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Influence of lunar cycles on growth of *Ashwagandha* (*Withania somnifera* [L.] Dunal)

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Abstract

Introduction: Ayurvedic classics have advocated to collect the medicinal plants according to part used and seasons in order to get desired pharmacological action and therapeutic benefits. The logic behind this principle is being validated by recent researches. **Aim:** To analyze the influence of lunar cycles on growth of *Ashwagandha* in *Shishira* and *Greeshma Ritu* (winter and summer season). **Materials and Methods:** Fourteen small crops of *Ashwagandha* of average size 10 cm were collected on October 7, 2013, from institute campus and then replantation was done at Charaka Herbal Garden, Gujarat Ayurved University, Jamnagar in an area of 60 cm × 60 cm (*l* × *b*). No fertilizers or pesticides were used. The plants were watered daily and plants were uprooted as per lunar cycles for analysis. Eight samples were collected and observed during *Shishira* and *Greeshma* season on *Pournima* (full moon) and *Amavasya* (new moon) days. The measurements were taken thrice and average values were taken into consideration for study purpose. The variations in morphological characteristics such as length, breadth, weight, and number of roots and twigs were studied through statistical procedure of principle component analysis, which makes interpretation of all possible related variables. **Results:** Root weight (RW), pith diameter (PD) and internodal distance (ID) were found to be increased on full moon days as compared to new moon days. The maximum RW was observed during *Greeshma Aashadha Pournima*. **Conclusion:** The study has shown a definite influence of lunar cycles on the growth of the plant parts assessed by RW, PD, and ID that have found to be increased on full moon days as compared to new moon days.

Key words: *Ashwagandha, Greeshma*, lunar cycles, *Shishira, Withania somnifera*

Introduction

Ashwagandha (*Withania somnifera* [L.] Dunal.) is an important herb used in more than 300 formulations in the Ayurvedic and indigenous medical systems.[1] Its annual demand is 7000 tonnes/year but its actual production is 1500 tonnes/year.[2] Due to its high medicinal use, the plant is seeking attention of Ayurvedic as well as modern research.[3] Being root is the main part used for medicinal purpose, uprooting of whole plant in order to obtain botanical trade leads to loss of it. Proper harvesting techniques are useful in order to obtain maximum yield and minimize wastage of raw materials. Collection of plants as per lunar cycle is one of the methods for obtaining plant with maximum phytoconstituents. Traditionally, it is practiced in Rome and Europe for getting excellence in the morphological characteristics such as weight, taste, growth, strength, germination, flowering, fruiting and final yield.[4] Recent researches has also showed the phytoconstituents variation as per lunar cycles.[2] One of the requirements of the drug is that they should possess maximum activity and should contain maximum percentage of active constituents. In cultivation, attention is paid to selection of proper drug, type of soil and climatic factors such as light, temperature, rainfall, and fertilizer, so that strong sturdy plants rich in active chemical constituents would grow. Ayurvedic

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classics have advised collection of *Sheeta Veerya* (cold potency) root during months of *Shishira* (winter) and *Ushna Veerya* (hot potency) in *Greeshma* (summer).[5] According to previous studies, hypothesis was made that drugs collected during lunar cycles shows maximum therapeutic effect during full moon days (*Pournima*).[6] In this study, an attempt has been made to observe changes in growth taking place in *Ashwagandha* collected in *Greeshma* and *Shishira* seasons in different lunar cycles.

Materials and Methods

To study the effect of lunar cycles on the growth and morphological characters of *Ashwagandha*, total 14 small plants of wild *Ashwagandha* of around 10 days old plant of average length of 10 cm were collected on October 7, 2013 from institute campus and then replantation is done at Charak a Herbal Garden, Gujarat Ayurved University, Jamnagar in an area 60 cm × 60 cm ($l \times b$), so as to maintain similar environmental and nutritional status to the plants. No fertilizers or pesticides were used. The plants were watered daily and were uprooted as per lunar cycles for analysis. Eight samples were collected and observed during *Shishira* and *Greeshma* season on *Pournima* (full moon) and *Amavasya* (new moon) days. These eight samples were labeled as, SMA: *Shishira Magha Amavasya*, SMP: *Shishira Magha Pournima*, SPhA: *Shishira Phalguna Amavasya*, SPhP: *Shishira Phalguna Pournima*, GJA: *Greeshma Jyeshtha Amavasya*, GJP: *Greeshma Jyeshtha Pournima*, GAA: *Greeshma Aashadha Amavasya*, GAP: *Greeshma Aashadha Pournima*. The measurements of uprooted plants were taken thrice to minimize error and average values were taken into consideration for analysis purpose.

