INNSPUB

International Journal of Agronomy and Agricultural Research (IJAAR)
ISSN: 2223-7054 (Print) 2225-3610 (Online)
http://www.innspub.net
Vol. 4, No. 5, p. 10-21, 2014

RESEARCH PAPER

OPEN ACCESS

Effects of fresh leaf materials of *Sesbania sesban* (L.) Merrill on the growth and photosynthetic pigments of nightshade (*Solanum nigrum* L. var. popolo)

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Article published on May 15, 2014

Key words: Carotenoids, cheaper nutrients, chlorophyll, green manure, Sesbania.

Abstract

Solanum nigrum L. is one of the African leafy vegetable consumed in Kenya. High cost of inorganic fertilizers has made it inaccessible by smallholder farmers leading to low yields. A study was conducted at Maseno University, Kenya to investigate the effects of *Sesbania sesban* fresh leaf materials on the growth of *Solanum nigrum* L. The study was conducted under greenhouse conditions using 3litre pots. Each pot was filled with 2kg of top soil and five treatments of fresh leaf materials of *S. sesban* incorporated at the rates of 0g (control), 15g, 30g, 45g and 60g. Ten seeds of *S. nigrum* L were planted in each pot and were watered daily until they germinated after which they were thinned to five seedlings per pot. The experiment was laid out in a completely randomized design (CRD) with 5 replications. Data on stem length, number of leaves per plant, leaf length, leaf breath were collected each week from the fifteen day after germination. Fresh and dry weights of the stems and roots, Leaf chlorophyll and carotenoids contents were determined at the end of the experiment. The data collected was subjected to ANOVA and means separated and compared using the least significant difference (LSD) at P = 0.05, using SAS statistical package. The study showed that there was a significant effect of application of fresh leaf material of *S. sesban* on the growth of *S. nigrum* plants, variety: popolo. Treatment consisting of 45g of fresh leaf material of *S. sesban* had the highest number of leaves, leaf area, plant height, fresh weight of the shoots and roots, and dry weights of shoots and roots. Chlorophyll a (chl a) and chlorophyll b (chl b) contents increased in all the treatments receiving fresh leaf materials of *S. sesban*. There were no significant differences in Chl *a* and chl *b* contents among the treatments receiving fresh leaf materials. Carotenoids contents of *S. nigrum* increased with increasing amounts of fresh leaf material of S. sesban. However, there was no significant difference in carotenoids contents between treatments. In conclusion fresh leaf material of sesbania promoted growth and increased photosynthetic pigments of *S. nigrum,* probably this was due to high amounts of nutrients supplied by *S. sesban*. The under exploited potential of *S.sesban* green manure can be harnessed in growing *S. nigrum* plants.

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Introduction

Solanum nigrum also known as black nightshade in english, crevechiene in French, ballerina in Spanish and tungujamito in Kiswahili is an important leafy vegetable grown in Kenya (Schippers, 2000). It is a source of food and nutrition and is rich in iron, calcium and vitamin A and C (Masinde *et al.*, 2010). Nightshade is also a source of income for the poor. It is mainly grown by traditional farmers for subsistence (Ondieki *et al.*, 2011). Nightshade is the largest and most variable species of the genus Solanum (Ayesha *et al.*, 2010). It is a medicinal plant (Ramya *et al.*, 2011). About three quarters of population of the world depend on plants and plant extracts for the care of their health (Ramya *et al.*, 2011). It has been traditionally used as analgesic, antispasmodic, antiseptic, antidysentric, antinarcotic, emollient, diuretic, soporific, laxative, anticancer, anti-ulcer and disorders of neuro-vegetative system (Ayesha *et al.*, 2010). This medicinal value is attributed to the alkaloidal contents of the plant. In India *S.nigrum* mixed with other herbal medicine has shown to be hepatoprotective in cirrotic patients. This protective effect can be attributed to the diuretic, anti flammatory, anti-oxidative, and immune modulating properties of the component herbs (Dhellot *et al.*, 2006). It has been used as a trap crop with ability to reduce pest infestation, since it has been reported as host for nematodes, bacteria, mycoplasma like organisms and virus (Nona, 2009; Defelice, 2003). The leaves can be blended well with the other greens and pulses to make porridge. Besides being used for human consumption, the leaves serve as fodder for domestic herbivorous animal (Akubugwo *et al.*, 2007). *Solanum nigrum* is a common herbaceous plant distributed worldwide (Padmapriya *et al.*, 2011) and usually grow as a weed in most habitats and different kinds of soils in tropical land and subtropical agro climatic regions. *Solanum nigrum* can be used in reclaiming degraded land (Ramya *et al.*, 2011) and propagation is by seeds and cuttings.

