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GENETIC DIVERGENCE STUDY IN SUNFLOWER (*Helianthus annuus L.*)

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Abstract

This study has been undertaken to investigate the seventy five hybrids developed by making crosses between fifteen female parents (lines) and five male parents (testers) in line x testers mating design along with one standard checks (HSFH 848). Hybrids and parents were evaluated under four different environments *i.e.* Summer 2014, last week of August (E_1) and First week of Sept. (E_2) and during spring 2015, *i.e.* first week of February (E_3) and last week of February (E_4). Randomly five plants are selected for each genotype and replication to recorded the data of different quantitative characters viz. plant height (cm), head diameter (cm), stem diameter (cm) days to 50% flowering, days to maturity, hundred seed weight (g), seed yield per plant (g), oil content (%), hull content (%), percent seed filling, germination (%), electrical conductivity ($\mu Scm^{-1}g^{-1}$), viability (%), vigour index and fatty acids (%) in all the test environments. On the basis of Euclidean minimum distance, all the genotypes were grouped into six clusters which showed the presence of enough amount of genetic diversity in the present material. The cluster IV was having highest numbers of genotypes followed by clusters V,I,VI, II, III .The intra-cluster distances were less than that of inter cluster distances which showed that there was narrow genetic variation within the clusters while there was maximum genetic variation in between the clusters. The use of genotypes in hybridization from these results is likely to produce more heterotic combination in future.

Key words: D^2 statistics, genetic divergence, clusters, sunflower

Introduction

Sunflower is an important oilseed crop widely adopted and accepted for its high quality edible oil. Sunflower (*Helianthus annuus* L.) belongs to the genus *Helianthus* of the family Asteraceae, which includes 20 genera with 400 species. Its basic chromosome number is n = 17. In plant breeding, genetic diversity is important as hybrids between lines of diverse origin generally display a greater heterosis than those between closely related parents. D^2analysis is a statistical method for genetic divergence that provides better choice of parents in any breeding program. The D^2 statistics equip to discriminate between different cultivars according to the diversity present (Mahalanobis, 1936). It furnishes a pleasant idea about the diverse nature of population. As per the ward method (Ward, 1963) of the Euclidean method, the clusters were used to determine the distance between and within clusters.

Material and Methods

The present investigation was carried out at experimental area and laboratories of Oilseed Section, Department of Plant Breeding and Genetics, Chaudhary Charan Singh Haryana Agricultural University, Hisar. The experimental material consisted of 15 CMS (cytoplasmic male sterile) lines used as seed parents and five restorers (R line) used as a pollen parents which were grown in paired rows and crossed in Line X Tester design to obtain 75 F_1

hybrids, and there is a commercial check hybrid HSFH 848. Each CMS and restorer lines were grown in 2 rows of 4 meter length with a spacing of 45cm x 30 cm. The evaluation of 75 hybrids and a check HSFH 848 was conducted over 4 environments during 2014 -2015.The genetic diversity existing between the genotypes with respect to the set of characters was estimated using Mahalanobis' D^2 statistic (Mahalanobis, 1936). Treating D^2 as a generalized statistical distance, the criterion used by Ward (1963) was applied for determining the group constellation. Average intra and inter-cluster distances were determined following the method of Singh and Chaudhary (1977).

Results and Discussion

The analysis of variance revealed significant variability among the genotypes for all the traits, but the extent of genetic diversity could not be explained, therefore, cluster analysis was performed to quantify the genetic divergence among all the genotypes using Mahalanobis' D^2 statistics (1936) as described by Ward (1963). The genotypes were grouped into different clusters on the basis of minimum genetic distance using Euclidean method (Ward, 1963).

Cluster analysis classified all the 96 genotypes into 6 clusters based on the relative magnitude of their D^2 values, in such a way that genotypes within each cluster had smaller D^2 value than between the clusters. Cluster pattern (Table 1) revealed that cluster IV and V had the maximum with 35 and 32 genotypes, respectively followed by cluster I (15 genotypes), cluster VI (8 genotypes), cluster II (5 genotypes) and clusters III (1 genotype). Genotypes from different sources were grouped in the same cluster thereby indicating that genetic divergence had little relationship with the geographic distance. Reddy *et al*. (2012) reported the similar result while analyzing the genetic diversity in germplasm accessions of *Helianthus annuus* L which also suggested that geographical divergence does not necessarily represent genetic diversity.

The genotypes included in the same cluster are considered genetically similar with respect to the aggregate effect of the characters examined; the hybridization attempted between these could not expect to yield desirable recombinants. Therefore, putative parents for crossing programme should belong to different clusters characterized by large inter-cluster distance. Earlier, Mohan and Seetharam (2005) also observed similar clustering pattern of genotypes among clusters, as some clusters were unique having only single genotype.

Intra and Inter cluster distance

The intra and inter cluster distances among various clusters involving ninety six genotypes are presented in table 2 and figure 2. The inter cluster distances were greater than intra cluster distance which indicates the presence of narrow genetic variation within a cluster and divergence among the different clusters. The maximum intra cluster D^2 value was observed for cluster I (5.451) followed by cluster II (5.099), V (3.800), and VI (3.711) which reveals the existence of maximum differences among the genotypes that fall in these clusters.

When diversity was studied among the clusters based on the inter-cluster D^2 values, intercluster distance ranged from 4.126 to 17. 040 (Table 2 and Figure 1). Clusters IV and V showed minimum inter-cluster distance of 4.126 indicating close relationship among the genotypes included in these clusters. Clusters III and V showed maximum inter-cluster distance of 17.040, followed by clusters III and IV (16.785), clusters I and III (16.190), clusters III and VI (15.898) and clusters II and III (14.929) which indicates that genotypes in these clusters are genetically diverse and can be used as promising parents for hybridization in a breeding programme.

Clusters mean value of different clusters

The cluster means for seed yield per plant and its component characters are presented in Table 3. The data revealed considerable differences among all the clusters for most of the characters studied.

From the table 3 (a), it was evident that genotypes present in cluster VI had higher plant height (cm) with a highest cluster mean value (136.97), while the lowest mean value (89.96) was observed for genotypes present in cluster III. Cluster VI also had highest value for head diameter (14.95 cm) and stem diameter (7.37 cm), while cluster III had lowest mean value (10.19) for head diameter and cluster I had lowest value (5.03) for stem diameter. Days to flowering was recorded lowest in cluster III (43.33), whereas higher mean value was observed in cluster I (62.05). Cluster III consist of lower mean value for days to maturity (69.42), while the highest value of days to maturity was recorded in cluster V (96.49).

Cluster VI showed the higher value (7.72) for 100 seed weight (g), while the minimum value was showed in cluster III (4.79). Cluster VI comprised of genotypes which have high cluster mean value for seed yield per plant (35.15), while lowest value was evident in cluster I (23.5). Cluster II showed higher value for oil content (48.33 %) and lowest value in cluster III (29.67). The minimum value for hull content (%) was recorded in cluster III (33.87) and maximum in cluster V (51.69). Seed percent filling had highest value in cluster V (85.83), while lowest value in cluster III (42.72).

Maximum germination per cent was recorded in cluster I (91.20 %) and minimum mean value in cluster III (51.02). Cluster IV had lowest mean value (0.51) for electrical conductivity (µScm^{-1}g^{-1}), while the maximum mean value was observed in cluster II (1.16).

From the table 3 (b), the maximum mean value for viability was observed in cluster I (86.05) and minimum mean value (43.64) in cluster III. Vigour index I showed highest mean value in cluster IV (2685.20) and lowest mean in cluster III (1300.48).

Cluster IV had the highest mean value (35.93) for vigour index II, while the cluster II had the lowest mean value (18.84). Palmitic acid displayed highest mean in cluster V (7.77) and lowest mean (4.87) for cluster III. Stearic acid had lowest mean value in cluster III (2.67), while the highest mean value in cluster VI (5.72). The maximum value for oleic and linoleic acid was recorded in cluster V (42.37) and cluster VI (47.12) respectively, where the minimum mean value for oleic (25.49) and linolenic (25.24) was recorded in cluster III.

The overall comparison indicated that cluster IV, V and VI, had better cluster means for characters *viz.*, 100 seed weight (g), head diameter (cm), stem diameter (cm), palmitic acid (%), stearic acid (%), vigour index II, oleic and linoleic acid (%). Therefore, cluster IV, V and VI could be considered while selecting genotypes for sunflower improvement for above traits. Neelima *et al.* (2016) reported that in their studies cluster XI had high mean value for seed yield per plant (g), Cluster X had higher mean value for plant height (cm) and head diameter (cm) and cluster XII had higher test weight (g). The maximum inter cluster distance was recorded between cluster XI and XII followed by cluster X and XII and clusters V and XII. It was suggested that if the diverse accessions from these diverse groups are used in the breeding programme, it is expected to produce a wide range of genetic variability in the population.

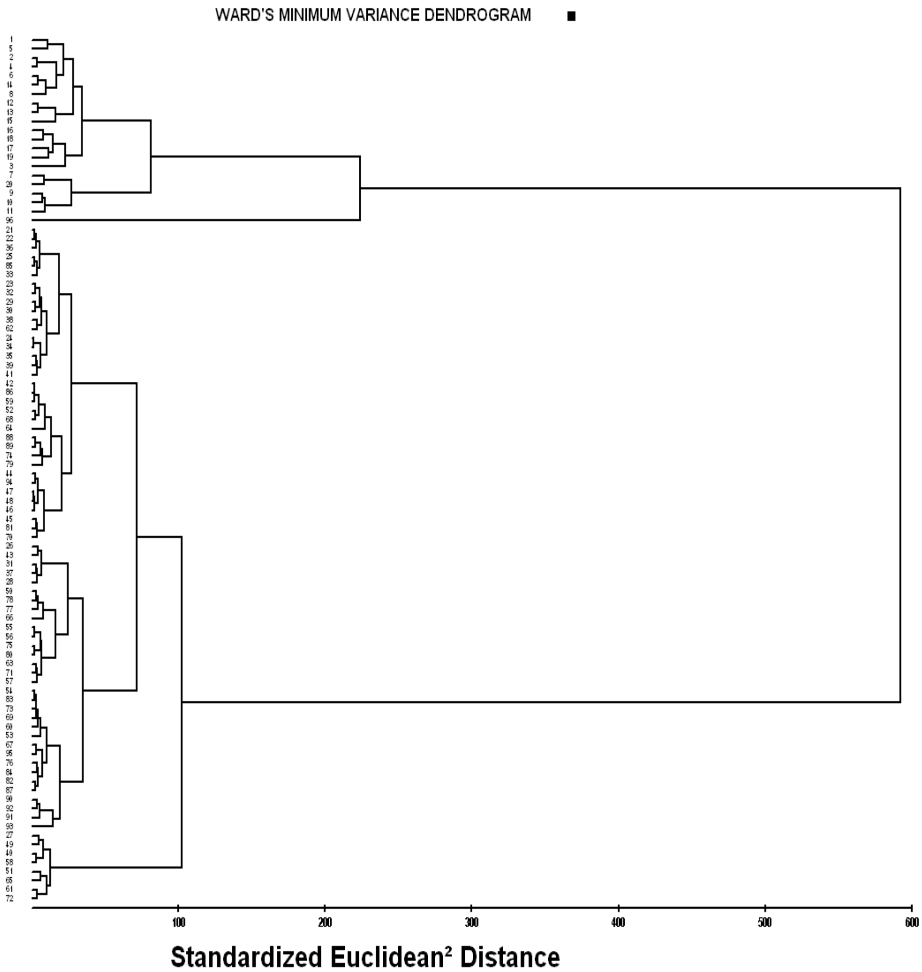

Figure 1: Ward's minimum variance dendrogram for 96 genotypes of sunflower based on standardized Euclidean's distance.

Table 1: Clustering of 96 genotypes of sunflower on the basis of Euclidean minimum distance

Clusters	No. of genotypes	Name of genotypes
Cluster I	15	CMS 11A,CMS 17A,CMS 234A,CMSH 91A,CMS 103A,CMS ARG6A,CMS 207A,CMS ARG2-A,CMS ARG 3-A,CMS DV-10,6D-1,HRHA 4-2,RHA 271,HRHA 5-3,CMS 44A.
Cluster II	5	CMS 148A, RHA 297, CMS 302A, CMS 607A, CMS 852A.
Cluster III	1	HSFH 848
Cluster IV	35	CMS11A x 6D-1,CMS 11A x RHA 271,CMS 148A x RHA 271,CMS 11A x RHA 297, CMS ARG 6A x RHA 297,CMS 44A x HRHA 5-3,CMS 11A x HRHA 4-2,CMS 44A x RHA 271,CMS 17A x HRHA 5-3,CMS 17A x RHA 297,CMS 148A x HRHA 4-2,CMS 607A x RHA 271,CMS 44A x HRHA 5-3,CMS 44A x RHA 297,CMS 148A x HRHA 5-3,CMSH 91A x 6D-1, CMSH 91A x RHA 271, CMS DV-1O x 6D-1, CMS 302A x HRHA 5-3,CMS 234A x HRHA 5-3,CMS 852A x HRHA 4-2,CMS 607A x HRHA 4-2, CMS DV-10 x HRHA 4-2,CMS DV-10 x HRHA 5-3,CMS ARG 3-A x HRHA 5-3,CMSH91 A x HRHA 5-3,CMS 207A x HRHA 5-3,CMS 103A x HRHA 5-3,CMS 103A x HRHA 4-2,CMS 103A x 6D-1, CMSH91 A x RHA 297, CMS ARG 6A x 6D-1, CMS 852A x RHA 297.
Cluster V	32	CMS 17A x 6D-1,CMSH91A x HRHA 4-2,CMS 44A x 6D-1.CMS 148A x RHA 271,CMS 17A x HRHA 4-2,CMS 103A x RHA 297,CMS ARG 3A x HRHA 4-2, CMS ARG 3A x RHA 271, CMS 852A x 6D-1, CMS 234A x RHA 297, CMS 302A x 6D-1, CMS ARG 2A x RHA 297,CMS ARG 3A x RHA 297, CMS 607A x HRHA 4-2, CMS ARG 2A x 6D-1,CMS 302A x RHA 271,CMS 234A x HRHA 5-3, CMS ARG 6A x HRHA 4-2,CMS ARG 2A x HRHA 4-2, CMS 852A x HRHA 5-3,CMS 302A x RHA 297, CMS 234A x HRHA 4-2, CMS 852A x RHA 271, CMS207A x RHA 297, CMS ARG 3A x 6D-1,CMS ARG6A x HRHA 5-3, CMS ARG 6A x RHA 271,CMS DV-10 x RHA 271, CMS DV-10 x RHA 297, CMS 207A x RHA 271,CMS 207A x 6D-1,CMS 207A x HRHA 4-2.
Cluster VI	8	CMS 17A x RHA 271, CMS 103A x HRHA 5-3, CMS 148A x RHA 297, CMS 302A x HRHA 4-2, CMS 234A x 6D-1, CMS 607A x RHA 297, CMS 607A x 6D-1, CMS ARG 2A x RHA 271.