Observations and Results

Geographical details of habitat: Latitude – 22°:47", Longitude – 70°:07" 65 m above mean sea level (MSL). The time schedule for collection of *Ashwagandha* root according to lunar cycles is placed at Table 1. The plants were collected within 1 h after sunrise to keep the "time" variable constant. Sunrise time was noted according to *Hindu Panchanga* (almanac) of year 2014. The growth variation in the characters of *Ashwagandha* is depicted in Table 2 and 3. The vertical length of the plant was found to be decreased from SMP to SPhA but at the same time, horizontal growth was found to be increased in the form of the twigs. Insignificant changes were seen according to lunar cycles on the area covered by root of *Ashwagandha*.

All the plants were selected of same size and kept under same environmental condition in the same habitat, thus parameter changes are assumed to be uniform. The results are analyzed using principle component analysis (PCA) through Unscrambler software (version 9.7; CAMO Software AS 2007, OSLO, Norway).

Sample of GAP is differentiated from GAA, GJP and GJA on the basis of root weight (RW), breadth of primary root (BTP), pith diameter (PD). Sample of GAA and GJP resembles each other on the basis of difference in parametric values such as breadth of secondary rootlets (BRS), twig length 2 (TL2), number of roots (NR), length of secondary rootlets (LRS), and night length (NL). Due to this, they are separated from GAP and GJA.

GJA sample differentiated from rest *Greeshma* samples (GAP, GAA, and GJP) on the basis of length of primary root (LRP), twig length 1 (TL1), number of secondary rootlets (NRS), internodal distance (ID) values [Graph 1]. All the four samples of *Shishira* are separated from each other. The variable NRS and LRS didn't show much variation. SMP is well separated on the basis of plant length (PL) and NL. SPhP is differentiated due to TL2, RW, and DL. SPhA is differentiated due to parameters such as NRT, LRP, BRS, BRP, PD, TL1, ID, and BR. SMA is separated due to NRS [Graph 2].

From PCA, it is clear that, all *Pournima* samples are well differentiated from each other as they lie in four different quadrants. Among *Pournima* samples, the parameters such as NL, DL, TL1, TL2, LRP, and NRS didn't show much difference as they lie in center of PCA. GAP sample differentiated on the basis of BR and SMP sample is separated on the basis of PL, NRS values [Graph 3]. All *Amavasya* samples showed well defined differentiation from each other. SPhA sample is separated from other sample by the parameter of NRS. GJA is separated from rest samples on the basis of LRP. GAA samples is different from rest samples on the basis of LRS, BRS and NRT. SMA sample is differentiated from each other on the basis of PL. The characters such as TL1, TL2, BTP, BRT, DL, NL and PD show resemblance among all *Amavasya* samples [Graph 4].

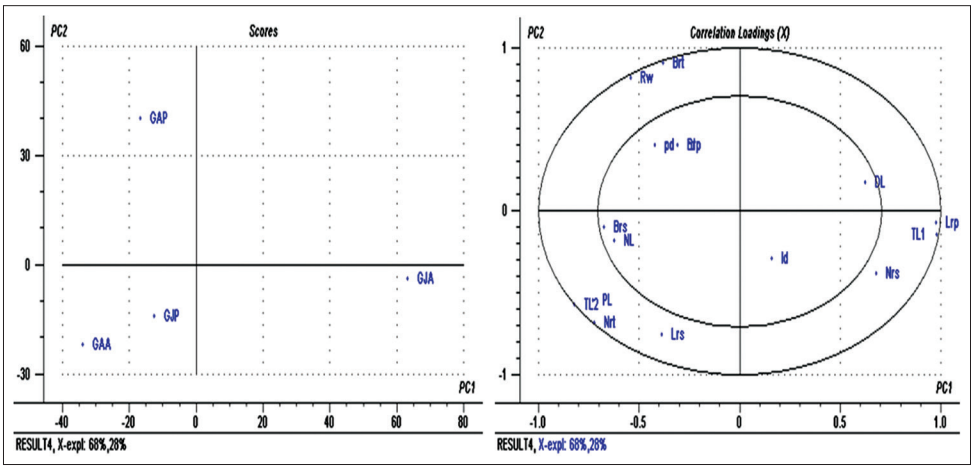
From PCA, it is clear that all the eight samples of *Ashwagandha* are differentiated from each other in two different seasons on the basis of plant morphology. There is a progression from *Amavasya* to *Pournima* samples but maximum difference of progression is seen in *Greeshma* season between *Pournima* and *Amavasya* suggesting the lunar phase influence on plant growth [Graph 5].

