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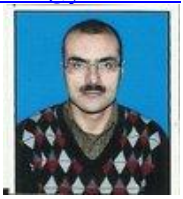

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FOLIAR, FLORAL AND ANATOMICAL CHARACTERISTICS WITH EDAPHOLOGICAL VARIABILITY IN *Abroma augusta* L.

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Abstract

Devil's cotton is an evergreen plant of medicinal importance which is distributed in tropical Asia, South and eastern Africa and Australia. In north-east India, this plant species is naturally distributed in Assam, Arunachal Pradesh, Meghalaya and Tripura. The present study was done on its distributional variation related with edaphic factors, abiotic as well as biotic factors associated with the target plant species in Assam, India where this plant species is declared threatened. A variation in edapholgical factors affects the morphological and anatomical characteristics of this plant species. The Pearson's Correlation Coefficient matrix was calculated for all edaphic, abiotic as well as biotic factors. A negative correlation was observed in site elevation with most of the factors with exception in soil temperature and available soil organic carbon where the correlation was positive (0.01, 0.07). But high negative correlation values were observed in case of soil electrical conductivity (-0.75) and plant height (-0.44) indicating their inverse relation with the site elevation. The high positive correlated factor (0.94) was found in relative atmospheric humidity (%) with soil moisture content (%). The available soil organic carbon (%) was observed to influence plant height as the observed correlation was positive (0.87). The plant height was also positively influenced by the edaphic factors with the exception of soil temperature which was again found negative correlated (-0.75) with soil *p*H. This study also further reflects the variations in foliar, floral and anatomical characteristics due to edaphological factors.

Keywords: Abiotic factors, Biotic factors, Edaphic factors, Edaphological variability, Pearson's correlation coefficient

Introduction

Abroma augusta L., commonly known as Devil's cotton (English), *Gorokhia korai* (Assamese) and *Ulat kambal* (Hindi) is an evergreen plant with spreading branches, quick-growing, pubescent shrub or a small tree with velvety branches, found in tropical Asia, South and eastern Africa and Australia (Das et al., 2012). It is found in both wild and cultivated areas, throughout the hot and moister parts of India ranging from Punjab and Uttar Pradesh eastwards to Arunachal Pradesh, Assam, Meghalaya and Tripura, ascending to 1,200 m, and southwards in peninsular India (Anon., 2006; Gupta et al., 2011). This plant is used for the treatment of various types of disorders in the traditional system (Parkash et al., 2013; Patel and Dhanabal, 2013) as well as in modern systems of medicine (Bisht et al., 2014; Parkash at al., 2014). The present study elaborates the distributional variation amongst the edaphic factors (*p*H, percent moisture content, electrical conductivity, temperature and available organic carbon percent of the soil), other abiotic (site elevation and relative atmospheric humidity) as well as biotic factors (plant height and seed weight) associated with this plant species. Moreover, this study also reflects the floral

biology along with foliar and caulis morphology as well as anatomy ofthis plant species in this research paper.

Material and Methods

Survey and Collection of Seed and Rhizospheric Soil Samples

Owing to the scattered distribution of *Abroma augusta* L., an extensive survey of different locations in Assam, India was done for the collection of roots along with rhizospheric soil samples. Rhizospheric soil and roots were collected from 8 natural locations/provenances of Brahmaputra valley, *viz.*- Titabor, Borholla, Namrup, Nagamati, Kokilamukh, Kaziranga, Amsoi and Jagiroad where *A. augusta* was naturally occurring in these geographic locations and distributed in 4 districts i.e. Jorhat, Dibrugarh, Golaghat and Nagaon of Assam state in India (latitude 24° 8′ to 24° 2′ N and longitude 89° 42′ to 96° 0′ E). These sites were also observed for its habitat as well as geo-positioning and/ or locational data. The major of rain fall (1800 mm to 3000 mm) in these regions occur during monsoon period *i.e.*, March to May, the heaviest precipitation comes with the southwest monsoon, which arrives in June, stays through September, and often causes widespread and destructive flooding (Das, 2014). The plant specimen were also collected, preserved in herbarium sheets for identification and deposited at herbarium of Rain Forest Research Institute, Jorhat, Assam. Rhizospheric soil samples (at least three samples) were taken by digging out a small amount of soil (500g) close to plant roots up to the depth of 15-30 cm and these samples were kept in sterilized polythene bags at 10°C for further processing in the laboratory and physico-chemical analyses of soil.

Physico-Chemical Analysis of Soil

The *p*H and soil temperature were measured for all soil samples using electronic digital *p*H meter (Eutech Instruments, make 2009) soil thermometer (Jain Co., make 1984). Moisture content was determined by oven dry technique (Allen et al., 1974). Organic carbon (%) estimation was done by Walkley-Black's method (Walkley and Black, 1934). The humidity (%) was calculated by hygrometer (make Germany) and moisture content of the sample was calculated using the following equation:

$$W(\%) = \frac{A - B}{B} \times 100$$

Where: W (%) = Percentage of moisture in the soil sample,

A = Weight of wet soil sample (grams), and

B = Weight of dry soil sample (grams)

Analysis of Floral Biology

Floral buds of this plant species were collected at several different locations and fixed in FAA (Formalin, Acetic acid and Alcohol). Flower morphology was described using 10 inflorescences of each collected sample of plant. The structure of the flowers, their position in the inflorescence and the morphology of the separate floral parts were assessed. Names of floral parts were followed as per Radford et al. (1974) and Gill (1988). The floral structures were observed minutely under a light trinocular microscope (AZM 100) following standard procedures (Prenner *et al.*, 2010) and datum was tabulated. The Floral diagrams were prepared both in Rosypal (Rosypal, 1992) and Ronse De Craene (De Craenae, 2010) formats prepared using the online utility Floral Diagram Generator(http://kvetnidiagram.8u.cz/index_en.php). But only Ronse De Craene format of floral diagram is depicted in this research paper.

Analysis of Foliar Epidermis

For the study of leaf epidermal morphological parameters, the leaf samples were treated as per standard methodology (Ahmad, 1974). The macro- and micro-morphological descriptions have been done following standard procedures (Mullan, 1930; Metcalfe and Chalk, 1950). The number of stomatal cells, Stomatal Index as well as Stomatal Index (percent) were calculated using a light trinocular microscope (Labovision, BIOXL) following standard formulae (Salisbury, 1927) and datum was tabulated.

Analysis of Caulis Sections

The anatomical slides of stem and flower of *Abroma augusta* were prepared and analyzed for various anatomical features as specified in literature (Metcalf and Chalk, 1979).

Results and Discussion

Phyto-Distribution with Regard to Edaphic and Other Environmental Factors

The edaphic as well as abiotic and biotic factors associated with the plant species have been tabulated in Table 1.The maximum (6.1±0.65) plant height was observed in the

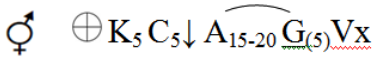
study site Jagiroad, while Nagamati showed minimum (2.77±0.12) plant height. The per gram seed count was minimum (156±3.91) in Titabor study site and maximum in Amsoi (228±1.83). Namrup recorded the highest values with respect to site elevation (121amsl) and available soil organic carbon (1.21%) while the lowest values for the said parameters were exhibited by Jagiroad (62.4 amsl) and Titabor (0.06%), respectively. The study site Kokilamukh exhibited maximum (8.2±0.24) value for soil *p*H and minimum (20°C) value for soil temperature; while the site Titabor exhibited minimum (4.37±0.24) value for soil *p*H and maximum (33°C) value for soil temperature. The highest (93.87±5.45 Sm^{-1}, 69±3.21) values of electrical conductivity and humidity were observed in Borholla whereas the lowest values for the said paramters (43.4±2.24 Sm^{-1}, 34±4.71) were recorded at Nagamati locations in case of electrical conductivity and Namrup for humidity, respectively. The available soil moisture content percent was recorded highest (6±0.25) and lowest (3.84±0.21) in Borholla and Namrup locations, respectively.

The Pearson's Correlation Coefficient matrix for the above mentioned characters/ factors are depicted in Table 2. When site elevation was analysed, negative correlation was observed with most of the factors with exception in soil temperature and available soil organic carbon where the effect was positive but the value was not very high. Also, high negative correlation value was observed in case of soil electrical conductivity (-0.75) and plant height (-0.44) indicating their inverse relation with the site elevation. The highest positively correlated value (0.94) was found between relative atmospheric humidity (%) and soil moisture content (%). The available soil organic carbon (%) was observed to influence (0.87) plant height (m). The plant height was also positively influenced by most of the edaphic factors, with the exception of soil temperature. Also the soil temperature was found to negatively correlated (-0.75) soil *p*H which can be attributed to the fact that increase in temperature, increases molecular vibrations leading to water ionization and formation of more hydrogen ions, thus, dropping the *p*H value (Mohd-Aizat *et al*., 2014).

