Winter Vegetables Production as Affected by Soil and Environment

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Abstract

The main purpose of this study is to determine the effects of soil and environment on winter vegetable production. It also explores the factors of soil and environment responsible for yield variation of winter vegetables. This study is a qualitative study which uses a number of secondary sources including journal articles, books, scientific magazines, statistical data and internet sources. This study reveals that there is a great impact of soil and environment on winter vegetable productions. It also explores that a number of edaphic factors like soil type, soil pH, soil fertility, and soil salinity and environmental factors like light, temperature, humidity, drought and flooding are responsible for variation of yield of winter vegetable production. This article suggest that a consciousness and knowledge dissemination is necessary to the farmers level about the effects of soil and environmental factors for maximum yield of winter vegetables.

Keywords: Soil, environment, winter vegetables, production, edaphic factor, yield.

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Introduction

Soil and environment is the major part of crop production. vegetables need good soil and environment for better production (Charrier *et al*., 2015). Mainly vegetable produce in winter but all over the season vegetables can grow. In vegetables production depends on soil and environment (Comas *et al*., 2010). In soil PH, soil moisture, soil humidity, soil texture, and soil fertility are the needs for good vegetables (Hartz, 2006). Other than temperature, rainfall, humidity, and light intensity are also need for vegetable production. Mainly vegetables production depends on environment (Sharmin *et al*., 2015). Bangladesh is called the land of six seasons. It has a temperate climate because of its physical location. Though the climate of Bangladesh is mainly sub- tropical monsoon, ie warm and humid; bangle calendar year is traditionally divided into six seasons; Grisma (Summer), Barsa (Rainy), Sarat (Autumn), Hemanta (Late Autumn), Shhit (Winter), And Basanta (Spring). In Bangladesh vegetables produce in mainly to two seasons such as winter and summer. Winter seasons are the major seasons for vegetables productions. In Bangladesh, 70% vegetables can grow in winter seasons such as Cole crop, brinjal, tomato, different types of leafy vegetables (Akter *et al*., 2016). they needs low temperature below than 20c. winter season called vegetables seasons in our country (BBS, 2016). All vegetables cannot grow in all regions in our country it can depends on soil types such as potato can grow in north part of our region such as Thakurgon, Rangpur, Bogra, and south part Munsigonj. This soil and environment are good for better potato production (BBS, 2016). Maximum Cole crop grown in north part of our country because of environment is better for Cole vegetables production. Slain soil is not suitable for vegetable production. and high temperature and rainfall also. Vegetable cannot tolerant high rainfall, slain soil, high temperature. According to statistics, maximum natural hazard in Bangladesh occurred in April to September in summer seasons (BBS, 2016). Humidity and temperature higher in this time than winter season and medium and lowland below water level by flooding. Flood decrease the productions area in summer seasons. Vegetable forms a group of specialized crops. They are important economically and from a health point of view. They fit well in most farming systems as their maturity period from planting to harvest is short (Ben *et al*., 2015). With the ever-increasing human population, vegetables have played an important role in our national economy. Vegetables provide maximum output and more income per unit area of land to small-scale farmers, particularly when compared to cereals (Bisbis *et al*., 2018). A wide range of vegetables

are grown in Bangladesh (Akter *et al*., 2012). The summer vegetables are mostly indigenous whereas most of winter vegetables are of European origin. Production of vegetables in the cool season is hazard free, and blessed with a favorable climate (Busch *et al*., 2017). During summer, vegetable production is affected by flood, cyclones, and other factors associated with high temperature, humidity and rainfall (Charrier *et al*., 2015). At present, vegetables are grown in about 4.52 lac hectares of land with total production of 30.8 lac metric tones (BBS, 2016). Vegetable production in Bangladesh is far below requirement. BARI and other organization have developed a good number of HYV of different vegetable crops including improved production technology (Akter *et al*., 2016). If farmers use these technologies then internal requirement will be met up even we can export some vegetables abroad. The most important vegetables are winter vegetables (BBS, 2016). Relations of soil and environment conditions are essential for winter vegetable productions. Different types of soil present in our country in different region. Winter season also called Rabi seasons. Rabi season start from October and last time of this season April. In this season temperature varies from 10 to 21^0C.