All the samples showed progressive age wise increase in the parameters analyzed. Parameters such as LRS, NRS, BRT, and BRS didn't show much variation. SPhP, GJA, and SPhA samples showed maximum differentiation on the basis of RW. GJP and GAA showed differentiation on the basis of NRT,

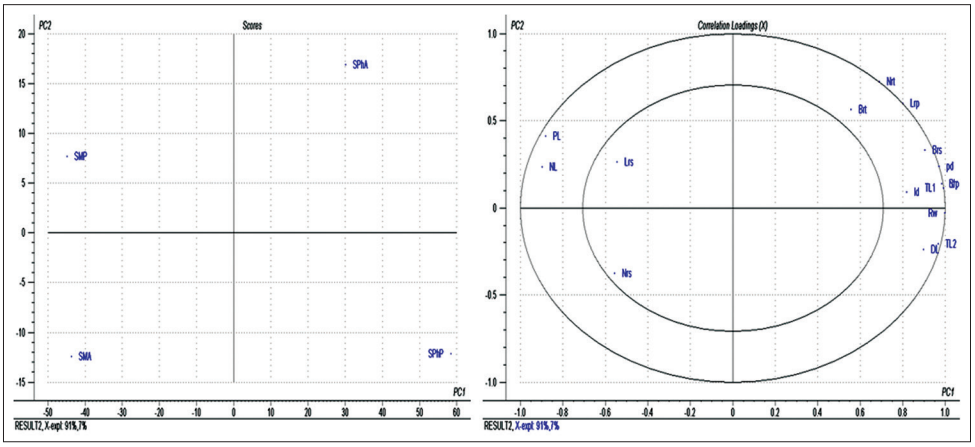
Table 1: Time schedule for collection of *Ashwagandha* according to lunar cycles (year 2014)

Shishira	Date	Sun rise (am)	DL (h)	NL (h)	*Greeshma*	Date	Sun rise (am)	DL (h)	NL (h)
SMA	30.01.2014	7:29	11.07	12.53	GJA	13.06.2014	6:04	13.56	10.04
SMP	14.02.2014	7:29	11.24	12.36	GJP	27.06.2014	6:07	13.57	10.03
SPhA	01.03.2014	7:10	11.42	12.18	GAA	26.07.2014	6:19	13.36	10.24
SPhP	16.03.2014	6:57	12.02	11.58	GAP	12.07.2014	6:13	13.49	10.11

SMA: *Shishira Magha Amavasya*, SMP: *Shishira Magha Pournima*, SPhA: *Shishira Phalgun Amavasya*, SPhP: *Shishira Phalguna Pournima*, GJA: *Greeshma Jyeshtha Amavasya*, GJP: *Greeshma Jyeshtha Pournima*, GAA: *Greeshma Aashadha Amavasya*, GAP: *Greeshma Aashadha Pournima*, NL: Night length, DL: Day length



Graph 1: Principle component analysis (PCA) of all morphological parameters of samples of *Greeshma* season. GJA: *Greeshma Jyeshtha Amavasya*, GJP: *Greeshma Jyeshtha Pournima*, GAA: *Greeshma Aashadha Amavasya*, GAP: *Greeshma Aashadha Pournima*, BRT: Breadth of tertiary rootlets PL: Plant length, PD: Diameter of pith, RW: Root weight, BTP: Breadth of primary root, BRS: Breadth of secondary rootlets, NL: Night length, DL: Day length, ID: Internodal distance, NRS: Number of secondary rootlets, NRT: Number of tertiary rootlets, TL1: Twig length 1, TL2: Twig length 2, LRP: Length of primary root, LRS: Length of secondary rootlets



