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Impact of Burning in Winter on Diversity of Ground Flora after Monsoon Period in Mid Altitude Chirpine Zone of Nahan Circle of Himachal Pradesh

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Abstract

The forest fire is common problem in chirpine forest. The controlled burning is practiced in winter to reduce the fuel load on the ground floor of chirpine forests. The research work was conducted in mid altitude zone of chirpine forest in Nahan Circle of Himachal Pradesh Forest Department. The investigation was conducted to study the diversity of ground flora. Two sites i.e. Jamun Ki Ser and Bagthan in Rajgarh Forest Division and one site i.e. Gaunth was selected in Nahan Forest Division. The controlled burning was conducted in 1.5 hectare (B) during 2017 in winter and the area of 0.5 hectare kept as control (C) in all three sites. The observation on phyto-sociological data was recorded to evaluate the impact of control burning on herbs. The number of species ranged from 23 to 25 in burnt site and 20 to 25 in controlled site. The highest value of diversity index (H) was 3.07 at Jamun Ki Ser (B) and lowest value (2.88) at site Gaunth (C). The maximum species richness index (R) was 3.613 at Bagthan (C) and minimum (3.080) at site Jamun Ki Ser (B). The maximum evenness index (E) was 0.972at Gaunth (B) and minimum (0.925) was at Bagthan (C).

Keywords: Ground flora, Phyto-diversity, Controlled Burning and Chirpine forest.

1. Introduction

Forest fire is the fire that occurs outside the agriculture area. The biological origin has been the main reason of the forest fire (Sharma, 2012). Fires are responsible for changes in the terrestrial ecosystem and plays important role in modifying plant community in forests (Knapp *et al*., 2007 and Agee, 1993) affecting the health of the forests by increasing the chances of insects, pests and fungal attack in vegetation. Forest fires not also only destroy the timber but also affect other ecosystem services provided by the forests. It also even cause human and wildlife causalities. The forests fire is main problem in 9/C1a lower or Shivalik Chirpine forest. The controlled burning has been practiced in these forests since long time. Which reduces the vertical and horizontal fuel load and also decreases the chances of crown fire (Bidwell *et al*., 2002). Controlled burning is carried out during winter when lower moisture in the forests (Knapp *et al*., 2007; Kauffman and Martin, 1989 and Knapp *et al.*, 2005) and surface temperature is low, which will also decrease the severity of fire in summer. Prescribed fire or controlled burning or planned burning are helpful to reduce the harmful effect of forest fire and also maintenance of ecosystem resilience. At present there is focus on burning under controlled condition globally (Hiers *et al*., 2020; Fernandes & Botelho, 2003; Ryan *et al*., 2013; Molina-Terren *et al*., 2016). The controlled burning can be used for enhancing tree regeneration, silviculture improvement, range and wildlife habitat management, biodiversity maintenance, control of weeds, insects and diseases (Fernandes & Botelho, 2003; Kilgore & Curtis 1987; Wade & Lunsford, 1989).

There is less information available on role of controlled burning on floristic composition, phytosociology and regeneration of trees and shrubs in chirpine forests. The species database can be utilized for conservation of species and sustainable management of forest. In the present study an attempt has been made to evaluate the effect of controlled burning on phytosociology of ground flora in chir pine forests.

2. Materials and Methods

2.1 Study area

The present investigation was carried out in mid altitude zone between 900-1200m amsl in chirpine forest of Nahan Circle of Himachal Pradesh Forest Department. Total three sites were selected i. e. Jamun Ki Ser and Bagthan in Rajgarh Forest Division and third site Gaunth was selected in Nahan Forest Division. The geo-coordinates and other details have been mentioned in Table-1.Total area of 2 hectare per site was selected in each site. The control has been designated as C and controlled burnt as B in the research experiment.

Table-1: The geo-coordinates and other details of selected study sites in Nahan Circle of HPFD in Himachal Pradesh.

