino acid etc (Thamburaj and Singh, 2015) along with iron, potassium, manganese, magnesium, copper and zinc which are important components of cell and body fluids to control heart and blood pressure, antioxidant enzyme, superoxide dismutase, for production of red blood cell, sperm generation, digestion and nucleic acid synthesis. It has also some health benefits like age related mascular degeneration, neurological benefits, strengthen muscles, helps in bone mineralization, reduce risk of cataracts and is anti-ulcerative with anti-cancer properties.

The yield of Indian spinach beet depends on vegetative growth like number of leaves per plant, size of leaves and plant height *etc*. It produces profusely many leaves during a short time in mild weather of spring and rainy season. Nitrogen compound is essential nutrient for the vegetative growth of the plant resulting higher green leaf yield. But, it cannot be stored for long time. The present work aimed at to produce leaves in longer duration with repeated cutting and application of nitrogen in various form of nutrient sources, so that, it can be made available for a longer time in the market and farmers can get repeated crop yield from same crop area without repeated sowing which helps to get more profit.

MATERIALS AND METHODS

The present experiment was carried out during November 2016 to April 2017 at Horticulture Research Farm, Babasaheb Bhimrao Ambedkar University (A Central University), Vidya-Vihar, Rae Barely Road, Lucknow, U.P., India which is situated at an elevation of 123 meter above Mean Sea Level (MSL) in Central Uttar Pradesh at 26^0 55′ North latitude and 80^0 59′ East longitudes. The climate of this region is Sub-tropical with maximum temperature ranging from 22- 40^0C in summer, minimum temperature ranging from 5.5-23.5^{0}C in winter and relative humidity ranging from 70-95% in

Email: majisutanu@gmail.com

different season of the year. The soil is sandy loam and slightly alkaline in nature (pH 8.2). There were 20 treatment combinations with four different source of nutrients (Urea, Vermicompost, FYM and Kitchen waste manure) and three cuttings (single at 35days, double at 35 and 55 days and triple at 35, 55 and 75 days after sowing) replicated thrice and laid out in two factors RBD design [Factor1 (M)- Urea, Vermicopost, FYM and Kitchen manure; Factor 2 (C)- single at 35days, double at 35 and 55 days and triple at 35, 55 and 75 days after sowing]. The palak seeds (var. All Green) were sown directly on plots (1 x 1.2 m) at 30 x 5 cm line spacing. Kitchen waste manure was prepared from kitchen waste materials after decomposing properly. The observations were statistically analyzed as per two factors RBD as stated by Sahu and Das (2014).

RESULTS AND DISCUSSION

The maximum plant height (Table 1) was recorded in the treatment (M_2) –vermicompost application and two times cutting (C_2). But, after second cutting plant height reduced due to lesser moisture, less nutrient uptake and increase of temperature. The response of kitchen waste manure application was also very close to vermicompost application. The combined treatment of vermicompost and two times cutting (M_2C_2) showed the maximum plant height (24.95cm) among the all treatment combinations. Similar result was also found by Dadiga *et al*. (2015), Bharad *et al*. (2013) and Baharvand *et al*. (2014) during the experiment on coriander and Indian spinach, with use of vermicompost, FYM and compost mixtures. They reported that use of vermicompost along with RDF 50 kg ha^{-1} increased vegetative growth of palak and coriander because vermicompost is rich in plant growth factors and B group vitamins which enhance crop growth.

Similarly, the maximum number of leaves of palak per plant (44.130) under the treatment vermicompost (M_2) + three time of cutting (C_3) was observed due to reason that in C_3 number of cuttings were three, therefore, in three cutting the number of leaves will increase because of addition of number of leaves for each cutting. The result corroborated with the findings of Naik *et al*. (2010) when experimented on spinach beet with use of vermicompost and compost mixtures might be due to availability of more nutrients and moisture as compost increases moisture holding capacity of soil and make soil porous.

The length of leaves was also observed maximum (13.11 cm) under the treatment (M_2) vermicompost + two time cutting (C_2). But, after second cutting length of leaves per plant reduced due to minimum moisture and increase of temperature. Treatment (M_2) -vermicompost and two time cutting (C_2) also showed the highest length of petiole. But, it showed a decreasing trend after second cutting due to shortage of moisture and increase of temperature. However, Dange *et al*. (2011) reported that poultry manure along with 50% RDF gave the best result of growth in terms of plant height, number of leaf area and length of petiole at all stages of growth. After second cutting width of leaves also reduced at third cuttings but, maximum width of leaves (8.35 cm) was recorded under vermicompost application (M_2) and two times cutting (C_2). Moisture content in leaves was calculated and it was found maximum under treatment vermicompost (M_2) application and two times cutting (C_2).

The fresh leaf yield as well as total crop yield (whole plant) $plot^{-1}$ was determined and it was found that two times cutting (C_2) gave maximum green leaf yield (1170.00 g $plot^{-1}$) along with treatment combination vermicompost application (M_2). Although, the number of leaves was maximum under three times cutting. It was also seen that the kitchen waste manure and FYM had similar yield response close to maximum yield as also found by Tiwari *et al*. (2016, 2017) and Kiran *et al*. (2017) in case of broccoli by waste compost application. Similar result was also found by Sarkar *et al*. (2014) and Rajender *et al*. (2013) while experimenting on spinach with use of organic manure mixture and found vermicompost as stimulant for higher yield.

The maximum root length was found under treatment M_2 (vermicompost) and three time cutting (C_3). It might be due to the fact that it the plants under C_3 grown for long time and therefore, root length automatically was higher. However, increase of root length with application of vermicompost, FYM and kitchen waste manure was also found by Singh *et al*. (2015) in spinach beet.