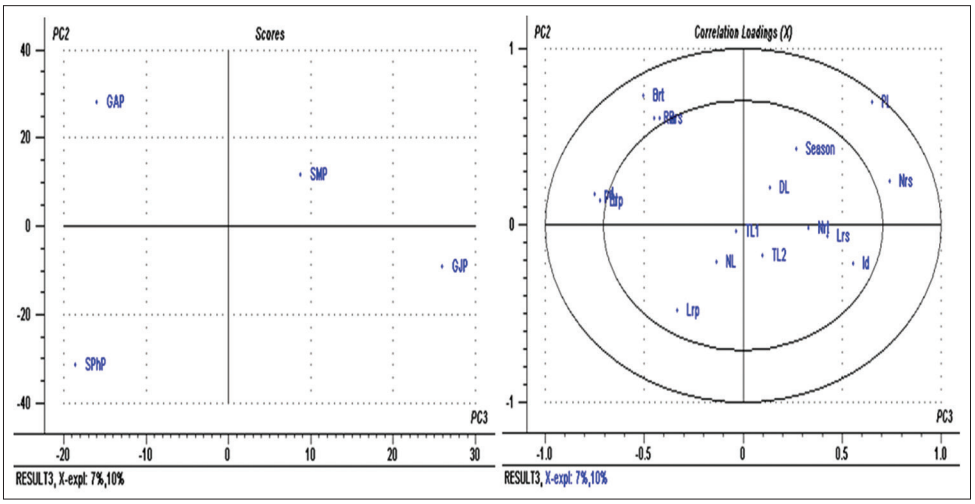
Graph 2: Principle component analysis (PCA) of all morphological parameters of samples of *Shishira* season. SMA: *Shishira Magha Amavasya*, SMP: *Shishira Magha Pournima*, SPhA: *Shishira Phalguna Amavasya*, SPhP: *Shishira Phalguna Pournima*, PL: Plant length, DL: Day length, NL: Night length, LRS: Length of secondary rootlets, NRS: Number of secondary rootlets, BRT: Breadth of tertiary rootlets, BRS: Breadth of secondary rootlets, NRT: Number of tertiary rootlets, LRP: Length of primary root, RW: Root, PD: Diameter of pith, ID: Internodal distance, BTP: Breadth of primary root, TL1: Twig length 1, TL2: Twig length 2

Table 2: Growth variation in the characters of the *Ashwagandha* based on lunar cycles

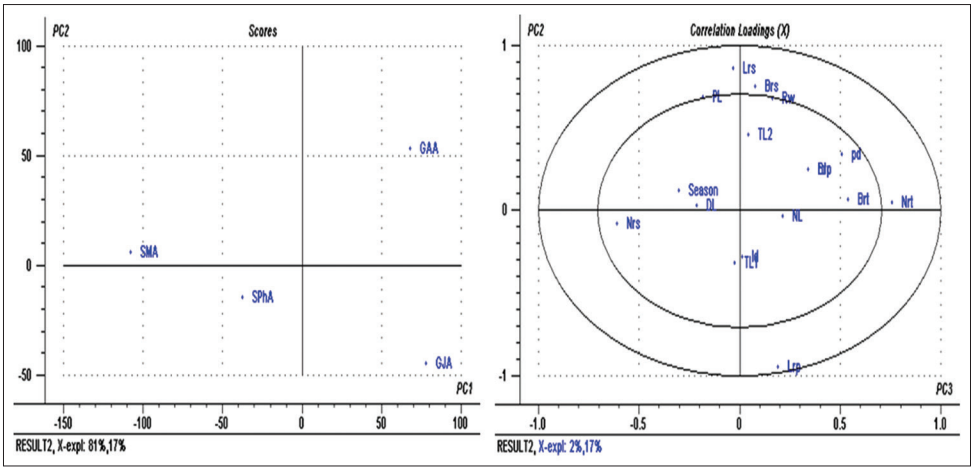
Season	PL (cm)	TL1 (cm)	TL2 (cm)	RW (cm)	NRS	NRT	LRP (cm)	LRS (cm)	BTP (cm)	BRS (cm)	BRT (cm)	RD (cm)	PD (cm)	ID (cm)
SMA	91.5	0	0	6.14	14	0	16	15.5	1	0.2	0	1	0.8	0.4
SMP	108	0	0	6.55	3	15	18	23.5	1.2	0.3	0.1	1.2	0.9	2
SPhA	85.5	63.5	30	13.79	5	34	22	15	1.8	0.4	0.1	1.8	1.6	2.2
SPhP	70	72	65	17.7	2	20	20	16	2	0.42	0.1	2	1.6	3.5
GJA	108	177	69	15.32	6	24	22	15.5	2	0.5	0.1	2	1.5	5
GJP	123	115	110	23.1	6	30	3.5	16	1.6	0.5	0.1	1.6	1.2	7.5
GAA	151	112	122	36.3	4	31	3.7	26	2.4	1.6	0.12	2.4	2	3.5
GAP	115.5	110	84	72.08	4	25	4	12	2.4	1	0.2	2.4	2	4

