Blueprint for Cultivation of Jute Mallow (Corchorus olitorius) Under Swedish Conditions

Plan för odling av Jute Mallow (Corchorus olitorius) under svenska förhållanden

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Foreword

In Syria, I worked for the department of the agricultural economic and social studies. Our work aimed to improve and develop rural areas that suffer of poverty, degradation of livelihood (social, economic, education, and health level) due to limitation of natural recourse such as groundwater and land. Most of our work was based on survey studies.

Agroecology was an unknown term for me. I read about it at SLU websites for the first time, when I decided to study at the Master program. I was excited and interested to learn about this field and how the agroecological practices could be sustainable and environmentally friendly especially in rural areas in the developing countries.

In my country, the economic aspects considering high yield, profit and quality are of great concern for farmer, without taking care about the environmental impacts in the future.

Learning agroecology concepts and principles during the past two years provides me with new experience and knowledge. It taught me that agroecological approach takes consideration of the interactions and interferences between the living organisms and their environments, and it be good with interaction and collaboration between actors to solve environmental issues, rather than each actor working in isolation.

An understanding of root causes of problems, based on deep analyses in a systems perspective, is key to determine solutions.

My study in this thesis is an investigation of agroecological farming practice for new crop that can potentially be introduced to the Swedish market. Introduction of jute mallow as exotic crop enhances the agroecology thinking considering different cultural practices and diversity of the cropping systems.

However, the big question for me remains, if these agroecological concepts are applicable in developing countries such as Syria, this requires a radical transformation in the learning and thinking systems, food production systems and agricultural policies.

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My biggest thank and grateful for my four children for their understanding and patience during the duration of my study

Shadia Awad

Abstract

Investigations were carried out in order to develop a natural science and social science approaches for introduction of new vegetable crops to the Swedish market and to meet the demographic changes in the society. The focus is on developing preliminary baselines for cultivation of jute mallow, a vegetable crop usually used in Middle East food culture. Within the frame of natural science approach, crop cultivation as affected by two different commercially available substrates, Mediterranean peat substrate (MPS) and vegetable peat substrate (VPS) and two different fertilizers, organic cow manure (CM) or synthetic fertilizers (NPK) were evaluated. In a pilot experiment in the greenhouse, each substrate was subjected to three different treatments; (1) control treatment with only substrate and no addition of either CM or NPK, (2) treatment with substrate and CM and (3) treatment with substrate and NPK. Each treatment consisted of four replicates and the experiment was conducted in three blocks. Effect of the treatments on plant development was judged using the BBCH scale. Plant height, leaf area, biomass measurements and nutrient content in leaves and substrate were also included as evaluation parameters. The results indicated that seed germination in MPS was faster compared to VPS, while side shoot development and plant height were higher in VPS. Higher plant height was recorded in the MPS treatments with either CM or NPK compared with the control treatment. Plant height in the control treatment with VPS surpassed plant height in amending VPS with either cow manure or NPK. Fresh biomass of leaves and stem was higher in all VPS treatments compared with the control treatment with MPS or the treatment with MPS and CM. In the contrary, the control treatment with MPS and MPS with CM indicated higher root biomass compared with all other treatments. Nutrient analyses of the substrate at harvest indicated higher amount of ammonium compared with nitrate in all the treatment, except for MPS treatment with NPK. Social science approach performed by a survey showed that consumers prefer to buy fresh jute mallow and they were interested in the quality and source of the importing product. Wholesale stated that introduction of jute mallow cultivation will attract many Swedish consumers. Results showed also that growers need knowledge and information of jute mallow cultivation, production, profits, and marketing and 20% of the growers were interested to be the first who grow jute mallow.

Key words: Mediterranean peat substrate, vegetable peat substrate, BBC scale, plant biomass, leaf area, fertilizers, cow manure, NPK.

Sammanfattning

Syftet med arbetet är att utveckla en vetenskaplig och en social basplan för införande av nya grödor till den svenska marknaden och för bemötande av de demografiska förändringarna i samhället. Fokus är på utveckling av preliminära baslinjer för odling av jute mallow, en välkänd och vanligt förekommande grönsak i mellanösterns matkultur. Effekten av två olika kommersiellt tillgängliga substrat, medelhavsjord (MPS) och grönsaksjord (VPS) och två olika gödselmedel, organisk kogödsel (CM) och syntetiskt gödselmedel (NPK) på planttillväxt och skörd utvärderades. I ett pilotförsök i växthus utsattes varje substrat för följande behandlingar; (1) kontrollbehandling med endast substrat och ingen tillsats av varken CM eller NPK, (2) behandling med substrat och CM och (3) behandling med substrat och NPK. Varje behandling omfattade fyra replikat och försöket utfördes i tre block. Behandlingseffekt på planttillväxt och utveckling bedömdes med hjälp av BBCH-skalan. Planthöjd, växtbiomassa, bladyta, och näringsinnehåll i blad och i substrat utvärderades också i försöket. Resultaten visade att förgroning var snabbare i MPS jämfört med VPS, medan sidskottsutvecklingen och planthöjden var högre i VPS jämfört med MPS. Högre planthöjd indikerades i MPS behandlingar med NPK eller CM jämfört med kontrollbehandlingen.

Planthöjden i kontrollbehandlingen med VPS överträffade planthöjden i VPS behandling både med CM och med NPK. Alla VPS-behandlingar hade högre blad- och stambiomassa samt bladyta jämfört med kontrollbehandlingen med MPS och MPS med CM. Däremot indikerade kontrollbehandlingen med MPS och MPS med CM högre rotbiomassa jämfört med alla andra behandlingar. Näringsämnesanalyser av substratet vid skörden indikerade högre mängd ammonium jämfört med nitrat i alla behandlingar förutom i behandling med MPS och NPK. Den socialvetenskapliga delen av arbetet utfördes i form av enkätundersökning visade att konsumenter föredrog att köpa färsk jute mallow och de var intresserade av kvaliteten och källan till den importerande produkten. Grossisten visade intresse för odling av jute mallow och uppgav att introduktion av grödan till svensk marknad kommer att locka många svenska konsumenter. Resultaten visade också att odlarna behöver kunskap och information om jute mallows odling, produktion, vinst och marknadsföring och 20% av odlarna var intresserade av att vara de första som odlar jute mallow.

Nyckelord: Medelhavsjord, grönsaksjord, BCCH skala, växtbiomassa, bladyta, gödselmedel, kogödsel, NPK.

Contents

1. Introduction

1.1. History and production of jute mallow

Jute mallow (*Corchorus olitorius L.*) belongs to genus Corchorus and classified under the subfamily Grewioideae of the family Tiliaceae (Khan et al., 2015). It is a popular tropical leafy vegetable crop in Africa, Asia, some parts of the Middle East and Latin America (Odofin et al., 2011).

Jute's word is an Orrisan word and perhaps coined from the word jhuta or jota, (Islam, 2010). Some common name of jute is jute mallow, saluyot, jute, Jew's mallow, Egyptian spinach, and bush okra. Jute was once known as the golden fiber of Bangladesh, since it was the most important cash crop for the country (Garjila et al., 2017).

Originally, jute mallow is coming from Indian subcontinent and is considered to be an important part of East Bengal culture.

Jute mallow fiber was the most export in the world compared with the synthetic fiber in the 21st century (Faisal, 2016). In the last decade production of jute mallow ranges between 2.5 -3.2 million tonnes. About 30-60% of world jute is grown in India and Bangladesh respectively. Bangladesh exports nearly 40% as raw fibers and about 50% as manufactured items. India exports nearly 200 000 tonnes of jute products, and the remainder being consumed domestically (FAO, 2018).

1.2. Nutritional and health value of jute mallow

Fresh vegetables are important components of a healthy and balanced diet. Consumer's interest in the quality of vegetable products has increased worldwide (FAO, 2017).

Jute mallow is known to be a nutrient rich crop and its nutritional importance is coming from the valuable content in the leaves which are elliptic-lanceolate, glabrous and serrate and rich with nutrients (FAO,2018). An amount of 100 g of jute mallow leaves contains 43-58 calories, 80.4-84.1 g water, 4.5-5.6 g protein, 0.3 g fat, 7.6-12.4 g total carbohydrate, 1.7-2.0 g fibre, 2.4 g ash, 266-366 mg Ca, 97-122 mg P, 7.2-7.7 mg Fe, 12 mg Na, 444 mg K, 6.41-7.85 mg beta-carotene equivalent, 0.13-0.15 mg vitamin B1 (thiamine), 0.26-0.53 mg vitamin B2 (riboflavin), 1.1-1.2 mg vitamin B3 (niacin), and 53-80 mg vitamin C (ascorbic acid) (Rume, 2010).

