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Effect of organic manures and number of cuttings on growth, yield and quality of Indian spinach

Ankita Gautam and RB Ram

Abstract
The present study was aimed to study on influence of organic manures and number of cuttings on growth and yield of Indian spinach. The field experiment was conducted during 2020-22 with 15 different treatment combinations at College of Horticulture, Dr. Bhim Rao Ambedkar Central University, Lucknow (U.P) INDIA. The experiment was field in Factorial Randomized Block Design with 15 treatment combinations replicated four times. The treatments comprised of the five levels i.*e.* four different organic sources of plant nutrients and RDF (50 kg N ha^{-1} through urea) and three cuttings. The green leaf yield of Indian spinach from different treatment combinations was studied for yield and different quality attributes. The result revealed that growth in term of number of leaves, plant height, leaf area, leaf yield and leaf quality were significantly influenced by the application of different sources of nutrients and number of cuttings. The growth performance in respect of plant height, numbers of leaves and leaf area were found to be maximum in 50 kg N ha^{-1} through urea but which was found to be at par with sheep and goat manure. While in respect of cutting the plant height and leaf area showed a decreasing trend with increase in cutting frequencies at all the stages of observation. Yield parameters like number of leaves, leaf yield q/ha were recorded highest 50 kg N ha^{-1} applied in the form of urea with three levels of cutting. The quality parameters leaf chlorophyll content, leaf moisture and leaf ascorbic acid content were also recorded highest in one cutting an 50 kg N ha^{-1} applied through urea.

Keywords: Indian spinach, organic manures, cuttings

Introduction
Indian spinach leaves are valued for their medicinal properties and are used in inflammation, paralysis, headache and remedy for diseases of spleen and liver, It also act as mild lacerative besides other medicinal value, it supply most of the nutrients in which other foods are deficient. Indian spinach is used as fresh vegetable for cooking and alto in salad form. Indian spinach is cultivated for its fresh and green leaves ready to harvest in about 40-45 days after sowing (Mishra *et al*., 1973) [2].

Indian spinach *(Beta vulgaris.* L) is one of the major leafy vegetable grown and consumed in India. It is native of indo-Chinese region. It was known in China as early as 647AD (Nath, 1976). In India this leafy vegetable commonly known as palak and it is popular due to its high nutritive value belongs to genus *Beta*, species *vulgaris* and family chenopodiaceae with Chromosome number 2n=l8 (Purohit, 1968) [9].

The yield of Indian spinach depends on vegetative growth it may expressed in terms of number of leaves per plant, size of leaf and plant height etc. For obtaining more vegetative growth cutting of crop is important due to cutting of crop side shoots are arises which increases the number of leaves per plant and ultimately increased the yield which demands higher amount of nutrients from the soils and nutrients applied through the organic sources *viz*., FYM, poultry manure, vermicompost, sheep and goat manure contains nutrients in form that are readily taken up by the plants such as nitrates, exchangeable phosphorus, and soluble potassium, calcium, and magnesium. The water soluble components of vermicompost such as humic acid, growth regulators, vitamins and micronutrients increases the availability of plant nutrients resulting in increased growth, higher yield and better quality produce. In addition to this it also plays vitalrole as organic nutrient sources for sustainable soil health and crop growth.

However, information on nutrient management through different organic sources and their interactions with cuttings on leaf yield and quality aspects of Indian spinach is still meagre. Keeping this view, the work was undertaken to study the effect of different combination of nutrient sources and number of cuttings on growth and yield of Indian spinach.

Research Methods

The experiment was conducted at College of Horticulture, Dr. Bhim Rao Ambedkar Central University, Lucknow (U.P) INDIA during 2020-21. The experiment was conducted in Factorial Randomized Block Design with 15 treatment combinations and replicated four times. The treatments included five levels of organic manures *viz*., M_1 - RDF N (50 kg ha^{-1}), M2 - FYM (10 ton ha^{-1}), M_3 - Poultry manure (3 ton ha^{-1}), M4 - Vermicompost (3 ton ha^{-1}) and M_5 - Sheep and goat manure (1.6 ton ha^{-1}) and three cuttings *viz*., C_1 - One cutting (up rooted at 40 DAS), C2 - Two cutting (cut at 40 DAS and up rooted 15 days after one cutting) and C_3 - Three cutting (cut at 40 DAS, 55 DAS and up rooted 15 days after two cutting).