The maximum ascorbic acid content (70.78 mg 100 g^{-1}) in leaves was recorded under the treatment (M_2) vermicompost along with two time cutting (C_2). But, after second cutting the moisture content reduced due to minimum nutrient uptake and high temperature. Bharad *et al*. (2013), Sharma and Agarwal (2014) also found similar result when they experimented on spinach beet, with use of vermicompost, urea and other organic manure mixtures. The reported that the FYM and vermicompost along with 10 and 3 t ha^{-1} increased moisture content.

However, maximum chlorophyll content was reported under the treatment urea application (M_1) and first cutting (C_1) followed by vermicompost application and it might be due to residual effect of nitrogen supplied through urea which helps in formation of chlorophyll. Bharad *et al*. (2013) and Padmanabha *et al*. (2002) also reported that the FYM and vermicompost along with urea increased chlorophyll content.

Table 1: Effect of manuring and multiple cutting on growth of palak

Treatment	Height of plant (cm)					Number of leaves per plant					Length of leaves (cm)				
	Number of cutting					Number of cutting					Number of cutting				
Manure	**C_0**	**C_1**	**C_2**	**C_3**	**Mean**	**C_0**	**C_1**	**C_2**	**C_3**	**Mean**	**C_0**	**C_1**	**C_2**	**C_3**	**Mean**
M_0–No manuring	13.70	13.87	22.87	19.58	17.50	9.807	10.257	20.783	38.38	19.803	7.32	7.91	10.35	4.32	7.48
M_1 - Urea	14.12	14.38	23.69	20.08	18.07	10.817	10.490	23.363	42.443	21.778	8.04	7.05	11.46	5.65	8.05
M_2- Vermicompost	14.96	15.06	24.95	22.02	19.24	12.450	12.377	25.247	44.130	23.557	8.29	9.16	13.11	6.03	9.15
M_3 – FYM	15.00	15.12	24.26	20.24	18.90	11.783	11.010	24.677	42.860	22.583	7.74	8.07	12.76	5.08	8.41
M_4– Kitchen waste manure	13.69	13.96	24.23	20.24	18.03	11.493	11.133	23.447	42.017	22.023	7.81	8.22	11.81	5.51	8.34
Mean	14.29	14.48	24.00	20.63		11.270	11.353	23.503	41.963		7.84	8.08	11.90	5.34	
	M	C	M x C	M	C	M x C	M	C	C X M						
SEm (±)	**0.262**	**0.234**	**0.524**	**0.428**	**0.383**	**0.855**	**0.235**	**0.210**	**0.469**						
LSD (0.05)	**0.753**	**0.674**	**1.54**	**1.229**	**1.099**	**NS**	**0.674**	**0.603**	**1.342**						

Table 2: Effect of manuring and multiple cutting on leaf length, width and moisture content in leaves

Treatment	Length of petiole (cm)					Width of leaves (cm)					Moisture content (%)				
	Number of cutting					Number of cutting					Number of cutting				
Manure	**C_0**	**C_1**	**C_2**	**C_3**	**Mean**	**C_0**	**C_1**	**C_2**	**C_3**	**Mean**	**C_0**	**C_1**	**C_2**	**C_3**	**Mean**
M_0–No manuring	4.86	5.66	8.76	3.46	5.68	3.99	4.10	5.69	3.22	4.25	80.93	81.50	81.70	79.29	80.85
M_1 – Urea	5.71	6.22	9.81	4.16	6.48	4.35	4.50	7.03	4.20	5.02	83.17	83.39	85.06	84.29	83.98
M_2- Vermicompost	5.58	6.34	11.06	4.80	6.94	5.04	5.07	8.35	5.10	5.89	81.59	85.19	86.29	86.03	84.77
M_3 – FYM	5.32	5.90	9.72	3.81	6.82	4.56	4.57	6.86	3.36	4.84	83.54	80.29	81.89	84.94	82.65
M_4– Kitchen waste manure	5.96	6.84	10.21	9.91	4.10	4.89	4.99	7.89	4.64	5.60	81.96	83.45	85.52	85.19	84.03
Mean	5.49	6.19	9.91	4.10		4.57	4.65	7.16	4.10		82.24	82.76	84.09	83.94	
	M	C	M x C	M	C	M x C	M	C	M x C						
SEm (±)	**0.125**	**0.112**	**0.250**	**0.103**	**0.092**	**0.206**	**0.563**	**0.504**	**1.126**						
LSD (0.05)	**0.359**	**0.321**	**0.890**	**0.297**	**0.265**	**0.593**	**1.618**	**1.448**	**NS**						

NS- Non significant

Similarly, the highest carotenoides content was analyzed under the treatment (M_2) and first cutting (C_1) which was supported by the works of Sharma and Agarwal (2014) while experimented on spinach with use of FYM, vermicompost and vermiculture + cattle dung.

In general, vermicompost increased the vegetative growth, yield and quality of palak. Maji and Das (2008) also mentioned the superior effect of vermicompost due to its beneficial effect of organisms which are brought about by mucun deposit of epidermal cell and coelomic cell of earth worm rich in plant growth factors and B group vitamins (Bano *et al*., 1987).

The study revealed that multiple cutting of leaves is beneficial for increasing leaf yield for the farmers. It was also observed that fertilization after each cutting is also important to regenerate leaf growth. Among the various nutrient sources, vermicompost application and two time cuttings are found to be the best for getting higher green leaf yield and superior quality of palak grown in slightly alkaline soil at Lucknow agro-climatic subtropical areas.

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