ACADEMIA International Journal for Social Sciences
Volume 5, Issue 3(b), 2026 ISSN-L (Online): 3006-6638

Morphological Characterization of Aloe Vera (Aloe barbadensis) Collected from District Bagh, Azad Jammu and Kashmir

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Received: 28-01-2026 **Revised:** 11-02-2026 **Accepted:** 26-02-2026 **Published:** 13-03-2026

ABSTRACT

Aloe vera (Aloe barbadensis) is a species belonging to genus Aloe and Liliaceae family, one of the most valuable medicinal and useful plants in the world. The current research was aimed at analyzing the morphological features of 7 sites of District Bagh, Azar Jammu and Kashmir (i.e. Dhirkot, Jahala, Banipasari, Awaira, Nindrai, Rehra and Koteri) on wild Aloe vera ecotypes. The study was conducted in a Randomized Complete Block Design (RCBD) in the Laboratory of Horticulture Department, University of Azad Jammu and Kashmir. Morphological parameters such as plant height (cm), plant weight (g), number of leaves per plant, leaf area (cm 2), leaf length (cm), leaf weight (g) and gel waste ratio were measured and compared statistically with ANOVA with means compared at P = 0.05 using LSD. Findings showed that there were very significant location differences in all morphological characteristics. The plants that were collected in Jahaala had the highest plant height (22.20 cm), plant weight (159.00 g), number of leaves (11.00), area of the leaf (85.06 cm 2), length of leaf (10.58 cm), weight of leaf (7.76 g), and ratio of gel waste (2.86:7.76), whereas D These results imply that geographically determined climatic and edaphic conditions also play important roles in morphological performance of Aloe vera ecotypes in Azad Kashmir which will be a foundation of choosing high-yield ecotypes used in commercial production in the area.

Keywords: *Aloe vera, morphological characterization, ecotypes, District Bagh, Azad Kashmir, plant height, leaf area, gel waste ratio*

INTRODUCTION

Aloevera derived by Arabic word “Alloeh” that means “shining bitter substance” because of the acidic liquid originate in the leaves and Vera obtained from Latin word which means “true”. It belongs to liliceae family of the order *Asparagels*. This family contains more than 250 species of plants. However, only two species are being used for commercial purposes, *Aloe barbadensis*is one of them (Sanjit and Tushara, 2018). Firstly Alovera species was introduced in 1753 by Carl Linnaeus who gave the following classification: Kingdom: Plantae, Family Lilaceae, Order: Asparagales, Genus: Aloe and Species vera. Aloe vera was grown in mostly sub-tropical and tropical zone as well as North America and South Africa, then in 17th century it was introduced in India, China and various areas of Southern Europe (Maurice, 2014).

Aloe vera plant is like a cactus, while it is linked to onion, garlic and asparagus. It has no stem and leaves are wedge-shaped, which range in color from light gray to light green and small white teeth on leaves side (Christaki and Panagiota, 2010). The leaves are made up of three cover internal gel, yellow milk and a top layer of 15-20 cells are said a rind. Aloe vera leaves are used for health foods, cosmetic and medicinal purposes. Aloe vera is made of latex and gel. Latex, which represents about 20-30% of the total leaf weight called aloe juice and aloe sap, is a sour yellow due to vitamin C,

these cells are smaller than those of the palisade mesophyll and are found in the lower part of the leaf (Christaki *et al*., 2010).

Aloe vera plant (*Aloebarbadensis Miller*) is very nutritious that originates in North Africa and is drought tolerant. Preliminary reports on the growing and utilization of Aloe vera in folk medicine also ago 1,500 B.C. (Christaki *et al*., 2010), (Hasanuzzaman *et al*., 2008).

Adult plants can grow up to 2 and a half inches to 4 meters and the average is 28 to 36 cm. The plant frequently has 12-18 leaves, when ripe it weight up to 15 pounds [3 kg]. A clear inner gel containing water 99% and rest is completed of amino acids, glucomannans, vitamins, sterols and lipids. Now a day, this plant is industrialized in many types of food, health care and cosmetic products because of its nutritional properties (Javed and Atta, 2014). Among the remedial propertie Aloe vera is considered for its major effect (Bozzi *et al*., 2007) wound healing properties (Hamman, 2008), immune function (Mulay *et al*., 2013), Anti-inflammatory activity and anti-inflammatory properties (Choonhakarn *et al*., 2008).

Aloe vera prefers temperatures of 21°C in day and night. Aloe vera gel contains about 99.5% water and crude ginger covers about 98.5% water. The solids of Aloe vera contain elements such as enzymes, vitamins, organic compounds and phenolics (Minjares *et al*., 2017).

Aloe vera has many benefits for both humans and animals. The three different plant arrangements are used such as Aloe vera latex, Aloe vera gel and Aloevera all extracted from the leaf. It is identified that Aloe gel gives the plant ability to retain for moisture very soft time and has comforting effects. Therefore, Aloe vera has gained wide spread in the application of cosmetics and bath industry, such as “moisturizers”, “cleansers”, “sun lotions”, “tooth pipes”, “mouth washes”, “shaving creams”, “deodorants” and shampoos. Polysaccharides and the growth hormone increased collagen and elastin formation can condense wrinkles *(*Mahesh *et al.,* 2019*)*.

In accumulation of the demand from the cosmetic, pharmaceutical, and processing industries, aloevera is also commercialized in Europe and the USA through workers. This land need cannot be met only by wild aloe harvesting, which is traditional in tropical Africa (Van *et al.*, 1996). As a result, small and medium-sized farms can take advantage of growing market demand around the world, and invest in exotic plants, such as aloe (Liontakis and Tzouramani, 2016).

Due to its drought resistant properties, aloevera can be grown in some arid and semi-arid areas due to its drought-resistant properties, drink and CAM practice. Plant tissue growth methods provide mass production of strong plant objects of a specified quality (Cristiano *et al*., 2016). The most effective horticulture management techniques can increase productivity, even more so than those of species that are usually bred below the equal conditions. Finally, proper harvesting and post-harvest conditions and proper processing methods can avoid the loss of toxic goods of the product (Pandey and Mishra, 2010).

In Aloe vera a lot of research was done to test parameters such as morphological and biochemical features. A few recent studies are those of biomass of tested growth, flavonoid, total phenolic content and pH, antioxidant and vitamin C etc. (Zapata *et al.,* 2013).This particular research was conducted to attain the following desirable objective

- To evaluate the morphological and biochemical characteristics of Aloevera.

