Original Research Article

Influence of Varieties and Nutrient Levels on Growth, Yield and Profitability of Palak (*Beta Vulgaris* var. bengalensis)

ABSTRACT

A field experiment was conducted at the Department of Vegetable Science, College of Horticulture, Mandsaur (M.P.) during Rabi season of year 2019-20 to study the "Influence of varieties and nutrient levels on growth, yield and profitability of palak (*Beta vulgaris* var. bengalensis)". The experiment comprised of two varieties V_1 (Pusa Bharati), V_2 (All Green) and 6 different nutrient levels (N_1- 00:00:00 NPK kg/ha, N_2- 40:30:20 NPK kg/ha, N_3- 60:40:30 NPK kg/ha, N_4- 80:50:40 NPK kg/ha, N_5- 100:60:50 NPK kg/ha and N_6- 120:70:60 NPK kg/ha).The experiment was laid out in a factorial randomized block design with three replications. The variety Pusa Bharati was found significantly better plant height (26.87 cm, 31.88 cm and 32.12 cm), maximum number of leaves per plant (8.18, 13.70 and 14.02), maximum leaf area (31.28 cm^2, 76.53 cm^2 and 79.88 cm^2), maximum fresh green yield per plant (19.12 g, 20.64 g and 21.79 g), maximum fresh green yield per hectare (191.19, 206.36 and 217.90 q/ha) at 1st, 2nd and 3rd cuttings, respectively. The significantly higher economic performance in terms of gross income (Rs. 246180.00/ha), net income (Rs. 196695.63/ha) and B:C ratio (3.95) was observed with variety Pusa Bharti.Among nutrient levels, N_6 (120:70:60 NPK kg/ha) found better for growth, yield and economics i.e., plant height (30.92 cm, 35.04 cm and 35.66 cm), maximum number of leaves per plant i.e. 9.60, 16.10 and 17.99, maximum leaf area i.e. 34.16 cm^2, 83.31 cm^2 and 88.76 cm^2, maximum fresh green yield per plant i.e. 20.27 g, 22.31 g and 24.46 g, maximum fresh green yield per hectare i.e. 202.72, 223.12 and 224.62 q/ha at 1st, 2nd and 3rd cuttings, respectively, highest gross income (Rs. 268180/ha), net income (Rs. 215587.30 /ha) and B:C ratio (4.10) was found with nutrient level N_6 (120:70:60 NPK kg/ha). It may be concluded that variety V_1 (Pusa Bharati) and nutrient level N_6 (120:70:60 NPK kg/ha) showed better performance for growth, yield and economics in spinach.

Keywords: *All green, economics, growth, NPK, nutrient levels, Pusa Bharati, yield, profitability.*

1. INTRODUCTION

Indian spinach (*Beta vulgaris* var. bengalensis L.) is one of the most common leafy vegetables of tropical and subtropical region and is widely grown in India. It is commonly known as Palak or beet leaf or spinach beet. Palak or Spinach beet belongs to family Chenopodiaceae, genus Beta and species vulgaris var. bengalensis. It has chromosome number of 2n =18 Indian spinach or palak is most probably native of Indo-Chinese region. It is extensively grown in Uttar Pradesh, West Bengal, Punjab, Haryana, Dehli, Madhya Pradesh, Bihar, Maharastra and Gujarat. However, it is not very popular in southern part of India. In the plains of India, this crop normally grown during autumn and spring season but it can be cultivated throughout the year in the region where relatively mild climate prevails. This crop can withstand frost and tolerate warm weather but high temperature leads to early bolting without giving sufficient leaf cuttings [1].