Objective

The main purpose of this study is to explore the responsible factors of soil and environment for yield variation of winter vegetables.

Methodology

This study is a qualitative study which uses a number of statistics for exploring the effect of factors of soil and environment on winter vegetable productions. This study is conducted based on secondary data. This study has been consulted about 57 scientific articles searched from web of science, science direct, google scholar and researchgate and environmental and edaphic factor data from Bangladesh Bureau of Statistics 2015 and 2012. Finally, it has consulted with a number of websites which bearing soil and environment related study especially for winter vegetable productions.

Review of Literature

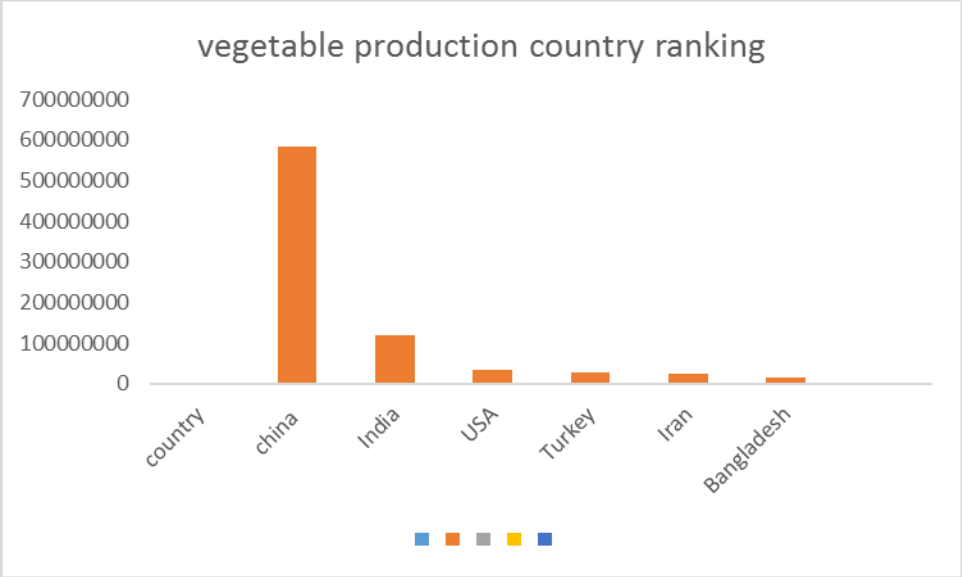
Bangladesh has been striving for rapid development of its economy. Economic development in Bangladesh could not be achieved unless a breakthrough is achieved in the agricultural sector (Akter *et al.*, 2016). The overall contribution of the agriculture sector is 16.33 percent to Gross Domestic Product (GDP) at current price (BBS, 2016). Agriculture, the main occupation of the people, witnessed a growth rate of 2.1% per annum with 47.35% of total labor force engaged in agriculture (BBS, 2016). Its total food grain and vegetable production are 375.08 lakh Metric Ton (MT) per year (BBS, 2012). Furthermore, export of agricultural commodities such as, frozen food, tea, raw jute and others covered about 7.49% of the total earnings (BBS, 2012). Though there is a trend of transformation of the share of agricultural and industry sector over the last two decades, the share of service sector remained constant for the same period except minor year to year variation (Hartz, 2006). The agricultural sector contributed 33% to GDP at the beginning of eighties which reduced gradually to 29% in 1990-91 and 25% in 2000- 01 (BBS, 2016). This share stands at 20.87% in 2007-08 and 18.70% in 2012-13 and 16.33% in 2013-14 (Akter *et al.*, 2016). The industry sector contributes 17% to gross domestic product at the beginning of eighties which reduces gradually to 21% in 1990-91 and 26% in 2000-01. This share is about 29.66% in 2007- 08 and 31.98% in 2012-13 (BBS, 2016). The growth and stability of the economy of Bangladesh primarily depends largely on the growth of agriculture. About 75% of the total population live in rural areas and are directly or indirectly engaged in a wide range of agricultural activities (Akter et al., 2012). The agricultural sector comprises crops, forests, fisheries, and livestock. Vegetable crops are attractive because: (1) they are labor intensive cash crops; (2) they are considered more profitable than staple crops and less risky as compared to the production of pulses and mustard; (3) they have relatively short production cycles as compared to many field crops;(4) they are suitable in some high land areas, particularly after irrigation has become available; available; and (5) they serve social purposes, occasionally given away as gifts to visiting neighbors (Machado & Serralheiro, 2017). But above all the demand for vegetables has been increasing, while demand for other crops, such as jute has declined. Vegetable sub-sector can play important role to solve these problems in the shortest possible time. Here importance of vegetable can be realized from two stand points such as, economic point of view and nutritional point of view. They provide dietary fiber necessary for digestion and health and combating malnutrition, curing nutritional disorders and diseases like anemia, blindness, scurvy,