Jute leaves provide many health benefits, and different literatures observed that leaves of jute mallow are rich of calcium which helps to protect the teeth and jaw and for strong bone, copper that diminishes heart diseases, vitamin B9 that is an essential for reducing the occurrence of cancer in the human body (Islam et al, 2013). Vitamin B2 in jute mallow maintain collagen levels and help to make up healthy skin and hair body, and vitamin C plays an important role in the body's ability to fight off colds and viruses. (Islam et al, 2013). The antioxidants in saluyot leaves may sharpen vision, fight arthritis and improve fertility (Watkins, 2017).

1.3. Economic importance

Jute mallow is an annual crop, of which leaves can be re- harvested 3-4 times during the growth season. The stems can be harvested for strong fibre depending on species (FAO, 2018). Yields may be about 3 - 4 tonnes/ha of green plants giving 2 tonnes/ha of dry retted fibre (FAO, 2018). Jute mallow has an economic importance due to the reuse of its fibers. From the same species leaves are used in food consumption and fibers can be used in different industrial applications. (FAO, 2018).

Jute fiber is extracted mostly from bark of two commercially important species, namely white jute (*Corchorus capsularis L*) and tossa jute (*Corchorus olitorius L*), due to their chemical and biological characters (Kar et al., 2009).

These species are also characterized by narrow genetic variability for adaptability to not only various agronomic environments, but also fiber yield, quality and susceptibility to diseases and pests (Kar et al,2009).

Furthermore, *Corchorus* species can be grown in several soil types, ranging from clay to sandy loam (Islam, 2013). They are ranked second after cotton in terms of global consumption by use of fibers, production, and availability (Khan et al., 2015).

Demand for natural fiber blends increases, and the demand for jute fibers that can be blended with cotton is expected to increase.

During the Industrial Revolution, jute yarn largely replaced flax and hemp fibers in sackcloth (FAO, 2018). It is the world most important bagging and wrapping textile (Adesina, 2001). Jute fibers are used in various textiles for furnishings as well as in composites particularly as a wood fiber (FAO, 2018).

Figure 1: The source of jute fibers used in different manufactured process. Photo: S. Awad.

1.4. Environmental importance

Jute fiber is renewable, cheap, biodegradable and can be recycled which increases the environmental value of the crop (Adediran, 2015). Manufacturing of jute emits negligible amounts of GHGs (Chavez et al., 2012).

Jute also does not generate toxic gases when burnt (FAO, 2018). A hectare of jute mallow plants consumes about 15 tonnes of carbon dioxide and releases 11 tonnes of oxygen during their cultivation period of 120 days (Khan et al., 2015).

Jute fibers can be extracted by either biological or chemical retting processes, stem biological processes are more widely practices due to the separation of the fibers from the stem before stripping (Adesina, 2001; Khan et al., 2015).

A key feature of jute fiber is in its ability to be used either independently or blended with a range of other fibers and materials and can be replace some synthetic material such as in manufacturing of containers for planting young trees and applications for soil erosion control where biodegradable fiber is no removal required (FAO, 2018).

Jute mallow is used as a substitute for forest wood, as it is used increasingly in rigid packaging and reinforced plastic and is replacing wood in pulp and paper. In terms of conservation agriculture, jute mallow also has a set role and is now accepted as an environmental and cost effective material for various soil applications (FAO, 2018).

1.5. Agroecological perspective of jute mallow cultivation

Jute mallow can be grown either as a single crop or intercropped with other field crops such as sorghum or maize (Mathowa et al., 2014). Jute mallow can also be planted in rotation with other crops, resulting in healthier plants that are more resistant to damage by pests. This, in turn, can result in a decreased need for pesticides (Boyd, 2016; Sarkar et al. 2013).

In the nutrient rich cultivation systems, jute mallow does not require artificial fertilizers (Boyd 2012).

In case of added fertilizers, a good response can be indicated particularly to the addition of nitrogen (Ogunrindé &Fasinmirin, 2011).

Cultivating jute in crop rotations enriches the fertility of the soil for next crop, and decomposition of jute plants residue after harvest reduce the chemical fertilizers use and their costs (Khan et al., 2015).

Organic fertilizers are eco-friendlier and better alternatives to chemical fertilizers (Adediran, 2015), Animal manures improve yield of jute mallow and maintain soil fertility (Garjila et al., 2017).

In the current thesis, natural and social science perspectives on cultivation of jute mallow is in focus. Currently, jute mallow product is shipped by air or truck to fulfil the requirements of Swedish market and new food cultures. However, transport and storage processes can affect the nutritional value of products (Gliessman 2015),

From agroecological point of view, development of cultivation systems for production of jute mallow in Sweden contributes to environmental benefits through reduction of transport related to the import process. Jute mallow could also be used as crop to enhance the diversity of the cropping system as well as catch crop in the system.

Jute mallow plays an important role in nutrition and household food security. It plays a role in providing food and nutrition security and income opportunities among smallholder farmers (Tovihoudji et al, 2015). Jute mallow could be cultivated on a small scale in fields next to the houses and home gardens (Tovihoudji et al, 2015). This crop is mostly carried out by marginalized producers have low incomes (Gensch et al., 2011).

Consumers choices of food support many practices of industrial agriculture in the exported countries, especially in developing countries, as well as, consumers are isolated from the information and knowledge of production process, and the negative impacts their food choices have on the environment (Gliessman, 2015).

Introduction of jute mallow enhances the local production and removes intermediaries in market place, more than 84% share of the consumer food dollar going to the processing, packaging, shipping, and marketing middlemen, and leaving farmers with less than 16¢ of every food dollar spent. (Gliessman, 2015). Despite its nutritional and economic importance, it has been neglected by scientific research and development (ibid).

2. Background

Sweden is home to 9.8 million people and is one of the European Union countries that has taken in the largest number of refugees in relation to its population, and most of these refugees are from the Middle East at a rate of 10,000 people a week in 2015 (Crouch, 2015). In addition, about 16% percent of Sweden's population belong to foreign background (Nilsson, 2004). These demographic changes during the last years with increasing population and different food cultures put requirement on the Swedish market to import new food products to fulfill consumers' needs.

This import leads to high environmental impact and reduces the quality of the imported product. Introduction of new vegetable crops in order to meet the needed requirements is thus of great importance and leads to environmental benefits through reduction in economic and environmental transport costs, promoting sustainable farming practices and removing intermediaries in the market place, which enhances circular economy at the local level (Gliessman, 2015).

The integration of new crops into existing cropping system to meet the ever increasing demand for food can enhance the diversification of the system. Agricultural diversification reduces production and marketing risks and their implications for food security. Diversification can spread the risk among multiple production enterprises and provide a range of food items for the households (Asante et al, 2016). Conservation of soil and water resources, reduced disease, weed and insect infestation, reduced erosion, increased soil fertility and increased yields are key determinants among the agronomic benefits of diversification (Mainik and Rüschendorf, 2010).

Jute mallow is a crop candidate included in the Middle East food culture and has high consumer requirements. This crop is suitable for cultivation outdoors in field as well as indoors. It requires high temperature, nutrient rich environment and good irrigation technique. Due to the shallow root system, the crop is sensitive for drought. It is usually grown in sandy clay loam soil and is harvestable three to four weeks after planting. It can be re-harvested three or four times a season. Farmers can harvest six to ten tonnes of crop biomass (leaves plus fiber) per hectare. Despite these benefits, jute mallow has largely gone ignored by researchers, leading to a lack of quality of seed and indigenous knowledge about cultivation practices (Boyd, 2012). The current study is the preliminary step for developing commercial production for jute mallow in Sweden and investigating the acceptance of the introduction of jute mallow as exotic crop to the Swedish market.

3. Objectives

The overall objective of the study is to develop a natural and social science approach for cultivation of jute mallow under Swedish conditions. The sub-goals are to:

1. Study jute mallows growth performance and yield as affected by:
   a. two different commercially available substrates, Mediterranean peat substrate (MPS) and vegetable peat substrate (VPS).
   b. two different fertilizers, organic and inorganic fertilizers
2. Study the industrial and market potential for the introduction of the new crop to the Swedish market.

The research questions are:

1. Can commercially available substrates be used for cultivation of jute mallow?
2. Is there a need for additional fertilizers during the cultivation period in order to achieve a good growth and yield of jute mallow?
3. What effect do organic or inorganic fertilizers have on growth and yield of the crop?
4. How acceptable is the introduction of jute mallow by the horticultural industry, consumers and market?

4. Hypothesis

1. Growth development of jute mallow is better in MPS than VPS.
2. Amendment of organic fertilizer to the investigated substrate has a positive effect on growth performance and yield of jute mallow compared with inorganic fertilizer.
3. Introduction of new and locally produced crops to the horticultural industry and market meets with acceptance.