REVIEW OF LITERATURE

Aloevera is very operative and main herbal plant. It provides so various medical and pharmacological effects for human and animals. Aloe-vera has medicinal applications in different systems of our values. Aloe-vera performs as an antimicrobial manager that inhibits the development and

improvement of microorganisms such as “bacteria”, “fungi”, “protozoan” etc. The Antimicrobial drugs are eliminates and suppressed the microorganisms or guard the development and progress of bacteria. Many parts of aloe vera plant were suitable in treatment of extensive health related issues. This plant manufactures huge range of secondary metabolites that are significant for medications (Anand *et al.,* 2019).

Aloe vera is an important medicinal plants similar to cactus plant that contain leaves like sharp knife which are flesh, reduction, emarginated, spinous and packed up from a strong white gluey gel. Aloevera is strong, drought-resistant, perennial tropical and succulent plant. The Aloe vera plant has formed a massive cultural in a common system of rules of medication such as the Siddha, Unani, Ayurveda and Homeopathy. There are more than 75 nutrients of food 200 chemical active compounds containing 20 minerals, 12 vitamins and 18 amino acid in aloe vera leaves and also controls the old age skin (Maan *et al*., 2018).

The aloe name originated from an Arabic word "Alloeh" "Halal" which means deeply shiny expert. It has carried a significant conventional part in the indigenous planning of pharmacological frame works. The plant is found in lance mold, and harsh pointed, and harsh and edge leaves. Aloe vera is the most standard and traditional curative plant ever recognized as the most supportive beneficial plant throughout the world (Pathak and Rajesh, 2017).

It contains a variety of compounds including, for example, proteins, sugars, natural amino acids, glycoproteins, anthraquinones e.g. (aloe-emodin, anthrones and glycosides anhydroglucosyl), sugar lipids, vitamins and minerals. Aloe vera contains a variety of uses and for the most part is used as a nourishing supplement and solution for the preparation and description of natural remedies. Aloe vera is increasingly used as pills part, splash, balms moisturizers, liquids, beverages, jam, salves, suspensions and conditioning creams. There are many varieties of Aloe vera are found worldwide used for cancer treatment conditions (Pathak and Rajesh, 2017), such a large number of therapeutic benefits were allocated to Aloe vera given polysaccharides containing Aloe vera gel. This plant is alternatively called the "fixing plant". Aloe vera has been used in the traditional rehabilitation program as part of a specific framework for thousands of years. In many studies it has been shown that treatment with Aloevera gel eliminate to bring about the effect of rapid wound healing. Many reports of Aloevera fore skin have a beneficial effect on recovery from both normal and diabetic rats. The most commonly usage of Aloe vera is in medication to improve wound healing function and other therapeutic activities (Baruah *et al*., 2016).

The Aloe vera plant commonly looks like a perennial small, dense stem 30-60 cm high, long board 10cm and 1.8 cm thick juice. The stem of flower is larger than the leaves and is thickened and enlarged. This plant gets adulterated after four years and has leaves that are between two and three feet [2 to 3 m] long and the leaves base diameter ranges from 3 to 5 inches. Every leaf weighs from [2 to 4 pounds]. The complete life cycle of a plant is twelve years. It creates an regular of 12 to 30 years leaves. The smell is a factor and the taste is boring and sour (Tragedy, 2013).

Aloe vera is indigenous to the South Africa and Orient, but it has been firstly introduced to the West Indies and it will also thrive in the Mediterranean. Its located in “Rajasthan” “Andhra Pradesh”, “Gujarat”, “Maharashtra”, “UK”, “Himachal Pradesh”, “Tamil Nadu”, which are the cities of India has developed economically in Aruba, South Africa Bonaire, Haiti, India, Venezula and United States. Turned there are more than 250 species of noses grown worldwide. However, only two types of products are currently manufactured, with Aloe barbadensis Miller and Aloe esconsene the most being common. Aloevera plant is grown-up in tropical and subtropical climates and can notendure temperatures. It is a perennial evergreen plant that grows up to 0.8 m by 1 m in small size. Plants directly in light (sandy) and loamy soils require that the entire area around the spilled soil be able to grow in poor, healthy soil. This plant is prone to destructive, non-invasive and important (basic) soils can't grow in the shade. It required dry earth and can tolerate dry spelling. They are xerophytic plants. It can be propagated by seeds in the spring seeds sown in a warm tropical area (Pathak and Rajesh,

2017).

Seeds as a law germinate at 1-6 months at 16 ^{o}C. Seedlings are transmitted to pot that contain very fine earth. They are allowed to grow in the bright part because in any event when winter start. The calculation balance was available, especially in the spring. Plants produce balance without restriction and can be separated at any time of the year whose length is warm enough to encourage new attachment development to allow for plant regeneration. The balance of youth is planted deep within the heart 60m. In the second year the leaves are collected by the locals and securing their hands because of the difficult method of removal. Leaves are separated near the foundation, stored inside a can of petrol, and transported to an important place for aloe vera preparation. Aloe juice is found in the parenchymatous cells of the adhesive glass peri cycle. In private mode the attachment cells are active (Pathak and Rajesh, 2017).

Goat skins are often filled, when Aloe vera is regenerated, and spontaneous evaporation allows for up to a month when it becomes more aggressive than conditions. In European countries dehydrated in wood pans with hot air up to a humidity of about 10% (Beck *et al.*, 2019).The trace elements of Aloe vera are the three isomeric Aloins, Barboloin and Isobarbaloin, which are crystalline Aalin, found in 10 to 30% Aaloin, milk, emodin and Aloe-emodin. Barbol in which is considered as the most important and found in all types of aloevera.

It is light yellow in color, strong, soluble, crystalline, now in Curacao aloe and in the following sequence in Cape aloe in Sococrrine and Zoe aloe. The central areas of Socortrine and Zanzibarn aloe are Barbaloin. Aloe contains an unparalleled amount of mix that can be divided into 3 broad circles. The main component, a compound sugar (amongst which is derived from acemannan) is contained in the leaf gel and has an unpleasant energy-boosting function. Other are the anthra quinoes, which are controlled in the upper portion of skin, with a strong cleansing function. Lastly there are a few things that have a lot of functions, for example, vitamins, minerals, essential and Non essential amino acids, phospholipids, natural acids, proteins, saponins and lignin (Amin and Selamoglu, 2018).

Aloe vera plant have flavonoids, lectins, terpenoids, unrefined oils, anthraquinones, cholesterol, mono chromones and polysaccharides, sterols, tannins, regularly tested acids ,salicylic corrosive , “ proteins”, “saponins”, “vitamins”, “minerals”, “aloin”, “anthrone”, “aloe emodin”, “aloetinic corrosive”, “choline” and “salicylate”, “complex mucopolysaccharides” such as “hyaluronic corrosive”, “sapogenins” and chemicals, i.e, “catalase”, “celluase” and “alliinase” (Wen and Guo, 2013).The morphological details were evaluated for the Aloe vera plant under consideration: plant length, leaf length and root, leaf size and width, wet shoot weight and roots, weight of dry twigs and roots and weight of gel melting sugar gel on Aloe vera leaves. In addition, diagnoses of Na, K, Cl and Ca sprout and root and K / Na and Ca / Na ratio were tested (Negahdari and Sedigheh, 2019).