and goiter (Worsley *et al*., 2016). including physical and mental growth and help increase efficiency of labor and span of working life, which eventually influence the economic potentials of the nation. Statistics over the past decade show a nearly 25 percent increase in the consumption of fruits and vegetables between the years 2000 and 2010. However, the average per capita fruit and vegetable consumption in 2010 was still low: 211g/capita/day (BBS, 2016) compared the desirable intake of 400 g/capita/day recommended by WHO and FAO (Akter *et al*., 2016). Bangladesh has three distinct production seasons: Rabi or winter season (November to February); Kharif-1 or summer season (March to June) and Kharif-2 or wet/rainy season (July to October). The main season for vegetable production is Rabi, which is dry and cool, when due to availability of large land areas and irrigation, farmers produce vegetables, pulses and oil seeds. This is followed by summer when summer varieties of vegetables are produced. The varieties of vegetables produced during the wet season are small and limited to raised homesteads, high land and floating beds (AVRDC, 1990).

Result and Discussion

World vegetables production ranking:

We compare to the other country our country vegetable productions very poor because of soil and environment . In Bangladesh are sub- tropical country soil and environment are not suitable for better winter vegetables production (Dr Golam Morshed *et.al*.2015) . In winter vegetable production are affected by soil and environment.



BDST: 1615 HRS, JAN 29, 2016

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Fig. 1 : winter vegetables production country ranking.

Vegetables growing seasons

In Bangladesh, vegetables are grown in two seasons such as Kharif (summer) and Rabi (winter), it depends on soil and environment. Cucurbitaceous vegetables are mainly grown in summer seasons and cruciferous vegetables are grown in winter seasons.

Table1. Seasonal vegetables

Seasons	Example of Vegetables
Rabi season	Rabi Brinjal, Cauliflower, Cabbage, Broccoli, Carrot, Radish, Bean, Onion, Garlic, Chili, Red Amaranth, Potato, Rabi Pumpkin, Bengal Spinach, and other winter vegetables.

Source: (BBS, 2016)

Vegetables production area

In Bangladesh, the major portion of the cultivated land is covered by rice, wheat and maize. Vegetables are cultivated small area compared to rice wheat and maize grown area. Total land is covered by winter vegetables like 12.13 portions by Brinjal, 6.95 by Pumpkin, 7.17 by Radish, 6.95 by Tomato, 4.63 by Bean, 4.41 by Cauliflower, and 57.21 by others vegetables (BBS 2012). Because our country climatic conditions not suitable for vegetable production (Akter *et al.*, 2016).