The edible portion of palak consists of compact rosette of leaves prior to the stock formation. It is cultivated for its fresh and green leaves which become ready to harvest (cuttings) in about 30-35 days from sowing, while it is biennial for seed production. In the early stage of the plant growth (at vegetative stage), it produces rosette, succulent, tender edible leaves on a small thick stem. Later, at reproductive stage the stem elongates 75 days after sowing, which results in bolting. Palak leaves are valued for their medicinal properties. The leaves of Indian spinach are used in inflammation, paralysis, headache, earache and are remedy for diseases of spleen and liver. The fresh leaves are applied to burn. It also act as mild laxative besides these medicinal values, it neutralizes the acidity produced during digestion of fatty substances and help to prevent constipation. It is highly nutritious, contains higher fibrous matter, which provides necessary roughage in the diet that stimulates intestinal action and prevents constipation. It is an excellent source of vitamin-K, magnesium, manganese and calcium, heart healthy folate, potassium and vitamin B_6; energy producing iron and vitamin B_2, free radical scavenging vitamin A and vitamin C [2]. On an average it's leaves

contain moisture 86.49 %, fiber 0.7 g, protein 3.4 g, minerals 2.2 g, carbohydrates 6.5 g, riboflavin 0.5 g, calcium 380 mg, iron 16.2 mg, thiamin 0.26 g, Vitamin-A 9770 IU, Vitamin-C 70 mg/100 g of edible portion [3].

Nitrogen is a primary plant nutrient that plays an important role in achieving the maximum economic yields. Nitrogen is essential for the plants because it is present in all living mater constituent of protoplasm. Application of nitrogen to increase yield in leafy vegetables is a well recognized practice. Cutting management is found beneficial for improving green yield, number of branches, number of leaves. Since, most of the leafy vegetables several cuttings are possible, they require a good amount of nitrogenous fertilizer for their quick growth, good vegetative growth and as well as for reproductive growth [4]. Phosphorus is also one of the most essential macro-nutrient; it is present in plasma membrane, nucleic acids, nucleotides, many co-enzymes and organic molecules. It plays an important role in energy metabolism. Phosphorous promotes healthy root growth. Phosphorous also has vital importance in increase plant height, better root, development and also improve the yield of Indian spinach [5]. Potassium activates plant physiology, improves fruit quality, increase disease resistance, prevents lodging and makes the plant capable of surviving moisture stress. Potassium activates plant physiology, improves fruit quality, increase disease resistance, prevents lodging and makes the plant capable of surviving moisture stress [5].

2. MATERIAL AND METHODS

Field experiment was conducted during rabi *Rabi* season, 2019-20 at Research Field, Department of Vegetable Science, College of Horticulture, Mandsaur (M.P.) India.Mandsaur is situated in western part of Madhya Pradesh, between latitude of 23^{o} 45' to 24^{o} 13' North, longitude of $74^{o}44$' to $75^{o}18$' East and at an altitude of 435.20 m above mean sea level. This region lies under Malwa Plateau, the 10^{th} agro climatic zone of the state. The topography of the experimental field was plain with good irrigation facilities.The soil of the experimental field was light alluvial soil having sandy loam texture with uniform topography.

The experiment was layout in the Factorial Randomized Block Design (FRBD) with twelve treatment combinations each replicated three times. Each replication compare with two varieties- Pusa Bharati and All Green and 6 different nutrient levelsi. e. N_1- 00:00:00 NPK kg/ha, N_2- 40:30:20 NPK kg/ha, N_3- 60:40:30 NPK kg/ha, N_4- 80:50:40 NPK kg/ha, N_5- 100:60:50 NPK kg/ha and N_6- 120:70:60 NPK kg/ha. Fertilizers were applied as per the treatments at the time of sowing. Nitrogen was applied in the form of urea, phosphorus in the form of di-amonium phosphate (DAP) and potassium in the form of muriate of potash in furrows at a depth of 10 cm according to the treatment doses. Small furrows were opened according to different spacing levels as per the treatments and seeds were dibbled in the furrows at different distances as per the spacing levels. After 15 days of sowing to maintain optimum plant population, gap filling and thinning operations were practiced. Optimum soil moisture was maintained in the field throughout the investigation by using flood irrigation system. The data obtained on various observations for each treatment were subject to "Analysis of variance" as recommended by Panse and Sukhatme (6).