It was tested that Aloe vera has conventionally been used medicinally in traditional medicines and has a good market value. Aloe vera invented in tropical and subtropical Africa, now it is cultivated in the temperate regions of “Asia, Europe”, and the America (Giuseppe *et al*., 2016).Aloe vera (Aloe barbadensis) has been shown to be an essential plant in cosmetics, medications, and the food production worldwide. In Colombia, it is cultivation can grown even though the management of crop crops is unknown. This study examined three aloe basal weight losses in two partner planting programs and monoculture (control). A completely random segmentation technique was used. The main sites were: aloe monoculture (AMN), planting a communal bean partner (CBCP), and establishing a large taro partner (GTCP).

Aloe vera is considered an important medicinal plant with a variety of healing properties. This study was performed to obtaine the chemical composition and biochemical activity of Aloe vera leaves. Immediate composition (moisture, ash, crude protein, crude lipid and crude fiber), ascorbic acid, superoxide

Aloe vera belongs to a plant which have ancient history as well as health importance. Plant with a variety of medicinal properties. This research was showed to find out the chemical composition and biochemical activity of Aloevera leave. Immediate composition (ash, moisture, , protein, crude fiber and lipid) ascorbic acid, superoxide dismutase, catalase, peroxidase, amylase, reducing sugar and completely dissolved sugar. The moisture content of 97.42 ± 0.13% was noted, while the percentage of percentage ash, fiber, protein and content was 16.88 ± 0.04%, 73.35 ± 0.30%,6.86 ± .06% and 2.9 ± 0.09%. Overall, this study provided a brief overview of the chemical composition and biological activity of Aloe vera leaves (Muaz and Fatma, 2013).

Aloe vera is a familiar plant having medicinal value that is prominent in medical and corporate industries. Local conditions cause genetic variation that eventually alters phyto constituents and their medicinal properties. Traditionally, variability is measured by measuring the variability of phenotypic or qualitative symptoms. There is a decrease in the ability of these morphological markers to measure genetic variation in plants, which are very important for their high reliance on the environment to communicate, but they can provide a basis for genetic diversity. Chemical and molecular markers avoid many of the environmental influences that work on characters by focusing directly on genetic or genetic variation. Molecular mechanisms have been shown to be useful in the study of the origin and breeding of species and the evolutionary relationships. This review resulted on the use of these tags in Aloe vera (Sabina *et al*., 2018).

MATERIAL AND METHODS

The current research was performed to evaluate the morphological and biochemical characteristics, of Aloe vera collected from district Bagh. The research was performed at Laboratory of University of Poonch Rawlakot Faculty of Agriculture, Department of Horticulture.

Sampling Site

Aloevera plants were obtained from different sites of Bagh include Deerkot, Jahala, Banipasri, Awaira, Nindrai, Rera and Koteri. GPS data for these sites is given below in the table 1.

Table.1 GPS data collected from Bagh villages

Distict	Villages in Bagh	Latitude	Longitude
Bagh	Dhirkot	36o 55, 63.74” N	74o 48’ 60.45o E
	Jahala	32o 44, 64.45” N	72o 47’ 62.32o E
	Banipasari	28o 43, 60.54” N	70o 45’ 63.49o E
	Awaira	32o 44, 55.64” N	71o 43’ 62.45o E
	Nindrai	33o 58’ 58.80” N	73o 46’ 58.80o E
	Rera	35o 54, 62.63” N	74o 46’ 59.78o E
	Koteri	32o 43’ 54.54” N	70o 44’ 60.62o E

Soil pH

Soil pH was measured through a 1:2 soil water ratio. Soil sample (1og) was taken in a beaker of 50ml

with water 20ml. This sample was stirrer with a glass rod and permitted to hold for 30 minutes and interruption was disturbed after 10 minutes intervals for a total of 3 times. With the help of pH meter pH was calculated (Estefan *et al*., 2011).

Electrical Conductivity

E.C of soil sample was calculated by preparing a soil suspension soil and water 1:2 ratio. The electrode of electrical conductivity meter was put in the suspension and evaluation was shown on E.C meter (Wang, 2011).

A. Morphological studies

Aloe vera plants were collected from seven locations of Bagh Azad Kashmir including Dhirkot, Jahala, Banipasari, Awaira, Nindrai, Rera and Kotairi. Aloe vera plants were analyzed for the following morphological parameters;

Plant height (cm)

Height of plant was taken from randomly collected three plants from the study area with the help of scale then their average was noted (Hopkins, 1997).

Leaf area (cm^2)

Leaf area was taken from randomly selected leaves of three plants from the study area with the help of leaf area meter (Yadav *et al*., 1983).

Number of leaves Per plant

Total leaves per plant was recorded as leaves were detached from represented of plants with the help of scale (Belorkar, *et al.,* 1992).

Plant weight (g)

Plants weight were recorded from the chosen plant of study areas and their average was noted with the help of balance

Leaf length (cm)

Leaf length was recorded from the sides of leaves through the usage of measuring tape and their average was noted.

Leaf weight (g)

Leaf weight was noted from a represented sample of the selected plant of study areas with the help of electrical balance.

Gel waste ratio (g)

Gel waste ratio was calculated as described by (Nudubisi *et al*., 2013).

$$\text{Gel waste ratio} = \frac{\text{Wfs}-\text{Wge}}{\text{Wfs}}$$

Here is

Wfs= Weight of sample in g

Wge= Weight of gel extraction

RESULTS AND DISCUSSION

The studied was conduct out during 2019-20 in Laboratory of faculty of Agriculture, Department of 'Horticulture, The University of Poonch Rawalakot. Intension of this study project was to investigate Morphological and bio-chemical characterization of Aloe vera (*aloe barbadenisis)* collected from seven localities of district Bagh. Following are the parameters discussed in this research.

Soil pH

TABLE: ANOVA FOR SOIL pH

S.O.V	d.f	S.S	M.S	F-value	P-value
Location	6	1.73	0.28	97.79	0.0000
Error	14	0.03	0.00		
Total	20	1.78			

Data regarding of pH of soil collected from seven locations of District Bagh were investigated statistically. Analysis of variance discovered that there were highly S ($P \leq 0.05$) changes between various locations. Means revealing significant dissimilarity for seven locations were subjected to LSD test.