Solanum nigrum ripe fruits are cooked, and can be used in preservatives, pies and in jams. Young leaves and new shoots are used raw or cooked as a potherb or added to soups. All green and unripe parts contain steroid glycosides inform of glycoalkaloides (Ayesha *et al.*, 2010). These are widely regarded as defensive allelochemicals of the plants against pathogens and predators (Defelice, 2003). Economically they are used as raw material for industrial production of corticoids. The main steroid alkaloids are solanin and solasonine (Bithel, 2004). The total contents of steroid alkaloids differ from 0.1% up to 0.5% depending on the species and plant parts. The highest amounts are found in fruits and seeds.

The fruits extracts of *S. nigrum* have anti-tumor and neuropharmacological properties and can be used as an anti-oxidant and cancer chemo-prevention matter (Son *et al.*, 2003). The fruits are richer in oil than tropical plants such as *Cananium Schwenfurnii* (36.1%) and cotton (16-28%) (Dhellot *et al.*, 2006). *Solanum nigrum* seeds have high lipid content. Glycoproteins are obtained from the fruits, 30.26% are mainly hydrophobic amino acids containing glycine and proline. Polysaccharides isolated from aqueous extracts of *S.nigrum* have shown to possess ant-proliferative activity (Ramya *et al.*, 2011).Their protein contents and mineral elements like magnesium are considerably prominent. *Solanum nigrum* oil is an important source of linoleic acid which gives these oils nutritional and dietic properties. The seeds also contain large quantities of unsaponifiable matter (green color) which is used in cosmetic industry (Dhellot *et al.*, 2006).

Green manure involves incorporating plant parts into the soil. The plant materials can be obtained from a crop that was grown after or within the same crop, or from a plant that grew during a fallow period. Plants will increase soil fertility and yields of subsequent crops especially in nitrogen depleted soils. Many plants are being adopted and evaluated for soil fertility improvement in Kenya (Kimenju *et al.*, 2007). Green manure is any plant or plant part produced exclusively to supplement or substitute nitrogen from mineral fertilization or plant material that is actively worked into the soil (Sabra *et al.*, 2010; Johannes, 2011). *Sesbania sesban* is a fast growing leguminous shrub and decomposes rapidly when incorporated in soil as a green manure to provide nutrients. It can be grown to serve as nitrogen source ((Heering *et al.*, 1996; Patra *et al.*, 2006). The nitrogen in *S. sesban* is readily available. Its manure is rich in phosphorus and potassium more than *Mimosa invisa* plant and also contains more nodules and can improve the yields of crops and is cost effective as compared to inorganic fertilizers (Nyalemegbe *et al.*, 2012). Green manure crops improve the tilth of both sandy and clay soils through addition of organic matter. According to Matata *et al.* (2011), green manure from *S.sesban* after a two year fallow can lead to a reduction of *Striga* infestation while still increasing the yield of maize. *Sesbania sesban* prunings act as source of plant nutrients. Incorporation of green manure from herbaceous and shrubby legumes gives better results than crop residuals and woods in terms of soil fertility improvement because of their narrow carbon – nitrogen ratio and low lignin content (Kanyama, 2005).