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

Plant Height

Plant height was recorded at 1^{st}, 2^{nd} and 3^{rd} cutting of leaves. The investigations revealed a significant variation among the treatments showed in Table 1. Results revealed that among varieties, the maximum plant height i.e. 26.87 cm, 31.88 cm and 32.12 cm at 1^{st}, 2^{nd} and 3^{rd} cutting, respectively was noted in variety V_1 (Pusa Bharati) and minimum plant height i.e. 25.62 cm, 29.43 cm and 29.90 cm at 1^{st} cutting, 2^{nd} cutting and 3^{rd} cutting was observed in variety V_2 (All Green). The observed variations in plant height among varieties are mainly due to genotype of each variety. The results are in conformity with findings of Dabhi et al.[7] and Meena et al.[8].

Nutrient levels exerted significant influence on plant height. Maximum plant height i.e. 30.92 cm, 35.04 cm and 35.66 cm at 1^{st} cutting, 2^{nd} cutting and 3^{rd} cutting, respectively was recorded by nutrient level N_6 (120:70:60 NPK kg/ha) followed by N_5>N_4> N_3> N_2 in descending order at all the stages under study. Whereas the minimum plant height i.e. 22.08 cm, 23.20 cm and 24.66 cm at 1^{st} cutting, 2^{nd} cutting and 3^{rd} cutting, respectively was observed in nutrient level N_1 (00:00:00 NPK kg/ha). Nitrogen plays an important role in growth and development of spinach. With the increase of nitrogen content up to a certain level in the soil with sufficient water it increases the plant height [9]. The more availability of nutrients under higher levels might have encouraged the photosynthesis, accumulation of food material and higher plant growth resulting in more plant height. These results are in accordance with the findings of Ali et al.[10], Singh et al.[11] and Hashimi et al.[12].

Number of leaves

A perusal of data indicates that number of leaves was significantly influenced by varieties. Among varieties, the maximum number of leaves per plant i.e. 8.18, 13.70 and 14.02 at 1^{st}, 2^{nd} and 3^{rd} cutting was counted in variety

V_1(Pusa Bharati) and minimum number of leaves per plant i.e. 6.98, 11.96 and 12.08 at 1st, 2nd and 3rd cutting, respectively was observed in variety V_2 (All Green). Similar findings were reported by Boroujerdnia and Ansari [13], Olaniyi et al.[14] and Hasan et al.[15].

It is evident from the data that nutrient levels had exerted significant effect on number of leaves per plant in palak. Nutrient level N_6 (120:70:60 kg/ha) found maximum number of leaves per plant i.e. 9.60 16.10 and 17.99 at 1st, 2nd and 3rd cutting, respectively. It was followed by N_5> N_4> N_3> N_2 in descending order, whereas the minimum number of leaves per plant i.e. 5.69, 8.95, and 9.23 was observed in nutrient level N_1 (00:00:00 kg/ha) at 1st, 2nd and 3rd cutting, respectively. The more availability of plant nutrients might have improved uptake of nitrogen, phosphorus and potash by the plant thus would have caused greater activity of meristematic tissue, cell division and cell elongation as well as protein synthesis [16]. Similar increase in the number of leaves per plant was also noticed by Aguoruet al. [17], Zaman et al.[18] and Zodgeet al.[19].

Leaf area

Data presented in Table 1 clearly depicting that leaf area of palak significantly influences by the varieties. Variety V_1 (Pusa Bharati) recorded maximum leaf area i.e. 31.28, 76.53 and 79.88 cm at 1st, 2nd and 3rd cutting, respectively. Minimum leaf area i.e. 30.14, 72.69 and 76.16 cm was recorded in variety V_2 (All Green) at 1st, 2nd and 3rd cutting, respectively. These results are in accordance with the findings of Alessa et al.[20] and Basuniaet al.[21].