Parkash and Saikia (2015) had also studied the influence of abiotic environmental factors on the rhizospheric arbuscular mycorrhizal composition of *Abroma augusta*. They analysed the effect of these factors on AM spore density and root colonization. Not only these factors have influenced mycorrhizal association but also overall microbial diversity around the rhizospheric region of this plant species (Parkash *et al*., 2014; Parkash and Saikia, 2018). Thus, the study of plant distribution with respect to edaphic and other environmental factors is an important aspect.

Floral Biology

The Inflorescence is solitary or few flowered racemes. The flowers are pendent, bisexual and actinomorphic. The peduncle and pedicel are slightly enlarged in fruit. The fruit is an obconical capsule, rounded at base, with truncate at apex, 5-winged and angled, beaked sometimes, enveloped by a slightly enlarged sepal, densely prickly hairy, with apical portion loculicidal, septicidally dehiscent lateral parts and with numerous seeds (See Plate 1: G). The whole flower is around 5 cm in length. The anatomical study of flower showed that flowers are bisexual, pentamerous; Sepals 5, triangular and greenish with red pigmentation, petals 5 which are spoon-shaped, concave and white at base, with maroon blade and fringed. The androecia has short cup-shaped staminal tube with 5 fascicles of anthers alternate with 5 petal-like staminodes apically; anthers sub-sessile at the sinuses. Each fascicle is with 2-4 anthers. The gynoecium has 5-lobed pistil, ovary sessile, superior, 5-locular, ovules many in each cell, ovules with axile placentation, and 5 stigmatic style branches (see Plate 1: A-F). The seed is cylindrical to obovoid, without wings or aril and black. Seeds many, small, blackish, covered with silky hairs. Seeds are the best propagation material. Mature seeds, which are black in colour at maturity, can be collected during December to January (See Plate 1: H-I). The floral formula and floral diagram of the plant species are shown below.



Foliar Morphology and Anatomy

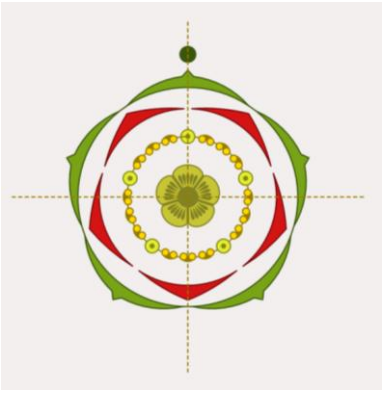


Table 1: GPS coordinates of locations and average of Physico-chemical properties of *Abroma augusta* L.

Locations	GPS Coordinates	Biotic factor(s)		Physiographic factor	Climatic factor	Edaphic factor(s)				
		Height of plant* (m)	Number of seeds/gm*	Site Elevation * (m)	Relative Atmospheric Humidity* (%)	Soil *p*H*	Soil Electrical Conductivity* (S m^{-1})	Soil Temperature* (ºC)	Available Soil Org. Carbon* (%)	Soil Moisture Content* (%)
Titabor	N 25º 54' 38.6" E 93º 40' 55.9"	3.15±0.47	156±3.91	78±0	55±2.36	4.37±0.24	80.8±4.71	33.0±0	0.06±0	4.44±0.11
Borholla	N 24º 32' 39.3" E 94º 11' 12.3"	4.33±0.72	162±1.31	83.67±0	69±3.21	4.9±0.26	93.87±5.45	33.0±0	0.48±0	6±0.25
Namrup	N 27º 11.012' E 95º 21.999'	5.5±0.84	190±2.47	121.33±0	34±4.71	5.22±0.21	55.4±2.83	22.33±0	1.21±0	3.84±0.21
Nagamati	N 27º 12.027' E 95º 21.4'	2.77±0.12	183±4.18	118±0	45±3.3	6.08±0.34	43.4±2.24	23±0	0.37±0	4.3±0.15
Kokilamukh	N 26º 49' 52.7" E 94º 10' 45.1"	6±0.58	201±2.51	63±0	50±2.4	8.2±0.24	91.4±4.41	20±0	0.81±0	4.6±0.28
Kaziranga	N 26º 38' 6.2" E 93º 33' 16.1"	6±1.08	205±3.08	65.33±0	53.67±1.91	5.25±0.11	76.1±1.89	22.67±0	1.15±0	5±0.38
Amsoi	N 26º 07' 26.9" E 92º 16' 11.4"	4.1±0.44	228±1.83	68.6±0	41.6±2.83	6.68±0.14	71.28±3.57	21.0 ±08	0.4±0	3.9±0.22
Jagiroad	N 26º 06' 49.1" E 92º 10' 53.9"	6.1±0.65	163±2.25	62.4±0	48.4±4.01	6.42±0.38	73.9±1.41	21.4±0	0.92±0	4.61±0.42

± Standard error of mean

* Average of all collected samples of a particular location/site

Table 2: Pearson's correlation coefficient values for various abiotic environmental factors

		Physiographic factor	Climatic factor	Edaphic factors					Biotic factors	
		Site Elevation * (m)	Relative Atmospheric Humidity* (%)	Soil pH*	Soil Electrical Conductivity* (S m-1)	Soil Temperature* (ºC)	Available Soil Org. Carbon* (%)	Soil Moisture Content* (%)	Height of plant* (m)	Number of seeds/g*
Physiographic factor	Site Elevation * (m)	1								
Climatic factor	Relative Atmospheric Humidity* (%)	-0.41	1							
Edaphic factor	Soil pH*	-0.34	-0.30	1						
	Soil Electrical Conductivity* (S m-1)	-0.75	0.72	0.09	1					
	Soil Temperature* (ºC)	0.07	0.71	-0.75	0.38	1				
	Available Soil Org. Carbon* (%)	0.01	-0.34	0.18	-0.09	-0.58	1			
	Soil Moisture Content* (%)	-0.30	0.94	-0.25	0.64	0.56	-0.05	1		
Biotic factor	Height of plant* (m)	-0.44	-0.10	0.37	0.33	-0.52	0.87	0.10	1	
	Number of seeds/g*	-0.14	-0.50	0.51	-0.16	-0.69	0.28	-0.44	0.22	1

* Based on average of all collected samples

Table 3A: Microscopic study on number of stomata and epidermal cells in *Abroma augusta* L.

Number of stomata and epidermal cells				
Microscopic fields	**Type of leaf**	**Apical leaf part**	**Middle leaf part**	**Basal leaf part**
1	Cordate	41 (S)	50(S)	40(S)
		42 (E)	52(E)	42(E)
2		42(S)	52(S)	44(S)
		44(E)	54(E)	47(E)
3		37(S)	45(S)	40(S)
		40(E)	48(E)	43(E)
4	Palmate	41(S)	45(S)	42(S)
		40(E)	47(E)	47(E)
5		42(S)	47(S)	45(S)
		42(E)	50(E)	49(E)

S = No. of stomata per unit area (field), E = No. of epidermal cells in the same unit area (field).

Table 3B: Stomatal Index and Stomatal Index (%) in *Abroma augusta* L.

Stomatal Index (SI) and Stomatal Index Percentage (%)						
Microscopic field	**Apical leaf part**		**Middle leaf part**		**Basal leaf part**	
	SI	SI (%)	SI	SI (%)	SI	SI (%)
1	0.49	49.40	0.49	49.02	0.49	48.78
2	0.49	48.84	0.49	49.06	0.48	48.35
3	0.48	48.05	0.48	48.39	0.48	48.19
4	0.51	50.62	0.49	48.91	0.47	47.19
5	0.50	50.00	0.48	48.45	0.48	47.87
Average	0.49	49.38	0.49	48.77	0.48	48.08
SEm	0.01	0.45	0.00	0.14	0.00	0.27
SD	0.0100	0.9967	0.0032	0.3208	0.0059	0.5938
CV (%)	2.02	2.02	0.66	0.66	1.24	1.24