Sr.No.	Name of the site	Name of beat	Name of Forest Range	Geo-coordinate		Elevation (m)
				Latitude (N)	Longitude (E)	
1	Jamun Ki Ser	Jamunki Ser	Sarahan	30˚41′46.5″	077˚10′11.9″	1065
2	Gaunth	Gaonth	Jamta	30˚38′41.2″	077˚16′56.6″	1155
3	Bagthan	Shakor	Sarahan	30˚40′53.8″	077˚17′04.1″	1005

2.2 Controlled burning

Controlled burning was conducted in 1.50 ha during winter in 2017 and control area of 0.5 hectare in three sites was kept where controlled burning was not done.

2.3 Field sampling and data collection

Data was collected on phyto-sociological attributes after monsoon period in 2017 for herbs. Total 40 numbers of quadrats of 1X1 m^2 were laid out in each sampling sites in both treatment i.e. burnt (B) and control (C). The young recruits of trees and shrubs were also included in data collection for phyto-sociological analysis of herbs.

2.4 Data analysis

The phyto-sociological analysis was done by calculating density, frequency, abundance and importance value index (IVI) as per Curtis and Macintosh 1950. IVI is the sum of relative value of density, basal area and frequency. The abundance to frequency ratio was calculated to determine the distribution pattern for different species. The ratio reflect contiguous (<0.050), random (0.025 to 0.050) and regular (> 0.050) distribution (Curtis and Cottom, 1956). Shannon- Wiener diversity index (H) was used to determine the plant diversity (Shannon- Wiener, 1963)

$$H = -1X\sum_{i=1}^{S}(ni/N)\ln(ni/N)$$

$$Cd = \sum_{i=1}^{S}(ni/N)^2$$

Cd= Concentration of dominance (Cd) was determined by Simpson (1949).

Where ni= Importance value of species i and
N= Total importance value of all the species in both the indices.
Richness Index (R) was calculated by using following formula (Margalef, 1958).

$$R = S-1/\ln N$$

Evenness index (E) was determined by using following formula (Hill, 1973)

$$E = H/\ln S,$$

Where, N= total number of individuals of all the species, H= Index of diversity and S= Total number of species.

3. Results

Phytosociologial analysis for three sites has been given in Table 2-6 and mentioned bellow.

Total number of species were 24 in control (C) and burnt (B) at Jamun Ki Ser, whereas it was 20 and 23 at Gaunth in C and B, respectively. At Bagthan the number of species was 25 in C and B, respectively.

3.1 Density (Ind/m^2)

Heteropogon contortus showed highest value for density/m^2 (4.73) in control (C) at Jamun Ki Ser followed by *Chrysopogon montanus* (4.00) and lowest value was observed for *Pinus roxburghii* (0.20) whereas in burnt (B), *Heteropogon contortus* showed highest value for density/m^2 (5.40) followed by *Chrysopogon montanus* (5.03) and lowest value was observed for *Pinus roxburghii* (0.40) at Jamun Ki Ser (Table-2).

Chrysopogon montanus showed highest value for density/m^2 (1.88) in control (C) at Gaunth (Table-2) followed by *Heteropogon contortus* (1.38) and least dominant (0.15) was recorded for *Syzygium cumini*, whereas in burnt (B) *Chrysopogon montanus* (3.30) showed highest value for density/m^2 followed by *Heteropogon contortus* (3.05) and least dominant (0.25) was recorded for *Thalictrum foliolosum* at Gaunth (Table-2).

Heteropogon contortus (3.38) showed highest value for density/m^2 followed by *Chrysopogon montanus* (3.35) and least dominant (0.15) was recorded for *Geranium wallichianum*, *Flacourtia indica* and *Pinus roxburghii* in control (C) at Bagthan. *Heteropogon contortus* (7.80) showed highest value for density/m^2 followed by *Panicum maximum* (7.53) and least dominant (0.15) was recorded for *Mallotus phillipensis* in burnt (B) at Bagthan(Table-2).