Table 2: Average intra- (diagonal) and inter- (above diagonal) cluster D^2 values for 96 genotypes of sunflower

Clusters	I	II	III	IV	V	VI
I	**5.451**	6.781	16.190	7.694	7.443	8.204
II		**5.099**	14.929	8.591	8.288	7.096
III			**0.000**	16.785	17.040	15.898
IV				**3.444**	4.126	5.299
V					**3.800**	5.240
VI						**3.711**

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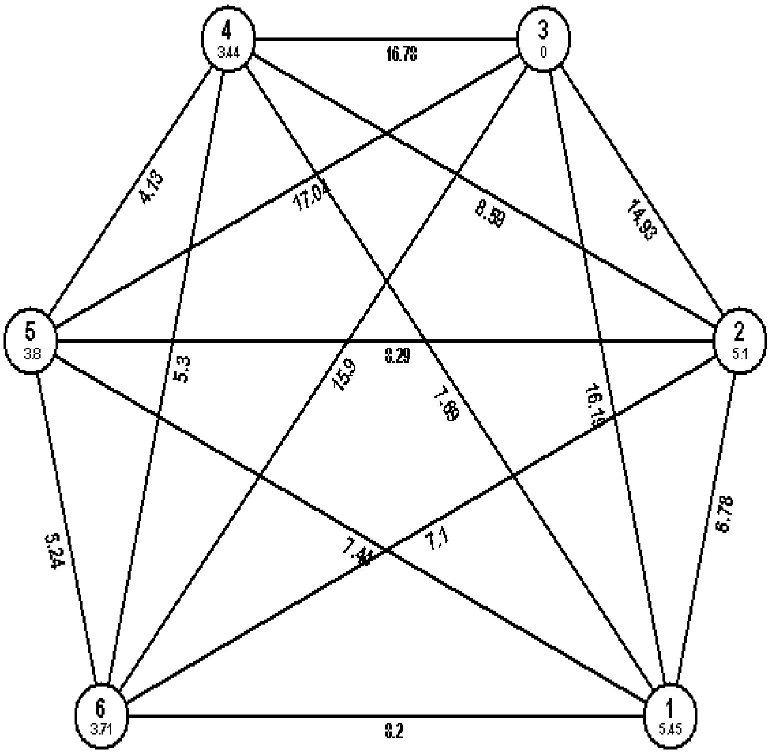

Figure 2: Clustering based on Mahalanobis D[2] analysis (Euclidian method)

Table 3a: Cluster Mean values of seed yield and its component traits in sunflower

Clusters	PH (cm)	HD (cm)	SD (cm)	DF	DM	100 SW (g)	SY (g)	OC (%)	HC (%)	% SF	GERM. (%)	EC (µScm-1g-1)
I	120.50	11.55	5.03	62.05	95.53	5.24	23.5	47.17	39.42	55.82	91.20	0.69
II	123.79	10.66	5.07	59.93	94.53	6.23	27.52	48.33	42.15	57.22	67.85	1.16
III	89.96	10.19	5.07	43.33	69.42	4.79	23.68	29.67	33.87	42.72	51.02	0.68
IV	136.14	14.93	7.35	59.40	95.54	7.40	34.65	38.58	50.82	84.88	88.97	0.51
V	134.36	14.55	7.15	59.52	96.49	7.42	34.04	38.73	51.69	85.83	88.98	0.56
VI	136.97	14.95	7.37	59.85	95.26	7.72	35.15	38.48	50.95	76.96	67.74	0.94

Table 3b: Cluster Mean values of seed vigour and fatty acids in sunflower

Clusters	VIAB. (%)	VI I	VI II	PALM (%)	STER. (%)	OLEIC (%)	LINO. (%)
I	86.05	2575.52	26.45	6.83	4.46	41.40	40.77
II	61.50	2591.73	18.84	6.69	3.84	41.95	40.14
III	43.64	1300.48	27.44	4.87	2.67	25.49	25.24
IV	84.94	2685.20	35.93	6.63	4.93	38.02	52.07
V	84.83	2532.72	33.48	7.77	5.37	42.37	46.93
VI	65.08	2496.71	29.08	6.96	5.72	40.08	47.12

PH –Plant height, HD -Head diameter, SD- Stem diameter ,DF- days to flowering, DM- days to maturity,100 Seed weight, SY- Seed yield per plant, OC- Oil content, HC- Hull content, % SF- Percent seed filling, GERM.- Germination ,EC- Electrical conductivity, VIAB. – Viability, VI I -Vigour index I, VI II – Vigour index II, PALM.- Palmitic acid, STER. – Stearic acid, OLEIC- Oleic acid, LINO. - Linolenic acid.

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EFFECT OF IAA AND BAP ON SEED GERMINATION AND VEGETATIVE GROWTH ATTRIBUTES OF *RAPHANUS SATIVUS* L.

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Abstract

The aim of this study was to investigate the effects of concentration of different growth hormones (auxin and cytokinin) on seed germination, growth and biomass of *Raphanus sativus*. Different concentration (viz 0, 50, 100 and 150ppm) both of IAA and BAP were used, to study the effect on germination and also the seeds were sown in field to study the effect on growth parameter and biomass of radish. The experimental finding indicated that between the two phytohormones used, IAA was more beneficial in enhancing germination percentage, growth and yield of *Raphanus sativus.* BAP showed enhancing effect only in belowground plant height and biomass, which was still lower than recorded in case of IAA treatment. However BAP in 50 ppm concentration showed the maximum values for radicle and plumule diameter. The overall comparative results indicated that IAA 50ppm significantly increased the germination percentage, growth attributes and biomass and hence contributing to an increased yield in radish.

Keywords: IAA, BAP, Seed germination, Vegetative growth, Biomass.

Introduction

Plant hormones are a group of organic substances which influence physiological processes mainly growth, differentiation and development (Philosoph- Hadas *et al*., 2005; Kucera *et al*., 2005). Plant Hormones regulate physiological process and synthetic growth regulators may enhance growth and development of field crops thereby increased total dry mass of a field crop (Das and Das, 1996; Abd-el Fattah, 1997; Chibu *et al*., 2000; Dakua, 2002; Rahman, 2004; Islam, 2007; Cho *et al*., 2008).). Application of plant hormones has positive effect growth and yield of crop plants. Auxins play key role in cell elongation, cell division, vascular tissue, differentiation, root initiation, fruit setting and flowering but also apical dominance regulation (McDonald, 1997). On other hand, cytokinins are mainly involved in stimulation of cell division in meristems, prevention of senescence and elimination of apical dominance (Sujatha and Reddy, 1998). Both auxins and cytokinins have been known for a long time to act either synergistically or antagonistically to control several significant developmental processes, such as the formation and maintenance of meristem (Su *et al*., 2011). Commonly PGRs improve seed germination capacity, increase biomass yield, confer resistance to diseases and adverse growth conditions, and produce yield earlier (Papadopoulos *et al*., 2006).

The radish is a root vegetable of the Brassicaceae family, commonly seen as a small-rooted, short-season vegetable, normally consumed in salads (Curtis, 2003). Radish are grown and consumed throughout the world being mostly eaten as a crunchy salad vegetable. Different parts of radish including roots, seeds and leaves are used for medicinal purposes (Nadkarni *et al.,* 1976). Radish has been used ethnically as a laxative, stimulant, digestive aid, and appetizer and in the treatment of stomach disorders (Kapoor, 2000). Studies also reported the antimicrobial (Esaki and Onozaki, 1982), antimutagenic (Hashem and Saleh, 1999) and anticarcinogenic effects (Hecht *et al.,* 2000) of *R. sativus* extract. The present investigation was undertaken to study the influence of growth hormones IAA and BAP at different concentration on seed germination of *Raphanus sativus*. In addition to this hormonal treated seeds were also sown in field to study the effect of different hormonal concentration on growth parameter and biomass of radish. In the present experiment radish is chosen as a model for study because of its number of valuable health availing benefits, and its wide use as a vegetable crop throughout the world.

Material and Methods

The seeds of radish were purchased from seed store, Dehradun. The seeds of *Raphanus sativus* were washed with distilled water and were surface sterilized with 1% (W/v) mercuric chloride followed by 70% Ethanol. Seeds were then thoroughly rinsed with deionised water. Thereafter different concentrations of aqueous hormonal solutions of IAA and BAP both were prepared viz. 50ppm, 100ppm and 150 ppm along with separate control set. Overnight soaking of seeds in hormonal solution was done. In control set distilled water was used for seed soaking.

Seed germination

Hormonal treated as well as control seeds were kept in seed germinator at 20^0 C for evaluation of germination percentage as well as radicle and plumule length. Seeds were kept in petri plates over wet and moist Whatmann filter paper No.1. 20 seeds in three replicates were used for each treatment. During this course of time filter paper in the Petri plates were changed in the consecutive day to avoid any fungal or bacterial growth in the plates. Observation on seed germination was recorded daily whereas, measurement of radicle and plumule length and thickness was measured at the termination i.e. 15^{th} day of the experiment. Seed germination was calculated using the following formula

$$\text{Germination\%} = \frac{\text{Number of seeds germinated} \times 100}{\text{Total number of seeds}}$$

Field study

To study the effect of different concentration of phytohormones (IAA and BAP) on vegetative growth parameters such as plant height, number of true leaves, root length, root thickness and difference in the biomass, the same set of phytohormonal treated radish seeds were sown in the prepared field for growth analysis.

Prepared field was divided into seven sections. 20 seeds in three replicates of each treatment were sown at the depth of ½ inch and 2 inches apart. Watering was done in a way to keep the beds moist but not water logged. Weeding was also done at a regular period to avoid the growth of weeds which could have adversely affected the proper growth and development of desired treated radish seeds. After the emergence of cotyledons from the seeds and the onset of true leaves, the plants were allowed to grow for the duration of two months. Thereafter, observations on various growth aspects like above ground plant height, leaf number were recorded by randomly selecting the five plants from each of the replicates. At last before the termination of experiment, selected plants were uprooted and parameters such as below ground plant height and thickness of below ground part (radish root) were also measured. To determine the plant dry weight, five plants from each treatment were uprooted at the end of the experiment, washed with running water, blotted dry and dried in an electric oven at 80^0C for 48 hours (Evans, 1972).

Results and Discussion

Seed Germination Data

Seed germination increased along the number of days of experiment till it reaches to constant. The highest germination percentage was recorded in seeds treated with IAA 50ppm (93.33%) whereas lowest percentage was recorded in IAA 150 i.e. 78.33% ppm respectively. In the case of both the treatments, seed germination was found in decreasing trend with the increase of hormonal concentration. In case of radicle and plumule length, maximum length was recorded in controlled treatment (2.51 cm and 6.53cm respectively) as compared to both the treatments. Comparing the control treatment to both IAA and BAP treatments, it was observed that both radicle and plumule length were not greatly affected by the treatment of growth hormones. However when the two hormones were compared, IAA was found more effective in enhancing the radicle and plumule length of radish seedlings, as compared to seeds treated with BAP.

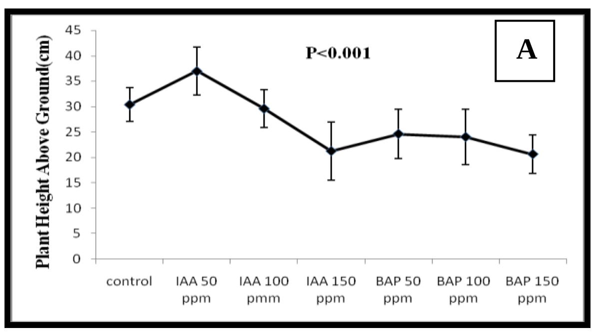
The diameter of radicle and plumule in radish showed an enhancement with the application of both the growth hormones and was more as compared to control. Comparing both the treatments, the diameter of both radicle and plumule was more in BAP than recoded in IAA. The maximum values of radicle and plumule diameter was recorded in BAP 50ppm (i.e. 1.05mm and 1.86mm respectively).

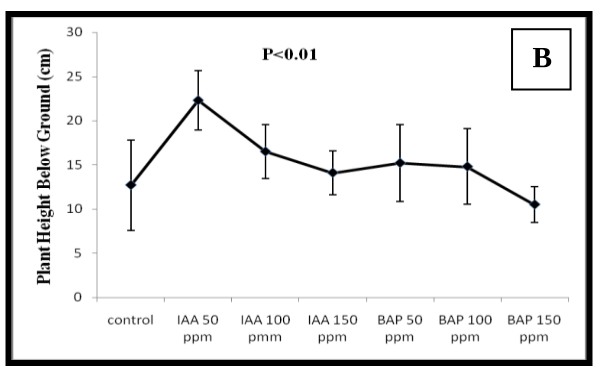
Table 1: Effect of different hormonal treatments on germination percentage, radicle and plumule length of *Raphanus sativus*

	Control	IAA 50	IAA 100	IAA 150	BAP 50	BAP 100	BAP 150	P value
Germination %	88.33±2.89	93.33±2.88	89.00±1.73	78.33±2.89	87.67±2.08	83.33±2.89	81.67±1.53	P<0.001
Radicle Length (cm)	2.51±0.64	0.99±0.15	0.77±0.15	0.72±0.03	0.47±0.01	0.43±0.01	0.42±0.02	P<0.001
Plumule Length(cm)	6.53±0.60	6.37±0.15	3.52±1.2	3.77±0.12	4.67±0.44	4.39±0.33	4.59±0.21	P<0.001
Radicle Diameter(mm)	0.63±0.14	0.78±0.10	0.66±0.07	0.59±0.11	1.05±0.23	0.66±0.52	0.64±0.02	P<0.001
Plumule Diameter(mm)	1.16±0.24	1.44±0.11	1.31±0.08	1.09±0.15	1.86±0.11	1.72±0.08	1.50±0.14	P<0.001

Effect of different phytohormonal concentration on vegetative growth parameters

The plant height data clearly shows that the maximum above ground height was recorded in IAA treated seeds followed by Control and BAP treated seeds (Fig. 1A). However an inverse relationship was observed between the plant height and increasing level of phytohormonal concentration. Maximum plant height was recorded in IAA 50 ppm (37cm) which was decreased to 29.6cm and 21.2cm in IAA 100ppm and 150ppm respectively. Whereas above ground plant height was less than 34%, 19% and 3% less in BAP 50ppm, BAP 100ppm and BAP 150ppm as compared to IAA treated seeds with significance level of P<0.001. Below ground plant height was enhanced in IAA treated plants followed by BAP and then control. Maximum below ground height was recorded in IAA 50 ppm i.e 22.3cm. Leaf number followed the same trend as that in above ground plant height and the data was significant at P<0.01 level (Figure 1D).





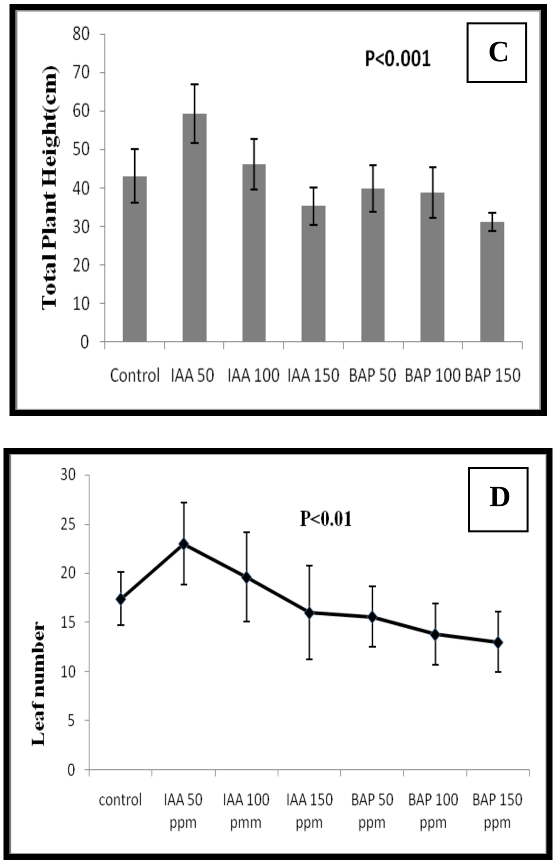


Figure 1: Effect of different phytohormonal treatments on (A) plant height above ground, (B)plant height below ground, (C) Total plant height and (D) Leaf number of *Raphanus sativus*

The phytohormonal treated seeds showed the enhancive effect on thickness of below ground part, in contrast to the controlled set (Figure 2). Maximum thickness of belowground part was recorded in IAA 50 ppm followed by IAA 100 ppm and 150 ppm which was 40.01mm, 31.22 mm, 28.99 mm respectively. Whereas in BAP underground thickness was 26%, 18% and 20% less than that recorded in IAA 50ppm, IAA 100ppm and 150ppm respectively.