The seeds of variety 'All Green' were sown in row (line sowing) at 30 cm apart on medium black soil which was free from weeds and disease infection. The observations were recorded on growth, yield and quality parameters vfr., plant height, number of leaves per plant, Leaf area, leaf petiole ratio, fresh green leaf yield, leaf chlorophyll content, leaf moisture and leaf ascorbic acid content.

Research Findings and Discussion

Data presented in Table 1 clearly indicate that, the maximum plant height (38.05 cm) was recorded under the treatment M_1 (urea) which was found at par with M_5 (36.62 cm) followed by the treatment M2 (35.28 cm) whereas, minimum plant height (32.91 cm) was recorded in the treatment M_4.

The maximum plant height was observed in the treatment M_1 (Urea) which might be due to the quick availability of nutrients, especially nitrogen, the chief constituent of protein, essential for formation of protoplasm which leads to cell division and cell enlargement. The above result is in conformity with Kaswan *et al.* (1995) [4] in fenugreek.

In respect of cutting the significantly maximum plant height recorded in C_1 (37.19 cm) followed by C2 (35.17cm) whereas, minimum plant height (34.37 cm) was observed in C_3. Less plant height was recorded in C2 and C_3 cuttings which might be due to pruning encourages the development of side shoots which resulted in increasing side shoots and decreased in plant height. The above results are conformity with Patil and Naik (2004) [10] in palak.

Table 1: Clearly indicate that, the maximum plant height

Treatments		
Manures		
M_1	38.05	118.55
M_2	35.28	115.86
M_3	35.01	107.48
M_4	32.91	94.19
M_5	36.62	114.90
'F' test	Sig.	Sig.
S.E.(m)±	0.84	4.79
C.D. (P=0.05)	2.42	13.70
Cuttings		
C_1	37.19	114.1
C_2	35.17	111.0
C3	34.37	104.2
'F' test	Sig.	Sig.
S.E.(m)± ,	0.65	3.41
C.D. (P=0.05)	1.87	9.82
Interaction: M x C		
'F' test	NS	NS
S.E.(m)±	I.46	8.31
C.D. (P=0.05)		

NS=Non-significance

Leaf area of spinach showed significant result. The maximum leaf area (118.55 cm^2) was recorded under the treatment M_1 (Urea) which was found at par with the treatments M2 (115.86 cm^2), M_5 (114.90 cm^2) and M_3 (107.48 cm^2) whereas, minimum leaf area (94.19 cm^2) was recorded in the treatment M_4.

Maximum leaf area with urea(M_1) treatment which might be due to the quick availability of nitrogen, essential for formation of protoplasm which leads to cell division and cell enlargement. The above results are in conformity with that of Biemond (2004) [3] in spinach.

Leaf area of Indian spinach as influenced by number of cuttings was found to be significant. The maximum leaf area (114.1 cm2) was recorded under treatment C_1 which was found at par with the treatment C_2 (1l1.0cm^2) and C_3 (104.2cm^2). Interaction effect of manure and cutting on plant height and leaf area was found to be non-significant.

Leaves per plant of Indian spinach showed significant influence by manures in Table 2. The maximum leaves per plant (16.88) under the treatment M_1 (urea) and was found at par with M_3 (15.40) and M_4 (15.04) whereas, minimum leaves per plant were recorded in M_5 (12.14).

The maximum leaves per plant were recorded in M which might be due to quick availability of nitrogen to plant, nitrogen imparts vigorous vegetative growth which resulting in increased in leaves per plant. The above results are in conformity with that of Biemond (2004) [3] in spinach.

Effect of organic manures and number of cuttings on growth, yield and quality of Indian spinach.

Table 2: Effect of organic manures and number of cuttings on growth, yield and quality of Indian spinach

Treatment Manures	Leaves per plant Cuttings				Treatments Manures	Leaf etiole ratio\Cuttings		
	C_1	C_2	C_3	Mean		C_1	C_2	C_3
M_1	15.01	14.30	21.37	16.89	M_1	1.20	1.11	0.77
M_2	10.20	12.87	15.30	12.79	M_2	1.00	0.81	0.76
M_3	13.05	16.65	16.55	15.41	M_3	1.01	0.82	0.67
M_4	I 1.55	19.22	14.40	I 5.05	M_4	0.77	0.80	0.63
M_5	10.07	12.60	13.80	12.15	M_5	0.85	0.90	0.58
Mean	11.97	15.13	16.28					