Incorporation of green manure from *S.sesban* was found to increase the yield of ratoon crop of sugarcane (Devendra *et al.*, 2003). Sesbania can be used as mulch especially in alley cropping systems and help to improve soil nutrients. The effect of *S.sesban* on the growth of *S. nigrum* has not been adequately documented especially on its response to sesbania green manure.

The current foods shortages in Kenya are attributed to a larger extend by the inaccessibility of inorganic fertilizers inputs due to poverty among many farmers. Small holder farmers are the most affected by the ever increasing cost of fertilizers and is the major reasons that make the commodity to be unaffordable to the small holder farmers (Kanyama, 2005). For instant in Kenya a 50 kg fertilizer bag costs around ksh 3000 hence being expensive to farmers hence, farmers need to change to organic fertilizers, such as the use of *S.sesban* to improve production of some crops**.** On annual basis sub Saharan Africa is losing 4.4, 0.5, and 3.0 metric tons of nitrogen, phosphorus and potassium respectively (Kanyama, 2005). Due to the high cost of inorganic fertilizers, poor farmers are unable to acquire the fertilizers hence low yields leading to food insecurity. Also Inorganic fertilizers are known to pose a threat to the environment through pollution. The main objective of this study was to investigate the effects of application of fresh leaf materials of *S.sesban* on growth and physiology of *Solanum nigrum* plants. It was hypothesized that application of fresh leaf materials of *S.sesban* affects the growth and photosynthetic pigments of *S.nigrum*.

Materials and methods

Plant materials and Growth Conditions

The experiment was conducted under greenhouse conditions. Seeds were planted in 3 litre pots containing soil from Botanic garden of Maseno University. Each pot was filled with 2kg of top soil which had been solarised (sun sterilized) for at least two days to prevent fungal growth. The Maseno soils are classified as acrisol, deep reddish brown friable clay with pH ranging from 4.5 to 5.5, soil organic carbon and phosphorus contents are 1.8% and 4.5mg kg^{-1} respectively (Netondo, 1999). *Sesbania sesban* fresh leaves were obtained from trees found in Botanic Garden at Maseno University. The leaves were cut into 2mm segments and then incorporated into the pots at the rates of, 0g (control), 15g, 30g, 45g and 60g fresh leaf materials. Each pot was seeded with ten seeds of *S.nigrum*. The pots were then placed in a greenhouse and irrigated daily. The pots were perforated at the base to allow for good drainage. The experiment was laid out in a completely randomized design (CRD) with 5 replications (Plate 1). The conditions within the green house were PAR which was approximately 700 $\mu molm^{-2}$, relative humidity 55% and temperature ranging from 29 (day) to 24 ^{o}C (night). Upon germination the seedlings were thinned to five seedlings per pot.

Measurement of growth parameters

Plant height

The plant height was measured every week using a transparent meter rule, fifteen days from germination of the seeds, by placing the ruler from the soil level to the tip of each crop.

Leaf number

The number of leaves was determined by just counting them after fifteen days from germination.

Leaf area

The leaf length was measured on leaf number four from the top, on one plant from each pot, by placing a transparent ruler from the leaf apex to the leaf stalk while the width was measured by placing the ruler at the center of the leaf blade and measurements read from one end of the leaf margin to the other margin. The leaf area was calculated using the following formula (Otusanya *et al.*, 2007).

$LA = 0.5 * L * W$, Where: LA=Leaf area, L=Leaf length, W=Leaf breath

Determination of fresh and dry weight of shoots and roots

Roots and stems of one plant from each pot were weighed on electronic balance to obtain the fresh weight. Each of the plants was packaged in separate envelopes and dried at 80°C in a gallenkamp incubator for two days and weighed using electronic balance to obtain dry weight.

Measurement of physiological Parameters

Determination of photosynthetic pigments

One gram of *S.nigrum* leaves was ground in 20 mm 80% v/v acetone using a mortar and pestle. The leaves used comprised of leaves on fourth position of one plant in each pot counted from the top. The supernant was read at 664^{nm}, 647^{nm} and 470^{nm} using uv-visible spectrophotometer.

