

EFFECTS OF VERMICOMPOST AND PK ON GROWTH AND PROTEIN CONTENT OF SPINACH (*SPINACIA OLERACIA* L.)

MD MAHFUZ ISLAM*, SAYADA MOMOTAZ AKTHER, SHAHIN AHMED SUJON,
MD ABDUL KARIM¹ AND MD KHALILUR RAHMAN

*Department of Soil, Water and Environment, University of Dhaka,
Dhaka-1000, Bangladesh*

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Abstract

Results of a pot experiment carried out on spinach with vermicompost (5, 10 and 15 ton/ha), phosphorous (10, 20 and 30 kg/ha) and potassium (20, 30 and 40 kg/ha) fertilizers showed that plant height, leaf area, fresh and dry weight of plants increased significantly ($p \leq 0.5$) over the control. Highest height (23.55 cm), leaf area (80.88 cm²/plant), fresh weight (3.838 g/plant) and dry weight (0.274 g/plant) were maximum in VC₁₅P₂₀K₃₀, VC₁₅P₃₀K₃₀, VC₁₀P₂₀K₃₀ and VC₁₀P₁₀K₄₀, respectively, while leaf number was almost same in all the plants. Highest protein content (24.61%) was obtained in the treatment VC₁₅P₁₀K₂₀. Highest dry matter of leaf was obtained at VC₁₀P₁₀K₄₀, but the highest protein content was at VC₁₅P₁₀K₂₀ which might be due to dilution effect. Similar values of protein content were obtained in treatments VC₅P₂₀K₃₀, VC₅P₂₀K₄₀, VC₅P₃₀K₂₀, VC₁₅P₁₀K₄₀, VC₁₅P₂₀K₃₀ and VC₁₅P₃₀K₂₀. Maximum value of nitrogen, phosphorous (1.621%) and potassium (4.066%) were obtained in treatments VC₅P₂₀K₂₀ and VC₁₀P₃₀K₄₀, VC₁₅P₁₀K₂₀, respectively.

Introduction

Spinach is believed to have originated in Persia, which later spread almost across the world and became a desirably leafy green known for good health; a reputation that stands firm still today. Spinach is an increasingly popular commercial vegetable crop in Bangladesh. Baby leaf vegetables such as rockets, lamb's lettuce and spinach are the subjects of increased consumption and are mostly recommended for mixed salad both as fresh market products and ready-to use vegetables. It is known to contain comparatively higher amounts of bioactive compounds (Gil *et al.* 1999), nutrient such as minerals, carbohydrates, vitamin A and C, riboflavin, nicotinic acid, thiamine (MacGillivray 1953) as well as folate, manganese, iron magnesium, potassium and calcium (USDA 2005).

The use of vermicompost to increase crop yield and soil quality has gained considerable momentum due to its contribution in agro-ecological sustainability (Xu and Mou 2016). Vermicompost has been shown to have significant beneficial effects on both soil and crop yield. It enhances soil quality by increasing microorganisms, soil aeration and by improving nutrient cycling and water (Srivastava *et al.* 2011, D'Hose *et al.* 2014) and thereby growth of spinach (Xu and Mou 2016). A very little information is available on the growth, nitrogen accumulation and protein content in spinach under Bangladesh edaphic conditions. The objective of this experiment was to study the effects of vermicompost, phosphorus and potassium on growth and protein content in spinach.

*Author for correspondence: <mdmahfuz789@gmail.com>. ¹Department of Botany, University of Dhaka, Dhaka 1000, Bangladesh.

Materials and Methods

Soil sample (0 to 15 cm depth) was collected from Keraniganj, Dhaka. The sample was air dried, ground and sieved through 2 mm sieve. The soil had a pH 6.89, organic matter 0.41% (Walkley and Black 1934), available N 23 mg/kg (Marr and Cresser 1983), available P 6.5 mg/kg (Murphy and Riley 1962), available K 30.8 mg/kg, field capacity 30% (Anderson and Ingram 1989), sand 12.18%, silt 69.34% and clay 18.48%, textural class- silt loam (Bouyoucos 1962). The N, P and K concentration of vermicompost were 1.1, 0.29 and 0.82 per cent, respectively. A pot experiment was carried out in the net house of the Department of Soil, Water and Environment, University of Dhaka. Seven kilograms of soil was taken per plastic pot (22 cm × 24.5 cm). Vermicompost (5, 10 and 15 ton/ha), phosphorus (10, 20 and 30 kg/ha) as TSP and potassium (20, 30 and 40 kg/ha) as MP were applied. Twenty eight treatments with three replications were completely randomized block design. Seeds of *Spinacia oleracia* were collected from local market, Dhaka. Fifteen seeds were sown and finally eight plants were kept per pot. Height, number of leaves and leaf area of the plants were measured.