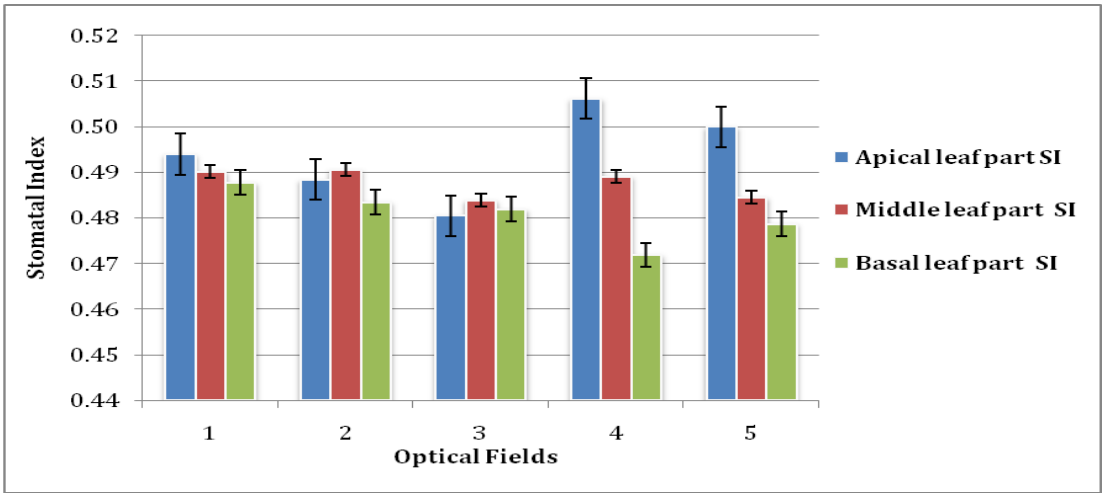


Figure 1: Stomatal Index at different optical fields (Optical field 1-3 for cordate type of leaf; Optical filed 4-5 for palmate type of leaf)

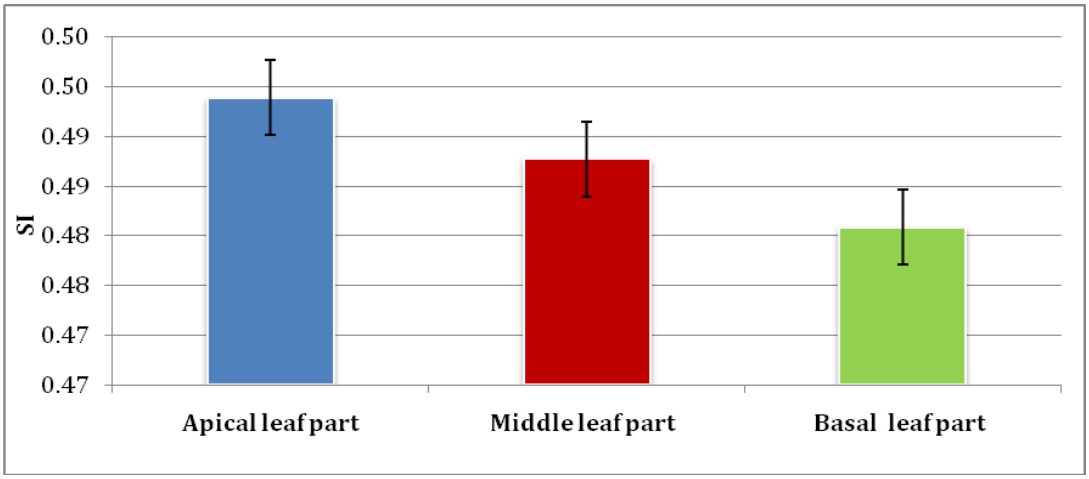


Figure 2: Average stomatal Index (%) of different leaf parts for both types of leaves.

The leaves are heterophyllous; occurring in two main forms *i.e.* cordate (restricted to the upper portion of plant) and palmate (restricted to the lower portion of plant); phyllotaxy alternate, simple, lobed or unlobed, pubescent. The unlobed form is the petiole up to *ca* 1.5 cm long, with lance-shaped blade; heart shaped at base, denticulate and palmate-pinnately veined while the lobed form is with petiole, cordate-ovate in outline, with palmately veined base and irregularly dentate margin.

The microscopic study on number of stomata and epidermal cells in *Abroma augusta* L. is shown in Table 3A. The leaf sections from apical, middle and basal part were taken and put in the solution as per the method as described above in Material and Methods. The stomata and epidermal cells were observed under five microscopic fields. The Stomatal Index and Stomatal Index (%) in *A. augusta* L. is shown in Table 3B. It is observed that the Stomatal index and Stomatal index (%) were high in apical leaf part (0.49, 49.38) followed by middle leaf part (0.49, 48.77) and basal leaf part (0.48, 48.08) (see Table 3B and Figures 1-2). Another observation was that the stomatal index and Stomatal index (%) for apical portion was higher in Palmate type of leaves as compared to cordate leaves (See Figure 1-2).

Stomatal density (SD) is a function of both the number of stomata plus the size of the epidermal cells. Thus, SD is affected both by the initiation of stomata and the expansion of epidermal cells. This expansion is a function of many variables (*e.g.* light, temperature, water status, position of leaf on crown and intra-leaf position), and can overprint the signal reflective of stomatal initiation. As it turns out, CO_2 plays a stronger role in stomatal initiation than in epidermal cell expansion (this is discussed in detail below). Salisbury (1927) introduced the concept of stomatal index (SI), which normalizes for the effects of this expansion *i.e.* density of epidermal cells (Royer, 2001).

Caulis Morphology and Anatomy

The stem is pentangular in shape. The transverse section of stem is shown in Plate 1: J-L. Transverse section of stem shows that the epidermis is composed of fine hair like setae followed by few layers of collenchymas which is flanked by in between with sclerenchyma. Pith is reduced and xylem vessels are composed of metaxylem and protoxylem and it is in endarch condition with vascular rays. Pre-cambial strip is reduced and vascular bundles are closed and collateral in nature (see Plate 1: J-L).

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Plate 1: A: Morphology and habit of Plant species, B: Flower, C: Flower showing calyx and corolla D: Calyx bearing anthers on androecial cup, E: Pistil having sessile anthers, F: Sessile lobed anthers, G: Pentangular Fruits, H: Different seed sources of plant species, I: Seeds, J: Xylem vessel in stem (black circle) , K: Eccentric xylem in stem with reduced pith, L: T.S. of stem showing e- Epidermis with fine setae, c- Collenchyma, s- Sclerenchyma, p- Phloem, pr-pre-cambium strip, v- vascular ray.

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INFLUENCE OF DIFFERENT ORGANIC MANURES ON GROWTH AND YIELD OF RADISH (*Raphanus sativus* L.) UNDER DEHRADUN VALLEY OF UTTARAKHAND

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Abstract

Present experiment was undertaken to study the impact of different organic manures on growth and yield of radish cv. Pusa Chetki. For this, a field experiment was carried out in Randomized Block Design with three replications. The experiment was conducted at the Horticulture Research Block of Shri Guru Ram Rai School of Agricultural Sciences during 2017-18. The experimental site is situated at 29°58' N latitude and 77°34' E longitude at an elevation of 640 m above mean sea level. For the experiment, ten treatment combinations are taken viz. T_1- Control, T_2- FYM 100 %, T_3-Vermicompost 100 %, T_4- Poultry manure 100 %, T_5-FYM 75%+ Vermicompost 25%, T_6- FYM 50%+ Poultry manure, T_7- FYM 75%+ Poultry manure 25%, T_8- FYM 50% + Poultry manure 50%, T_9- Vermicompost 75% + Poultry manure 25% and T_{10}- Vermicompost 50%+ Poultry manure 50%. Results shows that among the various sources of organic nutrients applied, treatment T_{10}- Vermicompost 50%+ Poultry manure 50% perform better than all other treatments in terms of vegetative growth as well as yield parameters of radish. It was followed by treatment T_6 - FYM 50%+ Poultry manure 50%.

Keywords: Vermicompost, poultry manure, vegetative growth, radish, organic manure.

Introduction

Radish (*Raphanus sativus* L.) is cultivated throughout India and belongs to the family Brassicaceae. It is a popular root vegetable crop in both tropical and temperate regions. It can be cultivated under cover for early production but large-scale production in field is more common in India. It is grown for its young tender tuberous root, which is consumed, either cooked or raw. Radish is a good source of ascorbic acid (vitamin C) and minerals like iron, calcium, potassium and phosphorus (Hazara and Som, 2006). It has refreshing and diuretic properties. In homeopathy, it is used for treatment of headache, neurological problem, sleeplessness and chronic diarrhea etc. The roots are also useful in urinary complaints and piles. The leaves of radish are good source for extraction of protein on a commercial scale and radish seeds are potential source of non-drying fatty oil suitable for soap making illuminating and edible purposes. Being a short duration and quick growing crop, the root growth should be rapid and uninterrupted (Choudhary *et al.* 2002). Per 100g Radish root has 94.4 per cent moisture, 3.4 g Carbohydrates, 0.7 g protein, 0.06 mg thiamine, 0.02 mg riboflavin, 15

mg vitamin C, 35 mg Calcium and 0.04 mg iron (Daliwal, 2014). Organic farming is gaining huge popularity in India due to the individual as well as group efforts to conserve our environment and avoid contamination of the farm produce from the excessive use of hazardous chemical fertilizers and pesticides. The use of organic matter such as household food wastes, yard wastes, animal manures, sewage sludge and composts etc. has long been recognized in agriculture field as beneficial for plant growth and yield as well as for the maintenance of soil fertility. Herbert (1998) reported that animal manures are excellent source of plant nutrients. Approximately 70-80 percent of the nitrogen, 60-85 percent phosphorus and 80-90 percent of potassium in feeds are excreted in the form of manure. He further added that manure contains all the plant nutrients needed for crop growth including trace elements too. The availability and efficiency of such organic manures utilization by a crop is determined by the method of its application, time to incorporate and the rate of manure decomposition by microorganisms in soil. The new approaches to the use of organic amendments in farming have proven to be effective means of improving soil structure, enhancing soil fertility and increasing crop yields. Keeping this in regard, the present investigation was carried out with the objectives to study the impact of various organic manures on growth and yield of radish.