The concentrations were calculated using the following formulae (Oyerinde *et al.*, 2009).

$Ch/a = [13.19 \times A664] - [2.57 \times A647]$ mgg^{-1} fresh weight

$Ch/b = [22.1 \times A647] - [5.26 \times A664]$ mgg^{-1} fresh weight

$Car = \dfrac{[1000 \times A470] - [2.270 \times Ch/a] - [81.4 \times Ch/b]}{227}$ mgg^{-1} fresh weight

Where:

Ch/a = chlorophyll a concentration

Ch/b = chlorophyll b concentration

Car = Carotenoids concentration

A664, A647 and A470 are the absorbance at 664^{nm}, 647^{nm} and 470^{nm} respectively.

Data analysis

The data obtained from the study were subjected to analysis of variance and mean separated and compared using least significant difference (LSD) at P=0.05, using SAS a statistical package.

Results

Plant height: There was a significant ($P \leq 0.05$) increase in plant height throughout the experimental period (Table 1 and plate 1).Treatment consisting of 45g fresh leaf material of *S. sesban* indicated the highest plant height, 121% of control treatment by the end of the experiment. The control treatment was not significantly different from treatment receiving 60g fresh leaf material of *S. sesban*.

Table 1. Effects of fresh leaf materials of *S. sesban* on plant height of nightshades (*S.nigrum)*.

Treatment	***Week1***	***Week2***	***Week3***
0g	6.20d	17.70d	23.40c
15g	7.40bc	21.00c	25.40b
30g	7.90b	22.60b	27.60a
45g	8.36a	24.80a	28.40a
60g	7.20c	20.80c	23.40c
LSD	0.42	0.79	0.91

Means followed with the same letters down the columns are not significantly different.

Fig. 1. Showing the growth response of nightshades (*S.nigrum)* under different amounts of fresh leaf material of S. sesban under greenhouse conditions at Maseno university Botanic Garden.

Leaf number

There was a significant ($P \leq 0.05$) increase in leaf number with increased application of fresh leaf material of Sesbania, but decreased in 60g fresh leaf material treatment (Table 2). Treatment consisting of 45g of fresh leaf material of Sesbania gave the highest number of leaves of *S.nigrum* which was 150 % of control plants.

Table 2. Effects of fresh leaf materials of *S. sesban* on leaf number of nightshades (*S. nigrum).*

Treatment	*Week1*	*Week 2*	*Week3*
0g	4.20d	7.60cd	8.80c
15g	5.20c	8.00bc	9.60c
30g	5.80b	8.40b	12.00b
45g	6.60a	9.60a	13.20a
60g	5.40bc	7.00d	11.40b
LSD	0.58	0.75	0.85

Means followed with the same letters down the columns are not significantly different.

Leaf area

There was a significant ($P \leq 0.05$) increase in leaf area with increase in application of fresh leaf material of S. sesban (Table 3). The leaf area increase from 15g to 60 g was 135%, 173%, 201% and 113% of control treatments respectively.

Table 3. Effects of fresh leaf materials of *S. sesban* on leaf area of nightshades (*S.nigrum).*

Treatment	*Week 1*	*Week 2*	*Week 3*
0g	0.55e	1.79d	2.98e
15g	0.79b	2.42c	4.04c
30g	1.12b	3.11b	5.16b
45g	1.44a	4.21a	5.99a
60g	0.63d	2.18c	3.38d
LSD	0.07	0.28	0.32

Means followed with the same letters down the columns are not significantly different.

Fresh weights and dry weights of shoot and roots

The fresh and dry weights of both the stems and roots increased with increase in the amounts of fresh leaf materials of *S. sesban* except in treatments receiving 60g of fresh leaf material of S.sesban (Table 4). There were significant differences ($P \leq 0.05$) among the fresh material treatments of S. sesban and the control plants. The treatment receiving 45g of fresh leaf material of S. sesban had the highest fresh weight and dry weight of root and shoots, which was

Table 4. Effects of fresh leaf materials *S. sesban* on fresh and dry weights of stems and roots of nightshades (*S.nigrum*).