Table-2. Density (Ind./m^2) of species within different selected study sites

Sr. No.	Name of species	Jamunkiser		Gaunth		Bagthan	
		C	B	C	B	C	B
1	*Achyranthes aspera* L.				0.73		
2	*Adiantum lunulatum* Burm.f.	0.60	2.28	0.58	0.83	0.30	0.33
3	*Ageratum conyzoides*(L.) L.	1.40	2.05	1.03	0.95	0.40	0.30
4	*Ajuga bracteosa* Wall. exBenth.				0.33	0.35	0.50
5	*Anaphalis triplinervis* (Sims) Sims ex C.B. Clarke	0.55	1.78			0.38	0.38
6	*Bidens pilosa* L.			0.50	1.15		
7	*Carex meiogyna* Nees					1.88	6.28
8	*Carissa carandas* L.**	0.50	1.40	0.18	0.40	0.45	0.63
9	*Cassia tora* Sensuauct.	0.28	1.55	0.35	0.60		
10	*Cheilanthes farinosa* (Forssk.) Kaulf	0.50	1.05			0.40	0.40
11	*Chrysopogon montanus* Trin.	4.00	5.03	1.88	3.30	3.35	6.68
12	*Ciissampelos pareira* L.	0.68	0.63	0.25	0.53	0.38	0.38
13	*Cymbopogon martini* (Roxb.) W. Watson	1.80	4.13				
14	*Dicliptera bupleuroides* Nees	0.90	1.28			0.50	0.55
15	*Digitaria sanguinalis* (L.) Scop.	2.30	3.38				
16	*Dryopteris nigro-paleacea* (Fraser-Jenk.) Fraser-jenk.					0.63	0.45
17	*Emblica officinalis* Gaertn.*			0.18	0.40		
18	*Erigeron vulgaris* Scheele ex Nyman		1.53				
19	*Flacourtia indica* (Burm.f.) Merr.*	0.28			0.48	0.15	0.23
20	*Fragaria vesca* L.	0.58	1.28			0.73	0.48
21	*Galium aparine* L.	0.65	0.88				
22	*Geranium wallichianum* D. Don ex Sweet	0.38	1.28			0.15	0.38
23	*Heteropogon contortus* (L.) P.bewauv. ex. Roem. & Schult.	4.73	5.40	1.38	3.05	3.38	7.80
24	*Hydrocotyl asiatica* L.	0.30				0.63	0.38
25	*Lantana camara* L.**			0.20	0.48	0.65	0.30
26	*Mallotus philippensis* (Lam.) Mull.Arg.*			0.18	0.40	0.20	0.15
27	*Murraya koenigii* (L.) Spreng.**		1.05	0.68	0.85	0.50	0.95
28	*Oxalis corniculata* L.	0.75	0.85	0.63	0.68	0.58	1.28
29	*Panicum maximum* Jacq.	2.25	2.58			2.05	7.53
30	*Parthenium hysterophorus* L.			0.70	1.08		
31	*Pinus roxburghii* Sarg.*	0.20	0.40	0.18	0.43	0.15	0.25
32	*Pyrus pashia* Buch.-Ham. exD.Don*	0.30	0.58	0.23	0.60	0.23	0.25
33	*Solanum* sp.	0.45	2.10	0.23	0.30	0.25	0.38
34	*Syzygium cuminii* (L.) Skeels *			0.15	0.35		
35	*Thalictrum foliolosum*DC.			0.30	0.25		
36	*Viola serpens* Wall. exGing.	0.38	0.90	0.48	0.55	0.55	0.80
37	*Zyziphus mauritiana* Lam.*	0.23	0.48				
		24.95	**43.80**	**10.23**	**18.68**	**19.18**	**37.98**

***Natural regeneration of trees and ** natural regeneration of shrubs**

3.2 Frequency (%)

Maximum frequency % was observed in control (C) at Jamun Ki Ser (Table-3) for *Chrysopogon montanus* (65.00) and *Heteropogon contortus* (65.00) followed by *Panicum maximum* (20.00) and minimum value (5.00) was observed for *Anaphalis triplinervis, Cassia tora, Carissa carandas, Cheilanthes farinosa, Galium aparine, Flacourtia indica, Oxalis corniculata, Hydrocotyl asiatica, Flacourtia indica, Geranium wallichianum, Solanum, Viola serpens* and *Ziziphus mauritiana.* Maximum frequency % was observed for *Chrysopogon montanus* (72.50) and *Heteropogon contortus*(72.50) in burnt (B) at Jamun Ki Ser followed by *Cymbopogon martinii* (65.00) and minimum value (10.00) was observed for *Pinu sroxburghii*.