Materials and Methods

The present field experiment was conducted during the winter season of 2017-18 at Experimental Research Block of Department of Horticulture, School of Agricultural Sciences, SGRR University, Dehradun, Uttarakhand (29°58' N, 77°34' E). The present investigation was undertaken to ascertain the impact of various organic manures on growth and yield of radish. The radish cultivar used in this experiment is Pusa Chetki which matures in 40-45 days. The soil of the experiment field was sandy loam with high pH (more than 7.1).The organic manure applied, were arranged in ten treatments and replicated thrice following Randomized Block Design. Radish seeds were dibbled half way down the ridges at the spacing of 15 cm in the soil. Thinning was done at 15 days after sowing by retaining one seedling per hill. The organic manures under study were FYM, vermicompost, poultry manure and their combinations.The details of the treatment are as follows; T_1- Control, T_2- FYM 100 %, T_3- Vermicompost 100 %, T_4- Poultry manure 100 %, T_5-FYM 75%+ Vermicompost 25%, T_6- FYM 50%+ Poultry manure, T_7- FYM 75%+ Poultry manure 25%, T_8- FYM 50% + Poultry manure 50%, T_9- Vermicompost 75% + Poultry manure 25% and T_{10}- Vermicompost 50%+ Poultry manure 50%. These treatments were applied during field preparation one week before sowing. In order to keep the soil porous and also free from weeds, hand hoeing and earthing up was done twice, once at 20 days after sowing and another at 40 days after sowing. The irrigations were given at an interval of 7 to 8 days depending upon the weather and soil conditions. The observations were taken on their vegetative growth and yield parameter such as Plant height, number of leaves, length of leaves,leaf weight, root weight, root length, root diameter and yield. Statistical analysis of data recorded in all observation was computed by method of analysis, of variance and treatments were compared with the help of vertical difference as suggested by Panse and Sukhatme (1989) and the mean value were compared at 50% level of significance.

Results and Discussion

Growth attributing characters

The application of organic manures into the soil not only increase the fertility status and moisture holding capacity of soil, but also plays an important role in soil water conservation by their binding and aggregation properties. Moreover, they are also helpful in balancing nutrient availability to the growing plants and boost of production and quality of the crops. The results obtained in this experimentation clearly revealed that radish respond well to organic manures and their combinations. In general, the treatment T_{10} (Vermicompost 50%+ Poultry manure 50%) recorded maximum plant height (51.78 cm), number of leaves (11.38) and leaf length (37.42 cm) followed by the treatment T_6 (FYM 50%+ Poultry manure) at the time of harvest. This might be due to the steady release of nutrients throughout the entire crop growth period. Plants grew taller than other plants possibly because more concentrated nutrients or minerals were made readily available and easily absorbable by the receiving

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Table 1: Effect of organic manures on plant height, number of leaves and length of leaves of radish cv. Pusa Chetki

Treatments	Plant Height (cm)			Number of leaves			Length of leaves (cm)		
	15 DAS	30 DAS	At Harvest	15 DAS	30 DAS	At Harvest	15 DAS	30 DAS	At Harvest
T_1- Control	2.42	29.82	41.16	3.96	5.65	7.87	6.13	14.22	26.86
T_2- Farm Yard Manure	2.55	31.13	41.77	4.17	6.64	8.40	6.17	14.31	32.65
T_3- Vermicompost	2.69	34.94	42.68	4.52	7.03	8.90	6.37	14.74	34.88
T_4- Poultry Manure	2.67	34.17	42.50	4.23	6.77	8.60	6.30	14.48	33.58
T_5-FYM (75%) + Vermicompost (25%)	3.02	35.79	45.58	4.80	7.40	10.33	7.27	16.33	35.68
T_6- FYM (50%) + Vermicompost (50%)	3.05	37.28	49.26	5.66	8.08	10.86	9.68	18.08	36.24
T_7- FYM (75%) + Poultry Manure (25%)	2.92	35.24	45.28	4.63	7.33	9.83	7.20	15.69	35.02
T8-FYM (50%) + Poultry Manure (50%)	3.03	36.01	45.97	5.13	7.83	10.33	8.17	17.14	36.00
T_9-Vermicompost (75%) + Poultry Manure (25%)	2.82	35.22	43.98	4.56	7.23	8.97	6.43	14.93	35.02
T_{10}-Vermicompost (50%) + Poultry Manure (50%)	3.08	39.06	51.78	6.24	8.86	11.38	9.96	18.58	37.42
SEm+	0.143	1.705	1.693	0.297	0.439	0.623	0.435	0.954	1.800
CD@ 5%	0.423	5.064	5.029	0.883	1.294	1.851	1.292	2.834	5.347

*DAS-Days after sowing

Table 2: Effect of organic manures on fresh weight of leaves, dry weight of leaves, fresh weight of root, root length, root diameter, yield kg/ha of radish cv. Pusa Chetki

Treatments	Leaf weight (g)		Fresh weight of root (g)	Root length (cm)	Root diameter (cm)	Yield (Kg/ ha)
	Fresh weight	Dry weight				
T_1- Control	54.00	11.24	76.66	18.83	3.73	25089
T_2- Farm Yard Manure	61.56	12.72	111.48	19.83	4.02	33227
T_3- Vermicompost	66.60	14.07	127.72	21.73	4.27	37313
T_4- Poultry Manure	62.28	12.98	118.06	21.00	4.10	24629
T_5-FYM (75%) + Vermicompost (25%)	92.22	19.46	144.35	24.67	4.60	45427
T_6- FYM (50%) + Vermicompost (50%)	99.42	21.70	151.01	26.59	4.69	48088
T_7- FYM (75%) + Poultry Manure (25%)	82.62	18.09	139.37	24.17	4.52	42627
T8-FYM (50%) + Poultry Manure (50%)	95.58	20.27	147.04	26.40	4.65	46588
T_9-Vermicompost (75%) + Poultry Manure (25%)	73.80	14.67	138.61	22.83	4.39	40787
T_{10}-Vermicompost (50%) + Poultry Manure (50%)	107.88	23.38	152.08	27.19	4.89	49899
SEm+	6.532	1.735	12.429	1.279	0.176	27.189
CD@ 5%	19.406	5.156	36.929	3.801	0.523	80.784

*DAS-Days after sowing

plants which lead to the faster growth and development. The increase in plant height and number of leaves may also be attributed to higher metabolic activity because of optimum nitrogen application resulting in higher production of carbohydrates and phytohormones which were manifested in the form of enhanced growth of the plant. The increase in number of leaves due to the vital macro and micronutrient availability with the application of vermicompost has been reported by Giraddi (2010). Enhanced plant growth and leaf production obtained by manure application with poultry manure and vermicompost might also indicate availability of balanced plant nutrients and obvious favourable growing conditions. Increased in number of leaf in soyabean attributed to beneficial effect of poultry manure which has been reported by Umoetok *et al*. (2017). Thannunathan *et al*. (2007) reported that the application of vermicompost appears to be very effective amendment for the enhancement of number of leaves and leaf area in onion.