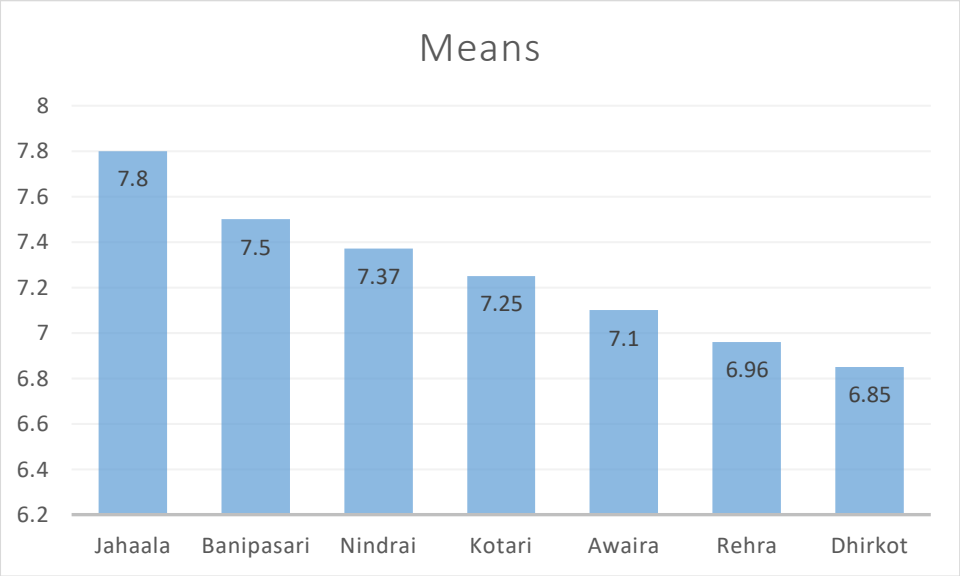
Results about pH of soil illustrate that maximum pH (7.8) was observed in the samples collected from Jahaala which was followed by plants of Banipasari (7.5), whereas minimum pH (6.85) was observed in the samples collected from Dhirkot. The highest value of pH from Jahala might be due to the Increasing salinity level influence water acidity (pH). This result highlighted that the pH of selected locations was not same (Riley *et al*., 2019).

Mean values for soil pH from seven locations of District Bagh Azad Kashmir.

Locations	Means
Jahaala	7.8A
Banipasari	7.5B
Nindrai	7.37C
Kotari	7.25D
Awaira	7.1E

Rehra	6.96F
Dhirkot	6.85G

LSD @ 0.05



pH of soil collected from seven locations of District Bagh

Electrical Conductivity

Table 2: ANOVA for Electrical Conductivity

S.O.V	d.f	S.S	M.S	F-value	P-value
Location	6	0.60	0.10	48.26	0.00
Error	14	0.25	0.00		
Total	20	0.64			

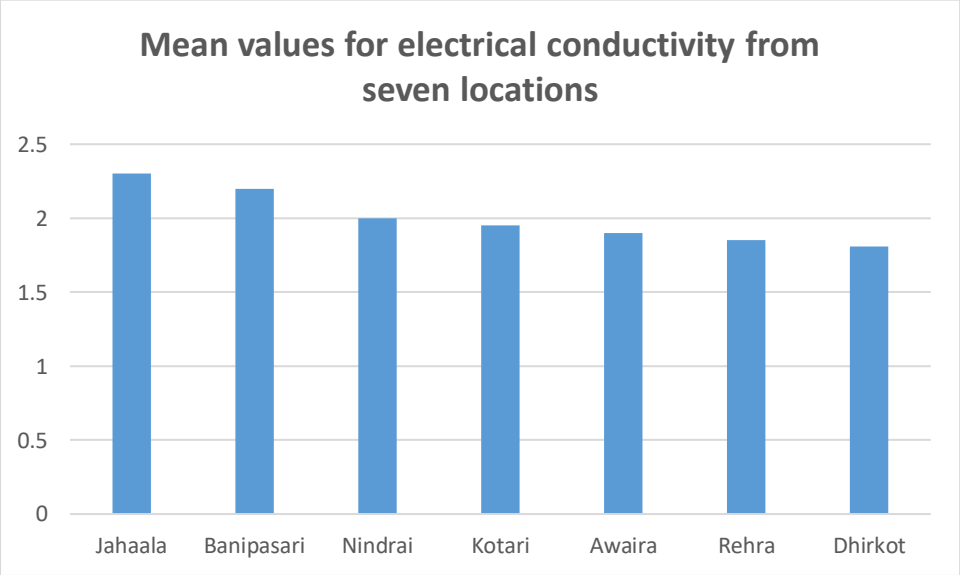
Data about electrical conductivity from seven locations of District Bagh were collected and evaluated statistically. Means revealing significant dissimilarity for seven locations were subjected to LSD test and their means were equated.

Results about electrical conductivity showed that maximum EC was observed in the sample collected from Jahaala (2.3) which was followed by that of Banipasari (2.2), although minimum plant height was observed in the sample collected from Dhirkot (1.81) Electrical conductivity of soil varies significantly due to soil minerals, climate, and soil texture (Lyklema,2001).

Mean values for electrical conductivity from seven locations of District Bagh Azad Kashmir.

Locations	Means
Jahaala	2.3A
Banipasari	2.2B
Nindrai	2.0C
Kotari	1.95CD
Awaira	1.90DE
Rehra	1.85EF
Dhirkot	1.81F

LSD @ 0.05



Morphological studies

Plant height (cm)

Results presented for height of plant was treated to statically analysis and "ANOVA" is show in Table 3.

S.O.V	d.f	S.S	M.S	F-value	P-value
Location	6	259.56	43.26	17304.43	0.00
Error	14	0.03	0.002		

Total	20	259.60			

Table 3: ANOVA of plant height (cm)

**HS at p<0.01 * S at p<0.05 NS

CV= 0.28%

Table 3 showed non significant differences for various location of aloe vera for plant height. Mean results are specified in Table 4.1.1 for plant height.