Nutrient levels showed significant influence on leaf area. Maximum leaf area i.e. 34.16 cm, 83.31 cm and 88.76 cm was observed with N_6 (120:70:60 NPK kg/ha) at 1st, 2nd and 3rd cutting, respectively. It was at par with N_5 (100:60:50 NPK kg/ha), whereas minimum leaf area i.e. 27.83 cm, 65.76 cm and 66.24 cm was found in nutrient levels N_1 (00:00:00 NPK kg/ha) at 1st, 2nd and 3rd cutting, respectively. Nitrogen fertilizers enhanced leaf growth and photosynthesis, thus increasing leaf area [10]. Increase in photosynthesis might have led to better vigour in plant ultimately increased leaf area [22]. A similar finding with different NPK levels was reported by Gairola et al.[23] and El-Saady et al.[24].

Table 1: Effect of varieties and fertility levels on growth of palak

Treatment	Plant height (cm)			Number of leaves per plant			Leaf area (cm^2) per plant		
	1st cutting	2nd cutting	3rd cutting	1st cutting	2nd cutting	3rd cutting	1st cutting	2nd cutting	3rd cutting
Varieties (V)									
V_1- Pusa Bharati	26.87	31.88	32.12	8.18	13.70	14.02	31.28	76.53	79.88
V_2 - All Green	25.62	29.43	29.90	6.98	11.96	12.08	30.14	72.69	76.16
S.Em±	**0.34**	**0.53**	**0.51**	**0.26**	**0.40**	**0.34**	**0.37**	**1.23**	**1.01**
CD at 5%	**0.99**	**1.57**	**1.50**	**0.78**	**1.17**	**1.00**	**1.08**	**3.60**	**2.95**
Nutrient levels (N)									
N_1 - 00:00:00 NPK kg/ha	22.08	23.20	24.66	5.69	8.95	9.23	27.83	65.76	66.24
N_2 - 40:30:20 NPK kg/ha	23.72	28.72	27.98	6.90	10.60	10.09	29.14	69.04	71.06
N_3 - 60:40:30 NPK kg/ha	25.64	31.37	30.80	7.25	12.12	11.77	30.29	71.30	75.75
N_4 - 80:50:40 NPK kg/ha	26.92	32.30	32.83	7.85	13.79	13.56	31.24	77.14	81.43
N_5 - 100:60:50 NPK kg/ha	28.20	33.30	34.17	8.18	15.43	15.65	31.59	81.10	84.88
N_6 - 120:70:60 NPK kg/ha	30.92	35.04	35.66	9.60	16.10	17.99	34.16	83.31	88.76
S.Em±	**0.59**	**0.93**	**0.88**	**0.46**	**0.69**	**0.59**	**0.64**	**2.13**	**1.74**
CD at 5%	**1.72**	**2.72**	**2.59**	**1.34**	**2.02**	**1.74**	**1.88**	**6.24**	**5.12**

Table 2: Effect of varieties and fertility levels on yield and profitability of palak