Yield attributing characters

The application of treatment (T_{10}) vermicompost 50% + poultry manure 50% recorded significantly higher values for fresh weight of leaves (107.88g), dry weight of leaves (23.38g), root length (27.19 cm), diameter of root (4.89 cm), fresh weight of root (152.08g) cm and yield of root (49899 kg/ha). The results are in similarity with the observations of Babalad (2015) in respect of dry weight and total dry matter recorded highest by applying poultry manure and other green manures in chilli. The increase in fresh and dry weight of leaves, length of leaf might be due to rapid elongation and multiplication of cells in presence of adequate quantity of nitrogen supplied by vermicompost and poultry manure and also to increase in nitrogen constituent of cell sap in the form of protein, amides and amino acid in the growing regions of meristematic tissues. The fresh weight and dry weight of plants was recorded higher by the application of vermicompost in chilli as reported by Yadav *et al.* (2013). The diameter and length of roots contribute considerably towards weight and finally yield of radish. The size of root was directly influenced by the enhanced vegetative growth on the plants resulted in increase in plant height, and number of green leaves. This might have been due to accumulation of more carbohydrate resulting into the increase in diameter of root. Increase in root length and diameter due to the combined application of vermicompost and poultry manure can be attributed to improved nutrient availability and improvement in physical condition of the soil which in turn provides a balanced nutritional environment in soil rhizosphere and plant system too.

Conclusion

From the present investigation it was concluded that the application of organic manures significantly affected the growth and yield of radish. It was found that the treatment combination of 50% Vermicompost + 50% Poultry manure (T_{10}) was the best in boosting and enhancing the growth and yield parameters of radish. The cost benefit ratio was found to be also best in (T_{10}**)** i.e.50% Vermicompost + 50% Poultry manure. Thus, the application of organic manure ensure the continuous supply of nutrients to plant at every stage resulting in more production of yield attributes and thus increase in root yield.

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STUDY ON SOCIO-ECONOMIC CHARACTERISTICS OF THE FARMER IN RUDRAPRAYAG AND UTTARKASHI DISTRICT OF GARHWAL HILLS OF UTTARAKHAND

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ABSTRACT

The present investigation was carried out with the aim to examining the socio-economic characteristics of farmers, types and uses of home gardens trees, soil status of home gardens and how trees help in biodiversity conservation in Rudraprayag (Malkhi and Khumera villages) and Uttarkashi district (Kurura and Panchan gaun villages) in Uttarakhand. The study was based on by using semi structure interview, field observation and simple preference scoring method in selected site. Three stage sampling technique was employed for constructing sampling plan of the study. The first stage of sampling plan was the selection of blocks from the selected districts, followed by selection of villages (second stage) and selection of respondents (third stage) from the selected villages. The study indicated that majority of the respondents were middle aged, belonged to general category, had education up to primary level, had nuclear family with small family size, pucca type house, small land holding pattern, maximum families served in government departments for income generation, lack of economic resources and maximum family engaged in bee keeping and horse rearing.

Introduction

Based on the information from informal interview and questionnaires were designed to collect the data.

Age

Age distribution of respondents is given in Table 1. The age of respondents were categorized as young, middle and old. Majority of the respondents, i.e., 62.50% were middle aged followed by 27.77% in young age category and only 15.27% respondents were in old age.

Table 1: Distribution of respondents on the basis of age (N=72)

Category	No. of respondents in Rudraprayag		No. of respondents in Uttarkashi		Total no. of respondents*	Percentage (%)**
	Malkhi	Khumera	Kurura	Panchan guan		
Young (21-35)	4	8	5	3	20	27.77
Middle (36-45)	12	10	10	13	45	62.50
Old (>45)	2	4	3	2	11	15.27

Number of respondents (*); Percentage of respondents (**)

This finding is supported by earlier studies (Hisrich and Brush, 1984; Arulprakash *et al.* 2005 and Mehram *et al.* 2006). It indicates the middle age person especially women have more entrepreneurial orientation, innovative ideas and they take up more income generating activities. On the other hand, young age group was busy with their studies and households activities and old age women were not very innovative thus, less involved in entrepreneurial activities.

Caste

Data related to caste of the respondents has been presented in Table 2. It is clear from the Table 2 that 50% of respondents belonged to general category, followed by 40.27% OBC category and rest, i.e., 9.7% fall under SC/ST category.

Table 2: Caste distribution of respondents in selected area

Category	No. of respondents in Rudraprayag		No. of respondents in Uttarkashi		Total no. of respondents	Percentage (%)
	Malkhi	Khumera	Kurura	Panchan guan		
General	18	11	3	4	36	50
OBC	-	-	15	14	29	40.27
SC/ST	-	7	-	-	7	9.73

According to 2011, Census figure, the total population of Rudraprayag and Uttarkashi district were 2, 36,857 and 3, 29,686, respectively. According to Integrated Management Information System (IMIS, 2012), maximum population of Rudraprayag falls in General category.

Education

The data in Table 3 gives literacy level of the respondents. It revealed that maximum number of respondents, i.e., 30.55% had education from 1 to 8th followed by illiterate, i.e., 27.77% whereas 19.44% had education level from 8 to 12th.

Table 3: Distribution of respondents on the basis of education

Category	No. of respondents in Rudraprayag		No. of respondents in Uttarkashi		Total no. of respondents	Percentage (%)
	Malkhi	Khumera	Kurura	Panchan gaun		
Illiterate	3	4	4	9	20	27.77
Primary (1 to 8th)	3	5	9	5	22	30.55
Intermediate(8 to 12th)	4	2	5	3	14	19.44
Above (12th)	8	7	-	1	16	22.22

During informal discussion with the respondents it was found that adequate education facility was available in the village and nearby area. It revealed that presence of colleges in the locality encouraged for higher studies. But the literacy level of women till date is less than the men because the women folk is fully involve in agriculture activity.

As per Census 2011 records, the education levels in Rudraprayag and Uttarkashi district were 82.09% and 75.98%, respectively. In Rudraprayag district, male literacy was recorded 94.97%. This stood 1st rank among Uttarakhand districts. Female literacy in Uttarkashi district was recorded second last, i.e., 62.23%.

Family type

Data represented in Table 4 shows the family type of the respondents. It is clear from the data that 69.49% of the families belonged to the nuclear family while only 30.55% respondents belonged to joint family.

Table 4: Distribution of respondents on the basis of family type

Category	No. of respondents in Rudraprayag		No. of respondents in Uttarkashi		Total no. of respondents	Percentage (%)
	Malkhi	Khumera	Kurura	Panchan gaun		
Nuclear	13	14	11	12	50	69.49
Joint	5	4	7	6	22	30.55

It indicates that nuclear family system is gradually replacing joint family system in rural areas also. This is due to change in socio-cultural fabric in the area under study.

Family Size

Data regarding family size has been presented in Table 5. It revealed that 55.55% of the respondents had small family, followed by 37.50% respondents had medium sized families and only 6.94% respondents had large family.

Table 5: Distribution of respondents on the basis of size of family

Category	No. of respondents in Rudraprayag		No. of respondents in Uttarkashi		Total no. of respondents	Percentage (%)
	Malkhi	Khumera	Kurura	Panchan gaun		
Small (up to 5)	10	12	11	7	40	55.55
Medium (6-10)	8	4	6	9	27	37.50
Large (>10)	-	2	1	2	5	6.94

Number of respondents belonging to small family corresponds with the number of respondents belonged to nuclear family. It can also be concluded that people in the study area are conscious about benefits of family planning.

Type of House

Data regarding type of house of respondents has been presented in Table 6. It was observed that half of the respondents, i.e., 55.55% resided in pucca (Cemented) house, followed by 34.72% respondents who resided in mixed house. Only 9.72% respondents had kaccha house (Wood+ Soil).

Table 6: Distribution of respondents on the basis of type of house

Category	No. of respondents in Rudraprayag		No. of respondents in Uttarkashi		Total no. of respondents	Percentage (%)
	Malkhi	Khumera	Kurura	Panchan gaun		
Pucca	5	14	11	10	40	55.55
Mixed	8	4	6	7	25	34.72
Kuccha	5	-	1	1	7	9.72

From the above data it can be concluded that the economic status of the villagers was above the average living standard.

Occupation

Data regarding main source of income for the households has been presented in Table 7. It revealed that 34.72% families were in the government jobs which were the primary source of income followed by farming as a primary source of income, i.e., 31.94%, followed by 29.16% families were dependent in the business for their livelihood, followed by 4.1% engaged in labour force.

Table 7: Distribution of respondent on the basis of Occupation

Category	No. of respondents in Rudraprayag		No. of respondents in Uttarkashi		Total no. of respondents	Percentage (%)
	Malkhi	Khumera	Kurura	Panchan gaun		
Services	8	3	9	5	25	34.72
Business	6	11	1	3	21	29.16
Farming	4	4	7	8	23	31.94
Wage labor	-	-	1	2	3	4.1

Annual income

Data regarding main source of income for the household has been presented in Table 8. It was observed that 76.38% of the household were above poverty line followed by 23.62% respondents who reported to below poverty line cards.