The phytohormonal treatment showed the enhanced effect on fresh weight and dry weight (above ground and below ground) as compared to control set (Figure 3). However IAA treated plants showed higher biomass than the BAP treated plants. As compared to control set, IAA 50ppm and BAP 50 ppm showed 57% and 33% increased fresh weight respectively and the data was significant at P<0.001 level. Similarly the maximum fresh weight of below ground part was showed by IAA 50 ppm i.e. 168.77 grams while the minimum fresh weight of below ground was showed by BAP 150 ppm i.e. 30.04 grams (P<0.001). In the control set the below ground fresh weight was recorded 43% less than the maximum weighed IAA 50ppm. In the control set the below ground fresh weight was recorded 77% less than that recorded in IAA 50ppm (Plate1).

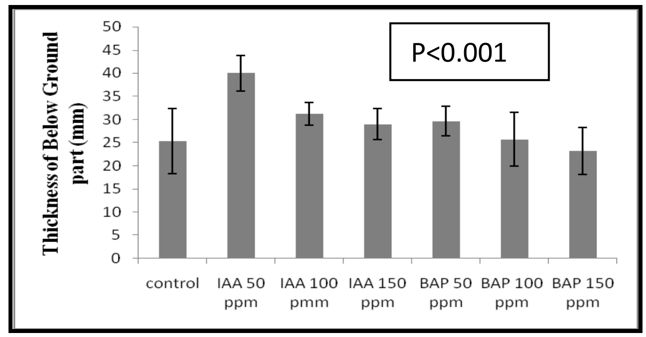


Figure 2: Effect of different phtohormonal treatments on below ground thickness of *Raphanus sativus*

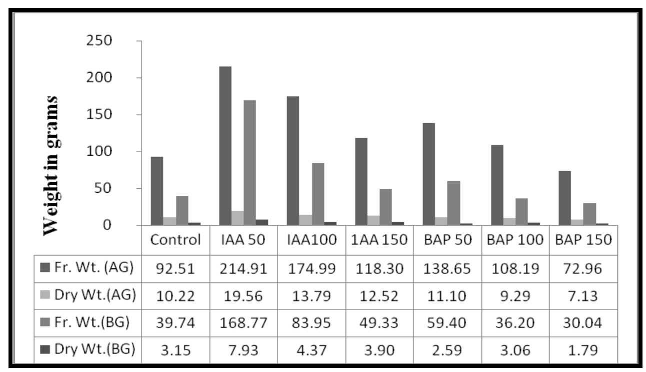


Figure 3: Effect of different phtohormonal treatments onfresh weight and dry weight of above and below ground parts of *Raphanus sativus*

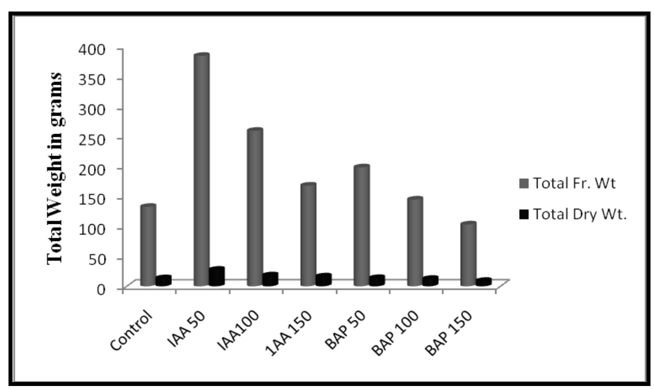


Figure 4: Effect of different phtohormonal treatments on total fresh weight and dry weight of *Raphanus sativus*

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Plate 1: Effect of different phtohormonal treatments on biomass of *Raphanus sativus*

Based on the main aim of the experiment to determine the different hormonal concentration effect on various aspects of germination and growth parameters, it is clear from the observations that IAA showed the incremental effect on all studied attributes than BAP. Out of the two hormones used to improve the seed germination of *Raphanus sativus*, IAA 50 ppm was found to be more effective in improving the germination rate. The results are in accordance with the study of Jeong *et al*. (2015), who found IAA to be most effective in improving seed germination of *Allium victorialis* var. *platyphyllum* among all the other PGR's (viz. IAA, GA_3 and BAP) used during the study. In a study showing Influence of various growth regulators on ridge gourd, application of NAA 50 ppm resulted in significant higher germination percentage (96.04 and 89.34) during summer and *kharif* season, respectively (Hilli *et al*., 2008). In contrast the lower germination percentage, plumule and radicle length in BAP treated seeds, could be attributed due to usual low activity of Cytokinins in germination control and dormancy compared to other hormones (Leadem, 1987). However in both the cases (i.e. IAA and BAP treatments), the germination percentage decreased when the concentration of hormones was increased, which shows the inhibitory effect of higher concentration on seed germination. The result is considered in parallel with the findings of Chauhan *et al*. (2009), who reported decreased seed germination of Black Gram and Horse Gram with increased concentration of IAA and GA_3. The maximum diameter of radicle and plumule in Raphanus was recorded in BAP treatment coincided with finding of Zadoo (1986), who confirmed that cytokinin induced expansion of growth in hypocotyl segments of morning glory and inhibited the extension growth. Cytokinins promote growth by swelling rather than elongation in soybean (Fatima & Bano, 1998).

Vegetative Growth parameters in *Rapahanus* showed the incremental effects as compared to control and the maximum growth was recorded in IAA 50 ppm. Das *et al*., 1996 also reported that foliar application of NAA at the concentration of 50ppm caused significant improvement in the vegetative growth and yield in garlic. Similarly in the present study both IAA and BAP enhanced the biomass as compared to control. Both fresh and dry weight of radish was maximum in IAA 50 ppm and compared to others. The results of biomass coincides with the findings of Quaderi *et al*. (2006) who reported that IAA increases dry matter by increasing photosynthesis activity in mungbean. Similary the application of IAA led to significant increase of vegetative growth characters such as shoot and root length, shoot and root fresh weights and dry weights in *Catharanthus roseus* (Muthulakshmi1 and Pandiyarajan, 2015).

While both IAA and BAP showed enhanced, former hormone was more effective in enhancing the growth and development of radish. Therefore clearly indicates that *Raphanus sativus* treated with IAA 50 ppm concentration showed best performance in field condition.

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FLOWERING, FRUITING, BREEDING TECHNIQUES AND BIOTECHNOLOGICAL APPROACHES IN MACADAMIA NUT

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Abstract

For development of macadamia cultivar germplasm identify with huge tree size, broadened adolescent period, cultivar life span, verifying stable subsidizing and long haul field preliminaries for estimation of efficiency. Macadamia has been financially developed for under 160 years and current cultivars are just two to four ages expelled from nature. There is critical potential for arrival of improved cultivars with proceeded with particular reproducing. We are contemplating strategies to improve reproducing effectiveness using quantitative hereditary qualities, genome-wide choice, and agreeable field preliminaries with business makers and elective rearing populace structures through utilization of polycrosses. Past reproducing has chosen essentially for nut-in-shell yield, portion recuperation and tree size. We are investigating chances to choose for different attributes including elective tree design, changed conceptive science, piece quality qualities and infection obstruction. Some portion of this procedure includes abuse of the wild germplasm that is local to Australia in the quest for novel qualities and expanded decent variety.

Key words: Breeding, Biotechnology, Germplasm and Macadamia nut

Introduction

Macadamia nut is originated in Australia. It was introduced to Hawaii in 1878 and to Brazil in 1931. Actually there were 10 known species, but just three were used as food (*Macadamia integrifolia, Macadamia tetraphyla and Macadamia ternifolia)*. Its culture expansion occurred from the 80's, precisely to the beginning of the 90's. It found good growing conditions in South America, from Bahia (NE, Brazil) to Uruguay. Macadamia is one of the few international food crops domesticated from the Australian flora. but developed as a crop in Hawaii after the First World War. The Hawai'ian cultivars are responsible for the majority of the world production.In Kenya, macadamia nut was introduced from New South Wales inAustralia in 1946. According to Harris, (2004) six*M. tetraphylla* seeds wereplanted at Kalamaini estate in Thika district of central province More seeds of *M. integrifolia, M. tetraphylla*and hybrids of the two were introduced in 1964from Australia, Hawaii and California. In 1968, graftedseedlings were produced using scion material of superior*M. integrifolia*varieties which were imported from Hawaii.The grafted Hawaiian varieties were planted in differentagro-ecological zones. Since most of the trees were seed-propagated,there was wide variation in yield and quality of nuts. In addition, knowledge of the pedigree of advanced selections can be used to improve prediction accuracy in analysis of breeding trials. Finally, improved knowledge of the domestication pathway will assist ongoing conservation and genetic improvement of the genus.

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Area and Production

Macadamia is mainly grown extensively in commercial plantations in Australia in around 20,000 hectares of macadamias with about 40% in Queensland and 60% in New South Wales. Macadamia is also commercially produced in South Africa,Brazil, California, CostaRica, Israel, Kenya, Bolivia, NewZealand, Colombia, Guatemala and Malawi and the country that cultivate the crop on a small scale include New Zealand, Mexico, Jamaica, Fiji, Argentina, Venezuela and Tanzania (Wasilwa*et al.*,2003; Hardner*et al.,* 2009).

Breeding objective

- To develop cultivars suitable to various agro ecological zones.
- To Identifying opportunities to improve productivity of the existing cultivars.
- To develop the climate resilient variety.
- To increase the sustainable use and conservation of macadamia genetic resources through biotechnology applications.
- To improve prediction of genetic value, and selection index to maximise gain from multi-trait selection.
- To identify elite candidate cultivars for improving the breeding population over generations to maintain the genetic diversity.
- To assess whether pollination is a limiting factor in nut production at tree and orchard sites.

Problems in breeding

- Trees are large and long-lived of orchard life i.e. more than 50 years.
- Slow maturity of the crop pose particular problems for breeding and selection.
- Lack of or little information about heredity/linkage associated with different economical traitsis available which makes the macadamia breeding difficult.
- Poor knowledge of crossability.
- Low percentage of fruit set and high percentage of fruit drop gives an uncertainresult in artificial crossing.
- Time of stigma receptivity and anther dehiscence is markedly influenced environmental factors. Few nut set and is followed by extensive drop, limit thehybridization work.
- Controlled crosses are very difficult to make and the stigma of the macadamia floweris extremely small, reducing the changes of successful pollination. In Hawaii, 300individual crosses were made but failed to produce acceptable progeny
- Low and inconsistent yields.

Flowering

Macadamia is an annual-flowering, evergreen tree that is bee-pollinated, partially self-incompatible and predominantly outcrossing.

Inflorescence

Macadamia nut has raceme inflorescences which develop from a node, each with whorls of between 100 and 300 tubular florets that are 6–12 mm long (Heard and Exley, 1994; Trueman, 2013). According to Heard, (1993) the flowers in inflorescence open over a period of 6–12 days generally starting from the top of the raceme and then proceeding downwards until the last flowers open near the base (Schroeder, 1959). The number of racemes per tree is reported as 2500–15,000, depending on variety and tree size (Urata, 1954a; Rhodes, 2001). The inflorescence (Racemes) are produced variably on one and two-year-old growth (Sedgley*et al.,* 1985; Rhodes, 1986).

Anthesis and Anther dhescience

Peak anthesis occurs early in the morning on flower opening (McGregor, 1999). Anthesis often progresses basipetally along racemes (Pisanu*et al.,* 2009) but it may also progress acropetally, from the centre, or from both ends depending on the cultivar and environmental conditions. Heard (1993) noted that pollen availability peaks mid-afternoon on the day of anthesis.

Pollen viability and Pollen germination

The pollen quantity and viability varies from variety to variety, with pollen germination in artificial media varying between 45 and 84% (Lavi*et al.*, 1996).In macadamia, pollen germination does not occur until 1–2 day after anthesis and pollen collected from a flower at one day before anthesiswill germinate on the stigma of flower which was opened three daybefore (Sedgley*et al.,* 1985).

Fruit set

In macadamia nut, initial fruit sets 7–21 day after pollination when swelling of the ovary takes place.The final fruit set in wild populations of *M. tetraphylla* resulted high cross-pollination (3.25–6.79%) than the self-pollination (0.67%) indicating that partial self-incompatibility in the species (Pisanu*et al.,* 2009).

Inheritance pattern

Scanty information of inheritance pattern is available. Hardner*et al*. (2001) estimated broad sense heritability, genotype and phenotypic correlations for nut and kernel traits. High broad sense heritability (H =0.63) for nut, kernel mass and kernel recovery, moderate for percentage whole kernels (H ≈0.30) and low for 1st grade kernel (H ≈ 0.20) was observed. There was little interaction between cultivar and location or age; however, for 1st grade and whole kernels, there were large 3-way and 4-way interactions. Strong correlation for nut and kernel mass (rg=0.80) and little for cultivar and location or age. There was also a large phenotypic correlation between these two traits (rp = 0.68). Kernel mass and kernel recovery exhibited some degree of genetic and phenotypic correlation (rg= 0.48; rp =0.49), however, there was virtually no genetic or phenotypic correlation for other trait combination. The prevailing variation has been effectively used in selection of cultivars with wide adaptability good nut and kernel characteristics, but very less on the inheritance pattern of traits through planned crossing is known or achieved. Some interspecific crosses between *M. integrifolia x M. tetraphylla* were developed by Storey and Saleeb (1970). Character three leafed whorls and petiolate leaves was dominant while leaf arrangement (Phyllotaxi) and leaf attachment under a single pair of genes. Complementary gene interaction of two pairs of alleles was responsible for trait spines & colour of young flush. Gene(s) for margin serrations and colour appears to be linked.

Marker-assisted selection

Marker assisted selection or marker aided selection (MAS) is a process whereby a marker (morphological, biochemical or one based on DNA/RNA variation) is used for indirect selection of a genetic determinant or determinants of a trait of interest (e.g. productivity, disease resistance, abiotic stress tolerance, and quality). The need of marker-assisted selection (MAS) in breeding of macadamia is essential for improvement of important traits. Marker assisted selection for enhanced breeding of macadamia considerable developments in biotechnology have led plant breeders to develop more efficient selection systems to replace traditional phenotypic-pedigree-based selection systems (Ribaut and Hoisington, 1998). Marker assisted selection (MAS) is the indirect selection process where a trait of interest such as disease resistance, abiotic stress tolerance, and/or quality is selected based not on the trait itself but rather on a marker linked to it. MAS will be useful in macadamia where selected characters like yield are expressed late in plant development due to long juvenile period. Selection of genotypes for such traits will not wait until fruiting time. Selection for high nut yield and quality of macadamia from an array of cross-bred population would also benefit from MAS such that useful crosses can be selected and advanced early enough. MAS can also be used to select for disease and pest resistance. However, limited molecular mapping work on macadamia has been reported. The first molecular linkage map of macadamia (*M. integrifolia and M. tetraphylla*) based on 56 F_1 progeny of cultivars `Keauhou' and `A16' was reported by Peace et al. (2003).