5. Materials & Methods

5.1. Natural science approach

5.1.1. Substrate and fertilizers

Two commercially available cultivation substrates, Mediterranean peat substrate (MPS) and vegetable peat substrate (VPS) (www.Plantage.com) were used. The major constituents of MPS were weakly decomposed peat (H2-4), highly decomposed peat (H6-8), bark, clay, coarse, sand, lime, mineral fertilizer, micronutrients (Table 1). The VPS consisted of weakly decomposed peat (H2-4), highly decomposed peat (H6-8), sand, clay, lime, chicken manure as described in table1. For the fertilizers part, one organic fertilizer, cow manure (CM) and one inorganic (NPK) were used. The nutrient content in CM (Econova Garden AB, Åby, Denmark) was N (2%), P (1,5%), K (1,7%) and Mg (0,8%). The NPK fertilizers (Svenska Foder AB, Lindköping) contains the N:P:K fertilizers in the proportions of 11:5:18.

Table 1: Properties of the used substrates, mediterranean peat substrate (MPS) and vegetable peat substrate (VPS).

Substrate properties	Unit	VPS	MPS
PH		5.5-6.5	5.0-6.5
Electrical conductivity	mS/cm	45	40
Density	kg/m^2	$450kg/m^2$	$490kg/m^2$
Organic matter content	%	>40% / ts	>70% / ts
Nitrogen (NO_3-N+ NH_4-N)	mg/l	160	190
Phosphorus	mg/l	45	50
Potassium	mg/l	290	220
Magnesium	mg/l	220	150
Sulfur	mg/l	160	100
Calcium	mg/l	250	150
Manganese	mg/l	15	20
Iron	mg/l	80	140
Boron	mg/l	0.3	0.5
Copper	mg/l	0.2	1.8
Zinc	mg/l	5	5.3
Molybdenum	mg/l	0.2	1.5

5.1.2. Experimental layout

A pilot experiment in the greenhouse facilities at Alnarp was conducted using 1.5 L pots. Each pot was filled with 500 g of either MPS or VPS. Each substrate was subjected to three different treatments; (1) control treatment with only substrate and no addition of either CM or NPK; (2) treatment with substrate and CM and (3) treatment with substrate and NPK. Each treatment consisted of four replicates (pots). This experiment design was conducted in three blocks leading to number of 12 replicates per treatment and substrate. The used substrates were moisturized before planting and five jute mallow seeds were sown in each pot. The pots were placed in a greenhouse chamber with the temperature of 20 $^{\circ}$C and relative humidity of 70%. Light supplement using high sodium pressure lamps with 160 µmol/m^{s}/s was also performed for 16 hours per day. The duration of the experiment was five weeks. During the first three weeks, the pots were manually moistured with 100 ml water every second day. In week four and five, the amount of irrigation water was increased to 200 ml every second day. One week prior to harvest CM and NPK fertilizers were integrated to the substrates with an amount of 8,8 g of CM and 1,6 g of NPK in each pot. Calculation was based on nitrogen application rate of 100 kg of N per hectare and according to the nutrient content in the substrate and fertilizers.

5.1.3. Analysis

5.1.3.1. Plant growth parameters

Plant development during the duration of the experiment was investigated according to extended BBCH-scale, general (Meier, 2001; Hack et. al., 1992), a system for a uniform coding of phenologically growth stages of plants. The phenologic development stages is recorded as follows: 0= Germination; 1=Leaf development (main shoot); 2= Formation of side shoots; 3= Stem elongation or rosette growth / shoot development (main shoot); 4= Development of harvestable vegetative plant parts or vegetative propagated organs; 5= Inflorescence emergence (main shoot) / heading; 6= Flowering (main shoot); 7= Development of fruit; 8= Ripening or maturity of fruit and seed and 9= Senescence, beginning of dormancy.

At harvest, biomass measurements including fresh weight of leaf and stems as well as roots were conducted.

5.1.3.2. Leaf area

Ten fully expanded leaves were randomly sampled from each replicate and the leaf area was measured using LI – COR. MODEL LI – 3100 AREA METER (LI – COR, inc. Lincoln. Nebraska USA)

5.1.3.3. Nutrient content in plan and substrate:

At harvest the nutrient content in plant and substrate with focus on micro- and macronutrients were performed. Analysis performed by LMI laboratory at Helsingborg, Sweden using SP-analyses for the leave samples and Spurway analyses fort the samples with the substrates.

5.1.3.4. Statistical analyses

The collected data were subjected to analysis of Variance Analyses (ANOVA) using the Minitab version 18. The data was analysed with One-Way ANOVA followed by Tukey's multiple comparison test. Differences were considered significant at $P < 0.05$. Tow- Way ANOVA was also used in the analyses considering two factorial effects of substrate and fertilizers.

5.2. Social science approach

Survey study is a tool used to build a primary picture about the industrial and market potential for the introduction of jute mallow to Sweden. The survey was performed using questionnaires. Questionnaires included questions (appendix 1) related to knowledge and interest in cultivation and consumption of jute mallow. The target groups were growers, consumers and wholesales. Vegetables growers located in south of Sweden and in particular Scania region were selected for this survey. Communication of the survey to the growers was performed by e-mail and in collaboration with Hushållningssällskapet. Questionnaires were send to ten growers, but only 5 growers responded to e-mail.

The consumers were randomly selected. The survey was communicated to consumers by personal interview. Five participants were included.

The survey was communicated to five wholesales by telephone as well as by personal interviews.

Survey with consumers and wholesales was performed by the master student.

6. Results & Discussion

6.1. Natural science approach

6.1.1. Plant growth parameters

6.1.1.1. Plant development and BBCH scale

In the current study, the phonological development stages 0-4 could only be observed and registed. Based on the development stages 0, the achieved results indicated significant difference ($p<0.05$) between seeds germination in MPS compared with VPS (Figure 3). This development stage starts from resting period or dry seed, then seed imbibition, bud swelling, seed imbibition complete, radicle (root) emerged from seed, shoot breaking through seed coat and growing towards soil surface, shoot/leaf breaks through soil surface and finally bud shows green tip (Meier, 2001).

Figure 2. Development of jute growth during the cultivation period of five weeks. Photo: S. Awad.

Germination was faster in MPS compared to VPS. This observation was recorded during the first week of cultivation where no extra fertilizers were added to the either of the substrates. The faster germination in MPS might attribute to the structure and nutrient content of this substrate, which differ from VPS. MPS contains bark, clay, and coarse which might contribute to more space and better water and gas exchange. In addition, MPS contained higher nutrient content regarding nitrogen, phosphor and micronutrients, which are essential in the germination process (Marchner, 2011). The higher nutrients content in MPS might also play an important role in the germination process. As indicated by Kumari. (2014), application of micronutrients could impact and speed seed germination.

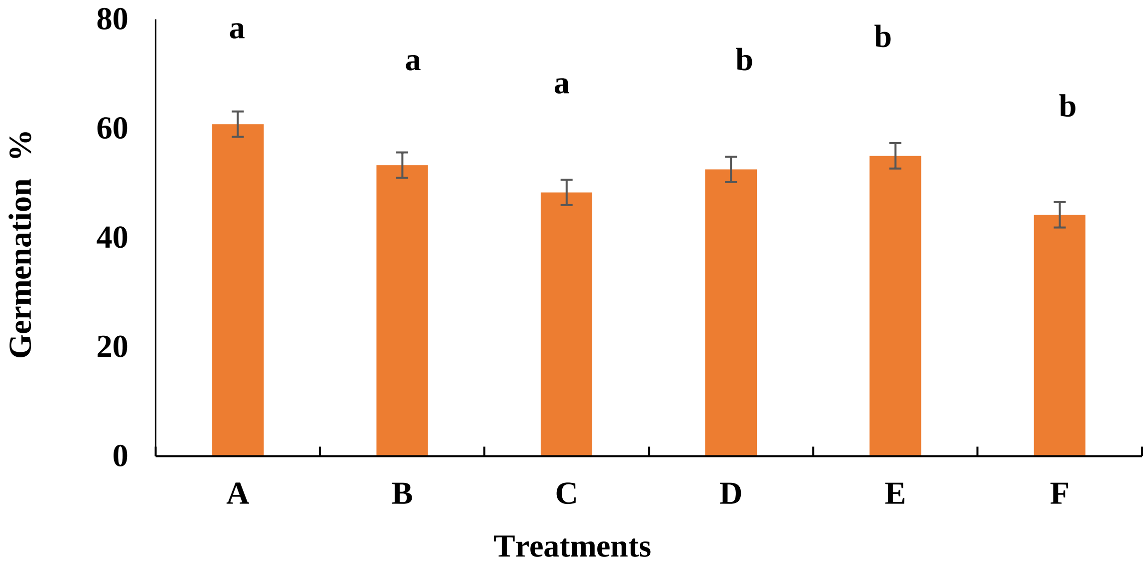

Figure 3: Germination in (%) of jute mallow plants during the first week of the cultivation period treated with, A-C= Treatments with mediterranean peat substrate (MPS) without addition of either cow manure or NPK and D-F= Treatments with vegetable peat substrate (VPS) without addition of either cow manure or NPK. Each bar is the mean of 4 replicates* 3 blocks. The letters indicate significant differences between the treatments.