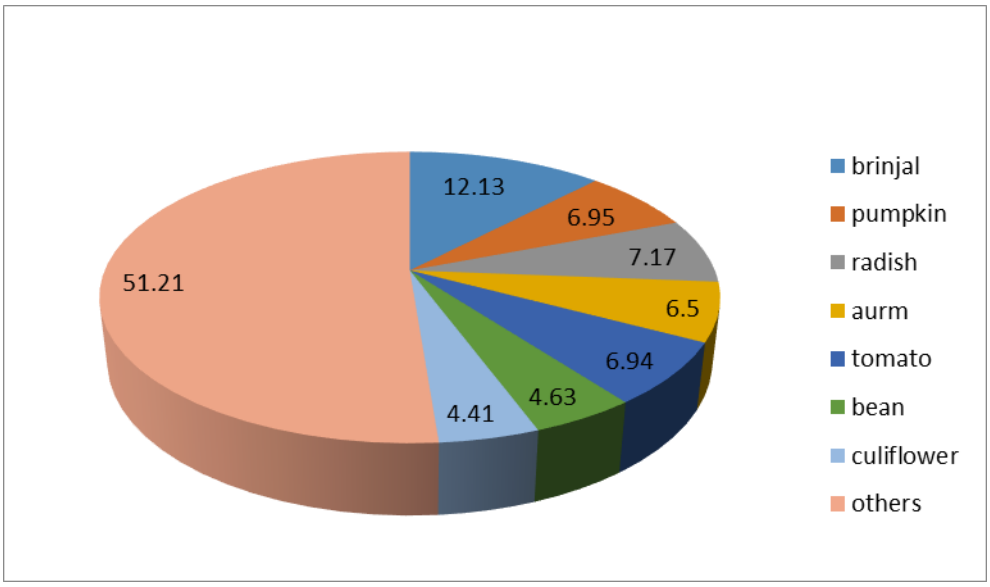

Fig2. Area under Vegetable (Winter) in Bangladesh, 2011-2012

Soil textural conditions for vegetables

Soil types refers to the physical composition or properties of the soil. Soil basically consist of mineral and decompose organic matter (Pascale & Barbieri, 1995). Optimum vegetables can produce in well drained sandy loam soil. Although winter vegetable can be grown on a wide

range of soil types, but they are not well adopted to heavy clay soil types but every texture has some common constraints for vegetables cultivation (Liu et al., 2015).

Table 2. Soil constraints associated with soil texture

Soil texture type	Common constraints
Sandy soil	• low water-holding capacity. Seedlings can wilt because of a rapidly drying soil surface • low nutrient retention. Excessive leaching of nutrients (particularly nitrate, potassium and sulphate) • acidity • extremely low phosphorus fixation • low organic matter content.
Clayey soil	• Excessive/prolonged wetness • Prone to compaction
Loam/clay loam soil	• hard-setting/surface sealing if texture is fine sandy loam or silty loam • prone to compaction

Source: Minh & Tri (2010)**,** Bandyopadhyay et al., (2007)**,** Re et al., (2004)

Land type classes of Bangladesh

In Bangladesh main land type is medium high land, but it contains different types of land such as hilly land, high land, medium low land, low land, very low land. Winter vegetables grown well in medium high land and medium low land with well drainage condition (Augustsson *et al*., 2017). It cannot tolerate water logged conditions, that's why it cannot grow well in low land and very low land (Liang *et al.*, 2018). In Chittagong 41% land covered by hill, 4% HL, 23% MHL, 8% MLL; in Barisal division 2% HL, 5% MHL, 5%MLL; in Rangpur 39%HL, 40% MHL, 5% MLL; in Sylhet 11% Hill, 6%HL, 20% MHL, 19% MLL.

Table 3. Land types classes of Bangladesh in different divisions

Divisions with area coverage	Hill	Cultivated land						Miscellaneous Land
		HL	MHL	M LL	LL	VLL	Total	
Chittagong (%)	41	4	23	8	3	1	90	10
Barisal (%)	-	2	5	5	1	0	63	37
Rangpur (%)	-	39	40	5	1	0	85	15
Sylhet (%)	11	6	20	19	20	11	76	24

Source: (BBS, 2016)