Transgenic

In present era, microbial induced food poisoning is a major issue to the food production industry. According to Mead *et al* (1999) incidences of food-borne illnesses in USA alone were estimated at 76 million cases, with at least 5000 deaths annually directly attributed to food poisoning.Later on scientific studies have examined the therapeutic potential of *M. integriflora*. Cock (2008) found that antibacterial activity of methanolic extracts of *M. integriflora* leaves and flowers against a panel of bacteria whereas other studies have reported that MiAMP1 protein which has been detected in macademia nuts, is also present in some other plant species with antimicrobial activities (Marcus et al., 1997). Natural antimicrobial alternatives are increasingly being sought to increase the shelf life and safety of processed foods. Later Gurel (2001)transferred a novel gene into the Agrobacterium tumefaciens strain (LBA4404) using plasmid (pPCV91)through a triparental mating system. The 5W gene was recently isolated from macadamia, a native nut tree species of Australia, and has been shown to have an antimicrobial effect against certain fungi in vitro. Secondly, this gene was tranferred into tobacco (*Nicotianatabacum cv. Xhantii*) using leaf explants to develop a system which could then be used for transferring this antimicrobial peptide into sunflower cultivars

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ETHNO BOTANICAL STUDIES ON BHOTIYA TRIBAL COMMUNIY OF UTTARKASHI DISTRICT

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Abstract

Plants provide food, medicine, energy, shelter, wood and non-wood products to sustain life on earth. Uttarakhand also known as DEVBHOOMI, one of the Himalayan states of India, is richest in resources with respect to the occurrence of religious and spiritual plants. These plants are utilized by ethnic societies of Uttarkashi district to their religious activities and are also important as food, fodder and medicine. We have identified a total so many plant species belonging to different families utilized traditionally by ethnic societies of Uttarkashi district during various religious, medicinal, mysterious and spiritual ceremonies. Recently, few ethno-botanical studies on some caste or tribes have been conducted . However, these attempts have ignored detailed study on religious and spiritual values of plants in heterogeneous Hindu dominated Indian society particularly Uttarakhand that gives higher social recognition on it. Therefore, this paper attempts to investigate and document some high value medicinal ,religious and spiritual values of plant species in Uttarkahi district of Uttarakhand state. In the present study, the description of religious plants is based on survey and discussion with local users (ethnic societies) of Uttarkashi district.

Key words: Ethnic societies, ethno-botanical, tribes and religious plants

Introduction

Bhotiyas are transhumant community of semimongoloid people of Tibetan origin, mainly inhabiting the high altitude region of Indian Central Himalaya and Indo-Nepal border, a zone of ethnic intermixing and cultural assimilation. The eight major Bhotias groups of Uttarakhand are Johari, Jeethora, Darma, Chaudansi, Byansi, Marchha, Tolcha, and Jad are scattered over the eight main river valleys known as Johar, Darma, Byans, Chaudans (Pithoragarh district of Uttarakhand), Mana, Niti (Chamoli district of Uttarakhand), Nilang, Jadung(Uttarkashi district of Uttarakhand) respectively.

Among the native societies of the Central Himalaya the Jad (Bhotia) are still one of the under developed and smallest separate tribal society. Jad are the native of Nelang and Jadung remote village (a part of Indian Trans-Himalaya) are a high altitude cold desert area, harbouring many rare and endangered plant and animal species. This area, strands at the height of over 11,000 ft MSL and characterized by high solar intensity, high aridity, low temperature, inadequate soil and short growing season, has low plant productivity) of

Uttarkashi district of Uttarakhand. After Indo Tibet War 1962 they Indian Army shifted in Harsil, Bagori and Beerpur Villages of Uttarkashi district.

They have a good knowledge on the use of high altitude medicinal plants due to their constant and close association with the Alpine and sub-alpine forests. These people use the medicinal plants for their effectiveness, lack of conventional health care facility and cultural preferences (Canigo & Siebert, 1998) and they have attained a quite good knowledge on both valuable and adverse effects of plants. However, this huge knowledge on medicinal plants verbally passed down from their ancestral generation is slowly diminishing and deteriorating due to changing socio-economic and cultural practices (Phondani, 2010) and shifting of young generation to urban areas. Several medicinal plants have been listed as endangered, vulnerable and threatened due to commercial over exploitation, unsustainable harvesting practice and climate change (Farooqee & Saxsena, 1996; Ratha et al., 2012). The loss of traditional knowledge is irreversible just as the loss of species (Joshi et al, 2005).

The documentation on ethno medicinal plant practices of Bhotiya tribe of Uttarakhand was done by various workers (Maikhuri, 1998; Negi, 2002; Kala, 2003; Samal, 2010) in a sporadic manner to recognize the use of plant species for different purposes. In the Central Himalayan region documentation of ethnobotanical knowledge was done by various workers (Paliwal and Baduni, 1988; Semwal and Gaur, 1981; Negi, 1986; 1988; Maikhuri et al., 2000; Nautiyal et al., 2001a) to understand the use of plant species for different purposes. Though some of them have been reported about the medicinal plants uses in health care system among the tribal communities living in similar geographical region (Maikhuri et al., 2000; Nautiyal et al., 2001a) however, small community residing in same area having own traditional knowledge is not documented yet by workers properly.

Need of Documentation

Hence there is an immediate need to document the various uses of the medicinal plants used by the tribe before some of them disappear from the areas or before switching over of the tribe to modern system of medicine. The following is the list of some important high altitude medicinal plants used by the Jad tribe along with their local names, Sanskrit names or names as mentioned in the Ayurvedic system of medicine, locality of collection, habit, part/s used, source of collection and period of collection.

Table 1: Enumeration of High altitude medicinal plants used by the Bhotiya tribe of Uttarkashi, Uttarakhand (Abbreviation used: H- Herb, T- Tree, S-Shrubs, Ft- Fruit, St-Stem, Lf- Leaf, Bk-Bark, Wp- Whole plant, Rt- Root, Rz-Rhizome, T-Tuber, Sd- Seed)

S. No.	Scientific name	Vernacular name	Locality	Habit	Part/s used	Source of collection	Period of collection
1	*Aconitum balfourii Stapf* (Ranunculaceae)	Mithavish, Mitha	Alpine forest	H	Rz	Wild	September-October
2	*Aconitum heterophyllum Wall. ex Royle* (Ranunculaceae)	Atis	Sub-alpine	H	Rz	Wild	September-October
3	*Aconitum violaceum* (Ranunculaceae)	Kadwa	Alpine	H	Rz	Wild	September-October
4	*Allium carolinianum* (Liliaceae)	Rukba	Sub-Alpine	H	Lf, B	Wild	August-October
5	*Allium humile Kunth* (Liliaceae)	Jimbu	Alpine	H	Lf	Wild	August-October

6	*Angelica glauca* (Apiaceae)	Chora	Subalpine	H	Rt	Wild & Cultivated	August-September
7	*Arnebia euchroma* (Boraginaceae)	Balchhadi	Subalpine	H	Rt, Lf	Wild	September-October
8	*Bergenia ciliata Sternb.*(Saxifragaceae)	Pattarchatta	Subalpine	H	Rz	Wild	August-September
9	*Bibersteinia odora* (Biebersteiniaceae)	Taksha	Sub-alpine	H	Wp	Wild	August-September
10	*Carum carvi L.* (Apiaceae)	Chongsa jeera	Sub-alpine	H	Sd	Wild	October
11	*Cedrus deodara* (Pinaceae)	Deodar	Sub-alpine	T	Sd	Wild	October
12	*Dactylorhiza hatagirea* (Ranunculaceae)	Hathajadi	Alpine	H	Rt	Wild	August-September
13	*Delphinium denudatum*	Nirvishi	Sub-alpine	H	Sd	Wild	September-October
14	*Hippophae salicifolia* (Elaeagnaceae)	Emli	Sub-alpine	T	Fr	Wild	September-October
15	*Hyssopus officinalis* (Lamiaceae)	Chhabra/lavender	Sub-alpine	S	L	Wild	September
16	*Nardostachys grandiflora* (Valerianaceae)	Jatamansi	Alpine	H	Rz	Wild	October
17	*Papaver somniferum* (Ranunculaceae)	Posth		H		Wild and cultivated	
18	*Picrorhiza kurrooa Royle ex Benth.* (Scrophulariaceae)	Kutki	Alpine	H	Rt	Wild and cultivated	September-October
19	*Pinus wallichiana* (Pinaceae)	Chir	Subalpine	T	Sd	Wild	
20	*Podophyllum hexandrum Royle* (Podophyllaceae)	Bankakri	Subalpine	H	Rt	Wild	September-October
21	*Prunus Armeniaca* (Rosaceae)	Plum	Subalpine	T	Sd	Wild and cultivated	
22	*Pyrus malus* (Rosaceae)	Seb	Subalpine	T	Fr	Wild and cultivated	August-September
23	*Rheum webbianum Royle* (Polygonaceae)	Archa	Alpine	H	Fr	Wild	September-October
24	*Saussurea costus (Falc.) Lipsch.* (Asteraceae)	Kut, Kuth	Alpine	H	Rt	Cultivated	September-October
25	*Saussurea obvallata (DC.) Edgew.* (Asteraceae)	Bramhakam Al	Alpine	H	Rt, wp	Wild	August-October

26	*Selinum vaginatum* (Apiaceae)	Bhutkesh	Subalpine	H	Rt	Wild and Cultivated	August-September
27	*Taxus baccata L.* (Taxaceae)	Thuner	Subalpine	T	Lf, St. bk	Wild	April-June

Conclusion

The present study indicated that the tribal community of Bagori Uttarkashi is a rich reservoir of important high altitude cold desert medicinal plants in regards to Indigenous System of Medicine and Ayurveda. The bhotiya tribe, inhabiting the area, has a good knowledge on the beneficial use of medicinal plant resources with regards to medicines. The Knowledge on ethno medicine of this tribe is eroding gradually due to modernization, and so documentation of it will benefit the younger generation of this community and will provide a platform for researchers to tap the medicinal potentialities of the available medicinal plants. Introducing techniques of ex-situ cultivation of commercially viable species would present a strong option for income generation and prevention of migration of the local people. Kitchen gardening presently in every household greatly benefits the tribe, and should be encouraged to venture into large scale production through promotion of nursery practices.

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STUDY THE POTENTIAL OF HOME GARDEN IN THE BIODIVERSITY CONSERVATION AND LIVELIHOOD

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ABSTRACT

The present investigation was carried out with the aim 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 homegardens are the sites for conservation of a large diversity of trees, because of their uses to the households. Data were analyzed using preference ranking method. A total of 35 species of trees (forest trees+ fruit trees), 18 species of agriculture crops, 13 species of vegetable crops, 7 species of grasses and 13 species of shrub were identified in the study area. Thus the homegardens were found to be complex systems due to plant diversity conservation through their multiple uses.

Introduction

Homegarden agroforestry systems have been proven to be an intermediary for biodiversity conservation. Selection of intercrop depends mainly on edapho-climatic condition of the area, farmer's need and resource availability (Saroj and Dadhwal, 1997). In the Himalayan region a number of traditional agroforestry system have been documented from Himachal Pradesh and Uttarakhand (Atul *et al.,* 1990). Out of which agrisilviculture, agrihorticulture and agrihortisilviculture practices are very common. Traditional homegardens in Garhwal region have been important multipurpose agroforestry systems that combine ecological and socio-economical sustainability. One of the salient features of homestead forests is that they tend to be small-scale enterprises aimed at subsistence production and income generation. Personal preferences and attitudes, socio-economic status and culture often reflect the appearance, structure and function of the homegardens (Christanty, 1985).

The high diversity of species in home gardens plays wide socio-economic and ecological roles. because it is related to the production of food and other products such as fuelwood, fodders, spices, medicinal plants and ornamentals (Christanty, 1985), prevention of environmental deterioration commonly associated with monoculture production systems, income generating sites (Hoogerbuugge and Fresco, 1993) and *in situ* conservation of agrobiodiversty (Watson and Eyzaguirre, 2002). Generally, homegardens serve as refuge to a number of plant species, particularly those not widely grown in the larger agro ecosystems.

Materials and Methods

Ethnobotanical data were collected by using semi structured interviews, field observations, ranking and scoring methods. Interviews and discussions were conducted in Garhwali (the local language) using a checklist of topics. Simple preference ranking was calculated for ten multipurpose tree species in order to assess their number in the study site. Based on their personal preference of efficacy, selected informants were asked to assign their preference to Highest score (1), was assigned to most preferred species was given the lowest score (10). The numbers are summed for all respondents, giving an overall ranking for the items by the selected group of respondents.

Name of trees species

It includes type of trees species grown by the farmers, i.e., Bhemal *(Grewia optiva)*, Khadik *(Celtis australis)*, Malta *(Citrus sinensis)* etc.

Numbers of trees species

It includes total number of different trees species grown by farmer on their field.

Measurements on Tree species:

Just to have an idea about the preference of tree species by the farmers in each village a minimum of 12 trees were resulted in 3 categories on the basis girth measurements, i.e., large, medium and small and rate of growth.

Frequency of tree species

Frequency of trees species are calculated by the help of dominant trees species prevalent in the given region. Those tree species which are more prevalent have more frequency.

Fodder and Fuel-wood sources

It refers to types of homegarden trees species, grasses and shrubs are grown traditionally in farmer's field.

Forest products

It includes fuel, fodder, fiber, fruit, furniture, timber, medicinal uses etc of various trees in the study area.

Agriculture products

It refers to amount of food grain, vegetable, fruits, livestock product etc which are marketable and sold by farmer to improve its livelihood. It also includes the agency which help in transport and the nearest place distance where farmer sell the products.

Amount of fodder use by livestock

It includes different livestock, *viz*; buffalo, cow, sheep, bullock and horses and also refers to how much amount of fodders was consumed by different livestock in different seasons.

Research Methodology

Various tools of participatory data collection were used to gather the field data. Opinion of the individual farmer as well as group regarding home garden practices was collected from formal and informal discussion. Different literature including books, project reports, etc. was reviewed to identify the current scenarios of home garden. Pre-testing of tool is also an important phase of research work, as it suggests incorporation of appropriate modifications. Pre-testing of the tool was done by selection of 24 family in each village namely of Rudraprayag & Uttarakashi district. Data collection was done in month of June 2013 by using schedule as tool for personal interview.

Result and discussion

Homegardens usually exhibit high diversity. Average number of species per homegarden varies with the size of the homegardens. A survey of 72 families in selected village indicated that the very few households practices home gardening. The position of homegardens is traditional type. The size and diversity of species in the study area have positive correlations. With an increase in holding size, more variations in species composition were encountered. Homegardens in the study area were composed of trees, shrubs, agriculture crops, herbs and climbing plants in different strata.

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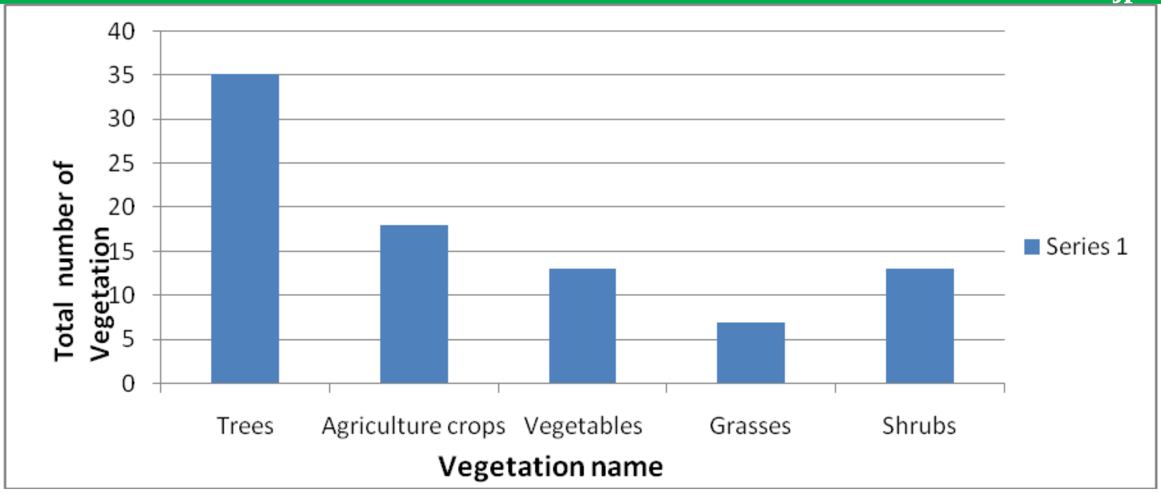

Figure1: Total number of vegetation in existing homegardens

A total of 35 species of trees (forest trees+ fruit trees), 18 species of agriculture crops, 13 species of vegetable crops, 9 species of grasses and 13 species of shrub were identified and documented from the study area. *Grewia optiva* was observed as dominant tree species and *Celtis australis* and *Citrus sinensis* as co-dominant species in the study site. *Grewia optiva* (36%) was the most preferred species, followed by *Celtis australis* (33%). These results indicated that homegardens play a vital role in *in situ* conservation of agribiodiversity The commonly represented families of trees species were Tiliaceae, Rutaceae, Ulmaceae etc.