Treatment	Fresh green yield per plant (g)				Fresh green yield (q ha^{-1})				Gross income (Rs)/ha	Net income (Rs)/ha	B:C ratio
	1st cutting	2nd cutting	3rd cutting	Total	1st cutting	2nd cutting	3rd cutting	Total			
Varieties (V)											
V_1- Pusa Bharati	19.12	20.64	21.79	61.55	191.19	206.36	217.90	615.45	246180.00	196695.63	3.95
V_2 - All Green	14.95	17.96	19.43	52.34	149.54	179.57	194.26	523.37	209346.67	159862.29	3.22
S.Em±	**0.26**	**0.53**	**0.46**	**0.73**	**2.59**	**5.26**	**4.56**	**7.28**	**2910.92**	**2910.92**	**0.06**
CD at 5%	**0.76**	**1.54**	**1.34**	**2.13**	**7.60**	**15.43**	**13.37**	**21.34**	**8537.43**	**8537.43**	**0.17**
Nutrient levels (N)											
N_1 - 00:00:00 NPK kg/ha	13.81	15.69	16.67	46.17	138.07	156.87	166.73	461.67	184666.67	139416.67	3.08
N_2 - 40:30:20 NPK kg/ha	15.26	17.31	18.41	50.97	152.57	173.08	184.08	509.73	203893.33	155823.53	3.24
N_3 - 60:40:30 NPK kg/ha	16.85	18.62	20.04	55.51	168.53	186.15	200.42	555.10	222040.00	172839.48	3.51
N_4 - 80:50:40 NPK kg/ha	17.45	20.35	21.11	58.90	174.48	203.50	211.05	589.03	235613.33	185282.08	3.68
N_5 - 100:60:50 NPK kg/ha	18.59	21.51	22.96	63.05	185.85	215.05	229.57	630.47	252186.67	200724.70	3.90
N_6 - 120:70:60 NPK kg/ha	20.27	22.31	24.46	67.05	202.72	223.12	244.62	670.45	268180.00	215587.30	4.10
S.Em±	**0.45**	**0.91**	**0.79**	**1.26**	**4.49**	**9.11**	**7.89**	**12.60**	**5041.86**	**5041.86**	**0.10**
CD at 5%	**1.32**	**2.67**	**2.32**	**3.70**	**13.17**	**26.73**	**23.15**	**36.97**	**14787.26**	**14787.26**	**0.30**

3.2 Yield Parameters

Yield parameters of palak viz., fresh green yield per plant (g) and fresh green yield per hectare (q/ha) were recorded during the present investigation. There was significant influence of varieties and nutrient levels on all the yield parameters.

Fresh green yield per plant (g)

Among varieties, maximum fresh green yield per plant i.e. 19.12, 20.64 and 21.79 g was noted in variety V_1 (Pusa Bharati) and minimum fresh green yield i.e. 14.95, 17.96 and 19.43 g was recorded in variety V_2 (All Green) in palak at 1st, 2nd and 3rd cutting, respectively. Maximum total fresh green yield per plant (61.55 g) was noted in variety V_1 (Pusa Bharati) and minimum total fresh green yield per plant (52.34 g) was recorded in variety V_2 (All Green). This is because of the fact that the variety Pusa Bharati gets better plant growth as compared to All Green, so it was increase in yield parameters of palak. Similar result was showed by Dabhi et al.[7].

Application of nutrient levels in palak showed significant effect on fresh green yield per plant. Maximum fresh green yield per plant i.e. 20.27, 22.31 and 24.46 g was recorded in nutrient levels N_6 (120:70:60 NPK kg/ha) and it was at par with treatment N_5 (100:60:50 NPK kg/ha), whereas the minimum fresh green yield per plant i.e. 13.81, 15.69 and 16.67g was found in treatment nutrient levels N_1 (00:00:00 NPK kg/ha) at 1st, 2nd and 3rd cutting, respectively. Maximum total fresh green yield per plant (67.05 g) was recorded in nutrient levels N_6 (120:70:60 NPK kg/ha) and it was at par with treatment N_5 (100:60:50 NPK kg/ha), whereas the minimum total fresh green yield per plant (46.17 g) was found in nutrient levels N_1 (00:00:00 NPK kg/ha). Nitrogen and phosphorus enhances the cell elongation and cell division affects juice percentage in spinach plants. It also accumulated more carbohydrate in plant which leads to early new leave growth as well as bud initiation, later on which brought about lengthening of spinach roots health. The spinach plants receiving required amount of N and P in an optimum proportion could have results in leaves quality by increasing number of cells [25]. Higher fresh weight of leaves per plant under higher N-P levels was related with increased plant height and more number of leaves per plant [26]. These results are in conformity with the findings of El-Saady [27].