Effects of Soil (Edaphic) Factors

Soil is a natural medium that provides anchorage for the plant and supplies water and mineral nutrients for normal growth. Soil consists of mineral matter, organic matter, air, and water. The proportion of these four constituents and the types of mineral and organic material determines soil properties such as soil type, soil pH, and fertility (Xie et al., 2016). Soil type Soil is made up in part of mineral particles grouped as sand (0.05 to 2 mm), silt (0.002 to 0.05 mm), and clay (<0.002 mm) (Anderson & Johnson, 2012). The ratio of these determines soil types, such as clay, clayey loam, loam, sandy loam, and sand. Loam is composed of sand, silt, and clay in relatively even amounts, and exerts a greater influence on soil properties than does sand, silt, or clay. Soil type determines the soil's capacity to store water and nutrients, aeration, drainage, and ease of field operations. Sandy soils are easily tilled, well-drained and aerated but usually have low fertility and water-holding capacity (Haferkamp, 1988). Clayey soils, on the other hand, are more fertile and have high water retention but are poorly drained and aerated. In Bangladesh, production of vegetables is more in winter seasons compare to the summer seasons. In summer seasons vegetable productions are less than winter (Akter *et al.*, 2012). Winter season produce more vegetables and provides our needs. Average production of winter vegetables is depending on environment. Winter season are favorable for vegetables production.

Table 4. Average winter vegetables production in total land in Bangladesh

	2013-2014		2014-2015	
	Area acres	Production MT	Area Acres	Production MT
Yield	495510	1945497	529023	2193920

Source: (BBS, 2016)

Effects of Soil pH

Soil pH is a measure of the soil's acidity or alkalinity, and it affects the vegetables indirectly by influencing the availability of nutrients and the activity of microorganisms. Nutrients are most available at pH levels between 6.5 and 7.5 (Monier & Amer, 2003). Nutrients in the soil may be chemically tied up or bound to soil particles and unavailable to plants if the pH is outside this range. Individual vegetables have pH preferences and grow best if planted in soils that satisfy their pH requirements (Xie *et al.*, 2016).

Table 5. A general guideline to crop tolerance of mineral soil acidity.

Slightly tolerance (pH 6.8-6.0)	Moderately tolerance (pH 6.8-5.5)	Very tolerance (pH 6.8-5)
Broccoli	Bean	Potato
Cabbage	Carrot	Shallot
Cauliflower	Radish	
Eggplant		
Tomato		
Lettuce		

[1] From Donald N. Maynard and George J. Hochmuth, *Knott's Handbook For Vegetable Growers*, 4th edition (1997).

Effects of Soil fertility

Soil fertility is the inherent capacity of soil to provide nutrients in adequate amounts and in proper balance for the growth of specific winter vegetables (Xie *et al*., 2016). A fertile soil is usually rich in nitrogen, phosphorus, and potassium, and contains sufficient trace elements and soil organic matter that improves soil structure and soil moisture retention (Monier & Amer, 2003).

Effects of Soil salinity

Soil salinity refers to the presence of excess salts in soil water, which often results from irrigated agriculture. After the plants take up the water, the dissolved salts from irrigated water start to accumulate in the soil. Soil salinity is usually measured as electrical conductivity (EC) of soil solution, and expressed in deci siemens per meter (dS/m) (Machado & Serralheiro, 2017). Excess salts generally affect vegetables growth by increasing osmotic tension in the soil, making it more

difficult for the plants to take up water. Excessive uptake of salts from the soil by vegetable plant also may have a direct toxic effect on the vegetables. Soil salinity is most pronounced in arid areas.

Table 6. Salt tolerance of vegetables crops as determined by soil salinity (ECe)

Vegetable	Soil	
	Threshold 1 (d*S*·m-1)	Slope Threshold 2 (d*S*·m-1)
Bean	1.0	19.0
Broccoli	2.8	9.2
Carrot	1.0	14.0
Cauliflower	-	-
Eggplant	1.1	6.9
Lattuce	2.0	13.0
Potato	1.7	12.0
Tomato	2.5	9.9

Source: (BBS, 2016)

Salt sensitive plant are grown on saline soils plant injury can occurred. Saline soil damage growth vegetables plant, stunted plant height, wilting and in several cases plant death because saline sensitive plant is less able to uptake water from saline soil and can be water stress. In costal 70% area in our country are affected by saline soil (BBS, 2016). Vegetable cannot grow in this area particularly winter vegetables because all of winter vegetables are saline sensitive but some can be grown in at the minimum range of saline soil mostly root vegetables such as carrots, onion, sweet potato etc. There are different types of land in Bangladesh such as High Land (HL), Medium High Land (MHL), Medium Low Land (MLL), Low Land (LL), Very Low Land (VLL) and different types of soil such as saline, calcareous, non –calcareous, peat, floodplain, and acid soil (Xie et al., 2016). Vegetable can be grown in all types of soil but acid soil is harmful for vegetable productions. pH less than 5 vegetables cannot have grown in our country. Winter vegetables can be tolerance mineral acidity. Not all plants respond to salinity in a similar