Table 1. Treatment combinations.

Treatments	Treatment combination (VC ton/ha and PK kg/ha)	Treatments	Treatment combination (VC ton/ha and PK kg/ha)
T ₁	VC ₀ P ₀ K ₀	T ₁₅	VC ₁₀ P ₂₀ K ₃₀
T ₂	VC ₅ P ₁₀ K ₂₀	T ₁₆	VC ₁₀ P ₂₀ K ₄₀
T ₃	VC ₅ P ₁₀ K ₃₀	T ₁₇	VC ₁₀ P ₃₀ K ₂₀
T ₄	VC ₅ P ₁₀ K ₄₀	T ₁₈	VC ₁₀ P ₃₀ K ₃₀
T ₅	VC ₅ P ₂₀ K ₂₀	T ₁₉	VC ₁₀ P ₃₀ K ₄₀
T ₆	VC ₅ P ₂₀ K ₃₀	T ₂₀	VC ₁₅ P ₁₀ K ₂₀
T ₇	VC ₅ P ₂₀ K ₄₀	T ₂₁	VC ₁₅ P ₁₀ K ₃₀
T ₈	VC ₅ P ₃₀ K ₂₀	T ₂₂	VC ₁₅ P ₁₀ K ₄₀
T ₉	VC ₅ P ₃₀ K ₃₀	T ₂₃	VC ₁₅ P ₂₀ K ₂₀
T ₁₀	VC ₅ P ₃₀ K ₄₀	T ₂₄	VC ₁₅ P ₂₀ K ₃₀
T ₁₁	VC ₁₀ P ₁₀ K ₂₀	T ₂₅	VC ₁₅ P ₂₀ K ₄₀
T ₁₂	VC ₁₀ P ₁₀ K ₃₀	T ₂₆	VC ₁₅ P ₃₀ K ₂₀
T ₁₃	VC ₁₀ P ₁₀ K ₄₀	T ₂₇	VC ₁₅ P ₃₀ K ₃₀
T ₁₄	VC ₁₀ P ₂₀ K ₂₀	T ₂₈	VC ₁₅ P ₃₀ K ₄₀

Fifty days old plants were harvested as leaf, stem, root and washed with tap water and finally with distilled water and wrapped with soft tissue paper. Immediately after harvest, fresh weight of leaf, stem and root were taken and then air-dried in the room temperature and finally oven-dried at 65°C in an oven for 72 hrs. Dry weight of the sample was recorded, ground with a mechanical grinder and stored. For nitrogen, 0.2 g of powdered sample was digested in a Kjeldahl digestion flask (Jackson 1962) and for PK, 0.5 g powdered leaf was digested (Shelton and Harper 1941). Phosphorous of the digest was determined by vanadomolybdophosphoric yellow color method at 430 nm using spectrophotometer (Model DR 5000). Potassium in the digest was determined by using JENWAY flame photometer (Model PFP 7). Protein content of the leaf was determined by the methods of Magomya *et al.* (2014).

Statistical analysis of the results was carried out using Microsoft Excel 2010 and respective LSDs are indicated. Graphs were also prepared by using the Microsoft Excel 2010.

Results and Discussion

Plant growth was assessed in terms of plant height, leaf number and leaf area (Table 2), fresh and dry weight of leaf, stem and root (Table 3). Results of height and leaf area varied significantly ($p \leq 0.5$) at harvest over the control but the values of number of leaves did not vary significantly (Table 2). However, the highest height (23.55 cm) was observed in pot treated with VC₁₅P₂₀K₃₀ followed by 23.5 cm under VC₅P₁₀K₃₀ treatment. Application of the highest vermicompost dose based on crop N requirements was likely to provide more nutrients to the crops (Edwards and Daniel 1992). Leaf number in different treatments increased up to harvest (Table 2) but did not vary significantly. Maximum leaf area (80.88cm²/plant) was achieved in VC₁₅P₃₀K₃₀ treatment followed by 77.55 cm in VC₁₅P₂₀K₃₀. The values for fresh weights of leaf, stem, root and dry weight of leaf and stem as well as total fresh and dry weight varied significantly ($p \leq 0.5$) (Table 3). The maximum total yields of fresh and dry weights were 3.8376 and 0.2744 g/plant recorded in VC₁₀P₂₀K₃₀ and VC₁₀P₁₀K₄₀ treatments, respectively (Table 3). Nitrogen is the most imperative element for proper growth and development of plants which significantly increases the yield and