Fresh green yield per hectare (q)

Among varieties, variety V_1 (Pusa Bharati) recorded maximum fresh green yield per hectare i. e. 191.19, 206.36 and 217.90 q/ha at 1st, 2nd and 3rd cutting, respectively. Minimum fresh green yield/ha i.e. 149.54, 179.57 and 194.26 q/ha at 1st, 2nd and 3rd cutting, respectively was recorded in case of variety V_2 (All Green). The difference among varieties was significant with respect of fresh green yield. Maximum total fresh green yield (615.45 q) per hectare was noted in variety V_1 (Pusa Bharati) and minimum total fresh green yield (523.37 q) per hectare was recorded in variety V_2 (All Green). Similar result was showed by Stagnariet al.[27] and Dabhi et al.[7].

Application of nutrients exhibited positive effect on fresh green yield per hectare. Maximum fresh green yield i.e. 202.72, 223.12 and 244.62 q/ha at 1st, 2nd and 3rd cutting, respectively was observed under nutrient levels N_6 (120:70:60 NPK kg/ha) followed by $N_5>N_4>N_3>N_2$ in descending order, whereas the minimum fresh green yield i.e. 138.07, 156.87 and 166.73 q/ha at 1st, 2nd and 3rd cutting, respectively was found in case of nutrient levels N_1 (00:00:00 NPK kg/ha).Maximum total fresh green yield (670.45 q/ha) was found with nutrient levels N_6 (120:70:60 NPK kg/ha), whereas the minimum total fresh green yield (461.67 q/ha) was recorded under nutrient levels N_1 (00:00:00 NPK kg/ha). The leaf yield per hectare most elevated in treatment is may be because of nitrogen which is the significant constituent of plant metabolites, for example, fat protein, catalyst and chlorophyll which are fundamental for fiery vegetative plant development. Vegetative growth characters viz., number of leaves, leaf area, and plant height increased which had directly related to yield [28]. These results are in conformity with the findings of Abgadet al.[22] and Singh et al.[11].

3.3 Economic of different treatments for palak production

The data presented in Table 2 revealed significant effect of varieties and nutrient levels on gross income (Rs./ha), net income (Rs./ha) and B:C ratio. Combined effect of varieties and nutrient level showed non-significant effect on gross income (Rs./ha), net income (Rs./ha) and B:C ratio.

Among the varieties, highest gross income (Rs. 246180.00/ha), net income (Rs. 196695.63/ha) and B:C ratio (3.95) was found with variety V_1 (Pusa Bharati) which was significantly superior over variety V_2 (All Green).

Nutrient levels indicated significant effect on gross income (Rs./ha), net income (Rs./ha) and B:C ratio of palak. Highest gross income (Rs 268180.00/ha), net income (Rs 215587.30/ha) and B:C ratio (4.10) was found with nutrient levels N_6 (120:70:60 NPK kg/ha), which was significantly superior over all other nutrient levels. Lowest gross income (Rs 184666.67/ha), net income (Rs 139416.67/ha) and B:C ratio (3.08) was recorded under nutrient level N_1 (00:00:00 NPK kg/ha).

Interaction effect of varieties and nutrient levels showed non significant influence on gross income (Rs./ha), net income (Rs./ha) and B:C ratio. But numerically highest gross income (Rs 291680.00/ha), net income (Rs 239087.30/ha) and B:C ratio (4.55) was realized in case of treatment combination V_1N_6, while lowest gross income (Rs 175413.33/ha), net income (Rs 130163.33/ha) and B:C ratio (2.88) was obtained with V_2N_1 combination.

4. CONCLUSION

It may be concluded from the findings of the present study that among the different varieties of palak, variety V_1 (Pusa Bharati) recorded superior performance for growth, yield and economics. Among the nutrient levels, application of N_6 (120:70:60 NPK kg/ha) recorded highest growth viz., plant height, number of leaves per plant, leaf area as well as yield. Though combined effect of varieties and nutrient levels was non-significant with respect to all the parameters of palak. However, numerically treatment combination V_1N_6 showed superior performance for growth parameters and yield parameters. It also recorded maximum gross income, net income and B:C ratio.

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