Homegardens exhibit complex structure, both vertically and horizontally. The vertical structure of homegardens was composed of 3–4 canopy layers. In the present study, four to five vertical canopy layers were identified in homegardens – the emergent layer, the canopy, the understory, the shrub and the herb layer. The emergent layer had a height of 15 m or more and was composed of multipurpose tree species represented in the canopy layer such as *Quercus leucotrichophora, Toona ciliata, Bombex ceiba and Celtis australis.* The canopy layer was between 10-15m with species such as *Juglans regia, Pinus roxburghii, Cedrus deodara* etc.The understory layer was between 5 and 10 m with species such as *Grewia optiva, Citrus sinensis, Ficus spp, Melia azedarach*, *etc.* The shrub layer had the height of 1–5 m and was composed of shrubs like *Rhus oarviflora, Rosa brunonii, Rubus niveus, Berberis asiatica*. Whereas the herb layer was less than 1 m and was mainly composed of vegetables and grass species like *Lycopersicum esculentum, Allium sativum, Andropogon munroi, Cynodon dactylon.*

All the five layers were not present in all homegardens. The canopy, shrub and herb layers were common in all homegardens. The shade provided by the upper layers supports a large number of shade-loving plants like *Colocasia esculenta and Curcuma longa.* In the study report, I found that there was no separate zone for fruit trees, these trees species were usually grown scattered in the boundary of the homegarden or grown mixed. Also majority of the trees with multipurpose uses such as timber, fuelwood, etc. were usually grown in the forest zones. The multi-layered, forest like vegetation structure of the studied homegarden in the area contributes substantially to the agro-ecological sustainability through reducing soil erosion. Research findings from homegarden of Meghalaya, North-east India also confirms that, multilayered vegetation structure prevents soil erosion, provides habitat to soil micro-organisms and promote a favourable microclimate for the household (Tynsong and Tiwari 2010). Similarly, only 28% of such products were sold in South African homegardens, the remainder being used for household consumption. The net income generated from homegardens was also correspondingly variable. For example, in Indonesia it ranged from 6.6% to 55.7% of total income with an average of 21.1% depending on the size of the gardens, family needs and species composition (Soemarwoto, 1987).

Plant diversity and composition of home garden in study site

The diversity and species composition of homegardens depend on requirements of the families, preferences and knowledge about use of the species.The Homegardens flora are composed of both food and non-food plants. Among the food crops 32%, 19% were fruit species, 7% species were vegetables and 6% pulses & cereals ranked 1st in that order. On the other hand, non-food components of the garden grown include fuel, fodder and medicinal plants.

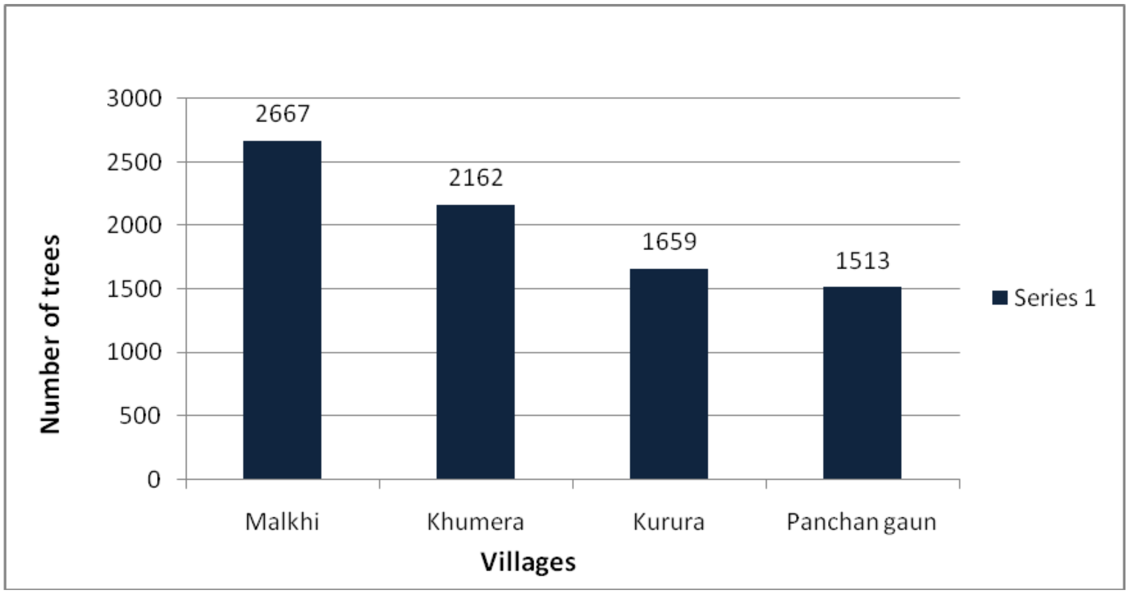

Figure 2: Total number of trees in selected villages

Total number of trees recorded in the study area of Malkhi, khumera, Kurura and Panchan gaun villages were 2667, 2162, 1659 and 1513. Average number of species per homegarden varies with the size of the homegardens. The high diversity and complexity in the structure of homegardens fulfil a range of social, economic and ecological functions.

Out of the total trees in the study site, ten trees were selected according to simple Preference ranking to determine the relative diversity. This technique was employed to rank some selected homegarden species according to their number. Based on their personal preference of efficacy, selected respondents were asked to assign values for each plant. Highest score (1) for maximum diversity, least diversity was given the lowest score (10). The results of trees diversity using simple preferences ranking in the three study sites showed that tree in Malkhi village have maximum diversity, i.e., 2157 and kurura have lowest diverstity, i.e. 1034. The tree species were chosen according to the respondents consensus. Thus, *Grewia optiva* showed a total number of 2217 trees and ranked first, *Celtis australis* and *Citrus sinensis* with a total of 1512 and 543 ranked second and third positions, respectively.

Table1: Simple preferences ranking for widely used trees in home gardens

Scientific name	Study site				Total	Rank
	Malkhi	Khumera	Kurura	Panchan gaun		
Ficus virens	34	67	25	90	216	7
Juglans regia	102	40	35	40	217	6
Grewia optiva	875	586	356	400	2217	**1**
Ficus subincisa	55	18	25	38	136	9
Citrus lemon	75	44	40	40	199	8
Celtis australis	548	300	367	297	1512	**2**
Quercus leucotrichophora	148	201	25	30	404	4
Rhododendron arboreum	25	115	80	57	277	5
Citrus sinensis	280	115	58	90	543	**3**
Toona ciliate	15	34	23	27	99	10
Total	**2157**	**1520**	**1034**	**1109**	**5820**	

Potential of home gardens in biodiversity conservation and livelihood

A total of 35 species of trees, 18 species of agriculture crops, 13 species of vegetable crops, species of grasses and 13 species of shrubs were identified.Among the all trees *Grewia optiva* showed a total number of 1817 trees and rank 1st.Total numbers of trees in Malkhi, Khumera, kurura and Panchan gaun villages were 2667, 2162, 1659 and 1513 trees. Highest homegarden biodiversity present in Malkhi village and lowest were observed in Panchan gaun village.By the study report, major contribution of the agroforestry trees and horticulture trees was around 55-70% and 30-45% in selected site.

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AN OVERVIEW ON *IN VITRO* REGENERATION OF MEDICINALLY VALUED ENDANGERED HIMALAYAN FLORAL SPECIES OF UTTARAKHAND

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Abstract

Indian Himalayan Region (IHR) spans most of the northern states of the nation. This incredible mountain is a hub for highly rich diversity in terms of flora and fauna. Some species are even endemic to this region. From the past few decades, this glorious habitat is facing many threats due to climatic change and increased human activities. Because of these factors, many species have become endangered and striving with their existence in nature. The floral species of this region are of great therapeutic values, some species have not yet been inspected for their medicinal value and for other industrially important products. In-situ and ex-situ methods of protection have been implemented to save these threatened species. Plant tissue culture in ex-situ terms, has proved to be an effective means for conservation of these threatened plant species as it provides a large-scale multiplication of plants under sterile lab conditions. Present review deals with results and conclusions of mass multiplication of endangered species with the help of *in vitro* regeneration technique, their therapeutic values and the future perspectives related to protection of these endangered plant species.

Key words: Endangered, Endemic, Ex-situ, Indian Himalayan Region (IHR), In-situ

Introduction

Indian Territory (6°45' to 37°6' N and 69° 7' to 97° 25' E) has a land perimeter of 15,200 km and a shoreline of 5400 km (R.R. Rao, 1997). Indian terrain can be classified into three distinct regions namely Himalayan province in northern part, the Indo- Gigantic plain and the plateau expanse in southern and central portions of the nation. The central Himalayan region is rich in medicinal and aromatic flora. India inhabits barely 2.4% of the earth's land area but its contribution to world's biological diversity is round about 8% of the total number of species (Khoshoo, 1996). In terms of floral diversity, India holds tenth rank in the world while fourth in Asia (Rodgers and Pawar, 1988).

India is a habitat to more than 48,000 species of plants, near about 3,000 species possesses therapeutic values and has been used in conventional medicament. Although a diversified species of plants has been reported in India, but wistfully this scenario has been reduced. According to investigators and botanists, at least 20 percent of numerous species of plants found in India are classified as either threatened or endangered. This species declination is due to threats such as habitat destruction, altered climate, or pressure from intruding species, increased urbanization. Pollution of soil, water and air, in addition to unrestricted usages of chemicals, fertilizers, plastics and expansion of factories and industries are devastating the natural necessity for flourishing these plant varieties.

Habitat alteration not only accelerate depletion of plant resources, but also affect conventional community life, cultural divergence, and accompanying proficiency of medicinal value of various endemic species (UNESCO, 1994b). On an average, 28 percent of plants species reported in India are endemic to the nation and hence, have to preserved and secured from getting extinct. If these medicinally important plants species get extinct in the near future, the world will be devoid of therapeutic products derived from these plants.

Uttarakhand is one the most important region of Indian Himalayan Region (IHR) as the state is specifically enriched with variegated collection of natural ecosystems hence, is considered as home to numerous variety and exclusive range of plant diversity of India. It is apparent that endemism is quite high in species of Uttarakhand in which some of the species has a high threat status. As claimed by scientific studies, diversity under 1503 genera and 213 families of flowering plants, including 93 endemic species is harbored in various vegetation types, extended from sub-tropical forests in upper Gangetic plain and Shivalik zone in the south to arctic-alpine vegetation of trans-Himalayan cold desert in the north of Uttarakhand. Besides 487 species of ferns of which 15 species are endemic, 18 species of gymnosperms have also been reported from the state. These plant species have economic, medicinal value as these contains, anti- oxidants, anti- inflammatory, and anti-cancerous activities that helps in curing various diseases.

These endangered plant species are at the verge of extinction, so if not provided with firm policies and strategies for their conservation, then there is every likelihood of their extinction. In-situ and Ex-situ, both the measures have been taken for the protection of such threatened species so far. Under In-situ conservation Forest Department had established different National Parks, Sanctuaries, Reserved Forest and Biosphere Reserve in order to ensure good survival rate of threatened floral and faunal species.

Along with these in-situ programs, ex-situ program such as Plant Tissue Culture was also employed to safeguard these species. Plant tissue culture, also called micro-propagation, is a practice used to propagate plants under sterile conditions or in a controlled environment, often to produce clones of plant. This process involves maintenance of tissues or cells, as suspensions or as solids under conditions, which encourages their growth and multiplication.

Plant tissue culture is based on the characteristic feature of plant cell i.e. totipotency which allows plant cells to regenerate into a whole plant, when placed on suitable nutrient medium in sterile conditions. Leaves pieces, nodes, internodes, single cells, less commonly roots can generally be used to regenerate a new plant on culture media when provided required nutrients and Phyto- hormones (Vidyasagar, 2006).

Tissue culture protocols for near about 70 angiosperms and 30 gymnosperms has been established thus far (Thorpe *et al*., 1991). *In vitro* propagation is a promising technique to proliferate and preserve critically challenged plants genotypes as the method is independent of environmental factors, geographical and seasonal variations, and offers an explicated production system, which corroborates the steady supply of plantlets, consistent in superior quality and yield (Kala, 2005).

Uttarakhand: Devbhumi ('Land of Gods')

Uttarakhand earlier known as Uttaranchal is a state situated in the northern region of India. It is often referred as Devbhumi ('Land of Gods') due to many Hindu temples and pilgrimage centers found throughout the state. Uttarakhand is known for its natural environment of the Himalayas, the Bhabhar and the Terai.

Uttarakhand is located at the foothills of the snow-covered Himalayas with flourishing green vegetation. The State has rich and diverse floral, faunal and microbial abundance inclusive of unique and threatened species of plants and animals.

Conventionally, the mountains present in the lower areas of Uttarakhand are roofed with damp deciduous forest. Large-scale dominant natural vegetation entails of Pine, Oak, Rhododendron, Walnut and Larch are present between the elevations of 1,500-3,000m.Vegetations like forests of Spruce, Fir, Cypress, Juniper and Birch are present below snow line, while going in the higher altitude of the State *i.e.* above the snow line, is Alpine vegetation, which consists of Mosses, Lichen and a variety of wildflowers like Blue Poppies and Edelweiss. Loads of pioneer flora and fauna of the Himalayas are confined to protected areas and sanctuaries because of deforestation.

Species Threatening

Miscellaneous developmental procedures and approaches such as industrialization, urbanization, hydroelectricity, global warming, oppression of lucrative plants, deforestation, alteration in climate have emerged as responsible factors for massive forfeiture of biological assets (Gaur 2005, 2007a, 2007b). As specified by an estimate, approximately 75 percent diversity dissipation is because of habitat variation while the remaining 25 percent losses are due to over exploitation (Gaur, 2008). Himalayan flora has been in use for miscellaneous purposes, which includes some scientific medicinal uses from pre-historic times. Plants of Himalayan range have many uses that are well described in ancient Indian Literature such as Rigveda, Charak Samhita, Sushruta Samhita, Atherveda, Upanishada.

Applications and usages of indigenous plants and natural assets and resources are increasing very abruptly for the past few decades. This put together massive hazards to the survival of numerous wild species and ecosystems, which are of enormous lucrative value to the society. There is a huge region in Shivalik Himalayas, where the woods have demeaned and transformed into small packets (Sharma *et* al., 2011). It is proposed that if no genuine attention and awareness will be provided in the direction to these rich economic diversities of this region, then it will hardly last for future.