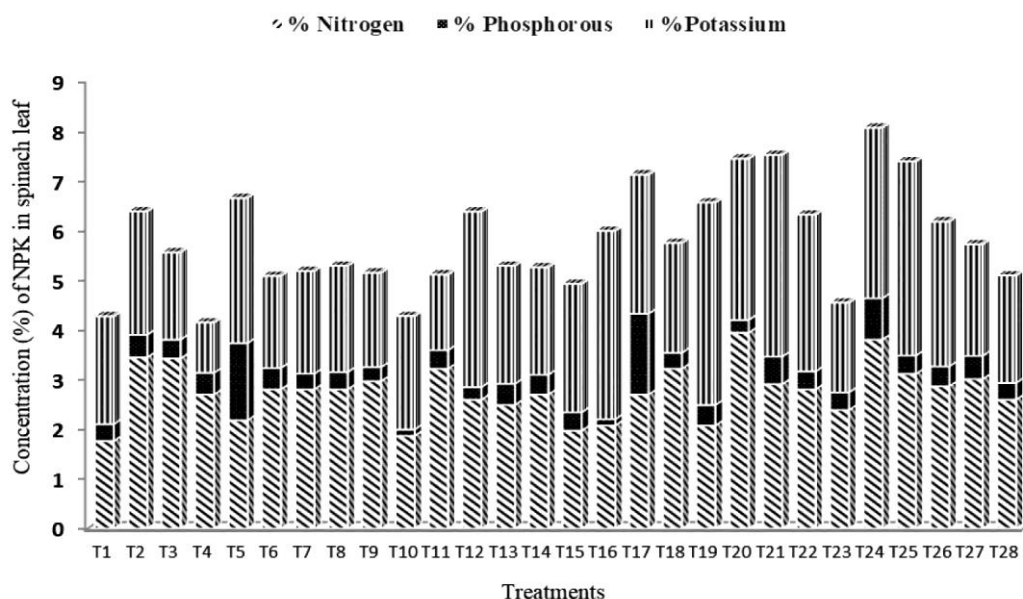


Fig. 1. Effects of vermicompost and PK on the concentration (%) of N, P and K in the leaf of spinach.

its quality by playing vital role in biochemical and physiological functions of plant (Leghari *et al.* 2016). Brady and Weil (2002) concluded that the organic manures contain a passive fraction of 60 to 90 per cent which is very slowly available to plants. Akon *et al.* (2018) found that height, leaf area, and fresh and dry weights of leaf of *Gynura procumbens* varied significantly ($p \leq 0.5$) under seven types of manures including vermicompost.

Table 2. Effects of vermicompost and PK on height, leaf numbers and leaf area of spinach (*Spinacia oleracea*) after 50 days of growth.

Treatments (VC ton/ha and PK kg/ha)	Height (cm)	Leaf number (no./plant)	Leaf area (cm ² /plant)
VC ₀ P ₀ K ₀	16.50	8	34.80
VC ₅ P ₁₀ K ₂₀	19.30	8	51.85
VC ₅ P ₁₀ K ₃₀	23.50	9	59.58
VC ₅ P ₁₀ K ₄₀	21.20	9	75.70
VC ₅ P ₂₀ K ₂₀	20.10	9	46.58
VC ₅ P ₂₀ K ₃₀	18.60	9	53.25
VC ₅ P ₂₀ K ₄₀	19.75	9	39.54
VC ₅ P ₃₀ K ₂₀	21.05	9	59.30
VC ₅ P ₃₀ K ₃₀	19.00	9	54.09
VC ₅ P ₃₀ K ₄₀	19.50	9	40.06
VC ₁₀ P ₁₀ K ₂₀	21.50	9	69.06
VC ₁₀ P ₁₀ K ₃₀	19.10	9	53.39
VC ₁₀ P ₁₀ K ₄₀	21.45	9	70.04
VC ₁₀ P ₂₀ K ₂₀	20.90	9	66.58
VC ₁₀ P ₂₀ K ₃₀	20.75	9	70.15
VC ₁₀ P ₂₀ K ₄₀	21.25	8	49.54
VC ₁₀ P ₃₀ K ₂₀	18.10	9	46.80
VC ₁₀ P ₃₀ K ₃₀	19.85	9	49.56
VC ₁₀ P ₃₀ K ₄₀	20.05	9	45.57
VC ₁₅ P ₁₀ K ₂₀	17.90	8	42.57
VC ₁₅ P ₁₀ K ₃₀	19.80	9	50.90
VC ₁₅ P ₁₀ K ₄₀	19.40	9	64.65
VC ₁₅ P ₂₀ K ₂₀	20.00	9	53.33
VC ₁₅ P ₂₀ K ₃₀	23.55	9	77.55
VC ₁₅ P ₂₀ K ₄₀	19.55	9	54.33
VC ₁₅ P ₃₀ K ₂₀	18.60	9	47.01
VC ₁₅ P ₃₀ K ₃₀	21.80	9	80.88
VC ₁₅ P ₃₀ K ₄₀	21.00	9	58.02
LSD at 5%	1.828	NS	7.301

Table 3. Effects of vermicompost and PK on the fresh, dry weights and protein content (%) of spinach (*Spinacia oleracea*).