PL: Plant length, TL: Twig length, RW: Root weight, NRS: Number of secondary rootlets, NRT: Number of tertiary rootlets, LRP: Length of primary root, LRS: Length of secondary rootlets, BTP: Breadth of primary root, BRS: Breadth of secondary rootlets, BRT: Breadth of tertiary rootlets, RD: Diameter of root, PD: Diameter of pith, ID: Internodal distance

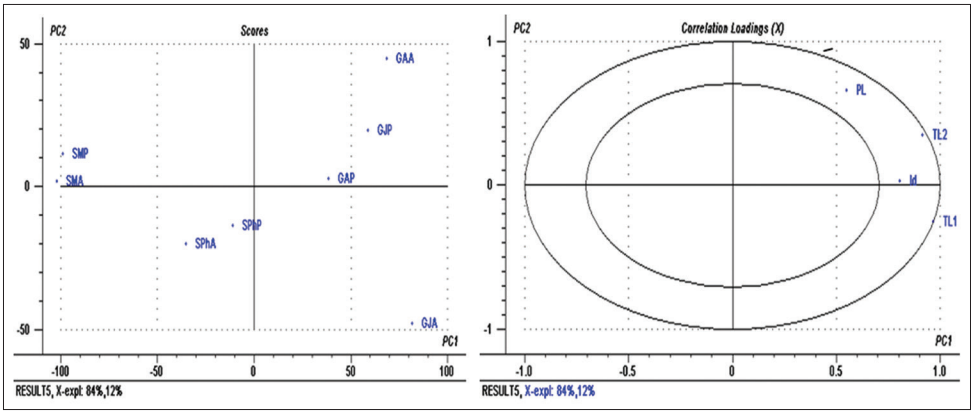
BRS, BTP and BRP. GAP sample is separated from rest seven samples on the basis of LRP and LRS values. SMA sample was differentiated due to maximum NRS and there was no tertiary root development found [Graph 6].



Graph 3: Principle component analysis (PCA) of all morphological parameters of samples of all *Pournima* days. GJP: *Greeshma Jyeshtha Pournima*, GAP: *Greeshma Aashadha Pournima,* SMP: *Shishira Magha Pournim*, SPhP: *Shishira Phalguna Pournima*, BRT: Breadth of tertiary rootlets, BRS: Breadth of secondary rootlets, BTP: Breadth of primary root, LRP: Length of primary root, LRS: Length of secondary rootlets, PL: Plant length, DL: Day length, NL: Night length, NRS: Number of secondary rootlets, NRT: Number of tertiary rootlets, TL1: Twig length 1, TL2: Twig length 2, PD: Diameter of pith, ID: Internodal distance



Graph 4: Principle component analysis (PCA) of all morphological parameters of samples of *Amavasya* days. SMA: *Shishira Magha Amavasya*, SPhaA: *Shishira Phalguna Amavasya*, GJA: *Greeshma Jyeshtha Amavasya*, GAA: *Greeshma Aashadha Amavasya*, BRT: Breadth of tertiary rootlets, BRS: Breadth of secondary rootlets, BTP: Breadth of primary root, LRP: Length of primary root, LRS: Length of secondary rootlets, PL: Plant length, DL: Day length, NL: Night length, NRS: Number of secondary rootlets, NRT: Number of tertiary rootlets, TL1: Twig length 1, TL2: Twig length 2, PD: Diameter of pith, ID: Internodal distance, RW: Root weight