However, the achieved results indicated no significant difference ($p > 0.05$) in growth development according to stage growth 1. Development of main shoot leaves in MPS was the same as in VPS. This indicates no significant effect of the substrate types on the development of main shoot leaves.

Based on development stage 2 the results showed significant differences ($p < 0.05$) on the effect of substrate type on side shoot development (Figure 4). Higher side shoot development indicated in VPS compared to MPS. These differences might be attributed to the type of nitrogen source in the substrate since VPS, contained chicken manure as a nitrogen source. Previous studies indicated the positive impact of chicken manure on the growth of jute mallow (Naim et al. 2015).

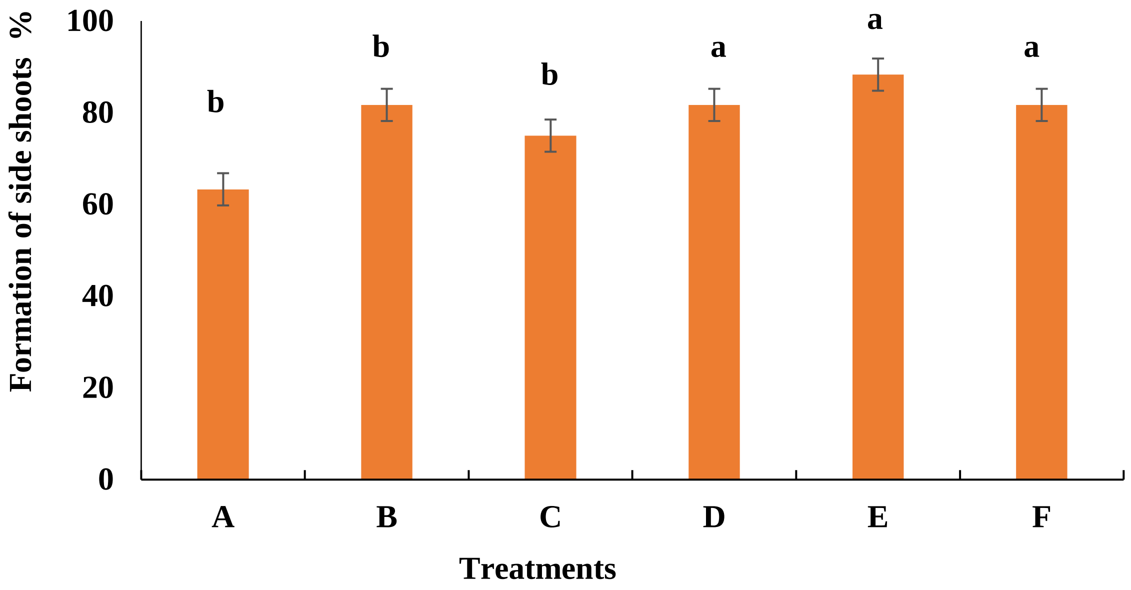

Figure 4: Formation in (%) of side shoot of jute mallow plants cultivated in two different substrates, A-C= Treatments with mediterranean peat substrate (MPS) without addition of either cow manure or NPK and D-F= Treatments with vegetable peat substrate (VPS) without addition of either cow manure or NPK. Each bar is the mean of 4 replicates* 3 blocks. The letters indicate significant differences between the treatments.

6.1.1.2. Plant height

Investigations regarding development stage 3 and plant height measurements indicated no significant difference ($P > 0.05$) in plant height between plants grown in MPS and VPS in week1 (Figure 5). The difference between plant height in MPS and VPS was significant ($P < 0.05$) in week 2. Plants grown in the MPS were significantly higher than its counterpart grown in VPS. The difference between plant height in MPS and VPS was also significant ($P < 0.05$) in week 3 (Figure 5). Higher plants were registed in MPS compared to VPS. Higher plant height in MPS might be related to the nutrient content in this substrate and especially to the content of the micronutrients. Studies performed by Patil et al. (2008) showed the positive interactions between plant height and application of micronutrients.

In week 4, no significant difference (P >0.05) in plant height between MPS and VPS could be indicated. As for the germination stage, the nutrients content and properties of the substrates affect plant height and enhance growth development during the first four weeks of cultivation.

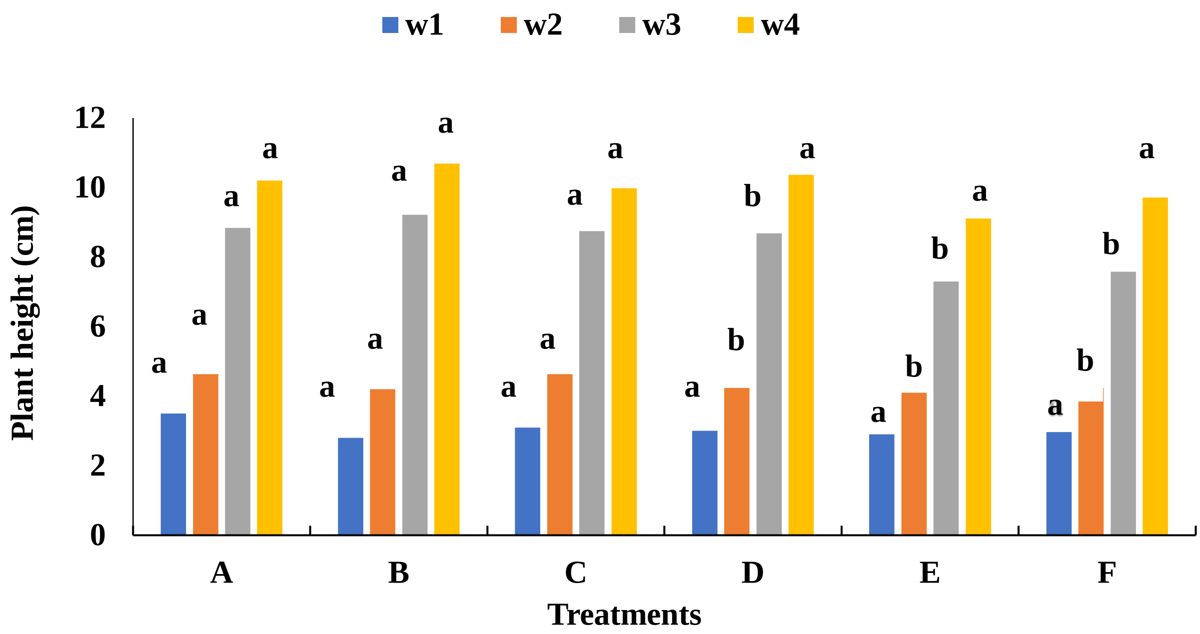

Figure 5: Height in (cm) of jute mallow plants during the first four weeks of cultivation in two different substrates, A-C= Treatments with mediterranean peat substrate (MPS) without addition of either cow manure or NPK and D-F= Treatments with vegetable peat substrate (VPS) without addition of either cow manure or NPK. Each bar is the mean of 4 replicates* 3 blocks. The letters indicate significant differences between the treatments.

In week 5, after the addition of either CM or NPK, there were significant differences ($p<0.05$) in plant height among the plants grown in MPS (Figure 8). Higher plant height was recorded in the MPS treatments with either CM or NPK compared with the control treatment. Plants cultivated in MPS and treated with NPK were highest followed by those treated with cow manure and thereafter the control treatment. These results indicated the effect of fertilization in on height of plants grown in MPS. The highest plant height in MPS treatment with NPK might due to the solubility of the NPK fertilizers in the substrate. In general, organic fertilizers are slower in releasing nitrogen than inorganic ones (Onasanya et al., 2009). Organic fertilizers have to decompose before the nutrients can be released and available for plant uptake, which makes their action slower than inorganic ones (Adediran, 2015).

Figure 6: Difference in plant height among the plants grown in MPS with treatments A, B and C in week5. Photo: S. Awad.

There was a significant difference ($p < 0.05$) in plant height among the plants grown in VPS. The control treatment with VPS showed the highest plants followed by those treated with either CM or NPK (Figure 8).