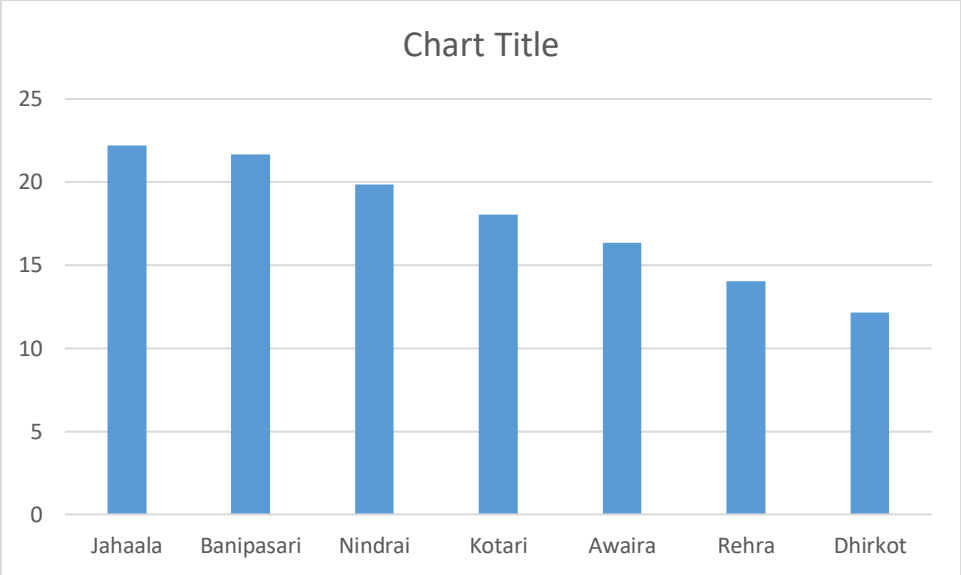
Data regarding the plant height of Aloe vera collected from seven locations of District Bagh were investigated statistically. Analysis of variance discovered that there were highly significant (P≤0.05) differences between various locations. Means revealing significant dissimilarity for seven locations were subjected to LSD test.

Results about plant height of Aloe vera illustrates that maximum plant height (22.20 cm) was observed in the samples collected from Jahaala which was followed by plants of Banipasari (21.65 cm), whereas minimum plant height (12.15 cm) was observed in the samples collected from Dhirkot (Table 4.1). The highest value of growth parameters observed in plants collected from Jahala may be due to the higher temperature that prevails during the growth period hastening vegetative growth of plants. This result show that the plant heights of different Aloe vera varieties were not the same and this character was genetically controlled (Shivaprakash *et al*., 2018).

Table 4.1.1 Mean values for Plant height of Aloe vera from seven locations of District Bagh Azad Kashmir.

Locations	**Means**
Jahaala	22.20A
Banipasari	21.65B
Nindrai	19.85C
Kotari	18.05D
Awaira	16.35E
Rehra	14.05F
Dhirkot	12.15G

LSD @ 0.05



Plant weight (g)

Data collected for plant weight were exposed to statically analysis and "ANOVA" is showed in Table 4.

Table 4: ANOVA for plant weight

S.O.V	d.f	S.S	M.S	F-value	P-value
Location	6	7331.01	1221.84	191.75	0.00
Error	14	89.21	6.37		
Total	20	S			

**HS at p<0.01 * S at p<0.05 NS, CV= 1.84

Table 4 showed non significant differences for different location of plant weight of aloe Vera. Mean values are given in Table 4.1.2 for plant height.

Data about the plant weight of Aloe vera from seven locations of District Bagh were collected and evaluated statistically. A Study of variance displayed that there was HS (P≤0.05) difference between locations of District Bagh. Means revealing significant dissimilarity for seven locations were subjected to LSD test and their means were associated.

Results about plant weight of Aloe vera showed that highest weight of plant was sample collected from Jahaala (159.00 g) which was followed by that of Banipasari (155.00 g), although minimum plant height was observed in a sample collected from Dhirkot (103.08g) (Table 4.1.2).

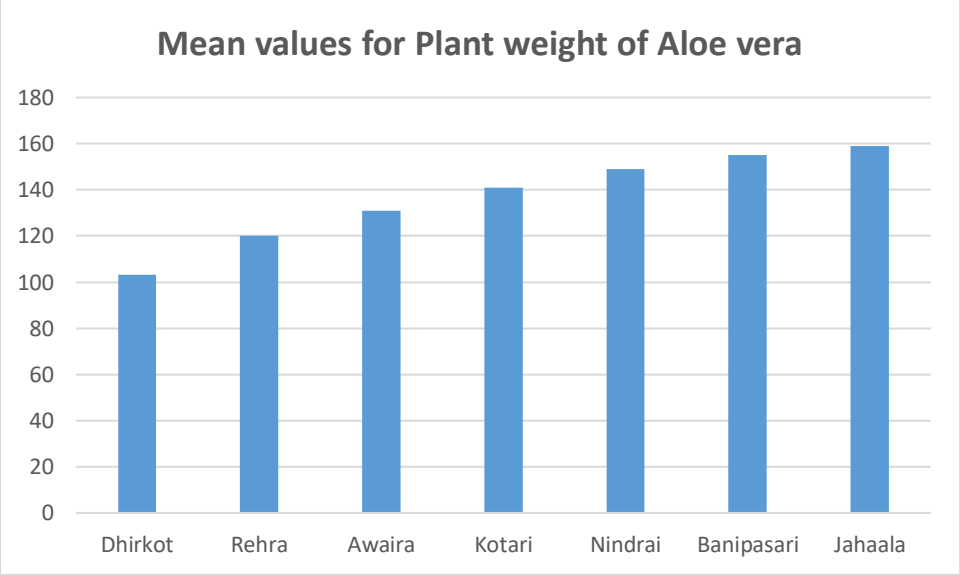
According to Asrey and Singh (2004) plant weight of Aloe vera varies significantly among the genotypes due to its inherent characteristics.

Table 4.1.2 Mean values for Plant weight of Aloe vera from seven locations of District Bagh of

Azad Kashmir.

Locations	**Means**
Dhirkot	103.08F
Rehra	120.00E
Awaira	131.00D
Kotari	141.00C
Nindrai	149.00B
Banipasari	155.00A
Jahaala	159.00A

LSD @ 0.05 level of significance



No of Leaves

Data related the number of leaves per plant was subjected to statical analysis and ANOVA is display in Table 5.

Table 5: ANOVA for NO of leaves

S.O.V	**D.f**	**S.S**	**M.S**	**F-value**	**P-value**
Location	6	28.47	4.74	49.83	0.00
Error	14	1.33	0.09		
Total	20	29.80			

**HS at p<0.01 * S at p<0.05 NS, CV= 3.47

Observation of Table 5 showed significant differences in the number of leaves per plant. Mean results are known In Table 4.1.3 for the amount of leaves.