Treatments (VC ton/ha and PK kg/ha)	Fresh weight (g/plant)			Dry weight (g/plant)			Protein content (%)
	Leaf	Stem	Total (root + shoot)	Leaf	Stem	Total (root + shoot)	
VC ₀ P ₀ K ₀	1.213	0.241	1.506	0.088	0.031	0.134	11.008
VC ₅ P ₁₀ K ₂₀	1.580	0.290	1.933	0.104	0.038	0.164	15.497
VC ₅ P ₁₀ K ₃₀	3.258	0.353	3.693	0.193	0.054	0.272	16.068
VC ₅ P ₁₀ K ₄₀	2.560	0.279	2.885	0.111	0.034	0.156	15.835
VC ₅ P ₂₀ K ₂₀	2.055	0.260	2.383	0.131	0.042	0.204	14.600
VC ₅ P ₂₀ K ₃₀	1.976	0.283	2.303	0.109	0.068	0.225	17.483
VC ₅ P ₂₀ K ₄₀	1.531	0.266	1.871	0.070	0.039	0.135	14.483
VC ₅ P ₃₀ K ₂₀	2.965	0.215	3.406	0.122	0.046	0.192	18.482
VC ₅ P ₃₀ K ₃₀	1.938	0.299	2.300	0.102	0.034	0.150	18.520
VC ₅ P ₃₀ K ₄₀	1.580	0.306	1.929	0.104	0.026	0.160	13.655
VC ₁₀ P ₁₀ K ₂₀	3.016	0.371	3.471	0.194	0.049	0.267	20.073
VC ₁₀ P ₁₀ K ₃₀	1.949	0.296	2.298	0.116	0.032	0.157	16.188
VC ₁₀ P ₁₀ K ₄₀	3.040	0.393	3.485	0.200	0.054	0.274	15.540
VC ₁₀ P ₂₀ K ₂₀	2.410	0.381	2.855	0.144	0.071	0.242	16.935
VC ₁₀ P ₂₀ K ₃₀	3.366	0.383	3.838	0.150	0.028	0.180	12.303
VC ₁₀ P ₂₀ K ₄₀	2.015	0.184	2.399	0.101	0.046	0.185	14.950
VC ₁₀ P ₃₀ K ₂₀	1.939	0.252	2.285	0.168	0.056	0.268	16.635
VC ₁₀ P ₃₀ K ₃₀	1.506	0.285	1.813	0.089	0.045	0.136	20.700
VC ₁₀ P ₃₀ K ₄₀	1.634	0.256	1.954	0.074	0.053	0.159	15.950
VC ₁₅ P ₁₀ K ₂₀	1.331	0.269	1.646	0.083	0.058	0.154	24.605
VC ₁₅ P ₁₀ K ₃₀	1.919	0.336	2.304	0.128	0.063	0.209	18.130
VC ₁₅ P ₁₀ K ₄₀	2.868	0.350	3.261	0.170	0.047	0.245	17.483
VC ₁₅ P ₂₀ K ₂₀	2.499	0.318	2.918	0.121	0.051	0.212	19.893
VC ₁₅ P ₂₀ K ₃₀	3.029	0.288	3.406	0.187	0.052	0.255	23.733
VC ₁₅ P ₂₀ K ₄₀	2.649	0.310	3.004	0.119	0.032	0.161	19.425
VC ₁₅ P ₃₀ K ₂₀	2.216	0.294	2.589	0.098	0.046	0.165	17.871
VC ₁₅ P ₃₀ K ₃₀	2.490	0.360	2.893	0.131	0.063	0.213	18.778
VC ₁₅ P ₃₀ K ₄₀	2.569	0.391	3.036	0.160	0.068	0.240	16.102
LSD at 5%	0.848	0.119	0.893	0.248	0.160	0.046	0.892

Protein content in leaf is presented in Table 2 where maximum and minimum amount of protein was achieved in VC₁₅P₁₀K₂₀ and control treatment (VC₀P₀K₀), respectively. Magomya *et al.* (2014) collected ten different plant samples from wild and farmland of Nizeria *viz.*, *Hibiscus cannabinus*, *Haematostaphis barteri*, *Sesamum indicum*, *Balanites aegyptiaca*, *Cassia tora*, *Celtis integrifolia*, *Anona senegalensis*, *Ceiba petandra*, *Ficus ingens* and *Solanum melongena* the protein of which ranged from 2.63 - 18.59%.

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