Maximum frequency % (Table-3) at Gaunth was 22.50 for *Chrysopogon montanus* and *Heteropogon contortus* in control (C) followed by *Ageratum conyzoides* (12.50) and minimum value (5.00) was observed for *Carissa carandas, Cissampelos pareira, Emblica officinalis, Lantana camara, Mallotus phillipensis, Pinus roxburghii, Pyrus pashia* and *Syzygium cuminii*. Whereas in burnt (B), maximum frequency % was 47.50 for *Heteropogon contortus* followed by *Chrysopogon montanus* (45.00) and minimum value (7.50) was observed for *Ajuga bracteosa* and *Thalictrum foliolosum.*

Maximum frequency % at Bagthan was 72.50 for *Chrysopogon montanus* and *Heteropogon contortus* (72.50) in control (C) followed by *Carex meiogyna* (55.00) and minimum value (2.50) was observed for *Geranium wallichianum.* Maximum frequency % at Bagthan was 75.00 for *Panicum maximum* and *Heteropogon contortus* (72.50) in burnt (B) followed by *Carex meiogyna* (70.00) and minimum value (7.50) was observed for *Flacourtia indica, Lantana camara, Mallotus phillipensis, Pinu sroxburghii* and *Pyrus pashia* (Table-3).

3.3 Abundance

Maximum abundance was observed for *Ageratum conyzoides* (18.67) in control (C) at Jamun Ki Ser followed by *Digitaria sanguinalis* (15.33) and minimum value (2.67) was observed for *Pinu sroxburghii*. At Jamun Ki Serin burnt (B) maximum abundance was observed for *Solanum* sp. (10.50) followed by *Cassia tora* (10.33) and minimum value (3.80) was observed for *Ziziphus mauritiana* (Table-4).

Maximum abundance (Table-4) was observed in control (C) at Gaunth for *Parthenium hysterophorus* (9.33) followed by *Murraya koengii*(9.00)and minimum value (3.00) was observed for *Solanum* sp. and *Syzygium cumini* whereas maximum abundance was observed in burnt (B) at Gaunth for *Chrysopogon montanus* (7.33) followed by *Oxalis corniculata* (6.75) and minimum value (3.00) was observed for *Solanum* sp.

Maximum abundance was observed for *Lantana camara* (13.00) in control (C) at Bagthan followed by *Hydrocotyl asiatica* (12.50) and minimum value (3.00) was observed for *Pinus roxburghii*, whereas in burnt (B) at Bagthan maximum abundance was observed for *Heteropogon contortus* (10.76)followed by *Panicum maximum* (10.03) and minimum value (1.63) was observed for *Adiantum lunulatum* (Table-4).

3.4 Importance Value Index (IVI)

Heteropogon contortus (42.68) was dominant species in control (C) followed by *Chrysopogon montanus* (40.51) and least dominant was *Anaphalis triplinervis* (5.34). *Heteropogon contortus* (26.82) was dominant species in burnt (B) at Jamun Ki Ser followed by *Chrysopogon montanus* (25.63) and least dominant was *Ziziphus mauritiana* (4.05) (Table-5).

Chrysopogon montanus (37.27) was dominant species on the basis of IVI (Table-5) in control (C) at Gaunth followed by *Heteropogon contortus* (29.60) and least dominant (7.25) was *Lantana camara. Chrysopogon montanus*(32.41) was dominant species in burnt (B) at Gaunth followed by *Heteropogon contortus*(30.02) and least dominant (6.68) was *Flacourtia indica*.