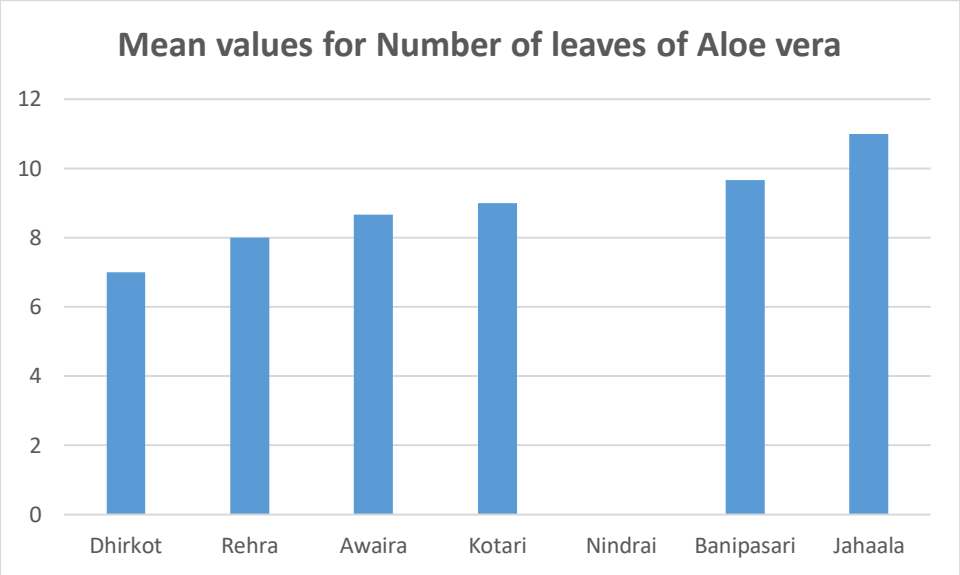
Data regarding no of leaves of Aloe vera collected from different locations of District Bagh were obtained and analyze statistically. Analysis of variance revealed that there was HS ($P \leq 0.05$) variance among locations of District Bagh. Means revealing significant dissimilarity for seven locations were subjected to LSD test and their means were equated.

Results regarding the number of leaves of Aloe vera showed that the maximum number of leaves were experienced in the material collected from Jahaala (11.000) which was followed by that of Banipasari (9.66), while minimum numbers of leaves were observed in the material taken from Dhirkot (7.00) (Table 4.1.3). Location affected the numbers of leave, climatic and soil situations (Babatunde and Yongabi, 2008). As the climatic situation of Jahala was warmer as related to Dhirkot so it significantly different the numbers of leaves. The leaves that were collected from Jahala were most strong.

Table 4.1.3 Mean values for Number of leaves of Aloe vera from seven locations of District Bagh of Azad Kashmir.

Locations	**Means**
Dhirkot	7.00E
Rehra	8.00D
Awaira	8.667C
Kotari	9.00C
Nindrai	9.00C
Banipasari	9.667B
Jahaala	11.00A

LSD @ 0.05 level of significance



Leaf area (cm^2)

Records noted for leaf area (cm^2) was analyzed statically and "ANOVA" is display in Table 6.

Table 6: ANOVA of Leaf area

S.O.V	d.f	S.S	M.S	F-value	P-value
Location	6	2738.38	456.39	8837.57	0.00
Error	14	0.72	0.052		
Total	20	2739.11			

**HS at p<0.01 * Sat p<0.05 NS, CV= 0.31

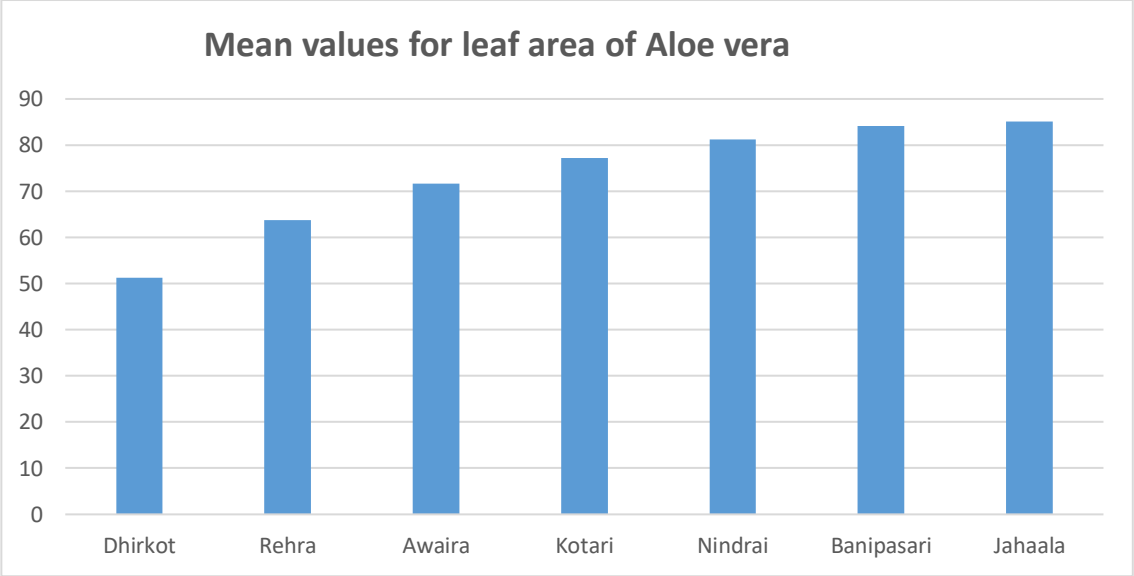
Table 6 displayed HS differences between Treatments for leaf area. Mean values are set in Table 4.1.4.

Data regarding leaf area of Aloe vera obtained from seven locations of District Bagh were analyzed statistically. Study of variance exposed that there was highly significant (P≤0.05) difference among locations of District Bagh. Means revealing significant dissimilarity for seven locations were subjected to LSD test and their means were equated.

Results regarding leaf area of Aloe vera illustrated that maximum leaf area was observed in the samples collected from Jahaala (85.06) which was followed by samples obtained from that of Banipasari (84.12), while minimum leaf area was observed in the sample collected from Dhirkot (51.26) (Table 4.1.4). These values are in line with the research of (Hernandez-Cruz *et al*., 2002). This difference was due to climatic influences eg "sun light" precipitation and geography.

Table 4.1.4 Mean values for leaf area of Aloe vera from seven locations of District Bagh of Azad Kashmir.

Locations	Means
Dhirkot	51.26G
Rehra	63.70F
Awaira	71.62E
Kotari	77.18D
Nindrai	81.17C
Banipasari	84.12B
Jahaala	85.06A



LSD @ 0.05 level of significance

Leaf length (cm)

Data noted on leaf area (cm) was examined statically and "ANOVA" is showen in Table 7.

Table 7: ANOVA for Leaf length

S.O.V	d.f	S.S	M.S	F-value	P-value
Location	6	12.77	2.12	4516.24	0.00
Error	14	0.00	0.00		
Total	20	12.78			

**HS at p<0.01 * S at p<0.05 NS, CV= 0.24

Table 7 showed HS changes among Treatments for leaf length (cm). Mean values are mention in Table 4.1.5.