manner; some crops can produce acceptable yields at much higher soil salinity than others (Monier & Amer, 2003). This is because some crops are better able to make the osmotic adjustments, enabling them to extract more water from a saline soil. For example, turnip and carrot are among the most sensitive vegetables and can tolerate soil salinities of only about 1dS/m before yield declines. Zucchini, on the other hand, can tolerate soil salinity of up to 4.7dS/m before yield reduces (Liu *et al*., 2015). The ability of a crop to adjust to salinity is extremely useful. In areas where a build-up of soil salinity cannot be controlled, an alternative crop can be selected that is both more tolerant of the expected soil salinity and able to produce economic yields.

Factors responsible for variation of yield of winter vegetables

Environmental factors

Light, temperature, water, and soil—greatly influence plant growth and geographic distribution (ALS Association, 2014). These factors determine the suitability of a crop for a particular location, cropping pattern, management practices, and levels of inputs needed (Yang, Chen, Wang, & Peng, 2016). A crop performs best and is least costly to produce if it is grown under the most favorable environmental conditions. To maximize the production of any crop, it is important to understand how these environmental factors affect plant growth and development (Worsley *et al*., 2016). Light Sunlight is essential for any crop. Dry matter production often increases in direct proportion with increasing amounts of light. The amount of sunlight received by plants in a particular region is affected by the intensity of the incoming light and the day length.

Effects of Light

The light intensity changes with elevation, latitude, and season, as well as other factors such as clouds, dust, smoke, or fog. The total amount of light received by a crop plant is also affected by cropping systems and crop density (Sharmin *et al*., 2015). Different plants differ in their light requirements. Sunlight is essential for any crop. Dry matter production often increases in direct proportion with increasing amounts of light. The amount of sunlight received by plants in a particular region is affected by the intensity of the incoming light and the day length (Liang *et*

al., 2018). The light intensity changes with elevation, latitude, and season, as well as other factors such as clouds, dust, smoke, or fog (Comas *et al.*, 2010). The total amount of light received by a crop plant is also affected by cropping systems and crop density. Different plants differ in their light requirements: plants thrive in full sun but grow poorly in shade, plants will produce an edible crop when grown in a shady location. However, these plants need at least 50-80% of full sun (Liu & Tong, 2017) and plants thrive in 30-50% of full sun but weaken in full sun (Allemann & Young, 2005). Shading sometimes is used to inhibit pigment development in crops in which the lack of color is an important quality factor. Due to the tilt of the earth's axis and its travel around the sun, the day length varies with season and latitude (Matschoss & Heiskanen, 2017). Photoperiod controls flowering or the formation of storage organs in some species

Effects of Temperature

Temperature influences photosynthesis, water and nutrient absorption, transpiration, respiration, and enzyme activity. These factors govern germination, flowering, pollen viability, fruit set, rates of maturation and senescence, yield, quality, harvest duration, and shelf life (Montri & Biernbaum, 2009). Different plants have different temperature requirements. However, for most crop species, optimum temperatures usually range around 25ºC (Pandey *et al.* 2012). Temperature requirements (usually based on night temperature) of plants are given below by the cardinal values and derived range for "effective growth" (growth range) and "optimum growth" (optimum range) that Krug (1991) has used for major vegetables. Depending on the situation and the specific crop, ambient temperatures higher or lower than the effective growth range will reduce growth and delay development, and subsequently decrease yield and quality (Savvas, Gianquinto, Tuzel, & Gruda, 2013). The extremes may be considered killing frosts at about 0ºC and death by heat and desiccation at about 40ºC.

Table7: Temperature in winter season.