Medicinal value of some endangered species of Uttarakhand

S. N.	Plant species	Medicinal values
1.	*Aconitum balfourii*	An alkaloid pseudacnitine is present in roots, which is biologically 1.5 times as active as aconitine and is highly toxic. Root Paste can be applied for rheumatism, against neuralgia, fever and bone complaints .it is used in gastric disorders, leprosy, swelling and sciatica and wound.
2.	*Aconitum heterophyllum*	Roots are used to cure dysentery, diarrhoea, fever, malarial fever, cough, cold colic, headache, piles, hysteria, throat infection, cure for dyspepsia, especially when appetite is lost after illness and also in vomiting, abdominal pain and diabetes. It also monitors sun controlled menstrual flow. Fresh leaves are used to cure toothache.
3.	*Aconitum violaceum*	An alkaloid called indoconitine is present in roots, which serves as tonic and is used in cough, cold, stomach pain, fever, bronchitis, epilepsy, headache, inflammations, snakebite, renal pain and rheumatism.
4.	*Eremostachys superba*	Gujjars of some states give tubers of this plant to buffaloes to increase the milk production.
5.	*Gentiana kurroo*	It is known to have beneficial effects on liver so acts as tonic, anthelmintic, emmenagogue, blood-purifier, and carminative, digestive agent and also used for the medicament of diabetes, digestive disorder, hepatic disorder, bronchial asthma, and urinary infection. Along with roots, whole plant can be used as therapeutic agent.
6.	*Nardostachys grandiflora*	The rhizome and the oil derived from the rhizome are regarded as tonic, stimulant, diuretic, emmenagogue, stomachic and laxative and is used in hysteria, insomnia, dysmenorrhea, skin diseases, throat trouble, lumbago, ulcer, rheumatism, paralysis etc. it is known to provide poise and calmness of mind and used conventionally as a hair tonic to cure hair loss as well.
7.	*Phaius tankervilleae*	it is used as tonic (personal communication). Paste of wild ginger along with plant acts as medicine in dysentery and healing bone fractures (Roy *et* al., 2007). Grounded pastes of pseudobulbs, roots and leaves are used as remedies for boils, infected wounds and abscesses (Chowdhary, 1998). Smoked flower of this plant along with food is taken by the women of Papua New Guinea as an aid to conception (Powell, 1976).
8.	*Cyathea spinulosa*	The whole plant parts are useful as remedies. It is used as general hair tonic, fronds powder is used as sudorific and aphrodisiac (Singh and Upadhyay, 2010). In case of indigestion and hair loss due to various reasons, mixtures of stem powders of *Cyathea spinulosa* and *Angiopteris helferiana*

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		is administered orally with water to the cattle such as cows, buffalos and goats. For rapid growth of hair, trace amounts of potion are also applied on the skin (Upadhyay *et* al., 2011).
9.	*Schrebera swietenioides*	The leaves are thought to contain stomachache-healing properties and are used in the medication of urinary discharges. Boils and burns can be treated by bark while roots can be beneficial to cure for leprosy. Local grazers also use crushed roots as an application for killing worms in infested wounds.
10.	*Meizotropis pellita*	------
11.	*Turpinia nepalensis*	------
12.	*Indopiptadenia oudhensis*	------
13.	*Trachycarpus takil*	------
14.	*Pinguicula alpine*	------
15.	*Pecteilis gigantean*	------
16.	*Diplomeris hirsuta*	------

Plant Tissue Culture

In vitro propagation is one of the modern techniques for propagation of plants. Apart from mass multiplication, it holds promise in multiplying genetically engineered, high yielding and disease resistant plant material. It saves time, requires less space and allows freedom from seasonal variations. In the nineteenth century the idea of experimenting with tissue and organs of plants under controlled laboratory conditions was born. For the first time in 1902, a German physiologist, Gottlieb Haberlandt, developed the concept of *in vitro* cell culture.

Micro-propagation has a high level of commercial potential and this potential is due to many reasons *viz*; high speed of propagation, germplasm conservation, genetic transformation, clonal propagation and it has ability to produce disease- free plants. It offers a rapid means of afforestation, multiplying woody biomass, conservation of elite and rare germplasm (Bajaj, 1986; Karp, 1994; Roja and Rao, 1998), regeneration of plantlets from both callus cultures and organ cultures (Chalupa, 1987), development from single cells into callus (Muir *et* al., 1958). *In vitro* plant regeneration is also used for conservation of those species that are at risk. Rare, endangered or of special cultural, economic or ecological value. Micro propagation of mature trees with vegetative explants has been a difficult task due to various factors i.e. presence of phenolic compounds, exogenous and endogenous infection, maturity, juvenility, slow growing habit, long genetic variations (Durzan and Gupta, 1986; Zimmerman, 1985; Bajaj, 1991).

Plant tissue culture of different endangered species of Uttarakhand

1) *Aconitum balfourii*

Pandey *et* al., 2004, had established a protocol of *in vitro* regeneration of *Aconitum balfourii*. Leaves were used for either callus induction using 4.5mM 6-benzyladenine (BA) and 26.9mM alpha-naphthaleneacetic acid (NAA) or multiple shoot induction using 1.1 mM BA only. Root was induced by supplementing 12.3mM indole-3-butyric acid (IBA). *In vitro* regeneration of *Aconitum balfourii* was also established by taking roots as explants by Sharma and Gaur, 2012, in which for the induction of callus 13.4 µM NAA with 5.55 µM BA was used. Shoots were regenerated in medium supplemented with 0.54 µM NAA and 8.88 BA. For complete regeneration of plant, rooting media was supplemented with 1.43 µM IAA and 1.23 µM IBA.

2) *Aconitum heterophyllum*

In vitro regeneration protocol was established and published in a book by Nandi *et* al., 2016 by taking seeds of *Aconitum heterophyllum*. When the seedlings (without radicle) were cultured on the medium containing BAP (0.01, 0.1 and 1.0 µM), best response (80 %) was obtained on a medium containing 1.0 µM BAP with maximum shoot formation (six shoots/explants) after 8 weeks.
Giri *et* al., 1993 and Jabeen *et* al., 2006-used BAP for shoot induction while micro- propagating *Aconitum heterophyllum.* The establishment of hairy root culture in *Aconitum heterophyllum* and the production of active ingredients was successfully demonstrated (Giri *et* al., 1997). Total aconitine content in transformed roots was found out to be 3.75-fold higher than the non-transformed roots.

3) *Aconitum violaceum*

An *in vitro* regeneration protocol was established by Mishra-Rawat *et* al., 2013 in which leaves shoot tips and nodal segments of the plants were used as explants. Basal MS medium with different plant growth regulators (PGRs) at various concentrations (0.0–2.5 l M BAP and 0.0–1.0 l M NAA) was tested for multiple shoot formation. Proliferating shoots (about 3 cm in length) were transferred to half-strength MS medium supplemented with IAA (0.0–0.5 l M) and NAA (0.0–1.0 l M) either individually or in combination for rooting.

4) *Eremostachys superba*

G. S. Panwar, S. K. Srivastava and P. L. Uniyal in 2015 established *in vitro* regeneration protocol for *Eremostachys superba* by taking seeds. Shooting was done with MS medium supplemented with most suitable concentration of BAP (6.6 μM), TDZ (4.54 μM) and kinetin (6.9 μM) was tested in combination with different concentration of NAA (0.53-1.59 μM). To prevent the browning of culture medium and necrosis of tissues from white-milky exudates of explants, the medium was supplemented with activated charcoal (1.0 g l-1) and poly-vinyl-pyrrolidone (PVP: 1.5 g l-1). MS medium supplemented with IBA (7.36 μM) for root regeneration. A subsequent rooting experiment was performed involving activated charcoal, PVP and gelling agents such as agar (0.8 and 0.6% w/v), agar gel (0.4% w/v), gelrite (0.2% w/v).

5) *Gentiana kurroo*

For the first-time *in vitro* regeneration of *Gentiana kurroo* was established by Sharma *et* al., 1993. Shoot multiplication of *Gentiana kurroo*, a threatened medicinal plant species, was achieved *in vitro* using shoot tips and nodal segments as explants. Fifteen-fold shoot multiplication occurred every 6 weeks on Murashige and Skoog's medium (MS) containing 8.9μM Benzyladenine and 1.1 μM 1-naphthaleneacetic acid. Rooting was accomplished successfully in excised shoots grown on MS basal medium containing 6% sucrose. Sharma and Kaur, 2014, developed efficient protocol for *in vitro* regeneration of *Gentiana kurroo* using different explants (leaves, petioles, and roots) and those explants responded differently for regeneration according to different combinations of growth regulators. They found out that the petiole explants were responding best for callus induction and consequently for indirect and direct regeneration. The callus induction was achieved on MS basal + 1.0 mg/l benzyladenine (BA) and 3.00 mg/l naphthalene acetic acid (NAA). MS medium supplemented with 0.10 mg/l NAA and 1.0 mg/l thidiazuron (TDZ) was recorded as the best medium for indirect regeneration. However, for direct regeneration the maximum number of shoot emergence was observed on MS basal fortified with 0.10 mg/l NAA + 0.75 mg/l TDZ. Half strength MS basal supplemented with indole-3-butyric acid (IBA) 1.00 mg/l gave best response for root induction. Actively growing shoots 3–4 cm in length derived directly from petioles (direct) and multiple shoots derived from calli induced from petiole (indirect) were transferred to MS basal solid and liquid medium of different strengths supplemented with various growth regulators like NAA (0.50 mg/l), IBA (0.50 mg/l–1.0 mg/l) (Kaur *et* al., 2007). Kaushal *et* al., 2014 developed *in vitro* regeneration protocol for *Gentiana kurroo* by using apical meristem as explants. The apical meristem was excised to a length of 0.2-2 mm from the shoot tips. Among different treatments of growth regulators either alone or in combination, the growth of meristem was best observed on Murashige and Skoog (MS) medium supplemented with 6- Benzyl amino purine (BAP) (1.0 mg/l) and Indole acetic acid (IAA) (0.5 mg/l). The maximum response for meristem proliferation was 83.3% with an average mean number of 8.1 ± 0.2 leaves /explant. Three weeks old sprouted meristems were transferred to the MS medium supplemented with 0.5 mg/l each of Kinetin (KN) and BAP for shoot elongation and proliferation resulting in 5- 6 shoots/ explant. When transferred to half strength MS medium supplemented with 0.5 mg/l Indole butyric acid (IBA), *in vitro* regenerated shoots developed roots in six weeks with a survival rate of 86%.

6) *Nardostachys grandiflora*

Callus cultures of *Nardostachys grandiflora* was maintained on Murashige and Skoog's medium containing 3.0 mg 1−1 of α-naphthaleneacetic acid and 0.25 mg 1−1 of kinetin when shifted to medium containing 0.25–1.0 mg 1−1 of indole-3-acetic acid or indole-3-butync acid showed profuse rhizogenesis. The callus-regenerated roots when transferred to medium containing 2.0–6.0 mg 1−1 of kinetin produced shoot buds. The *de novo* shoot bud regeneration took place either directly from cortical cells or from the inner stellar region. In addition, concomitant root-shoot development was also observed (Mathur, 1992). Callus cultures of *Nardostachys grandiflora*, were established using petiole explants on MS medium supplemented with 16.1 μM ∝-naphthaleneacetic acid and 1.16 μM kinetin. Embryogenesis in these callus cultures took place only upon sequential subculture of the callus on media having gradually decreasing auxin (16.1 to 1.34 μM NAA) and simultaneously increasing cytokinin (1.16 to 9.30 μM kinetin) concentrations over a period of 7 months. Somatic embryo to plantlet conversion took place on a medium containing 9.30 µM kinetin and 1.34 µM NAA (Mathur, 1993).

7) *Phaius tankervilleae*

In vitro seed germination and seedling development of *Phaius tankervilleae* technique was successfully established for rapid multiplication using 0.8% (w/v) agar solidified MS medium supplemented with different concentrations and combinations of Kinetin (Kin) and NAA. MS medium supplemented with 1.0 mg L-1 Kin + 1.0 mg L-1 NAA was the most ideal condition for early seed germination (2.87 weeks) (Thokchom *et* al., 2017).

8) *Cyathea spinulosa*

In vitro regeneration protocol for *Cyathea spinulosa* was developed by Shukla *et* al., 2004 by - employing leaf primordium explants excised from *in vitro*-raised sporophytes through spore culture. Calli were induced from the explants on Parker's and Thompson (P&T) media using 8.87 µM 6-benzylaminopurine (BAP) and 2.21µM 2, 4-dichlorophenoxyacetic acid (2,4- D). Maximal multiple shoots (12.5±0.45) were differentiated from callus and elongated on P&T media with 4.52 µM BAP and 5.36µM α -naphthalene acetic acid (NAA). *In vitro*-raised shoots rooted on P&T with 2.24µM indole- 3-butyric acid (IBA).

9) *Meizotropis pellita*

An efficient protocol for high frequency *in vitro* regeneration of *Meizotropis pellita* an endangered and endemic plant was developed by taking seeds. Leaf was taken as explants for callus induction and proliferation. Callus initiation stated within 15 - 20 days of incubation in MS medium containing 2 - 4, D (9.06 µM) alone or in combination with 2 - 4, D (9.06 µM) + 2-iP (7.38 µM). Shoot regeneration was attained callus as explant in MS medium boosted with BA (17.6 µM) + GA_3 (1.0 µM). Proliferation of shoots was also achieved from cotyledonary node of *Meizotropis pellita* in MS medium using Kinetin + GA_3 (4.6 µM + 1.0 µM) or BA (13.2, 17.6 µM) + GA_3 (1.0 µM) after 30 - 45 days of incubation. IBA (4.9 µM) was found out to have more effect for root regeneration from micro shoots (Singh *et* al., 2013).

Future Perspectives

The Indian Himalayan Region (IHR) is a mega hot spot of biological diversity (Myers 2000). It comprises about 18% of India, is more than 2,800 km long and 220 to 300 km wide, with altitudes from 200–8000 m. The flora includes about 8,000 species of angiosperm (40% endemic), 44 species of gymnosperm (16% endemic), 600 species of pteridophyte (25% endemic), 1737 species of bryophyte (33% endemic), 1,159 species of lichen (11% endemic) and 6,900 species of fungi (27% endemic) (Singh and Hajra 1996; Samant *et* al., 1998).

Conservation of bio-diversity is an important task for well sustenance of life. Plants are crucial component of our daily life. They maintain a proper environment by exchange of gases in atmosphere, checks soil erosion, reduces levels of certain pollutants, such as benzene and nitrogen dioxide, reduces airborne dust levels, keeps air temperatures down, conserve water and energy. Along with that, plants are the great source of energy and nutrient rich foods like fruits, cereals etc. They are abundant source of essential oils, have therapeutic value as these contain anti-inflammatory, anti-oxidants, anti-cancerous activity-based compounds, which helps in curing many diseases. Plants are also beneficial to animal and birds as it is habitat, provides food and fodder to them. Plants also offer great economical and aesthetical value

Due to large-scale human activity and interference, increasing urbanization, extreme deforestation, intruding wild species reduces the habitat of native species. In addition to physical encroachment, human development of animals' habitats pollutes the natural landscape with petroleum products, pesticides, and other chemicals, which destroys food sources and viable shelters for the creatures and plants of that area. Environmental pollution, illegal smuggling of exotic plant species, natural calamities like forest fires, earthquakes etc, along with extreme research and collection of plant species for institutes, nurseries etc also affect the existence of plant species in nature. Improper handling, negligence of people towards floral habitat, diseases in them is some other important causes because of which floral diversity is at the verge of extinction. Due to extreme human actions and other environmental factors, some plant species have become threatened but needs to be conserved for future as they are of great medicinal and economical value.
Plant tissue culture offers *in vitro* regeneration of plants under sterile conditions in laboratory. For the conservation of threatened species, tissue culture is one of the best medium, which is used ex-situ. This technique has many advantages over conventional method of propagating plants. It provides mass multiplication, off-season and disease-free plant variety.

There are many endangered plant species found in Uttarakhand in which some are endemic to the state. *In vitro* regeneration has been used for conservation of these endangered species, but still no proper evidence was found for some species *viz*; *Schrebera swietenioides*, *Turpinia nepalensis*, *Indopipta deniaoudhensis, Trachycarpus takil, Pinguicula alpina, Pecteilis gigantean* and *Diplomeris hirsuta.* Plant tissue culture can be done for future references and investigations in order to find out the requirements of phytohormones for these endangered plant species. With the combination of recombinant DNA technology plant with desired characteristics can be developed in order to have proper balance and mass production of these threatened plants in nature.

Some endangered floral species such as *Aconitum balfourii, Aconitum heterophyllum, Aconitum violaceum, Eremostachys superba, Gentiana kurroo, Nardostachys grandiflora*, *Phaius tankervilleae*, *Cyathea spinulosa* are rich in disease curing properties for various disease like cancer, rheumatism, gastric disorders, fever, headache, bronchitis, leprosy, dysentery etc. if one plant species gets extinct, the potential benefits, such as a source of medicine, will be forfeited. Pharmacological investigations can be carried out in future in order for the betterment of medicine preparations by using active compounds of these medicinally value plants.