Treatment	*Fresh weight of Stem*	*Fresh weight of roots*	*Dry weight of Stem*	*Dry weight of Roots*
0g	6.40c	0.30c	3.48c	0.16d
15g	7.40cb	0.36bc	3.66cb	0.24c
30g	8.80ab	0.44ab	4.50ab	0.33ab
45g	9.20a	0.52a	5.02a	0.39a
60g	7.00c	0.42ab	3.78cb	0.31cb
LSD	1.55	0.11	0.86	0.07

Means followed with the same letters down the columns are not significantly different.

Photosynthetic pigments contents

There were significant differences ($P \leq 0.05$) in chl a and chl b contents between control treatments (0g) and treatments receiving fresh leaf material of S. sesban (Table 5). Chlorophyll a, chl b and carotenoids contents increased with increasing application of the various amounts of fresh leaf material of sesbania. There was no significant difference between fresh leaf material treatments and control plants in carotenoids contents, but 60g fresh leaf material treatment had the highest carotenoids contents which were 84% over the control plants.

Table 5. Effects of fresh leaf materials of *S. sesban* on chlorophyll and Carotenoids concentrations after three weeks of treatment.

Treatment	*Chl a*	*Chl b*	*Carotenoids*
0g	0.43b	0.03b	0.04a
15g	0.86a	0.49a	0.03a
30g	0.87a	0.46a	0.03a
45g	0.87a	0.28a	0.22a
60g	0.88a	0.51a	0.25a
LSD	0.22	0.22	0.23

Means followed with the same letters down the columns are not significantly different.