Graph 5: Principle component analysis (PCA) of all morphological parameters of samples of *Shishira* and *Greeshma* seasons. SMA: *Shishira Magha Amavasya*, SMP: *Shishira Magha Pournima*, SPhA: *Shishira Phalguna Amavasya*, SPhP: *Shishira Phalguna Pournima*, GJA: *Greeshma Jyeshtha Amavasya*, GJP: *Greeshma Jyeshtha Pournima*, GAA: *Greeshma Aashadha Amavasya*, GAP: *Greeshma Aashadha Pournima*, TL1: Twig length 1, TL2: Twig length 2, PL: Plant length, ID: Internodal distance

All the eight samples are differentiated from each other with 100% data values on PC2. All lunar values of specific season didn't show much difference except GJP and GJA, which are separated through PCA and GJA showing differentiation from rest of the samples. The maximum RW was observed during GAP though the PL, NRS, and NRT were found maximum in GAA [Graph 4 and 5].

Table 3: Difference between root diameter, pith diameter and area of root samples

Season	Difference (RD-PD) cm	Area of RP (LRP × BTP) cm²	Area of RS (LRS × BRS) cm²	Area of RT (LRT × BRT) cm²	Total area (cm²)
SMA	0.2	16	1.8	-	17.8
SMP	0.3	28.65	7.05	-	28.65
SPhA	0.2	45.6	6	-	45.6
SPhP	0.4	40	6.72	-	46.72
GJA	0.5	44	7.75	1	52.75
GJP	0.4	5.6	8	1.32	14.92
GAA	0.4	8.88	28.8	1.8	39.48
GAP	0.4	9.6	22	3.6	35.2

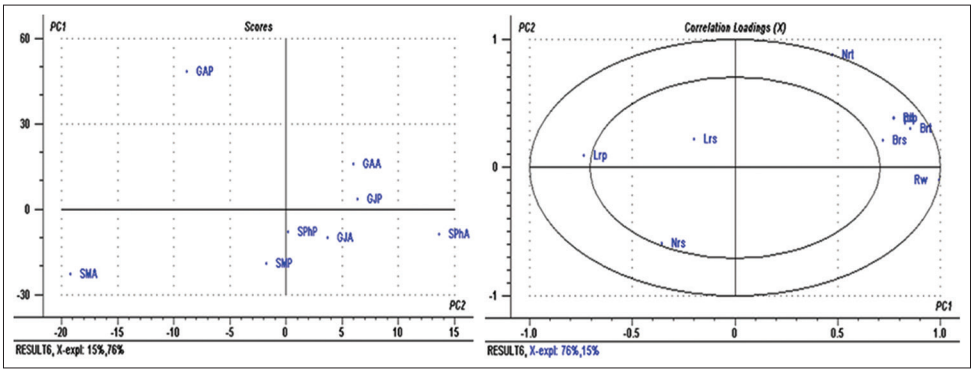
SMA: *Shishira Magha Amavasya*, SMP: *Shishira Magha Pournima*, SPhA: *Shishira Phalguna Amavasya*, SPhP: *Shishira Phalguna Pournima*, GJA: *Greeshma Jyeshtha Amavasya*, GJP: *Greeshma Jyeshtha Pournima*, GAA: *Greeshma Aashadha Amavasya*, GAP: *Greeshma Aashadha Pournima*, RD: Diameter of root, LRP: Length of primary root, BRT: Breadth of tertiary rootlets, BRS: Breadth of secondary rootlets, BTP: Breadth of primary root, PD: Diameter of pith

All *Greeshma* and *Shishira* samples got varying amount of light thus placed in different quadrant on PCA [Graph 7].