There is no proper evidence, which suggests the medicinal and therapeutic value of certain endangered species like *Turpinia nepalensis, Indopiptadenia oudhensis, Pinguicula alpine, Diplomeris hirsuta, Trachycarpus takil.* Further analysis can be done on this area so that a potential drug and medicines can be developed by finding out the active ingredients present in these plant species in future. Other research and studies may include the anti- microbial activity, anti-inflammatory activity, anti-cancerous activity that can be researched in future for these plant species. Plants are also a great source of active industrial products such as flavonoids, pigments, alkaloids etc.so, a phytochemical analysis can be done in these species in order to find out the type and number of active compounds.

According to the U.S. Fish and Wildlife Service, one lost plant species can lead to the loss of 30 other insects, plant, and other animal species found in the higher levels of the food chain. These individual species of plant or animal are sometimes called the keystone species. If that species is removed, the whole ecosystem will be changed drastically.

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SCOPE AND CHALLENGES OF EXPLOITATION OF MALE STERILITY FOR DEVELOPING NEW HYBRIDS IN ORNAMENTAL CROPS

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Abstract

Hybrid seed are highly demanded in ornamental crops due to their vigour and uniformity. In Ornamental crops hybrids are preferred as both loose flower and bedding plants. Traditional method of emasculation and hybridization is very labour intensive and thus increase the cost of production of hybrid. Exploitation of male sterile lines for development of hybrids not only reduces labour cost but is quit practical also. Presently male sterile line has been reported in few ornamental crops only and further work is going on other crops regarding development of male sterile line in more ornamental crops.

Key word: male sterile line, hybrids

Introduction

Flowers have been associated with mankind since time immemorial, as they have been used for religious offerings, social ceremonies and other purposes. Growing of loose flowers mostly for worshipping, garland making and decoration forms the backbone of Indian floriculture. F_1 hybrids are gradually getting popular with the growers due to their several advantages, *viz*., large size of bloom, uniform flower, better yield, etc (Goldsmith ,1968). This trend led to increased demand for their seed, Globalization of Indian economy and subsequent liberalization of Seed Act paved the way for the advent of hybrid seed production in India. It is a lucrative business having high returns per unit area. (Kundu and Mehta, 2005). The term heterosis, often used synonymously with hybrid vigour, refers to the superiority of the F_1 hybrid in one or more characters over its parents. Generally heterosis is manifested as an increase in vigour, size, growth rate, yield or some other characteristics. Development of hybrid varieties for genetic improvement of yield is referred to as heterosis breeding. Heterosis can be fully exploited in the form of hybrids and partially in the form of synthetic and composite varieties. Expression of heterosis is confined to the first generation only. Heterosis may be positive or negative both positive and negative heterosis are useful in crop improvement, depending upon the breeding objectives.

Traditionally emasculation and subsequent hybridization technique is used to form hybrid which is a very labour intensive procedure. But with the discovery of male sterile line this tedious work of emasculation can be substituted with plantation of male sterile line. This technique is now very commonly used for making hybrid in vegetable and agronomical crop such as rice but in ornamental crops application of male sterility for hybrid seed production is limited to few crops only. Male sterility is defined as the failure of plants to produce functional anthers, pollen, or male gametes. Male sterility is manifestations as absence or malformation of male organs (stamens) in bisexual plants or no male flowers in dioecious plants or failure in development normal microsporogenous tissue- anther. Abnormal microsporogenes formation or nonviable pollen also results is male sterility. Abnormal pollen maturation or inability of pollen to germinate on compatible stigmata also causes male sterility. Sometimes pollen may be viable but there is nondehiscent, this type of male sterility is sporophytic control. Barriers other than incompatibility also preventing pollen from reaching ovule and results in non fertilization.

Male sterility could be genetically controlled such as genic male sterity. Male sterility could also result due to some mutation i.e., In stamenless male sterile mutant very often the stamen can be deformed to a varying extent, undeveloped or do not form a stamen at all. It is controlled by a single recessive gene – *sl* (Stamenless) (Hanson and Bentolila, 2004). Male sterility could be due to maternally inherited trait such as cytoplasmic male sterility. Male sterility can also be artificially induced using some certain chemicals.(Mac,1985)

Occurrence male sterility in ornamentals

Among ornamental, both genic and cytoplasmic male sterility is found in petunia. Many deleterious side affects are associated with CMS in Petunia CMS is also found in petunia which is associated with environmental factors. Welzel(1954) reported induced genic male sterility within the commercial variety 'Rose of Heaven' by X-rays. It had tapetal failure linked with reduced plant and flower size. Genic male sterile mutant RL-a6 isolated from cultivar 'Moonstone' of petunia (Wiering, 1979).This was controlled by single recessive gene.

S. Izhar and R. Frankel in 1973 compared free amino acid contents in the anthers of male fertile, cytoplasmic male sterile (*cms*) and genic male sterile (*gms*) petunia lines at different developmental stages of the male gametophyte and found that there was quantitative differences in the amounts of free amino acids between the fertile and male sterile lines and between the *cms* and *gms* lines. The differences between the sterile lines were correlated with the different developmental stages at which the breakdown in microsporogenesis occurred. In the Rosy Morn (*RM*) *cms* line, where breakdown of microsporogenesis occurred at the end of prophase 1, there was an associated increase in asparagine and decrease in the other amino acids. In the *RM gms* line, in which breakdown occurred at the tetrad stage, an accumulation of asparagine in the anthers corresponded with an accumulation of glutamine beginning at prophase 1. Compared with fertile anthers, the sterile anthers accumulated much proline at the early meiotic stages, but no γ-aminobutyric acid. Comparison of the free amino acids of the fertile and the male sterile lines indicates that certain biochemical events leading to breakdown of microsporogenesis precede the observed cytological breakdown. The results from adding asparagine and glutamine to extracts of anthers at different developmental stages suggest that the amino acid balance may contribute to the changes in pH in the fertile and male sterile anthers

Apetalous male sterile inflorescence is found in zinnia. These line are referred as "femina", their head are entirely pistillate. Cowen and Ewart(1990) reported single recessive inheritance of male sterility in zinnia in apetalous male sterile line MS_1, MS_2, MS_3 and MS_4 .The apetalous and male sterile characters are very likely pleiotropic. Ewart (1981) reported Genic male sterilty in *Salvia spendens* and concluded that it has single recessive inheritance. Savchenko, L. F. (1980) studied environmental effect on expression of male sterility in salvia and reported that Under optimum soil moisture conditions (80% full field capacity), normal anthers developed on long filaments in fertile forms of Salvia regardless of fluctuations in air temperature. Artificial drought combined with increased air temperature resulted in the appearance of sterile anthers, generally on long filaments. In forms of S. sclarea with cytoplasmic male sterility, only sterile stamens differing from the norm in the length of their filaments were formed under both normal and drought conditions. An increase in air temperature under fairly moist soil conditions increased the number of sterile anthers on long filaments, while soil drought increased the number of short filaments. A fertile allopolyploid form of M. piperita proved resistant to fluctuations in soil moisture and formed fertile flowers at both 100% and 50% full field capacity. A decrease in soil moisture after meiosis led to a reduction in the number of fertile flowers. A sterile hybrid of M. piperita generally produced sterile flowers; a few fertile anthers developed only when the plants were well supplied with moisture.

Tower (1961) reported apetalous male sterile association in genus *Tagetes*. He coined the term "femina" for inflorescence of this type. The occurrence of the unique apetalous characteristics associated with the male sterile trait is extremely beneficial for hybrid seed production as they are easily recognized. Apetalous and male sterile characters are pleiotropic. Inheritance of apetalous male sterility in marigold was also found to be governed by a single recessive gene i.e., *msms*. (Gupta *et al*., 1999). Since almost all male sterile lines reported in different flowering annuals are recessive in inheritance. So they segregate into male sterile and male fertile plants in 1:1 ratio. Hence, only 50% of female parent population can be utilized for hybrid seed production and rest goes waste. To avoid wastage of 50% of population which is generated at the cost of huge labour charges, field maintenance and several other inputs, otherwise can be used effectively for some other purposes. To avoid this *in vitro* technique to clone male sterile line was standardized (Ajit Kumar *et al.,2003).* Sykorova, O (1975) found a new type of male sterility in the snapdragon cultivar 'Slavia' and reported that Male sterile plants produced no fertile pollen grains. Crossing of sterile plants with fertile ones from the same cultivar gave a 100% fertile F1 population; in the F2 generation there was a segregation 3:1 in the fertile: sterile plants. Crossing a sterile form with some chlorophyll mutants of the wild snapdragon, produced, in F2 populations, few plants with the parental phenotype. The amount of fertile pollen grains in fertile plants ranged 0-100%. A study of the anatomical development of anthers showed differences between a sterile form, a form with 0-10% viable pollen grains and plants with higher percentage of viable pollen grains. More than 1 system of genetic control apparently acts in this type of male sterility.

Conclusion

Although there is large domestic and international market for hybrid seeds but still technique of male sterility is rarely used for development of new hybrid particularly in case of ornamentals. Moreover farmer at local domestic market also prefer self pollinated seed as compared to hybrid due to its high cost. So there is an urgent need for development of commercial strategies for exploitation of heterosis includes economizing the cost of hybrid seeds. There should be scope for the development of more efficient male sterility systems in respective crops Hybrid must satisfy the needs of the customer for all important traits. It must ensured that price of hybrid seed must be low enough to enable the customer to make substantial profits from annually recurring investments but price must be high enough to enable the seed company to make substantial profits from its investments in research, production and sales.

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PRACTICE OF SHIFTING CULTIVATION IN NORTH-EASTERN INDIA

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Abstract

India dominantly an agricultural country has diverse land cultivation techniques. Shifting cultivation being one amongst it. The practice of shifting agriculture dates back to about 8000 BC in the Neolithic period. In India, shifting cultivation is practised in the hill areas of North-Eastern Region, Sikkim, Bihar, Orissa, Andhra Pradesh, Madhya Pradesh, Tamil Nadu, Kerala, Karnataka and Maharashtra. But among all these states, such practices are still prevalent in the hill areas of North-Eastern states, Orissa and Andhra Pradesh. In Northeast it is also known as jhum cultivation where a patch of land is set on fire for clearing after cultivating for limited number of years. This farming system has been widely disputed as environmentally and economically unfeasible. Since time immemorial, shifting cultivation has been component and parcel of the tradition and culture and its practice is still common to this day. An in-depth look at the importance of shifting cultivation to the indigenous tribes is required along with adoption of feasible measures to protect natural resources.

Keywords: Crops, Deforestation, Fire, Jhumming, Shifting cultivation

Introduction

Shifting cultivation is a practice prevalent throughout the world, particularly in the hills, which are inhabited by the tribals. This practice is called 'shifting cultivation' because in this the cultivators do not use a particular piece of land year after year. A patch of land is selected; all the trees, shrubs, herbs etc. are cut down at or near the ground level and then left to dry in the sun and thence set on fire. The clearing thus obtained is taken up for cultivation. Seeds are sown by dibbling small holes in the ground by means of a wooden stick or metal piece or they are broadcast. In this type of cultivation, no plough or animal labour is made used of. All the operations are carried out by human labour. Conklin (1961) has defined shifting cultivation as, "Any continuing agricultural system in which any impermanent field is cropped for some years and then are fallowed". FAO/UNFPA Project 1978 has defined shifting cultivation as, "Cultivation involving the removal and usually the burning of vegetation to create non-permanent clearings, which are fallowed to bush or forest for varying lengths of time; but also includes the temporary removal of vegetation for pasturage or other purposes of livelihood". One peculiarity of areas which have been under shifting cultivation is that they do not get any replenishment of nutrients in the form of manure (except ashes obtained from burnt material). Thus, yield from these areas starts diminishing from the second year onwards. The cultivators then move to a fresh patch of land. Vegetation reappears on this abandoned piece of land. The cultivator may or may not return to the same land again. The time interval that elapses between two series of cultivation of a piece of land varies with local conditions.

Shifting Cultivation in India

It has been estimated by Vidyarthi (1975) that about 2.6 million tribal people living in the interior hilly areas practice shifting cultivation. About 1.35 million acres of land is under this form of cultivation in India in Assam, Arunachal Pradesh, Andhra Pradesh, Meghalaya, Mizoram, Nagaland, Manipur, Tripura, Bihar, Orissa, Madhya Pradesh, Karnataka and Kerala. It is called Lo or jhum in Mizoram, Jhum in Assam, Tekeonglu in Nagaland, Adiabik in Arunachal Pradesh, Rookuis momo in Tripura, Bagada, Koman and Dahi in Orissa, Panda, Bewar, Dipa and Datus in Madhya Pradesh, Watra in South East Rajasthan, Walar in Gujarat, Kumasi or Kumari in Western Ghats, Podu in Andhra Pradesh and Khalla and Kurai in Bihar.

Patterns of Operations

By and large, shifting cultivation belongs to the community but when it is taken up for cultivation, the cultivating family has all the rights over it. After the land has been vacated, the land again goes back to the community. The broad set of operations followed in shifting cultivation in North east India are as discussed under:

a) Selection of Site: the area for cultivation is allotted to a household by a village community or headman or village council.
b) Clearing: The forest is cleared by cutting down all types of vegetation including trees, herbs and shrubs. They are then left to dry.
c) Burning: The dried material is burnt. For this step, a good sunny day is selected, so that most of the debris is burnt up and the clearing operation becomes easier.
d) Dibbling and Sowing: Paddy crop is sown by turning the soil. Ginger, potato etc. are raised by digging the soil, maize seeds are dibbled, brinjal, mustard sorghum seeds are sown broadcast, before the onset of monsoon.
e) Weeding: Due to the heavy rains in most of the area, weeding has become a must. Weeding is carried out 3 to 4 times in the entire cropping period.
f) Protection: The tribals protect their crops from wildlife, birds etc.
g) Harvesting: Harvesting of paddy is done mainly in November or early December.
h) Threshing, Storing: The harvested paddy is kept in bundles. Threshing is carried out on a good sunny day. Threshing may be done by beating the stalks on the ground or by trampling or beating with a stick. The grains are then stored in earthen pots.
i) Celebrations: After the crop has been harvested and stored, merry making takes place.

Some crude implements used in the above operations include axe, dao, clod crusher, hoe, digging stick or rod, rake, winnowing fan, spade, sieve etc.

Season of Cultivation

Land is selected in November or early December. During the winter months (from December to February) the forest patch is cut either collectively or cultivator wise and the debris is left to dry. Burning of the debris is done in April, before the onset of monsoon. After the first few showers, the ash mixes with the topsoil and the area is ready for sowing. It is a usual feature to sow a mixture of multiple types of crop. Weeding is a continuous process which may take place up to a few weeks before harvesting. Harvesting starts from the third month after sowing and continues up to December. Thus about a year is taken from clearing the land to its final harvesting.

Shifting Cultivation and Traditional Practices

Majumdar (1978) states that Garo religion is nothing but a way to obtain bumper crops and to keep away from disease and disaster. Hence all operations of shifting cultivation are carried out in close relation with religious practices in a series of annual rites. The festivals are linked with the different stages and operations of cultivation. Thanga (1982) in his dissertation has collected a set of religious festivals and rites, which are linked on to various stages of cultivation operations. "After allocation of plots for cultivation, each family performs a religious rite on the plot, marked by dancing and singing. Burning and planting is marked by the *Agal maka* rites. A series of festivals and rites are celebrated and performed at the end of the harvest and close of one agricultural season. The celebrations may go on for a considerable amount of time.

Jha (1976) is of the opinion that the socio-cultural life of the tribes of northeast India is regulated according to the Jhum calendar. As already discussed above, all the festivals are celebrated according to the completion of a particular set of jhuming operations. Social and religious pursuits such as marriages etc. centre around the timings of jhuming operations. In Siand district of Arunachal Pradesh, a newly married wife is brought inly when harvesting is complete or about to be completed.