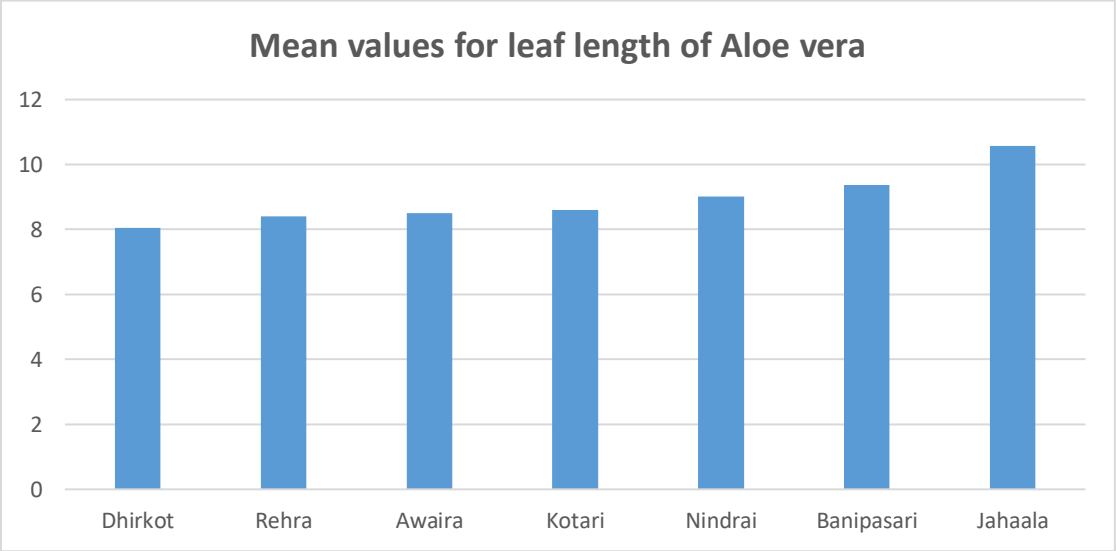
Data regarding leaf length of Aloe vera from seven localities of District Bagh were collected and analyzed statistically. Analysis of variance shows that there was a HS ($P \leq 0.05$) variance among locations of "District Bagh". Means revealing significant dissimilarity for seven locations were subjected to LSD test and their means were equated.

Results related leaf length of Aloe vera showed that maximum leaf length was observed in the samples collected from Jahaala (10.58) which was followed by Banipasari (9.370), while minimum leaf length was observed in the sample collected from location Dhirkot (8.050) (Table 4.1.5). Plants have a positive effect on leaf length depends on climatic conditions and increased temperature is negatively correlated with leaf length (Hossain *et al*., 2014).

Table 4.1.5 Mean values for leaf length of Aloe vera from seven locations of District Bagh of Azad Kashmir.

Locations	**Means**
Dhirkot	8.050G
Rehra	8.400F
Awaira	8.510E
Kotari	8.610D
Nindrai	9.020C
Banipasari	9.370B
Jahaala	10.580A

LSD @ 0.05 level of significance



Leaf weight (g)

Results noted on leaf weight (g) was analyzed statically and "ANOVA" is showed in Table 8

Table 8: ANOVA for Leaf weight

S.O.V	D.F	S.S	M.S	F-value	P-value
Location	6	14.95	2.49	919.68	0.00
Error	14	0.03	0.00		
Total	20	14.98			

**HS at p<0.01 * S at p<0.05 NS, CV= 0.86

It was showed (Table 8) HS changes among Treatments for leaf weight (g). Mean values were presented in Table 4.1.6 for their judgment.

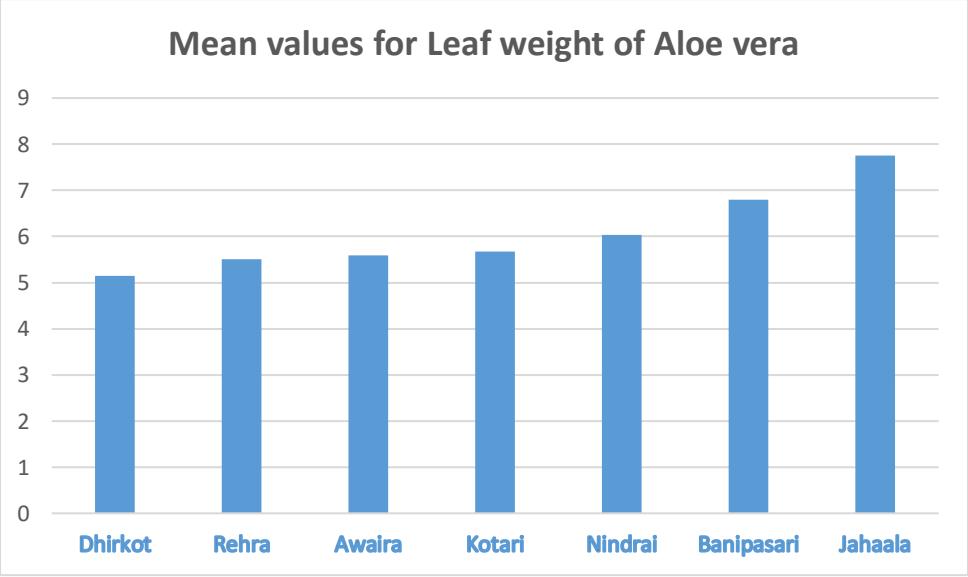
Data regarding leaf weight of Aloe vera collected from seven locations of District Bagh were collected and analyzed statistically. Analysis of variance revealed that there was a highly significant ($P \leq 0.05$) changes among locations of District Bagh. Means revealing significant dissimilarity for seven locations were subjected to LSD test and their means were equated.

Results related plant height of Aloe vera showed that highest leaf weight was observed in the plant collected from Jahaala (7.76) which was followed by that of Banipasari (6.80), while minimum leaf weight was observed in the sample collected from Dhirkot (5.15) (Table 4.1.6).). According to Asrey and Singh (2004), the leaf weight of Aloe vera varies significantly among the genotypes due to its inherent characteristics.

Table 4.1.6 Mean values for Leaf weight of Aloe vera from seven locations of District Bagh of Azad Kashmir.

Locations	**Means**
Dhirkot	5.15F
Rehra	5.50E
Awaira	5.59DE
Kotari	5.67D
Nindrai	6.04C
Banipasari	6.80B
Jahaala	7.76A

LSD @ 0.05 level of significance, C.V 0.75



4.1.7 Gel Waste Ratio

Data noted on Gel Waste Ratio was examined statically and "ANOVA" is showed in Table 9.