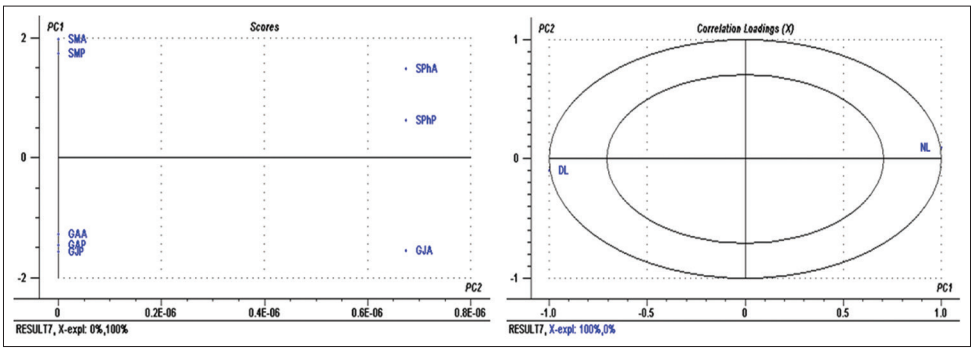
Discussion

The concept of drug collection has importance since *Vedic* period.[7] In modern era, it has gain attention for obtaining a good amount of qualitative as well as quantitatively potent yield. The concept of lunar gardening is adopted to obtain good amount of yield of phytoconstituents. Through microscopic observation, it is proved that the moon controls the sap flow in plants.

From the laboratory experiments, it is known that light intensities as low as 0.1 lux (approximately 0.01 foot candle) during the night can influence the photoperiodic time measurement in some plants. The light intensities are three times greater, that is 0.3 lux at full moon days, which may be one of the causative factors for the influence of lunar.[8] The concept is also supported by Newton's law of gravitation, which states that tides are affected by the gravitational pull of the moon. The pull of the moon is stronger than the sun because, even though the sun is larger, the moon is closer to the earth. The strongest effect is felt when the moon and sun pull from the opposite sides of the earth, at the full moon phase. These forces effect the water content of the soil, creating more moisture in the soil at the time of the new and full moon days.



Graph 6: Principle component analysis (PCA) of root characters of *Shishira* and *Greeshma* seasons. SMA: *Shishira Magha Amavasya*, SMP: *Shishira Magha Pournima*, SPhA: *Shishira Phalguna Amavasya*, SPhP: *Shishira Phalguna Pournima*, GJA: *Greeshma Jyeshtha Amavasya*, GJP: *Greeshma Jyeshtha Pournima*, GAA: *Greeshma Aashadha Amavasya*, GAP: *Greeshma Aashadha Pournima*, NRS: Number of secondary rootlets, NRT: Number of tertiary rootlets, BRT: Breadth of tertiary rootlets, BRS: Breadth of secondary rootlets, LRP: Length of primary root, LRS: Length of secondary rootlets, BTP: Breadth of primary root, RW: Root weight



Graph 7: Principle component analysis (PCA) of light intensity of *Shishira* and *Greeshma* seasons. SMA: *Shishira Magha Amavasya*, SMP: *Shishira Magha Pournima*, SPhA: *Shishira Phalguna Amavasya*, SPhP: *Shishira Phalguna Pournima*, GJA: *Greeshma Jyeshtha Amavasya*, GJP: *Greeshma Jyeshtha Pournima*, GAA: *Greeshma Aashadha Amavasya*, GAP: *Greeshma Aashadha Pournima*, DL: Day length, NL: Night length

This increased moisture encourages the root to grow. It is also found that, even the small parts of the plant has more oxygen consumption during lunar period.[9]

From the above experimental observation, it is clear that all the eight samples collected during *Shishira* and *Greeshma* season on *Amavasya* and *Pournima*, respectively, showed differentiation in morphological characters. As the plant age increases, there is linear increase seen in all the features but the extra residual increment or difference, is calculated through PCA and described in graphical manner for easier understanding.

In *Shishira* season, length of the plant started increasing from SMA to SPA but afterwards horizontal growth was started in the form of twig formation. During *Phalguna* season, plants were affected by leaf spot disease creating stressor response, which has produced damage to leaves and probably retardation in length of plants. It has been seen that during new twigs formation, the length of the plant has not increased in constant manner. Number of rootlets (NRS, NRT), breadth of rootlets (BRP), etc., didn't show significant differences according to lunar phases probably due to environmental stressors pertaining to habitat or plants adaptations. During such stressor conditions, the plant mainly functions for protective mechanism and secretes compounds such as phenols and flavonoids.[10,11] In *Greeshma*, increase in length as well as breadth took place proportionately. The number and length of twigs increased subsequently. The weight of root was increased subsequently in all samples except a fall is noted in GJA sample may be due to environmental stress like sudden increase in heat, which resist the normal growth of the plants.