Interaction (M x C)	Manure	Cutting	M x C
F' test	Sig.	Sig.	Sig.
S.E. (m)±	0.73	0.57	1.27
C.D. (P=0.05)	2.10	1.63	3.64

Numbers of leaves per plant were increased with increase in cutting frequencies. Maximum numbers of leaves were recorded in treatment C_3 (16.28) and was found at par with C_2 (15.13) whereas, minimum leaves per plant were recorded in C_1 (11.97). This might be due to the fact that, pruning encourages development of side shoots which resulted in increased in number of leaves per plant after first cutting. The above results are in conformity with that of Kasture *et al.* (2000) [8] in Indian spinach.

Interaction effects of manures and number of cuttings on leaves per plant were found to be significant. The leaves per plant were found to be maximum (21.37) under the treatment combination M_1C_3 which was found at par with M_4C_2 (19.22) followed by M_3C_2 (16.65) and (16.55) M_3C_3 whereas, minimum leaves per plant (10.07) observed in the treatment combination M_5C_1. This might be due to M_1 treatment *i.e.* urea imparts, vigorous vegetative growth plant and pruning encouraged optimum number of leaves which resulted in increase in leaves per plant in C_2 and C_3. The above results are conformity with that of Lal *et al.* (1979) [1] in *Beta vulgaris.*

The data presented in Table 3 revealed that, leaf petiole ratio was influenced by manures. The maximum leaf petiole ratio recorded under the treatment combination M_1C_1 (1.20) followed by M_1C_2 (1.11) whereas the minimum leaf petiole ratio was under the treatment combination M_5C_3 (0.58).

The maximum leaf petiole ratio was attributed to more length of leaf as compared to the length of petiole. The leaf size was increased in the treatment combination M_1C_1 (Urea), it is rich source of nitrogen and nitrogen is essential for formation of protoplasm which leads to cell division and cell enlargement The above results are in conformity with that of Bhore e/ *al.* (2000) [5] in palak.

Data on spinach leaf yield per hectare presented in Table 4 revealed that, the maximum leaf yield per hectare (277.63 q) was recorded under treatment M_1 followed by the treatment M_2 (234q) whereas, the minimum yield per hectare was recorded under the treatment M_4 (132.10 q).

The leaf yield per hectare highest in M_1 treatment is might be due to nitrogen which is the important constituent of plant metabolites such as, fat protein, enzyme and chlorophyll which are essential for vigorous vegetative plant growth. Vegetative growth characters *viz*., number of leaves, leaf area, plant height increased which had directly bearing in yield, the above results are in conformity with those of Bhore *et al.* (2000) [5] in beet palak.

The effect of cutting frequencies on leaf yield q/ha showed that, the maximum leaf yield per hectare was recorded in C_3 (250.94 q) which was at par with C_2 (238.94 q) whereas, the minimum yield per hectare was recorded in C_1 (126.49 q).

The maximum leaf yield per hectare was recorded in C_3 which might be due to in C_3 cutting the yield attributing characters *vis*., number of leaves, leaf area were contributed for maximum yield. The above results are in conformity with that of Jana et *al.* (1999) [6] in palak.

An interaction effect of manures and number of cuttings on leaf yield per hectare of Indian spinach was found to be significant. The maximum leaf yield per hectare was recorded in the treatment combination M_1C_3 (357.97 q) followed by the treatment combination M_1C_2 (313.82 q) whereas, the minimum yield per hectare (89.60 q) recorded in the treatment combination M4C_1.

Table 3: Leaf petiole ratio was influenced by manures

Treatments Manures	Leafy yield/ ha (q) Cuttings			
	C_1	C_2	C_3	Mean
M_1	161.10	313.82	357.97	277.63
M_2	126.15	273.87	302.00	234.00
M_3	95.85	217.80	225.02	179.55
M_4	89.60	159.52	147.17	132.10
M_5	159.75	229.67	222.52	203.98
Mean	126.49	238.94	250.94	

Interaction (M x C)	Manure	Cutting	M x C
'F' test	Sig.	Sig.	Sig.
S.E.(m)±	6.43	4.98	11.14
C.D. (P—0.05)	18.35	14.21	31.79

The maximum leaf yield per hectare was recorded in the treatment combination M_1C_3 which might be due to fact that nitrogen imparts vigorous vegetative growth of plant and in C3 cutting. The yield attributing characters *viz*., number of leaves and leaf area increased which resulted in increase in yield. The above results are in conformity with that of Jana *et al.* (1999) [6] in palak.