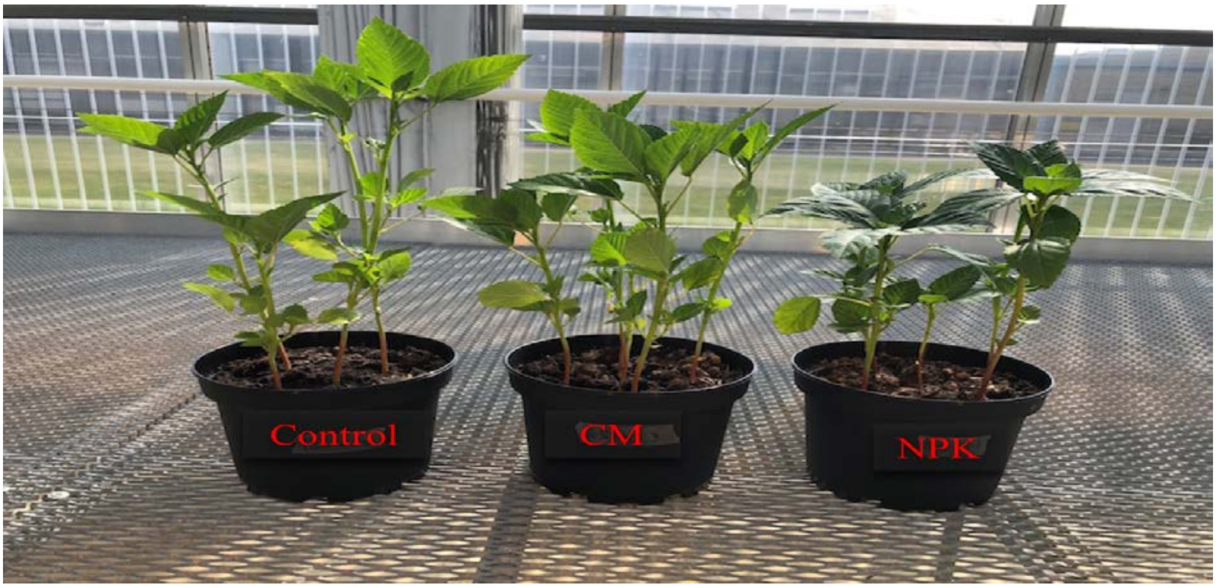

Figure 7: Difference in plant height among the plants grown in VPS with treatments D, E and F in week5. Photo: S. Awad.

This indicated a reduction in plant height after the addition of the fertilizers. However, this reduction might be contributed to slower solubility of CM and NPK in VPS due to the structure of the substrate compared with MPS that included bark, coarse as components. This strength also the conclusion about the slower release of nitrogen from organic fertilizers and that the time between the application of the fertilizers and plant measurements is too short for any conclusions. Since plant height measurements were taken one week after the application of the fertilizers which is short time to indicate an effect by cow manure. Under these circumstances, this would lead us to the rejection of the hypothesis considering the addition of CM as an organic fertilizer has a positive effect on the growth of jute mallow more than inorganic fertilizer, NPK in MPS. Further, the amount of the added fertilizers might be high to be added to the organic substrate and thereby causing a reduction in plant growth.

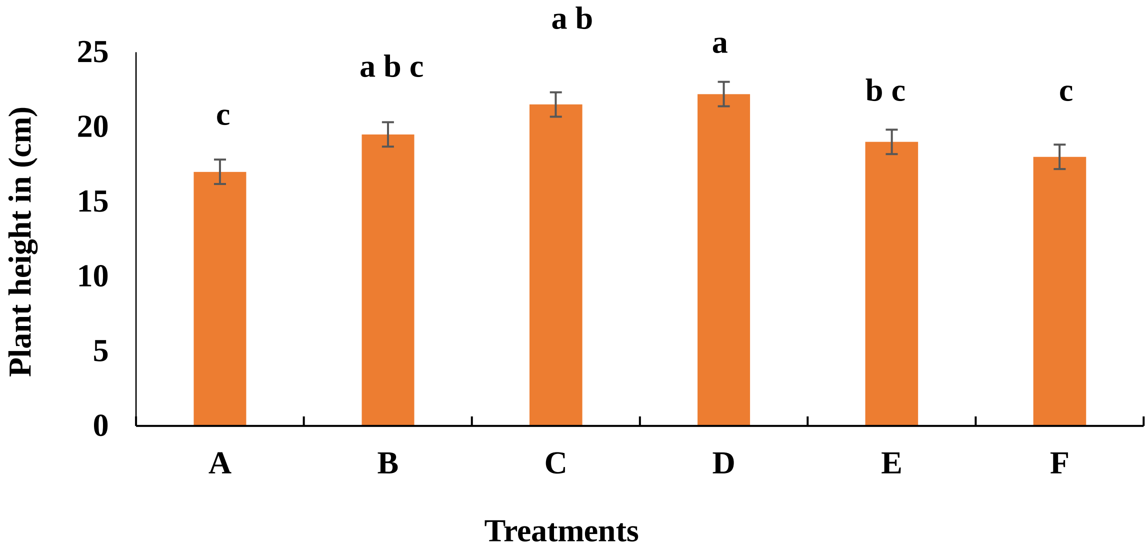

Figure 8: Height in (cm) of jute mallow plants after five weeks of cultivation subjected to six different treatments; A= Mediterranean peat substrate (MPS) used as a control without addition of fertilizers; B= MPS with cow manure as a fertilizer; C=MPS with NPK as a fertilizer; D= Vegetable peat substrate (VPS) used as a control without addition of fertilizers; E= VPS with cow manure as a fertilizer; F= VPS with NPK as a fertilizer. Each bar is the mean of 4 replicates* 3 blocks. The letters indicate significant differences between the treatments.

6.1.1.3. Plant biomass

6.1.1.3.1. Fresh leaf and stem biomass

At harvest leaf and stem biomass as well as root biomass were analysed. The results show highly significant difference ($p < 0.001$) in leaf and stem biomass among plants grown in MPS.

The biomass of plants grown in the amending MPS with NPK was highest compared to the control treatment with MPS and the amending MPS with CM (Figure 9).

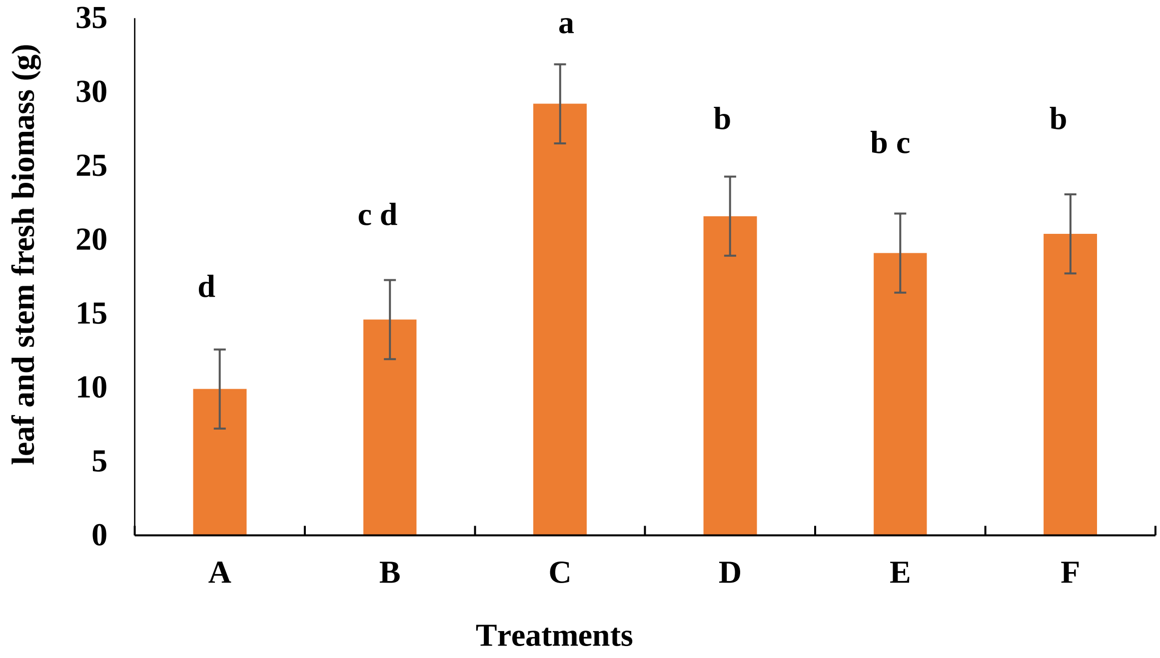

Figure 9: Fresh biomass in (g) of jute mallow leaves and stems subjected to six different treatments: A= Mediterranean peat substrate (MPS) used as a control without addition of fertilizers; B= MPS with cow manure as a fertilizer; C=MPS with NPK as a fertilizer; D= Vegetable peat substrate (VPS) used as a control without addition of fertilizers; E= VPS with cow manure as a fertilizer; F= VPS with NPK as a fertilizer. Each bar is the mean of 4 replicates* 3 blocks. The letters indicate significant differences between the treatments.