Discussion

Green manure is any plant or plant part produced exclusively to supplement or substitute nutrients from mineral fertilization (Johannes, 2011). Green manures are the crops which are returned into the soil in order to improve the growth of subsequent crops. Green manures offer considerable potential as a source of plant nutrients and organic matter (Yadvinder-Singh *et al*., 1991).The application of fresh leaf segments of *S sesban* in soil positively influenced plant height, leaf number, leaf area, fresh and dry weights of the shoots and roots, and chl a, chl b and Carotenoids contents of *S. nigrum*. Higher plant height (Table 1) was attributed to the favorable effect of green manuring. These results are consistent with those of Khan *et al.* (1968) and Saleem (1993), who reported that green manuring of soil increased the plant height of wheat. Increase in plant height may suggest an increased cell division and enlargement, which could be probably due to high amounts of N supplied by the fresh leaves of *S. sesban* which at the same time contributed to increased fresh weight and dry weight of the shoots and roots. Green manure crops improve the physical, chemical and biological condition of soils. Improvement of soils physical condition by adding green manure crops into the soil create the potential for crop growth. The control plants (0 g) of *S.nigrum* had poor growth in terms of height as compared to the other nightshade plants supplied with fresh leaves, and this could have been probably due to inconsistent growth in leaf area and leaf number (Tables 2 and 3) which may affect photosynthesis and hence proper growth of plants. Reduced leaf area and leaf number could result to lower photosynthetic capacity of the plants and ultimately limit growth (Ayobola *et al.*, 2010). Other studies have reported nutrient accumulation as a result of applying organic materials over several seasons resulting in increased yields (Goyal *et al.*, 1992). The amount of plant nutrients supplied via organic materials is highly dependant on the quantity of the organic materials applied. The main advantage of organic manures is that they provide more than one of the many substances needed by plants for their growth. Organic manure improves soil quality and continuous addition of manures, such as farm yard manure and compost in soil increased soil organic carbon content and other constituents that affect soil humus content, biological activity, and soil physical structure (Wagner and Georg, 2004). Plants supplied with 60g of fresh leaf materials of *S. sesban* showed decreased growth in plant height, leaf number, leaf area and fresh and dry weights this could be attributed to decreased cell division and cell enlargement; this may be linked to the production of some inhibitory compounds by the fresh leaves of *S. sesban*. Many investigators have reported that large number of metabolites occur in different parts of plants and may have stimulatory or inhibitory effects on seedling growth of other plants (Chou and Yao 1983; Jayakumar and Manikandan, 2005). Release of these active substances may be as the result of decomposition, leaching of plant residues in the soil, and root exudation (El- Rokiek *et al.*, 2010). Previous studies using Extracts of *Euphorbia serpens* stimulated growth of the aerial parts and roots of *Lactuca sativa* (Dana and Domingo 2006), and leaf extracts of *Phytolacca americana* stimulated growth of the aerial parts and roots of *Cassia mimosoides* (Kim *et al.*, 2005). The growth of nightshade plants in soils incorporated with fresh leaves of *S. sesban* improved from week one to week three, probably due to N released from decomposing organic material. Previous studies by Patra *et al.*(2006) indicated that N in S. sesban as a green manure is readily available and can be used effectively by a crop even if applied during crop growth (i.e. top dressing). *Sesbania sesban* is a fast growing leguminous shrub, which decomposes rapidly when incorporated in soil (Palm *et al.*, 1988; Yadvinder-Singh and Bijay-Singh, 1992). Addition of legume biomass such as for *S. sesban* with low C: N ratio results in quick mineralization of N (Sharma and Behera, 2009). In addition to supply of N, organic manure also provides other beneficial effects on crop plants due to release of various growth promoting substances and improving availability of other nutrients including micronutrients (Sharma and Behera, 2009) and this could have probably brought the significant differences in growth in plant heights, leaf area and leaf number in *S. nigrum* plants supplied with fresh leaves of *S. sesban*. Green manure biomass incorporated in the soil can release nutrients needed by *S. nigrum* crop. Green manure crops provide a significant increase in the N supply or other essential nutrients. Sangakkara *et al.* (2004) found that the addition of green manure for three years was reflected in an improvement of the physical properties of soils, as well as increased amounts of available N, P and K. Incorporation of Crotalaria, with higher nitrogen content, promoted plant growth, while Tithonia favored the development of the root system of maize. Elfstrand *et al.* (2007) also reported that green manure application increased nitrogen content of plant. Also findings of Ryan *et al.* (2008) indicated that application of vetch as green manure enriched the N in grain and straw. Significant increase in uptake of N by nightshades could probably have led to significant increase in leaf number, leaf area, plant height, fresh weight and dry weights of shoots and roots. Treatment with 45g of fresh leaves indicated the best response in plant growth. This suggests that mineralized N could have been utilized efficiently by plants supplied with 45g of fresh leaves hence having the highest number of leaves, the tallest plants and also the highest fresh and dry weights of stem and root (Table 4). Similar studies have been reported where green manure significantly increased rice plant height; number of tillers, number of panicles per plant and grain yield (Kayeke *et al.*, 2007). Losses of N from green manure is minimal

(Sharma and Behera, 2009) and could be probably the reason why there was significant difference in the parameters in the nightshade plants supplied with *S. sesban* fresh leaves compared to plants which were not supplied with the fresh leaves (control treatment).