The data regarding leaf moisture, leaf chlorophyll and ascorbic acid content as influenced by manures and numbers of cuttings are presented in Table 5

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Table 4: Effect of organic manures and number of cuttings on growth, yield and quality of Indian spinach

Treatments	Quality Parameters		
	Leaf moisture (%)	Leaf chlorophyll (mg/g)	Ascorbic acid (mg/ 100g)
Manures			
M_1	89.53	1.97	74.23
M_2	87.80	1.74	69.20
M_3	85.15	1.62	68.28
M_4	85.33	1.66	62.02
M_5	88.42	1.51	65.30
'F' test	Sig.	Sig.	Sig.
S.E.(m)±	1.06	0.05	-
C.D. (P=0.05)	3.04	0.14	4.49
Cuttings			
C_1	88.74	1.91	70.24
C_2	87.40	1.68	68.20
C_3	85.59	1.58	64.98
'F' test	Sig.	Sig.	Sig.
S.E.(m)±	0.82	0.03	1.22
C.D. (P=0.05)	2.36	0.11	3.48
Interaction M x C			
'F' test	NS	Sig	NS
S.E.(m)±	1.84	0.08	2.73
C.D. (P=0.05)	-	0.25	-

Leaf moisture content of Indian spinach was found to be significant due to manures. The maximum leaf moisture content (89.53%) was recorded under the treatment M1 (Urea) which was found at par with the treatments M5 (88.42%) and M2 (87.80%). This might be due to nitrogen increases succulence and tenderness of leaves which results in increase in moisture content. The above results are in conformity with those of Kaswan ef *al.* (1995) [4] in fenugreek, Bhore *et al.* (2000) [5] in palak.

Regarding cutting effect on leaf moisture, the maximum leaf moisture content (88.74%) was recorded in C_1 which was found at par with C2 (87.40%) whereas, the minimum leaf moisture content was recorded (85.59%) in C_3. The leaf moisture content was maximum in C1 which might be due to moisture content is directly related to leaf area as cutting increases the leaf area and moisture content decreases.

An interaction effect of manures and number of cuttings on leaf moisture content of Indian spinach was found to be non-significant.

The maximum leaf chlorophyll content in Indian spinach under the treatment M_1 (Urea) (1.97 mg/g) followed by M2 (1.74 mg/g) whereas, minimum leafchlorophyll content (1.51 mg/g) was recorded in the treatment M5.

The maximum chlorophyll content was recorded in the treatment M1 (Urea) which might be due to urea which is rich source of nitrogen and nitrogen is a major constituent for formation of chlorophyll molecule. The above results are in conformity with that of Gairola *et al.* (2009) [7] in spinach.

The data presented in Table 5 indicated that, leaf chlorophyll content of Indian spinach showed significant influenced by number of cuttings. The maximum leaf chlorophyll content was in C_1 (1.91 mg/g) followed by C2 (1.68 mg/g) whereas, the minimum leaf chlorophyll content was recorded in C3 (l.51 mg/g). The above results are in conformity with that of Gairola *et al.* (2009) [7] in spinach. The photosynthesis activity is based on quantity of chloroplast pigment, which is directly proportional to the amount of photosynthetic area of leaves but the leaf area decreased as the cutting frequency increased.

An interaction effect of manures and number of cuttings on leaf chlorophyll content of Indian spinach was found to be significant and the significantly maximum leafchlorophyll content was recorded in the treatment combination M1 C1 (2.26 mg/g).

The maximum ascorbic acid content in Indian spinach leaves (74.23 mg/100g) was recorded under the treatment M_1 followed by M2 (69.20 mg/100 g) whereas, the minimum ascorbic acid content in Indian spinach was recorded in M4 (62.02 mg/ 100 g). The present findings are in agreement with the findings of Bhore ct n/. (2000) [5] in palak.

The maximum ascorbic acid content was recorded in C_1 (70.24 mg /100 g) which was at par with in C2 (68.20 mg/1009) whereas, the minimum ascorbic acid content was recorded (64.98 mg/1009) in C3.

An interaction effect of manures and number of cuttings on ascorbic acid content in Indian spinach was found to be non-significant.

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