The results showed no significant difference ($p > 0.05$) in fresh leaf and stem biomass among plants grown in the VPS. On the other hand, fresh biomass of leaves and stem was higher in all VPS treatments compared with the control treatment with MPS or the treatment with MPS and CM. the results in the current study indicated a highly significant difference ($p<0.0001$) in plant biomass between the investigated growing media with and without application of cow manure.

Consumption of jute mallow is connected to the leaves, and the fresh weight of leaves is an indication of plant yield. In the current study, plant yield in MPS was best after application of NPK. This might due to the faster solubility of NPK as inorganic fertilizer compared to the organic fertilizers, which could affect both growth and yield of the plants.

However, VPS indicated better yield in all treatments compared to the control treatment with MPS or MPS with CM. This might conclude that VPS is better candidate for the cultivation of jute mallow with or without fertilization compared with the control treatment MPS, since yield in MPS could only be achieved after fertilization with NPK.

Further, the content of chicken manure in VPS provides plant nutrients and enhance plant growth as indicated by Kilande et al., (2011) and Babiker et al. (2009).

Application of CM or NPK to the VPS indicated no effect on fresh leaf biomass. This might due to the structure of VPS and slower solubility of CM and NPK in such substrates.

However, despite the advantages of organic fertilizer application, organic manure using it have to also limited to enhance the crop yield. organic fertilizers have to decompose before it can release nutrient for plant uptake thereby making its action slower, as well as use of organic fertilizers increases the risk of infections (Adediran, 2015)

According to a United Nations report, livestock release 14.5 percent of all greenhouse gases (methane, carbon dioxide, nitrous oxide and fluorinated gases) and over half that comes specifically from cows. Cow's manure can be problematic, the phosphorus and nitrogen in cow manure can be leached and contributed to produce toxins harmful in the environment (water). (DeMartini, 2017).

From environmental point of view, application of NPK needs to be replaced by environmentally friendly alternative. Organic fertilizers are better alternatives to chemical fertilizers and jute mallow response well (Adediran, 2015).

However, organic manure performs better when used at the optimal rate (Tovihoudji et al, 2015).

6.1.1.3.2. Fresh root biomass

The achieved results indicated significant differences ($p < 0.05$) in fresh root weight among plants grown in the MPS.

The highest fresh root biomass was indicated in MPS with cow manure (Figure 10).

This could be attributed to improvement of soil properties by application of cow manure and enhancing the nutrient content of the substrate. As well as, P fertilization stimulates root growth over shoot growth (Ristvey, 2007).

Moreover, A study performed by Baldi and Toselli. (2013) showed that application of cow manure enhanced production of new roots.

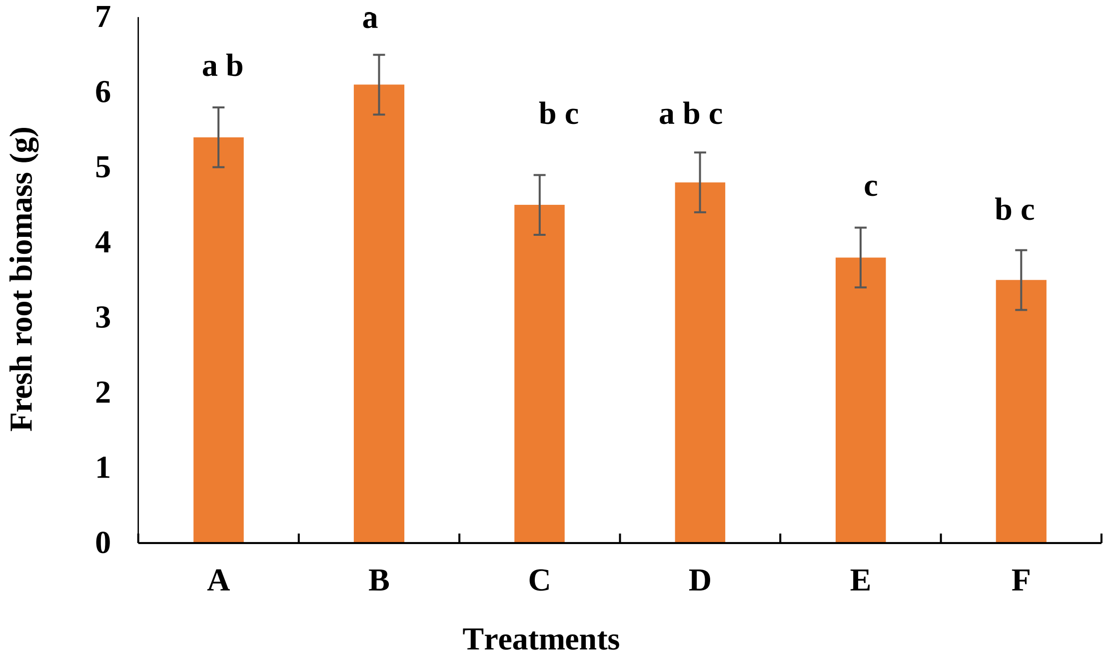

Figure 10: Fresh root biomass of jute mallow plants in (g) with six different treatments: A= Mediterranean peat substrate (MPS) used as a control without addition of fertilizers; B= MPS with cow manure as a fertilizer; C=MPS with NPK as a fertilizer; D= Vegetable peat substrate (VPS) used as a control without addition of fertilizers; E= VPS with cow manure as a fertilizer; F= VPS with NPK as a fertilizer. Each bar is the mean of 4 replicates* 3 blocks. The letters indicate significant differences between the treatments.

The results showed no significant differences ($p > 0.05$) in fresh root biomass among plants grown in VPS.

However, the effect of substrate type and addition of the fertilizers provide a highly significant difference ($p < 0.0001$) in the fresh root biomass between plants grown in MPS compared to VPS (Figure 10).

The maximum fresh root biomass was recorded in the amending MPS with cow manure and the minimum in the amending VPS with NPK.

This might also be related to substrate structure and further studies on the effect of substrate physical properties on root growth need to be perform.

As mentioned by Hati et al. (2005) physical properties in soil have a strong interaction with root growth.

6.1.1.4. Leaf Area

The results show highly significant difference ($p < 0.0001$) in leaf area among plants grown in MPS.

Figure 11: Leaves area by using LI – COR. MODEL LI – 3100 AREA METER. Photo: S. Awad.

The highest leaf area was recorded in the amending MPS with NPK and the minimum leaf area in control treatment of MPS (Figure 12).

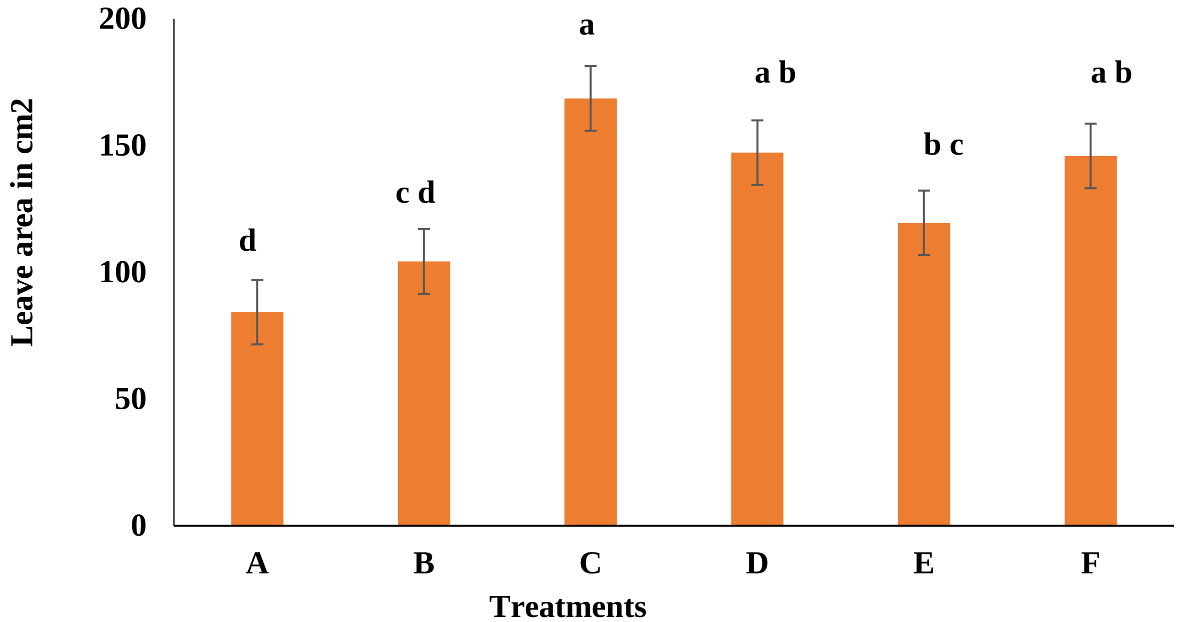

Figure 12: Leave area of jute mallow plants in (cm^2) subjected to six different treatments: A= Mediterranean peat substrate (MPS) used as a control without addition of fertilizers; B= MPS with cow manure as a fertilizer; C=MPS with NPK as a fertilizer; D= Vegetable peat substrate (VPS) used as a control without addition of fertilizers; E= VPS with cow manure as a fertilizer; F= VPS with NPK as a fertilizer. Each bar is the mean of 4 replicates* 3 blocks. The letters indicate significant differences between the treatments.