In some of the areas, which have come under the effect of modern civilization and in areas which have been influenced by Christianity, people are beginning to shed the habit of combining religious festivals and rites with jhuming operation. They now take up shifting cultivation merely as an occupation as the people in th rest of the world take their respective occupations. They do celebrate their festivals but more according to season than timing of jhuming operations.

Environmental Problems

The following are some of the environmental problems caused by shifting cultivation.

- Cutting and burning of vegetation reduces the forest cover leading to the loss of timber worth lakhs of rupees and loss of other forest produce. Loss of forest also leads to loss of potential sources of raw material for industries such as paper and pulp, plywood etc. it deprives the people of the area of a potential source of employment.
- Tribals working in the interior forest areas draw heavily upon forest resources, and even encroach upon forest areas.
- Damage to the vegetation leads to so erosion, silting up of rivers, reservoirs, choking up of soil, depletion of nutrients in the soil, floods and other environmental problems related to biotic pressure and forests.
- By accident, jhum cultivators may set fire to the adjoining forest. Burning of cut down debris is a very important part of jhuming cultivation. If by chance, the fire is not properly controlled, there is danger of its spreading to the adjoining forest area and destroying crores of rupees worth of valuable forest produce. Small fires may destroy seedlings upto pole stage, herbs, shrubs, may alter the status of the soil microbiology. Fire also disturbs the forest fauna by driving them away from the fire affected areas. Fire on jhum lands has been known to destroy villages, telephone-telegraph installations, wires etc., causing a great loss of resources.
- Shifting cultivation has also affected the lives of many reservoirs in east India.
- It is unfortunate that hundreds of square kilometres of land is engaged for 10-15 years in this type of cultivation, without giving any production. With the rapid increase of population, there has become a severe pressure on land, so much so that, a time is bound to come when the fallow period for jhum land will have to be brought down to let off this pressure.
- In some spots certain trees and shrubs are scarce and may become further rare or even eliminated from the flora of the region.
- In the process of cutting trees and burning the site, many parasites and epiphytes get eliminated from the flora.
- Jha (1979) has reported considerably lower content of total sesquioxides, aluminium, calcium, iron, potassium, phosphorus, cation exchange capacity in a jhum patch in comparison to other forest areas.
- Mishra and Ramakrishna (1980) report that the process of sediment and water loss increases by 21 and 5 times respectively when a 8-10 years old forest is put under this practice.
- Das (1976) states that in the plains of North east India, the problems of floods has become very serious and almost annual. This problem is not so grave as far as heavy runoff is concerned but with the associated silt load. The sediments are derived from the hills which are under shifting cultivation.
- The practice of shifting cultivation amongst the tribals of the area is a big impediment in the path of its development. Due to their almost nomadic habits, modern facilities such as schools, health centres, dispensaries, veterinary centres, drinking water supply, wells etc. cannot be provided to them. The provision of such facilities needs permanent settlements. These are generally lacking in the case of shifting cultivators who keep shifting from time to time, so that they may live near their lands.

Some of the plant species which occur in areas of jhuming cultivation are Euphorbia prostrate, *Oxalis corniculata, Spergula aroensis, Syprus, Gnaphelium enteoalbum, Galinsoga parviflora, Lumex, Chenopodium album, Cardamum hirsuta, Plantago major, Tridax, Spermaeoce hispida, Ageratum conyzoides, Erigeron, Mikemia Nacarantha, Eupatorium odoratum* etc.

When the patch of land under shifting cultivation is abandoned, the vegetation which gradually establishes itself includes species like *Lantana camara, Ageratum conyzoides, Eupatorium adenosperma, Gynura angulosa, Solanum, Erigeron* sp. Etc. Perennial grasses are gradually established and in a short time the area is covered with a wide variety of grasses,, intermingled with shrubs and herbs. At higher altitudes the lands are invaded by Artemisia, Eagopyron, Rubus etc. On the lower slopes Mikemia, Gleichemia, Canabis etc. get established.

The following are the main grasses which are established in an area which was previously under jhum: *Arundinalia, Saccolepis interupta, Saccharum munja, S. spontaneum, Pteridium acquilinum, Setaria pelmifolia, Themedia canadata* etc. The major herbs are *Anaphalus, Ainseiala, Calamintha, Solanum, Murdannia, Oldenlandia, Lagerstromium, Eupatorium, Hypercium, Impatiens, Careamine, Dichrocephala* etc. The main tree species are – *Syzygium fruticosum, S.cumini, S. nepalsis, S. mishimiansis, Sauraiya roxburhgii, Krema angustifolia, Rhododendron santapani, Calophyllum polyanthum, Diterocarpus alata, D. macrocarpus, Lagerstromia* sp. *Phoebe cooperiana, Bombax ceiba, Ficus sikkimensis, Anplectrum assamica, Terminalia alata, Castanopsis indica, Altingia excels, Amoora wallichii, Bischofia javanica, Eurya acuminate, Macaranga pellata* etc.

Shifting Cultivation in The North Eastern Region

Shifting cultivation, known as jhuming in the north eastern region, is regarded as the first step in the transition from food-gathering or hunting to food production. Although this system of farming is believed to have originated in the Neolithic period around 7000 B.C (Sharma, 1976), yet this most primitive system is still being practised in different form sin several parts of the world, particularly in the wet tropics (Schlippe, 1956; Conklin, 1957). Shifting cultivation is widely prevalent in the North-eastern region of India, comprising Assam, Manipur, Mizoram, Arunachal Pradesh, Tripura, Meghalaya and Nagaland. The reasons for the continuance of the practice are linked up with ecological, socio-economic and cultural factors, including the lack of communication, leading to physiographical remoteness and isolation.

The System

The essential features of jhuming, as practised in the region are:

i. The selecting of sites on hill slopes, usually before December
ii. The clearing of sites by cutting jungles in December-January
iii. The burning of jungles around mid-February to mid-March
iv. The planting of various crops in an intimate mixture by dibbling
v. The abandoning of the land after cultivation for two years usually, and shifting to another site
vi. Returning to the same site to repeat the process after 3-6 years

No animal or large implement is used by the jhumias for preparing the land. The only implements used in farming are the chopping-knife, the dibbling-stick and a small hoe for weeding. Similarly, no scientific technology is employed. The only inputs used are seeds and human labour. Except the cutting of jungles, and watching to protect the crops, the other operations including weeding, are usually carried out by women. All essential crops including rice, maize, tapioca, colocasia, sesame, cucurbits, beans, yams, banana etc., are planted in an intimate mixture although a single crop is rice is sometimes grown in the second year of jhuming. The land is left fallow for regeneration after 2-3 years of jhuming, to be used again after some years. The farmers then select another site and repeat the same method of farming. The jhuming cycle on the same land, which extended to 20-30 years in olden days, has now been shortened to 3-6 years because of pressure on land due to increased population and decrease in productivity, leading to the utilization of more areas under jhuming.

Effects of Jhuming

Although the system of jhuming was good when it commenced, yet it is considered to be extremely wasteful in the present time. The various adverse effects of jhuming are summarized below:

A. There has been large scale deforestation, resulting in the denudation of hilltops and slopes. This deforestation leads to undesirable ecological changes. Further, since the hilltops are the sources of water, the deforestation of them leads to the elimination of the source of water.
B. There occurs soil erosion on a large scale owing to deforestation and cultivation on hill slopes without effective soil-conservation practices, leading, in turn to several adverse effects:
   i. The erosion of soil in catchment areas results in the silting up of reservoirs and streams, leading to floods in the plains (Goswami, 1968)
   ii. The removal of top soil leads to the depletion of fertility, which is not easily built up again. This depletion leads to low productivity and subsequent pressure on land.
C. The continuation of this primitive form of agriculture leaves very little scope for introducing modern technology. This faulty agriculture, along with the loss of fertility, has led to such a low level of productivity that the jhumias live under-famine conditions (Saha

1973 & 1976). For a particular period during January to July, they have to live on root crops, jackfruit etc.

D. The system is labour-intensive compared with the low technology involved and very low productivity (Roy Burmon & Sarma; Goswami, 1970). Further there is no scope for developing sources of subsidiary income for the farmers. Besides these sources, which are directly related to agriculture, there are other aspects which adversely affect social welfare. Public health, education, communication and such other basic facilities are difficult to be developed when there is no permanent settlement. Further, the large size of a family is considered to be an asset, since there will be a large working force.

The Jhum Control Schemes

Each state of the North-eastern region has some programme of jhum control, either as special programmes or as part of the programme of the Department of Soil Conservation. In Meghalaya, there are two kinds of schemes in operation. These are:

- Integrated scheme for the Control of jhuming, and
- The Rehabilitation of jhumias though Aforestation and Cash Crop development.

In the first scheme, 100 acres of land is terraced in a compact area and 50 families of jhumias are settled, allotting 2 acres of land to each family. Assistance is provided in the first year for constructing houses and for agricultural operations. Roads and water are also provided under the scheme. Under the second scheme, the plantations will be raised by the Department and ultimately handed over to the jhumia families at one hectare per family.

In Tripura also, there are two schemes in the state sector. The scheme run by the Department of Agriculture includes the terracing of land for agriculture as well as for growing orchards and forest plantations. Another scheme operated by the Forest Department aims at providing terraced land, homesteads, link roads, poultry, piggery as well as assistance to purchase bullocks.

In the other areas of the North-eastern region, the Departments of Soil Conservation has formulated programmes of bench-terracing and other soil-conservation measures, including the planting of cash crops.

The North-Eastern Council has sanctioned eight schemes on soil conservation and jhum control with an outlay of 530.95 lakhs of rupees during the Fifth-Five year Plan. Out of these, two schemes are in operation in Mizoram, whereas there is one scheme each for the other six constituent units. These schemes aim at providing terraced land and orchard or forest plantations for the jhumia families, except in Assam, whereas the scheme includes soil-conservation measures.

In addition to the above schemes, a Central Sector scheme for the Control of Shifting Cultivation was sanctioned during 1977-78 with a provision of Rs. 140 lakhs for operation in the North-eastern region, Andhra Pradesh and Orissa. The scheme aims at providing one hectare of irrigable terraced land and one hectare of orchard or forest plantation to each family. Besides, there are provisions for link roads, homesteads as well as for inputs at a sliding rate for three years.

Problems

A few survey shave been made on the success of the schemes under operation, although no detailed and thorough survey has yet been taken up. It is, however, a fact that the schemes have not been as successful as expected. In many instances, the jhumias have either abandoned the new settlements or have carried on jhuming even after been settled.

The primary causes for the failure to attract the jhumias to permanent settlement are:

i. The new settlement cuts into their socio-cultural life abruptly;
ii. They are not used to cultivation on terraces, using bullocks and implements;
iii. They find the production to be low on the terraces in the first year owing to the removal of the top soil while developing the terraces;
iv. The production technologies for terraces, water-management, water-conservation practices, etc. are also not properly developed for the region.

Schlippe (1956) observed in his studies on shifting cultivation in Africa that “the modern civilisation has failed to improve African agriculture because it has proved so far incompatible with the environment of the wet tropics. Agriculture is that sector of human activity in which there is greatest interaction between the environment and the human culture which has grown in and from it.” He has therefore advocated “to find improvement without doing violence to the limiting framework of tradition and environment”.

Majumdar (1971) feels that shifting cultivation in the north-eastern region cannot be avoided for a long time and hence conscientious efforts are needed to improve the productivity of the jhum cultivation and minimize soil erosion. While doing so, he advocates that "an important aspect duly recognised as a crucial strategy for the development is the need to tailor the programmes to the local conditions and values".

Unless the attitude of the jhumias is changed and they are convinced of the need for settled agriculture and terracing, governmental schemes will take many more years to terrace and replant other areas. It would not be desirable to allow the soil and fertility erosion to continue for long periods. Yet, there is no proven technology or message with the development departments to bring about the awareness among the jhumias, because there has been no systematic study of the problems faced by the jhumias particularly with regard to the improvement of agriculture in the environment in which they live. It may be of interest to note here that in the existing system of jhuming, cultivation is done on hill slopes, up to 100% or even more. In fact, in Mizoram, hills are so steep that areas with less than 50% slope are very limited.

The earlier studies on shifting cultivation were made primarily by the anthropologists and economists. May have advocated that this is a way of life and part of their socio-cultural system and hence should not be disturbed. It is, however, high time that we make concerted efforts to change this way of life in order to bring prosperity among the jhumias.

Corrective Measures

A publication by the Food and Agriculture Organization of the United Nations (FAO) suggest that if managed properly, shifting cultivation can be beneficial. As quoted by Frank Sejersen, Chairman of the Board of International Work Group for Indigenous Affairs (IWGIA) "Studies show us how the diverse and dynamic indigenous peoples' livelihood and land use systems are, but they also show that the age-old practice of shifting cultivation, that has been at the core of such systems for centuries, is still misunderstood by policy makers and thus under enormous pressure". Chaturvedi and Uppal (1953) are of the opinion that "the correct approach to the problem of shifting cultivation has in accepting it not as a social evil, but recognising it as a way of life, not condemning it as an evil way of life but regarding it an agricultural practice evolved as a reflex to the physiographic characters of the land."

On June 18 and 19, 1976, a seminar on the socio-economic problem of shifting cultivation in northeast India, organised by the North East India Council (NEIC) for Social Science Research was held at Shillong. The seminar brought out some very significant problems regarding shifting cultivation and suggested a broad based approach at solving the problems. The following are the deliberations made at this gathering:

1) The seminar agreed that shifting cultivation has to be replaced by improved form of land management but the switch over has to be in a phased manner and should be gradual and smooth, causing least disturbance to the people concerned. It is agreed that shifting cultivation is a way of life and as any way of life, is subject to change due to changed circumstances, the way of jhuming is also undergoing changes. However, the forces of change should perfectly enmate from within the society even though the role of state help, particularly in the form of technical and scientific guidance and funds cannot be denied to accelerate the pace of development. The provision of infrastructure for development including roads, credit and marketing facilities will play an important role in bringing about the desired change.
2) While bringing the change from shifting cultivation to settled cultivation there will necessarily come about some changes in the social and land reforms. Special care should be taken so that there is no undesirable social consequence.
3) It is estimated that data on shifting cultivation practices should be collected for a correct interpretation of the situation and suggestion of proper remedies. The authorities should refrain from basing their strategies as far as possible on inadequate information of the subject.
4) Any suggested change in shifting cultivation will have a bearing upon the forest policy. The forest policy may be suitably reformulated with special reference to the north east hill region.
5) The possible impact of the gradual decline in production of the cash crops like cotton and various oil seeds, consequent upon the decline of shifting cultivation upon the national economy should be studied.
6) Horticulture as an alternative and subsidiary occupation may be desirable and feasible provided there is an adequate organisation to cater to the production and marketing needs.
7) Terracing is costly and cannot be immediately resorted to, in many steep hills of north eastern India. However, the soil survey should

help in identifying the areas where it can be undertaken.

8) Immediate action should be taken to identify potential locations by some rapid soil survey technique and photo-interpretation, where the integrated approach for control of shifting cultivation can be tried.
9) The scope of animal husbandry, raising of plantation crops in the hill areas should be further explored.
10) Where settled land management is being introduced, adequate protection measures including shifting cultivation should be adopted. Integrated area development should be supported by effective supply of inputs including seeds, manures, fertilizers, tools, implements etc. as well as by effective follow up programme.
11) But since the switch over from shifting cultivation will take some time, it is necessary to undertake studies meanwhile to improve the farming practices of the jhumiyas, so as to cause minimum soil erosion and loss of soil fertility.
12) The loss and degeneration of flora and fauna as a result of shifting cultivation should be studied in greater details and loss of same from other sources should also be identified and estimated.
13) The seminar has made a strong plea for integrated research on the basic problem connected with the shifting cultivation by scientists of all disciplines including social scientists.

The detailed discussions at the seminar helped to highlight the seriousness of the problem and ways and means to solve it. The above mentioned suggestions/solutions can help overcome the problems of shifting cultivation without effecting tribal people drastically.

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