Table 8: Distribution of respondents on the basis of annual income

Category	No. of respondents in Rudraprayag		No. of respondents in Uttarkashi		Total no. of respondents	Percentage (%)
	Malkhi	Khumera	Kurura	Panchan gaun		
APL	14	15	14	12	55	76.38
BPL	4	3	4	6	17	23.62

APL: Above Poverty Line, BPL: Below Poverty Line

As per 2011 census, 29.8% of the population of India was under the poverty line and 18% of population of Uttarakhand lies below poverty line. The percentage of below poverty line households is less than the state average in the study area.

Land holding

Data regarding land holding pattern in the study area has been represented in the Table 9. It was found that maximum numbers of land households, i.e., 52.77% were marginal land followed by small landholding households 27.77%, followed by large land holding 9.72% and only 2.7% respondents were landless.

Similar type of study conducted by Daniel *et al.* 2012 where it was found that small farms of the hill region with an average farm size of less than 2.0 ha do not produce enough to feed the family even if a satisfactory crop was harvested. In the hill areas of Uttarakhand, about 70% of farmers were marginal possessed less than 1.0 ha of land while 15-18% farmers possess 1-2 ha. Land farming is often reduced to a supplementary source of income for the household as men seek employment elsewhere. As a result, cultivation activities of a large proportion of farms were carried out by women who were already burdened with other daily activities. The overall status was the use of agricultural practices without modern technologies options and low input levels for crop production.

Table 9: Distribution of respondents on the basis of land holding pattern

Category	No.of respondents in Rudraprayag		No. of respondents in Uttarkashi		Total no. of respondents	Percentage (%)
	Malkhi	Khumera	Kurura	Panchan gaun		
Large (>2ha)	-	3	1	3	7	9.72
Medium (2-5ha)	1	2	1	1	5	6.94
Small (1-2ha)	5	4	6	5	20	27.77
Marginal (<1ha)	11	9	10	8	38	52.77
Landless	1	-	-	1	2	2.77

Role of women

Women play the most important role in farm management, rearing of animals and also manage family expenses for food, clothes, child care and education. It appeared that their role was less significant in managing family debt and the purchase of agricultural inputs or other family expenditures. Overall, homestead gardens also perform an important social function. They help to established family, territorial identity, facilitate neighbourhood cohesion and beneficial community interaction. But data regarding role of women in different activities (Table 10) clearly indicates that the role of women in decision making was less in comparison to role of women in participation.

Moreover, nearly 50% of the rural households in the hills were headed by women as the men folk migrate to augment the farm income. Thus, women were actively involved in agricultural operations in addition to their regular household's works. This leads to work pressure and decline in health.

Table 10: Role of women in following activities

S. No.	Activity	Role in decision making (%)	Role in participation (%)
1	Agriculture	20	80
2	Silviculture/Horticulture	20	80
3	Livestock	40	60
4	Cottage industry	25	75
5	Social organization	35	65
6	Household activities	40	60

Same results were also found in the present study that women play important roles in managing homestead plots, primarily in plant production rather than in animal and fish production. Primary roles of women were crop management (74.8% of households) and harvesting (55.7%), with smaller role in marketing (36.6%). Women role in using money to pay debts and buy agricultural production inputs was less significant (Arifin *et al* .2012).

Assets

Assets possessed by respondent's household have been presented in Table 11. In the present study assets were divided in two categories: Agricultural implements and livestocks. Agriculture implements include ploughs, sickles and shovels. It was found that all of the households i.e., 72 (432) possessed shovels followed by sickles 72(360) followed by plough 24 (24). Livestocks include cows, goats, buffalos, horse, poultry and bullocks. It was found that the 56 % of household owned at least one cow followed by bullocks 40, buffalo 22, horse 19, poultry 4 and goat 2 in numbers.

Table 11: Distribution of assets in the study area

S. No.	Category	No. of Agriculture implements	No. of households Involved
Agriculture implements			
1.	Plough	24	24
2.	Sickle	360	72
3.	Shovel	432	72
		No. of Livestock	
1.	Cow	87	56
2.	Buffalo	26	22
3.	Poultry	22	4
4.	Horse	45	19
5.	Goat	60	2
6.	Bullock	80	40

Same experiment conducted in Indonesia which stated that homestead plots was associated with a greater number of these assets. Additional property (other agriculture land) had no significant correlation to total assets. Moreover, there were only 4 kinds of business assets held by farmers, i.e., (1) sprayers/dusters (1.4%), (2) small equipment as sickles, axes, hoes etc. (88.9%), (3) storage facilities (1.4%) and (4) pump (5.6%). Statistical analysis showed significant correlation between (1) homestead plot size and the value of farmer's assets and (2) availability of OAL and the value (Rupiahs) of farmer assets. The larger the plot, the higher the assets value and the more available other agriculture land contributed to the higher assets value. (Arifin *et al,* 2012)

The total livestock population of the respondents was found as 320 animals out of which buffalo and cow were classified as milch and non-milch animals. It revealed during the discussion that bullocks played important role in these villages due to lacks of mechanical instruments used for ploughing, levelling and threshing. More than 90% of the animals in these areas belonged to local breeds of low productivity. This low potential was further aggravated by poor quality nutrition and other management practices.

Economic Resources

Economic resources possess by respondents households have been presented in Table 12. In the present study, economic resources include thresher mill (0), flour mill (5), khadi gramudhyog unit (0), gobar gas plant (3), hand pump (3), sericulture unit (0), poultry (2) and rice mill (2).

Table 12: Economic resources availability in selected site

Economic resources	Malkhi	Khumera	Kurura	Panchan gaun
Thresher mill	0	0	0	0
Flour mill	1	2	1	1
Khadigram udhyog unit	0	0	0	0
Gobar gas plant	0	1	1	1
Hand pump	0	1	1	1
Sericulture unit	0	0	0	0
Poultry	0	1	1	0
Rice mill	0	1	1	0

From the above data it may be concluded that the maximum economic resources present in Khumera village (6) and minimum economic resources present in Malkhi village (1).

Source of irrigation

About 91.89% area is under rainfed and only 8.11% is irrigated area of the total

cultivated area. The irrigation was done from primal sources through small gulls in valley areas. Rainfed agriculture on terraced slopes is common in selected sites. Despite the presence of springs and streams, lack of water for irrigation was a common constraint. Net sown area of Uttarkashi district was 290.19 sq. km.

In Rudraprayag district only 14.02% area was under cultivation and net sown area of Rudraprayag district was around 114.30 sq. km. Total irrigated area was 44.13 sq. km.

Table 13: Sources of irrigation in study site

Source	Malkhi	Khumera	Kurura	Panchan gaun	Total
Nullah	-	1	-	-	1
Streams	1	-	1	1	3
Spring	1	1	1	0	3
Gull	-	-	-	1	1

There was also evidence that irrigation of agroforestry systems in the Himalaya can be highly beneficial. For example, in the Garhwal Himalaya, the total cost of establishing an irrigated agroforestry system was 1.23 fold that of the unirrigated one, whereas the total benefit was 209-fold (Maikhuri *et al*. 1997).

Subsidiary enterprises

Subsidiary enterprises include poultry, dairy, apiculture, horse rearing etc. As contribution to total household income, average homestead output provides about 7% of total farm income, about 93% of which was derived from animal such as dairy (22), horse rearing (19), apiculture (18) etc.

Table 14: Distribution of respondents on the basis of Subsidiary enterprises

Enterprises	Malkhi	Khumera	Kurura	Panchan gaun	Total
Poultry	2	1	2	1	5
Dairy	2	10	3	7	22
Sheep rearing	-	2	1	1	4
Apiculture	8	3	5	2	18
Rabbit	1	-	1	2	4
Horse rearing	5	10	3	1	19

Arifin *et al.* 2012 stated that on an average, income from animal production was positively correlated with size of un-built area and occupation of head of household was negatively correlated with number of unmarried children. For the households that used their plots most intensively, the contribution to income was 20.9%, which suggested that there was an unrealized potential for small *pekarangan* plots to contribute to household income.

Socio-economic characteristics of respondents in the study are:

1. Maximum number of respondents, i.e., 30.55% had education level from 1th to 8th followed by illiterate i.e., 27.77% followed by above 12th respondents, i.e., 22.22% whereas 19.44% had education from 8th to 12th level.
2. Maximum number of land households, i.e., 52.77% were marginal land followed by small landholding households, i.e., 27.77%, followed by large land holding 9.72% followed by medium 6.94% and only 2.7% respondents were landless.
3. Role of women in different activities like agriculture, silviculture/horticulture etc. clearly indicate that role of women in decision making was less in comparison to the role of women participation due to low literacy rate of women.