NPK fertilization in MPS enhanced leaf area. As indicated by Gliessman. (2015), nitrogen fertilizers increase leaf area of plant in addition to increase plant yield and growth.

The results showed a significant difference ($p < 0.05$) in leaf area among plants grown in VPS. The difference between MPS and VPS in leaf area was highly significant ($p < 0.0001$).
Higher leaf area was indicated in control treatments and treatments with cow manure in the VPS compared to its counterparts in MPS.
Organic manure as well as nutrient content enhanced and increased the capacity of plant to trap solar energy for photosynthesis (Detpiratmongkol et al., 2014; Madisa et al., 2013).

6.1.1.5. Nutrient content in growing media

Analyses of the nutrient content in substrates after the cultivation period of five weeks indicated lower pH values in the control treatment of MPS and MPS together with NPK (Table 2) compared to the start values in table 1. The pH value of acidic character is related to the mineralization process and the high amount of ammonium in the soil compared to nitrate content (Mathowa et al., 2014).
Nitrates accumulate to a greater degree in soils of high pH value (Larsinos,2014)
However, our results indicate higher ammonium content in all the treatments compared with nitrate content except for the treatment with VPS together with NPK.
The higher nitrate content compared to ammonium is an indicator of good nitrification in substrate. The results indicated also better nitrification effect in the treatment with VPS and NPK compared with all other treatments. This may be attributed that the amount of fertilizer applied to the substrate is the most important in the accumulation of nitrates. Given a large amount of applied fertilizer, nitrates accumulate in large amounts in soils (Larsinos,2014)
Nitrate is often the major source of N available to higher plants, especially to vegetables, and plant growth response highly dependent on nitrate supply (Chen et al., 2004; Lucarini et al., 2012 and Boink, 2001).

Table 2: Properties of substrates after 5 weeks of cultivation with six different treatments: A= Mediterranean peat substrate (MPS) used as a control without addition of fertilizers; B= MPS with cow manure as a fertilizer; C=MPS with NPK as a fertilizer; D= Vegetable peat substrate (VPS) used as a control without addition of fertilizers; E= VPS with cow manure as a fertilizer; F= VPS with NPK as a fertilizer.

Treatments	Unit	A	B	C	D	E	F
PH		4.9	5	4.4	6.2	6.5	5.9
Electrical conductivity	m_S/cm	0.5	1.2	2	1.9	1.7	3.3
Nitrogen	mg/l	2.6	6.6	19	2.0	5.6	44
Nitrate-N	mg/l	1	1	4	1	2	26
Ammonium	mg/l	3	7	15	2	4	18
Phosphorus	mg/l	12	54	45	15	74	40
Potassium	mg/l	75	160	190	190	290	380
Magnesium	mg/l	64	91	97	190	190	180
Sulfur	mg/l	33	54	200	190	97	280
Calcium	mg/l	270	320	350	860	740	790
Manganese	mg/l	5.1	5.2	9.4	1.8	2	3.7
Iron	mg/l	1.9	1.7	2	0.97	1.1	1.1
Boron	mg/l	0.3	0.4	0.72	0.28	0.36	0.58
Copper	mg/l	2.1	1.8	2.9	0.92	1.1	1.2
Zinc	mg/l	5.2	5.8	6.4	3.8	6.8	5
Molybdenum	mg/l	0.17	0.2	0.33	0.1	0.1	0.071
Sodium	mg/l	43	81	75	110	110	100
Chloride	mg/l	16	50	34	95	90	100
Aluminum	mg/l	2.5	2.5	2.1	1.8	2.1	2.1

The nutrient content of the harvest substrates was obviously due to the residual nutrients deposited in the soil after nutrient uptake by the crop (Garjila et al., 2017).

Considering the mineral elements, iron amounts reduced in all treatment compared with its values in start values in MPS and VPS (Table1). This may be attributed that plants absorbed the dissolved iron salts from the growth medium. Moreover, Iron content in all treatments with VPS was lower compared with MPS treatments. Manganese amount reduced in all treatment of substrates compared with the start value of manganese (Table1). Calcium ranges 270-860 mg/l, and the calcium content was the highest in the control treatment in VPS. The content of potassium increased in all treatments in MPS and in VPS treated with CM, but it increased highly in VPS treated with NPK. This is might be related to potassium application in NPK treatment that might affect the uptake of the nutrient elements (Onasanya et al., 2009).

6.1.1.6. Nutrient content in plant

Analyses of nutrients content in leaves at harvest indicated a significant difference ($p < 0.05$) in nitrate-N amount in plants grown in treatments with control substrates or treated substrates with either CM or NPK (Table 3).

Table 3: Nutrients content (mg/100g) of jute mallow plants with six different treatments: A= Mediterranean peat substrate (MPS) used as a control without addition of fertilizers; B= MPS with cow manure as a fertilizer; C=MPS with NPK as a fertilizer; D= Vegetable peat substrate (VPS) used as a control without addition of fertilizers; E= VPS with cow manure as a fertilizer; F= VPS with NPK as a fertilizer.

Treatments	A	B	C	D	E	F
Nitrate-N	7.7	12.6	129.3	2.5	12.5	503.0
Ammonium	10.4	8.0	12.3	6.5	4.5	18.5
Phosphorus	1106.7	1110.0	1011.0	525.3	515.3	630.0
Potassium	3233.3	3566.7	4633.3	3133.3	2307.7	4450.0
Magnesium	394.7	308.0	463.0	326.0	327.7	428.0
Sulfur	303.3	340.0	653.3	230.0	235.0	495.0
Calcium	2443.3	2176.7	1793.3	1776.7	1640.0	1615.0
Manganese	70.0	78.0	130.0	30.7	29.0	33.0
Iron	6.3	7.7	11.7	7.5	7.5	5.9
Boron	3.5	3.8	8.0	3.6	2.7	6.3
Copper	0.8	0.7	0.8	0.4	0.3	0.4
Zinc	4.8	4.4	8.1	3.5	2.9	3.7
Molybdenum	0.1	0.1	0.1	0.0	0.0	0.1
Aluminum	0.9	1.0	0.9	0.8	0.7	1.0
Silicon	4.4	3.0	5.5	3.3	4.5	3.6

Nitrate-N amount ranged 7.7-503 mg/100 g. Nitrate concentrations increased after addition of either CM or NPK compared with the control. The highest amount was registed in NPK treatments with either MPS or VPS compared to CM treatments. The highest amount was recorded in VPS with NPK. On other hand, the control treatments indicated the lowest nitrate content. However, the control with VPS showed lower content than the control with MPS.

Nutrient uptake efficiency was affected primarily by the amount of nutrient applied (Ristvey, 2007).

Commonly, P fertilizer is applied to ensure that sufficient P is available to optimize crop yield and maturity (Grant et al.2005).

Phosphorus fertility should be based on an N rate that is sufficient for growth and one that stimulates higher uptake efficiencies.