Table 9: Gel waste Ratio

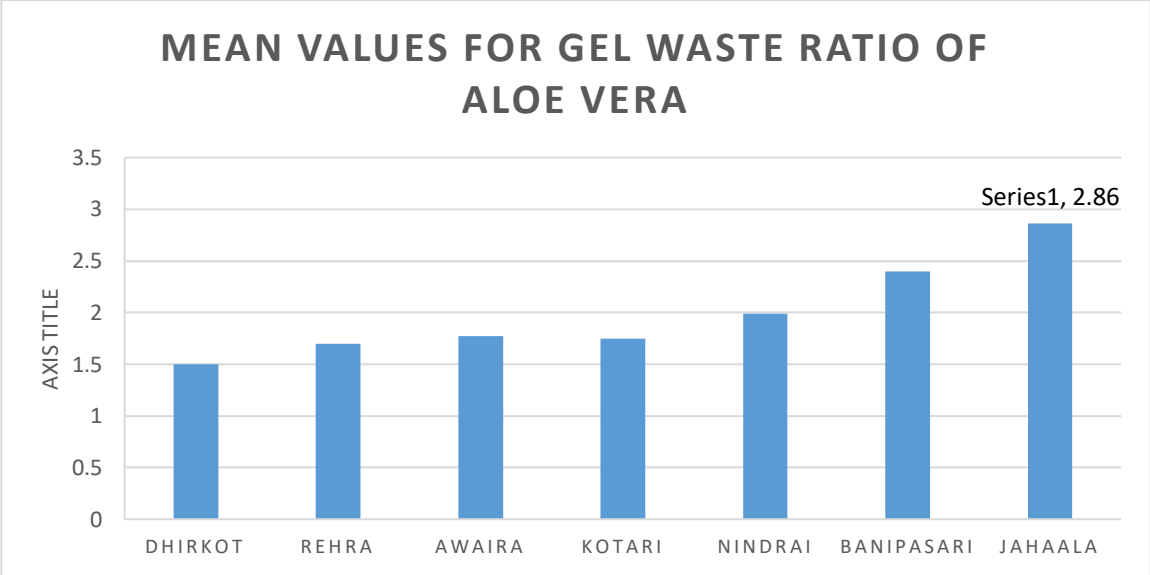
S.O.V	D.F	S.S	M.S	F-value	P-value
Location	6	1.1743	0.19573	141**	0.00
Error	14	0.01940	0.00139		
Total	20	1.19378			

**HS at p<0.01 * S at p<0.05 NS, CV= 1.1%

Data regarding gel waste ratio of Aloe vera obtained from different seven locations of District Bagh were collected and analyze statistically results regarding gel waste ratio of Aloe vera showed maximum gel waste ratio was observed in the sample collected from Jahaala (2.86:7.76) which was followed by that of Banipasari (2.4:6.80), while minimum gel waste ratio was observed in the sample collected from Dhirkot (1.5:5.15), this variation might be due to plant size and weight (Moghissi *et al.*, 2011). Means values are given in Table 4.1.7.

Table 4.1.7 Mean values for gel waste ratio of Aloe vera from seven locations of District Bagh of Azad Kashmir

Locations	Ratio
Dhirkot	1.5:5.15
Rehra	1.7:5.50
Awaira	1.77:5.59
Kotari	1.75:5.67
Nindrai	1.99:6.04
Banipasari	2.4:6.80
Jahaala	2.86:7.76



DISCUSSION

The current research found that there is a high morphological diversity among Aloe vera (Aloe barbadensis) ecotypes in various sites of District Bagh, Azar Jammu and Kashmir. The ANOVA analysis showed that all the traits studied such as plant height, plant weight, the number of leaves, the leaf area, the length of the leaf, the weight of the leaf and the ratio of the gel waste, had significant effects that arose due to the unique environmental conditions of the locality. Jahala, compared to other sampling sites, was the site with the best performance in all morphological parameters. The highest plant height (22.20 cm), plant weight (159.00 g), number of leaves (11.00), leaf area (85.06 cm 2), length of leaves (10.58 cm), and weight of leaves (7.76 g) indicates that this site has the best conditions to support vegetative growth. The improved characteristics can be explained by the positive climate conditions like moderate temperature, sufficient sunlight, and rather high soil pH and electrical conductivity, and an overall combination of these factors increases the nutrient availability and metabolism of plants. The same has been noted by Shivaprakash et al. (2018) and Asrey and Singh (2004) who pointed out that environmental conditions play a significant role in determining Aloe vera growth performance. Dhirkot, on the contrary, had the lowest scores of all morphological characteristics, which would suggest relatively unfavorable growing conditions. The lower plant height (12.15 cm), plant weight (103.08 g), and leaf parameters could be associated with low soil pH and electrical conductivity that could reduce the absorption of nutrients and physiological processes. This confirms the results of Lyklema (2001) and Riley et al. (2019) who found that the chemical properties of soils have a strong influence on the growth and development of plants. The differences in the number of leaves per plant across locations further highlight the role played by the environment and genetic factors. Warm-season plants like Jahala generated more leaves, which is probably supported by increased metabolic rate and rapid growth rates as Babatunde and Yongabi (2008) assert. In the same manner, leaf area and leaf length, which are important indicators of photosynthetic efficiency, were much greater in Jahala indicating that the plants had a better light interception and biomass accumulation. The same tendency was observed in the leaf weight and the ratio of the gel waste, the highest values of which were recorded in Jahala. The higher the ratio of gel waste to the mass of the leaf the larger the share of usable gel is in relation to the mass of the leaf which is a positive quality in commercial and industrial practice. This may be caused by differences in the maturity of the plants, water content and genetic flexibility as earlier documented by Moghissi et al. (2011). All in all, the morphological variation between Aloe vera ecotypes is a reflection of

the mutual action of environmental factors (climate, soil pH and electrical conductivity) and genetic diversity. The results are consistent with those of the prior research (Hernandez-Cruz et al., 2002; Hossain et al., 2014), where the researchers found that agro-ecological conditions are very important in defining the growth and productivity of plants.

CONCLUSION

The current research arrived at the conclusion that there is a great deal of morphological diversity between Aloe vera ecotypes sampled in various sites of District Bagh, Azad Jammu and Kashmir. Out of the sites studied, Jahala was selected as the most viable location in which Aloe vera could grow, with the best performance in all morphological parameters, such as plant height, plant weight, leafeous characteristics, and efficiency in the production of gels. Dhirkot, on the contrary, performed worse, which means that the environment is not so favorable. These findings reveal that the climatic and edaphic conditions, especially the pH and electrical conductivity of soil are critical determinants of growth and productivity of Aloe vera. The results offer a scientific justification to the choice of ecotypes that are high in performance and the selection of the location where commercial culture is possible in the area. It is suggested that the Aloe vera growing should be encouraged in places with a similar environmental condition with Jahala to ensure they get maximum yield and quality. Moreover, biochemical and molecular characterization of these ecotypes in future studies should be done to have a fuller picture about the genetic diversity and industrial potential of these ecotypes.

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