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POSTHARVEST PHYSICO-CHEMICAL AND MECHANICAL CHANGES IN APPLE (*Malus domestica Borkh*.) FRUITS

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Abstract

Little data is available in the scientific literature on postharvest changes taking place in apple (*MalusdomesticaBorkh*) fruits, an increasingly popular fruit in the Uttarakhand Himalaya region. In this study the postharvest physico-chemical and mechanical properties, namely, fruit color, weight loss, pulp firmness, total soluble solids, pH and titratable acidity were determined during the postharvest storage period under ambient conditions of *Malus domestica Borkha* fruits. It was observed that weight loss, total soluble solids (TSS) and pH of the Apple fruits increased with time whilst pulp firmness and the color index of the fruits decreased. T_1Turmeric powder(*Curcurmalonga)* (15%), T_2Turmeric powder (*Curcurma longa)*(25%), T_3 Drake *(Meliaazedarach)*(15%), T_4 Drake *(Meliaazedarach)* (25%), T_5 Mint*(Menthaarvensis)* (15%), T_6 Mint*(Menthaarvensis)* (25%), T_7 Water washes (control).

Keywords:*MalusdomesticaBorkh*, postharvest physico-chemical changes, antioxidant, flavonoid and phenolic content Abbreviations: AA-ascorbic acid TA-titratable acidity; TSS-total soluble solids.

Introduction

Apple (*Malusdomestica.Borkh*) belongs to family Rosaceae, is the premier fruit of the world. It is originated in Eastern Europe and Western Asia in the Caucasus region near Gilan and domesticated by Greeks and Romans a few centuries BC in the Middle-East and South-Eastern Europe as a result of travels invasions (Shoemaker and Teskey,1959).The movement of apple to Western Europe was helped by the Christian settlers. Romans are believed to have been responsible for its introduction in France and England. It has been cultivated in Europe for over 2,000 years and was brought to North America by the earlier settlers in early seventeen century.The leading producing state is Jammu and Kashmir contributing 70.4% of total production followed by Himanchal Pradesh (21.5%),Uttarakhand (6.4%) and Arunachal Pradesh (1.6%), Apple was first introduced in Uttarakhand by F.E. Wilson in 1859 at Garhwal areas (Harsil areas of Uttarkashi District) while it is introduced in Kumaun hills by Mr. Allen and Mr. Smith at Chaubatia around 1872 (Chaddha and Awasthi, 2005).Nutritionally an apple having average fruit weight (182g) containing following nutrition carbohydrate 25g, sugar 19g, vitamin C

11mg, 150 calorie, iron 1mg, calcium 13mg, protein 1g (USDA 2012). The desired qualities in the modern commercial apple are colourful skin, absence of russeting, ease of shipping, lengthy storage ability, high yield and disease resistance (Anon, 2010). Higher plants contain a wide spectrum of secondary metabolites such as phenols, flavanoids, quinones, tannins, essential oils, alkaloids, saponins and sterols. Such plant-derived chemicals may be exploited for their different biological properties (Wain 1977; Tripathi and Dubey 2004). Biologicals because of their natural origin are biodegradable and mostly do not leave toxic residues or by products. Although the neem based formulation are available in the market but there are other plants also which are having growth regulating and fungicidal properties like Malia, Mentha etc. (Graingeet *al*., 1984). Similarly, the leaf extract of bael showed antifungal activity (Ganguly, 1994).Other physiological factors important in ripening of fruit are total soluble solids (TSS), organic acids, which play an important role in the sugar to acid ratio and affect the flavor of fruits. Furthermore, pH and mineral composition may also affect the catalytic activity of cell wall enzymes and can have a profound effect on anthocyanin stability and color expression (Huber and O'Donoghue, 1993; Almeida and Huber, 1999; Holcroft and Kader 1999). An important category of naturally occurring chemicals that has been widely studied in fruits and vegetables are antioxidants as they have the potential to reduce the risk of free radicalrelated health problems (Bjelakovic, et al. 2007). In this study we investigated several physico-chemical and mechanical properties of the *MalusdomesticaBorkh*, fruit after harvesting, namely, skin color, weight loss, firmness of tissue, TSS, pH and titratable acidity. Antioxidant activity, total phenol and total flavonoid content were also determined throughout the storage period.

Materials and Methods

The experiment was conducted department of horticulture Uttarakhand University of Horticulture and Forestry Campus Ranichauri, Tehri-Garhwal (Uttarakhand). The details of the materials used and the procedure followed during this study have been described hereunder:

T_1 Turmeric powder(*Curcurmalonga)*(15%),
T_2 Turmeric powder(*Curcurma longa)*(25%)
T_3 Drake *(Meliaazedarach)*(15%),
T_4 Drake *(Meliaazedarach)*(25%)
T_5 Mint*(Menthaarvensis)*(15%),
T_6 Mint*(Menthaarvensis)*(25%),
T_7 Water washes (control)

Procedures adopted for recording observations on the various parameters have been discussed here under the different sub-heads:
Standard methods were used for recording observations on various physical and chemical parameters of different treatments. Total number of 25 fruits were kept under each treatment for quality analysis out of which 10 fruits were kept for recording physiological loss in weight (PLW)and remaining 15 fruits for determination of physico-chemical and quality traits. The fruits were evaluated for any changes in physico-chemical traits at an intervals *viz*.0, 30,60, 90, and 120 days.The preparation of coating solution aqueous extracts of different plant materials was prepared under laboratory condition on per cent weight basis as per the method described by Gakhukar (1996) and Sharma et al. (1997). Procedures adopted for recording observations on the various parameters for ascorbic acid titratable acidity; total soluble solids; Physiological loss in weight, Total Sugars.

Results and Discussion

Physiological Loss in Weight (PLW)

The data presented in Table 1 shows that PLW is significantly varies among different treatments and storage intervals. The data predicts that there was significant difference in treatment among the interactions. Minimum PLW was observed in (1.02 %) in T_1 (turmeric powder @ 15%) at 30 days interval while maximum (19.14 %) in T_6 (mint @ 25%) at 120 days of intervals.

It was observed PLW increases with increase in storage duration under all treatments. It is a well known fact that with an increase in storage duration the respiratory losses keeps on increasing which result in loss of metabolites and moisture ultimately resulting in lower fruit weight (Wikinson, 1965; Wills *et al*., 1980; Singh and Rana, 1992). Effectiveness of plant leaf extracts was reducing the physiological loss in weight and

prolonging the shelf life of fruits as comparison to control which was found in present study and could be corroborated by previous findings in various fruits, like mango, guava and banana (Khanna and Chandra, 1989; Purohit, 2000; Singh *et al.,* 1993 and Singh *et al*., 2000).

Table 1: Effect of botanical extracts on Physiological loss in weight (%) of apple fruits during storage

	STORAGE DAYS				
TREATMENTS	**D1(0)**	**D2(30)**	**D3(60)**	**D4(90)**	**D5(120)**
T_1 Turmeric powder (*Curcurma longa)* (15%)	0	1.02	4.42	6.00	9.45
T_2Turmeric powder (*Curcurma longa)* (25%)	0	1.96	7.44	10.70	15.33
T_3 Drake *(Meliaazedarach)* (15%)	0	2.58	4.91	6.92	14.14
T_4Drake *(Meliaazedarach)*(25%)	0	2.13	4.66	6.52	11.52
T_5Mint*(Menthaarvensis)*(15%)	0	2.62	6.77	9.54	13.24
T_6Mint*(Menthaarvensis)*(25%)	0	1.96	4.42	6.48	19.14
T_7 Water washes (control)	0	2.53	4.95	10.31	18.99
Treatment (T)Storage Days(D) Interactions (T×D)					
SEM±	0.76	0.49	1.69		
$CD_{0.05}$	2.12	1.37	4.76		

Total Soluble Solids

The observation on total soluble solids revealed (Table 2) that significant variation exists among the different treatments and storage intervals. Among the treatments highest T.S.S was recorded in T_7 Water washes (control) throughout the periods and minimum in T_1 Turmeric powder (*Curcurma longa)* (15%) and T_3 Drake *(Meliaazedarach)* (15%). While at different storage intervals the T.S.S of fruit increases ranging from 12.18 to 16.45˚B from 0 days to 120 days of storage. The data also shows that there was significant difference in among the different treatment combination. Highest (16.45 ˚B) fruit T.S.S was observed in T_7 at 120 days interval.