Leaf area was smallest in control plants, that were not supplied with fresh leaves of *S. sebania* (Table 3) and this could have been due to lack of nitrogen, since no green manure was added and nitrogen is essential for foliage growth and development. Nightshade plants supplied with 45g of fresh leaves had the highest number of leaves and this could have been due to the high amount of N supplied by the fresh sesbania leaf materials. Plants use leaves for photosynthesis, if the number of leaves and leaf area is reduced, it could result in lower photosynthetic capacity and finally reduced plant growth (Ayobola *et al*., 2010), and this will reduce the plant height and finally the fresh and dry weight of the plants. According to Tahir *et al.* (1995), legumes applied as green manure may supply upto 0.44kg of P. Green manure applied at high levels (45 g) may have improved the soil structure and optimized root growth conditions by providing organic matter and nutrients (Mohammadi *et al*., 2010). There was a low root fresh weight in roots of nightshade plants that were not supplied with the green manure; and this was probably due to low amounts of soil P and N thus affecting the growth of the plants. Tripathi *et al.* (1998) studied the allelopathic activity of *Tectona grandis, Albizia procera* and *Acacia nilotica* on germination and growth of soybean, in which, the leaf extracts of all the three species at lower concentrations there was stimulatory effect on germination, growth, chlorophyll, protein, carbohydrates and proline contents of soybean, but in higher concentrations, there was a decreasing trend of all the parameters in the soybean.

The pattern of dry weight increase resembled that of fresh weight (table 4). High amounts of N in the green manure that increased the rate of photosynthesis, probably led to increased shoot fresh and dry weight accumulation. Adequate nitrogen supply always increases the amount of protoplasm and chlorophyll which are key factors for increasing photosynthetic leaf area, which in turn enhanced dry matter production of *S. nigrum* (Kwo and Chen, 1980). Sangakkara *et al*., 2004) demonstrated the beneficial effects of legumes on the root growth of maize and tobacco.

There was no significant difference in chlorophyll a concentration in leaves of plants supplied with 15g, 45g and 60g (Table 5), and this could be probably due to the presence of both N and magnesium minerals. It was low in plants without the fresh leaves and this could be due to absence of these minerals. Studies by Mohammadi *et al.* (2010) showed that green manure significantly increased leaf chlorophyll of chickpea. Previous studies have shown that elements such as nitrogen, iron and magnesium play a role in chlorophyll structure. It is possible that supply of these elements by green manure is the main reason for increasing leaf chlorophyll content. Sahni *et al.* (2008) reported that compost application increased the availability and uptake of minerals like Zn, Mn, and Fe in chickpea plants. Nutrient uptake was least in control due to the low availability of these nutrients in the soil. Green manure improves the availability of other nutrients including micro nutrients (Sharma and Behera, 2009). Whapham *et al. (*1993) noted that the application of Seaweed liquid fertilizer of *Ascophyllum nodosum* increased the chlorophyll of Cucumber cotyledons and tomato plants. *Gracilaria edulis* extract on *Vigna unguiculata* and *Phaseolus mungo* (Lingakumar *et al*., 2002), *Caulerpa scalpelliformis* and *Gracilaria corticata* extract on *Cyamoposis tetragonoloba* (Thirumal *et al*., 2003). Carotenoids content increased with application of fresh leaf materials of *S. sesban*. These results are in agreement with those obtained by Wroble and Wolniak (2008); where they found that chlorophyll a, b and carotenoids were increased in *Salix viminals* L. plants with biostimulator application.

Conclusion

Application of fresh leaf materials of *S. sesban* significantly improved growth and photosynthetic pigments of *S. nigrum*. Application of 45 g of fresh leaf material of *S. sesban* gave the best response. The *S. sesban* green manure had effect on the plant height, leaf number, leaf area, fresh weight and dry weights, chlorophyll and carotenoids content of *S. nigrum*. This was probably due to high amounts of nitrogen supplied by the green manure and also due to various growth promoting substances and high availability of other nutrients including micronutrients. Based on the findings, it can be concluded that the use of green manures can significantly improve the survival and growth of *S. nigrum* seedlings. Higher amounts of *S. sesban fresh* leaf segments (60g) inhibit the growth of *S. nigrum*. Further experiments are needed to evaluate the application of *S. sesban* on the growth of *S. nigrum* under field conditions.

Recommendation

The under exploited potential of sesbania green manure need to be harnessed and farmers should be advised to turn to cheaper nutrient sources like use of green manure like sesbania in production of nightshades.

Acknowledgment

The project was funded by the department of Botany, Maseno University.

Competing interests

Authors have declared that no competing interests exist.

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