Winter vegetables	Need temperature ºC	Bangladesh temperature ºC
Cabbage	10-15	
Cauliflower	10-15	
Carrot	13-17	

Lettuce	8-12	17-20
Bean	10-15	
Radish	15-17	
Broccoli	10-13	
Brinjal	15-20	
Tomato	15-20	

Source: Agriculture research council 2013.

Effects of Rainfall

Water is absolutely essential for winter vegetables. Vegetables can be grown according to their natural habitats with respect to water supply like Hydrophytes are plants that are adapted to living in water or in soil saturated with water (Liang *et al*., 2018). The hydrophytes usually have large interconnected intercellular gas-filled spaces in their root and shoot tissues to facilitate air exchange (Sharmin *et al*., 2015). Mesophytes are the most common terrestrial plants that are adapted to neither a long wet nor a long dry environment. Depending on the extension of their root systems and other plant features, however, their water requirement varies (Lam *et al.*, 2018). Xerophytes are plants that can endure relatively long periods of drought. The xerophytes usually have special features such as reduced permeability to decrease water loss, swollen tissues to conserve water, or deep and extensive root systems to acquire water (Sinesio *et al.*, 2018).

Table8: Rainfall in winter season.

Winter vegetables	Need rainfall(ml)	Bangladesh rainfall(ml)
Cabbage	90-150	48-105
Cauliflower	70-150	
Carrot	100-150	
Lettuce	80-110	
Bean	90-120	
Radish	110-150	

Broccoli	90-120	
Brinjal	100-170	
Tomato	100-150	

Source : BBS 2009-15

Water is crucial for vegetable productivity and quality. However, water requirements of vegetable differ according to vegetable and soil types. A plant's total sum of water requirement includes the water the crop uses by itself and also the losses due to evapotranspiration, water application, land preparation, and leaching during the crop growth period (Savvas *et al*., 2013).

Effects of Drought

Drought is defined as a period without significant rainfall or soil moisture. Droughts may lead to vegetable water deficit (drought stress) and growth may be impacted. Drought stress usually occurs when soil water content is less than 50% of field capacity (i.e., when the soil is full of water, hence 100%). Drought stress symptoms include wilting, droopy, curling or rolling of leaves; or browning of shoot tips (Haferkamp, 1988). Among the mesophytes, the effect of drought stress varies with the species, variety, degree and duration of drought stress, and the growth stage of vegetable. The yield formation stage is most sensitive for most vegetables. Periods of even short drought stress during this period can reduce yield.

Effects of Flooding

Flooding occurs when water enters soil faster than it can drain away. Intense rainfall, river overflow, increased surface run-off, over-irrigation, and slow drainage through the soil profile all contribute to flooding, especially in lowland regions (Kristiansen *et al.*, 2017). Under waterlogged conditions all pores in the soil are filled with water, depriving the soil of oxygen. As a result, plant roots cannot obtain oxygen for respiration to maintain their activities for nutrient and water uptake. Weakened plants are susceptible to soil-borne diseases (Felix *et al.*, 2007). Oxygen deficiency in the soil due to waterlogging also causes death of root hairs, and increases formation of compounds toxic to plant growth. All of these lead to retarded growth or the death

of the plant. The extent of flooding damage depends upon the species or variety, stage of vegetable development, duration of flooding, water level in the soil, soil texture, temperature, and type of microorganisms' attendance. High temperatures usually accelerate the damaging effects (Charrier *et al.,* 2015). Most mesophytes and xerophytes are sensitive to flooding. However, some species are able to tolerate flooding because of their abilities to increase porosity of the shoot base, or to replace damaged roots (Liang *et al.,* 2018).

Conclusion

This study analyzes the soil and environmental conditions around the globe and searches literature according to the purpose of the study. The aim of this research is to explores the responsible factors of soil and environment for yield variation of winter vegetables. It reveals that there is a great impact of soil and environment on winter vegetable productions. It also explores that a number of edaphic factors like soil type, soil pH, soil fertility, and soil salinity and environmental factors like light, temperature, humidity, drought and flooding are responsible for variation of yield of winter vegetable production. This article suggest that a consciousness and knowledge dissemination is necessary to the farmers level about the effects of soil and environmental factors for maximum yield of winter vegetables.

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