The increase in TSS with increasing storage days might be due to the hydrolysis of insoluble polysaccharides into simple sugars. Such changes are expected to be slower and more gradual when the metabolism of the commodity is slowed down by the application of various coating treatments (Sharma *et al.,* 2010 and Sharma and Singh, 2010). Increase in TSS content in apple fruit during storage has previously been reported to be due to hydrolysis of polysaccharides and dehydration of fruit (Fidler *et al.,* 1973 and Suni*et al.,* 2000). Chauhan *et al.* (2012) also reported that Post harvest application of extract increases the TSS of apple fruit

Titratable acidity

Data recorded on titratable acidity (Table 3) of fruit represented non significant variation among all the different treatments while significant differences was observed during the storage days and different treatment combinations. Minimum acidity (0.12%) was found in T_2 (turmeric @ 25%) and maximum acidity (0.19%) was found in T_4 (drake leaves extract @ 25%). It was noticed that acidity was decreased with increasing the storage intervals. Maximum acidity (0.52%) was found at 0 days of storage and minimum was found (0.12%) at 120 days of storage.

The faster rate of decline of acidity in fruits in the treatment could be due to the faster metabolic reactions occurring within them. The application of different coating treatments may also slow down the metabolism of fruits as these have been reported to maintain higher CO_2 and lower O_2 levels inside the coated fruits (Kader *et al.,* 1989).

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Table 2: Effect of botanical extracts on Total Soluble Solids (°B) of apple fruits during storage

	STORAGE DAYS				
TREATMENTS	**D1(0)**	**D2(30)**	**D3(60)**	**D4(90)**	**D5(120)**
T_1 Turmeric powder (*Curcurma longa)* (15%)	12.18	13.40	14.34	14.86	15.90
T_2Turmeric powder (*Curcurma longa)* (25%)	12.18	14.41	14.23	15.54	16.39
T_3 Drake *(Meliaazedarach)* (15%)	12.18	14.32	14.60	15.47	15.90
T_4Drake *(Meliaazedarach)*(25%)	12.18	14.04	14.78	15.11	15.99
T_5Mint*(Menthaarvensis)*(15%)	12.18	14.35	14.53	15.19	16.16
T_6Mint*(Menthaarvensis)*(25%)	12.18	14.23	14.30	14.95	15.99
T_7 Water washes (control)	12.18	14.38	14.70	15.63	16.45
Treatment (T)Storage Days(D) Interactions (T×D)					
SEM±	0.28	0.16	0.57		
$CD_{0.05}$	0.81	0.46	1.62		

Table 3: Effect of botanical extracts on fruit titratable acidity (%) of apple during storage.

	STORAGE DAYS				
TREATMENTS	**D1(0)**	**D2(30)**	**D3(60)**	**D4(90)**	**D5(120)**
T_1 Turmeric powder (*Curcurma longa)* (15%)	0.52	0.38	0.26	0.21	0.13
T_2Turmeric powder (*Curcurma longa)* (25%)	0.52	0.43	0.37	0.26	0.12
T_3 Drake *(Meliaazedarach)* (15%)	0.52	0.45	0.40	0.36	0.17
T_4Drake *(Meliaazedarach)*(25%)	0.52	0.48	0.41	0.37	0.19
T_5Mint*(Menthaarvensis)*(15%)	0.52	0.41	0.38	0.27	0.16
T_6Mint*(Menthaarvensis)*(25%)	0.52	0.48	0.39	0.28	0.15
T_7 Water washes (control)	0.52	0.43	0.36	0.28	0.16
Treatment (T)Storage Days(D) Interactions (T×D)					
SEM±	0.29	0.19	0.65		
$CD_{0.05}$	NS	0.26	0.18		

Ascorbic acid

The perusal of data in (Table 4) clearly indicates that fruit ascorbic acid is significantly varies among different treatments and storage intervals. Among the treatments maximum (5.73 mg/100g) ascorbic acid was recorded in T_5Mint*(Menthaarvensis)*(15%) which was at par withT_6Mint*(Menthaarvensis)*(25%) (5.56mg/100 gm).While at different storage intervals ascorbic acid of the fruit decrease ranging from 11.24 to 4.96 mg/100g from 0 days to 120 days of storage. The data also shows that there was significant difference among the different treatment combinations. Maximum (11.24 mg/100g) ascorbic acid was observed after harvesting (0 days) while minimum (4.96 mg/100g) in T_3 (drake leaves extract @ 15%) which was at par with T_4 (drake leaves extract @ 25%) andat 120 days of storage.

The ascorbic acid decreased significantly with incremental increase in storage duration.The ascorbic acid in fruits is sensitive to storage temperature or duration and its degradation is enhanced by adverse handling and storage conditions such as higher temperatures, low relative humidity, physical damage, and chilling injury (Adisa, 1986). Beside abiotic factors, the ascorbic acid can be irreversibly oxidized (Pardio-Sedas *et al.,* 1994). Sharma *et al.* (2003) also reported that extract was effective in maintain the ascorbic acid content of the apple fruit as compared to the control fruits.

Table 4: Effect of botanical extracts on ascorbic acid (mg/100g) of apple fruits during storage

	STORAGE DAYS				
TREATMENTS	**D1(0)**	**D2(30)**	**D3(60)**	**D4(90)**	**D5(120)**
T_1 Turmeric powder (*Curcurma longa)* (15%)	11.24	9.26	7.70	6.23	5.30
T_2Turmeric powder (*Curcurma longa)* (25%)	11.24	9.46	7.46	6.23	5.23
T_3 Drake *(Meliaazedarach)* (15%)	11.24	9.80	7.60	6.50	4.96
T_4Drake *(Meliaazedarach)*(25%)	11.24	9.56	7.19	7.19	4.96
T_5Mint*(Menthaarvensis)*(15%)	11.24	9.46	7.03	6.00	5.73
T_6Mint*(Menthaarvensis)*(25%)	11.24	9.40	7.53	6.10	5.56
T_7 Water washes (control)	11.24	9.46	7.66	6.03	5.06
Treatment (T)Storage Days(D) Interactions (T×D)					
SEM±	0.47	0.30	0.10		
$CD_{0.05}$	0.13	0.58	0.29		

Total sugar

The critical examination of data indicates that total sugar content varied significantly among all the treatments and storage intervals in (Table 5) Post harvest applications of almost all the botanical extracts were effective in increasing the sugar content of the fruit. Among the treatments maximum total sugar (14.25 %) was recorded in T_1 treatment (Turmeric @ 15%) and minimum (13.45%) in T_5Mint*(Menthaarvensis)*(15%). While at different storage intervals total sugar ranging from 9.83 to 14.25 percent from 0 days to 120 days storage. The data also shows that there was significant difference in treatments among the interactions. Maximum total sugar (14.25 %) was observed at 120 days storage while minimum (9.83 %) after the harvesting of fruits (initial period).

The apple fruit accumulate starch at the early stages of maturation that is later on hydrolyzed to sugars at edible maturity (Margein and Leurquin, 2000). The starch to sugars conversion continue during storage (Beaudry*et al.,* 1989), resulting in increased total sugars with storage duration (Crouch, 2003).Chauhan and Joshi (1990) reported the efficacy of phyto-extracts on the storage quality of mango cv. Ratna and found them significantly better in retaining total soluble solids and sugar content of the fruit.Treatment of *Citrus sinensis*fruit with harvest have also been reported to retain higher total soluble solids and total sugar contents (Bhardwaj and Sen, 2003).

Table 5: Effect of botanical extracts on total sugar (%) of apple fruits during storage

STORAGE DAYS					
TREATMENTS	**D1(0)**	**D2(30)**	**D3(60)**	**D4(90)**	**D5(120)**
T_1 Turmeric powder (*Curcurma longa)* (15%),	9.83	10.46	11.65	12.62	14.25
T_2Turmeric powder (*Curcurma longa)* (25%)	9.83	10.44	11.67	12.47	14.06
T_3 Drake *(Meliaazedarach)* (15%),	9.83	10.41	11.52	12.62	14.07
T_4Drake *(Meliaazedarach)*(25%)	9.83	10.38	11.62	12.58	13.98
T_5Mint*(Menthaarvensis)*(15%),	9.83	10.26	11.52	12.23	13.45
T_6Mint*(Menthaarvensis)*(25%),	9.83	10.44	11.68	12.42	14.06
T_7 Water washes (control)	9.83	10.24	11.26	12.05	13.56
Treatment (T)Storage Days(D) Interactions (T×D)					
SEM±	0.97	0.57	0.19		
$CD_{0.05}$	0.27	0.15	0.54		

1. There was a steady increase in total sugars of fruit of different treatments during storage. Post harvest applications of almost all the botanical extracts were effective in increasing the sugar content of the fruit in comparison to the control except the treatment of mint leaves extract @ 15%. Among the treatments maximum total sugar (11.76 %) was recorded in T_1 treatment (Turmeric @ 15%) and minimum (11.39%) in T_7 treatment (control) after 120 days of storage.
2. The maximum reducing sugar (9.90%) was obtained in T_{12}treatment (control) and minimum (9.19%) in T_4 treatment (Turmeric @ 25%) after 120 days of storage

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