The difference between RD and PD has increased consequently maximum being at GJA sample, that is 0.5 cm then it has constant in *Greeshma* season suggesting dense accumulation of tissues. A slight decrease of this difference was seen in SPhA sample. In *Greeshma* season, there was stability in these differences [Table 2].

The ID of all samples has increased except a fall in GAA sample and being maximum at GJP, that is 7.5 cm. It is noted that the increase in ID was observed during *Pournima* days. During new moon light period the leaf size and length of twigs were found to be increased.

The parameters such as RW, PD and ID were found to be increased on full moon days as compared to consecutive new moon days samples.

The energy received from sun is used for photosynthesis, which is prime function of plant, the residual energy is utilized for the synthesis of metabolites which helps plant to resist against environmental stress such as heat and fungal attack. The exposure of plant to sunlight was more in *Greeshma Pournima* days as compared to *Greeshma Amavasya* and *Shishira*. Thus, though there is no specific conclusion on growth of *Ashwagandha* as far as lunar cycles are concerned still the *Greeshma* season samples had exhibited variation of growth in comparison to *Shishira Ritu*.

Conclusion

The study carried out to assess the effect of lunar cycles on the growth of the plant has shown a definite influence on the growth of the plant parts which is assessed by the parameters such as root weight, pith diameter, and intermodal distance which have found to be increased on full moon days as compared to new moon days. The present study clearly indicates that full moon day influences the growth of root of *Ashwagandha* in comparison to new moon day. However, the study is done on small sample size in a defined habitat of Jamnagar. Hence, before generalizing the principle of lunar cycles experiments on large sample in different seasons and habitats are recommended.

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Conflicts of interest
There are no conflicts of interest.

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हिन्दी सारांश

चन्द्र चक्र का अश्वगंधा के विकास पर प्रभाव

स्वागता टाव्हरे, निष्ठेश्वर के., विनय जे. शुक्ला

आयुर्वेद के आचार्यों ने ऋतु के अनुसार द्रव्य के प्रयोज्यांग संग्रहण करने का विधान किया है। इसे प्राधान्य देते हुए चन्द्र चक्र का अश्वगंधा के विकास पर प्रभाव का निरिक्षणात्मक अध्ययन करने का ध्येय प्रस्तावित किया है। ७ ऑक्टोबर २०१३ को उचित प्राकृतिकवास से १० से.मी. ऊंचाई के १४ अश्वगंधा के पौधों को संग्रहित करके चरक वनौषधि उद्यान, गुजरात आयुर्वेद युनिवर्सिटी, जामनगर मे ६० द ६० (सेमी) के क्षेत्र में पुनः रोपित किया गया। प्रिंसिपल काम्पोनंट अनालिसिस के सोफ्टवेअर द्वारा पौधों के वृद्धि–क्षय के निकषों का परिक्षण किया गया और इस निरीक्षण में निकषों के आधार पर ८ ऋतुओं में पौधों के आकारिकी और रूप में फर्क पाया गया। चन्द्र चक्र का मूल के वजन में, मूल के व्यास की लंबाई और दो पत्तों के पोर की लंबाई में अमावस्या से अधिक पूर्णिमा में वृद्धि पाई गयी। संभवतः पर्यावरण के तनाओं की वजह से पौधे की लंबाई, टहनियों की लंबाई, पार्श्वजडों की संख्या और चोडाई आदि निकषों में विशेष प्रभाव नहीं पाया गया। इस अध्ययन में अश्वगंधा के आकारिकी और रूप में शिशिर की तुलना में ग्रीष्म ऋतु में अधिक वृद्धि तथा चन्द्र चक्र के अनुसार संग्रहण का उपरोक्त उल्लेखित विकास के कुछ निकषों पर गृहित क्षेत्र में उचित प्रभाव पाया गया।