Few studies have related N and P availability (from fertilization) to nutrient uptake and nutrient uptake efficiency by plant (Ristvey, 2007).
Many standard fertilizer formulas have N: P ratios well more than plant P requirements
Growth plant required P is associated with growth of tissue and in particular root growth.
Reducing excess N and P fertilization to match plant growth requirements increases nutrient uptake efficiency and reduces nutrient loss to the environment (Ristvey, 2007).
The effect of P fertilizers is related of the balance of other nutrients present (Grant et al.2005). and P fertilizers should be added in very early stages of crop growth to achieve the adequate tissue P concentrations (Grant et al. 2001).
Jute mallow plants grown in MPS have almost twice as high P content than plants grown in VPS . The substrates content of phosphorus was 45 and 50 mg/l in VPS and MPS respectively (Table 1), and P fertilizers can increase the P concentration in plant tissue (Liu et al. 2000) and this is related of the soil P also (Grant et al.2005).
The nutrient concentration and their ratios in roots can influence the tissue nutrient content or nutrient imbalances (Muthukumar and Udaiyan 2000).
The rate of P uptake is related to the rate of water uptake and P concentration in soil solution, and plants absorb P ions from the soil solution quickly (Grant et al.2005).
However, the high P content in plants grown in MPS might be attributed to faster solubility of the NPK fertilizers in the MPS due to its structure compared with VPS.
Nitrates play an important role during nutrition, growth and development of plants (Lucarini et al., 2012). Leafy vegetables contain the highest concentrations of nitrate (Iammarino, 2014; Temme, 2011). However, an amount of nitrate in green leafy vegetables can have both positive and negative effects on the human body (Brkic et al., 2017). European Food Safety Authority's recommendation daily intake (ADI) of nitrate in the human body is 3.7 mg/kg body weight/day (Brkic et al., 2017). The achieved results showed that control treatment with VPS is suitable candidate for cultivation of jute mallow since nitrate content is lower in comparison to the other treatments.
Results showed that the highest amounts of ammonium, potassium, sulfur and boron were indicated in plants grown in amendment substrates with NPK. The highest amount of calcium was indicated in the control with MPS (Table3). As reported by (Ndlovu and Afolayan, 2008), jute mallow contains per 100 g about 250-266 mg calcium and 4.8 mg iron. The achieved results showed an exceeded amount the one presented in these studies. However, more investigation should be performed in nutrient content in jute mallows leaves. Iron content in VPS substrate was lower than MPS substrates in all treatments (Table2). The iron amount in plants grown in

VPS with NPK or CM was lower compared with its counterparts in MPS. As mentioned by Rume. (2010), iron concentration ranged between 7.2 -7.7 mg/100g. The achieved results showed a concentration within this range in the control with VPS control and VPS with CM.

6.2. Social science approach

6.2.1 Survey study

Results of the survey study presented different perspectives about knowledge and interest in cultivation and consumption of jute mallow.

Consumers indicated that jute mallow is sold in only Arabic stores in Sweden, and it is available all year round in dry form. 80% of consumers or 4 consumers prefer to buy fresh jute mallow for more heath and good quality. The average consumption of dry leaves of jute mallow ranged between (200-800) g per month. Consumers were interested in the quality and source of the importing product.

Based on survey with consumers, locally produced jute mallow to the market meets with acceptance. The achieved results from the survey study showed that jute mallow is sold in only Arabic stores in Sweden. It is available all year round in dry form and 80% of the consumers prefer to buy fresh jute mallow. Average consumption of dry jute mallow was between 200 and 800 g per month. Around 80% of consumers were interested in the quality and source of the importing product.

Figure 13: Dry jute mallow product in Arabic store in Malmö. Photo: S. Awad.

Jute mallow is imported to Sweden in fresh form during spring and summer from countries such as Jordan, Lebanon, Egypt and Africa.

For the wholesale, the high import costs and the reduced quality of the product due to transportation make local production of jute mallow a good and interesting alternative. Wholesale stated also that import of jute mallow from countries outside Europe is more difficult compared to imported products from other European countries. According to wholesale wholesalers, the demand of jute mallow increased in the last years because of increase foreigners from the Middle East region. Furthermore, 80% of wholesales preferred importing of jute mallow from abroad, because they are afraid that the taste of jute mallow may change under Swedish agricultural conditions as well as production costs in Sweden will be higher.

Wholesalers indicated that 100% of consumers the Swedish consumption of jute mallow belong to foreign background.

However, they stated that introduction of jute mallow to the Swedish market will attract Swedish consumers.

With focus on growers' answers, 40% of the growers lack information about jute mallow plant, how it is cooked or eaten and whether it is sold in Sweden or not. 20 % of growers stated that jute mallow cultivation in Sweden depends on yield, multiple uses, and its cultivation success under Swedish conditions and is related to the consumers' number. Moreover, an interest was indicated by the growers to grow jute mallow but they need more knowledge about the cultivation requirements and economic support to perform that. However, 40% of the growers think that jute mallow does not success due to its requirements for high temperature and warm weather, but 20% of the growers were interested to be the first who grow jute mallow if seeds are available. Growers stated also that there are always difficulties in introducing new crop and new tastes to the customers.

7. Conclusions

The current study revealed that cultivation of jute mallow could be performed in commercially available substrates. The structure of the substrate with content of large fractions and the content of macro- and micronutrients are good component to achieve fast germination. This was designated by faster germination of jute mallow seeds in Mediterranean peat soil (MPS) that contains bark and coarse fractions unlike the content in the other used substrate, vegetable peat soil (VPS). Further, VPS contained higher amount of nitrogen and phosphorus in addition to the micronutrients. However, cultivation of jute mallow in the control treatment with VPS enhanced plant growth development, leaf area and yield, as indicated by leaf and stem biomass, compared to the control treatment with MPS. This pointed out a scientific baseline that the nutrient content in VPS with organic manure, chicken manure, is a suitable alternative to achieve a good growth and yield of jute mallow plants. The results revealed also that addition of extra organic or inorganic fertilizers showed no effect on growth and yield of jute mallow in VPS compared to the control treatment, while only inorganic fertilizers could affect the examined parameters in MPS. Moreover, control and fertilized VPS showed better growth and yield effect compared with the control treatment in MPS. This is an additional indicator showing that VPS is a good candidate for cultivation of jute mallow compared to MPS. The results lead us to the conclusion that extra fertilization of VPS is not needed in an early stage of the cultivation period, while fertilization is need in MPS but more time is required to achieve an effect from organic fertilizers and apply the in the system aiming in reducing the use of inorganic ones.

The Social science approach showed that jute mallow is a crop appreciated to its high health, environmental and economical values. However, lack of information about its cultivation and marketing is a challenge for the growers and makes it difficult for them to take a step forward towards the cultivation of jute mallow. Introduction of jute mallow cultivation under Swedish conditions is an agroecological practice in order to maintain a sustainable cultivation using different growing media and optimize the used of organic fertilizers instead of NPK to enhanced growth and yield. Jute mallow cultivation contributes to environmental benefits and enhances the diversity of the cropping system.

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Appendix

Questionnaire about a new leafy vegetable to Swedish market

Number (---------)

Name: Shadia Awad

Agroecology master program

Swedish University of Agricultural Sciences in Alnarp

Tick the answer option that you think suits best or write your answer to the line

- **The studied:**

  ☐ growers ☐ Wholesales ☐ Consumer

- What is this vegetable's name in the bild?

 answer: ___________________________

1. **Growers**

Did you test this leafy vegetable?

☐ Yes ☐ No

Did you know if this vegetable is sold in Sweden?

☐ Yes ☐ No

If yes, where? ___________________________

Do you think that there is a need to plant it here?

☐ Yes ☐ No

If yes, why? ___________________________

Are you thinking to grow it?

☐ Yes ☐ No

If yes, what do you need to apply that?

____

What is your information sources about cultivation this leafy vegetable?

____

Have you interest to prove new agricultural ideas?

____

Would you like to be the first grower of jute mallow?

☐ Yes ☐ No

If yes, why? ___________________________

What is the difficulties of cultivation of new vegetable for you?

____

Do you need help or support to cultivate new crops?

☐ Yes ☐ No

If yes, what is kind of this help? ___________________________

Do you think that jute mallow will be part of Swedish food or diet?

☐ Yes ☐ No

Do you think that jute mallow will be a popular crop in future?

☐ Yes ☐ No

What are your requirements to grow jute mallow?

____

2. Wholesales

Which country do you import jute mallow from? ______________

What is the difficulties of import of new vegetable? ___________________

How much % of consumers of jute mallow? ____________________

Who is the most consumers of jute mallow as (%)? ____________

Is demand of jute increasing largely? ________________________

☐ Yes ☐ No

Why? ________________________

What is factors that affect supply and demand of jute mallow?

____

Would you like that jute is grown in Sweden instead of importing it?

☐ Yes ☐ No

Why? ________________________

3. Consumers

Where do you buy jute mallow? ________________________

Would you prefer to buy fresh or dry jute mallow?

☐ fresh ☐ dry

Why? ________________________

Is jute mallow available at any time?

☐ Yes ☐ No

What is average your consumption of jute mallow per months? _______

Are you interested with the exporting country for jute mallow?

☐ Yes ☐ No

why? _______________________