Heteropogon contortus (39.24) was dominant species in control (C) at Bagthan followed by *Chrysopogon montanus* (38.41) and least dominant (3.35) was recorded for *Geranium wallichianum*. *Heteropogon contortus* (33.73) was dominant species in burnt (B) at Bagthan followed by *Panicum maximum* (33.30) and least dominant (4.86) was *Pinus roxburghii* (Table-5).

Table-3. Frequency per cent of species within different selected study sites

Sr. No.	Name of species	Jamunkiser		Gaunth		Bagthan	
		C	B	C	B	C	B
1	*Achyranthes aspera* L.				22.50		
2	*Adiantum lunulatum* Burm.f.	5.00	25.00	10.00	15.00	5.00	20.00
3	*Ageratum conyzoides* (L.) L.	7.50	22.50	12.50	15.00	5.00	15.00
4	*Ajuga bracteosa* Wall. exBenth.				7.50	5.00	12.50
5	*Anaphalis triplinervis* (Sims) Sims ex C.B. Clarke	5.00	20.00			5.00	15.00
6	*Bidens pilosa* L.			10.00	20.00		
7	*Carex meiogyna* Nees					55.00	70.00
8	*Carissa carandas* L.**	5.00	20.00	5.00	10.00	5.00	17.50
9	*Cassia tora* Sensuauct.	5.00	15.00	7.50	15.00		
10	*Cheilanthes farinosa* (Forssk.) Kaulf	5.00	15.00			5.00	12.50
11	*Chrysopogon montanus* Trin.	65.00	72.50	22.50	45.00	72.50	67.50
12	*Ciissampelos pareira* L.	7.50	12.50	5.00	12.50	5.00	12.50
13	*Cymbopogon martini* (Roxb.) W. Watson	17.50	65.00				
14	*Dicliptera bupleuroides* Nees	7.50	15.00			7.50	15.00
15	*Digitaria sanguinalis* (L.) Scop.	15.00	60.00				
16	*Dryopteris nigro-paleacea* (Fraser-Jenk.) Fraser-jenk.					7.50	12.50
17	*Emblica officinalis* Gaertn.*			5.00	12.50		
18	*Erigeron vulgaris* Scheele ex Nyman		17.50				
19	*Flacourti aindica* (Burm.f.) Merr.*	5.00			10.00	5.00	7.50
20	*Fragaria vesca* L.	5.00	15.00			7.50	15.00
21	*Galium aparine* L.	5.00	17.50				
22	*Geranium wallichianum* D.Don ex Sweet	5.00	15.00			2.50	12.50
23	*Heteropogon contortus* (L.) P.bewauv. ex. Roem. &Schult.	65.00	72.50	22.50	47.50	72.50	72.50
24	*Hydrocotyl asiatica* L.	5.00				5.00	12.50
25	*Lantana camara* L.**			5.00	10.00	5.00	7.50
26	*Mallotus philippensis* (Lam.) Mull.Arg.*			5.00	10.00	5.00	7.50
27	*Murraya koenigii* (L.) Spreng.**		15.00	7.50	15.00	7.50	15.00
28	*Oxalis corniculata* L.	5.00	12.50	7.50	10.00	7.50	22.50
29	*Panicum maximum* Jacq.	20.00	62.50			50.00	75.00
30	*Parthenium hysterophorus* L.			7.50	17.50		
31	*Pinus roxburghii* Sarg.*	7.50	10.00	5.00	12.50	5.00	7.50
32	*Pyrus pashia* Buch.-Ham.exD.Don*	7.50	15.00	5.00	12.50	5.00	7.50
33	*Solanum* sp.	5.00	20.00	7.50	10.00	5.00	12.50
34	*Syzygium cuminii* (L.) Skeels *			5.00	10.00		
35	*Thalictrum foliolosum* DC.			7.50	7.50		
36	*Viola serpens* Wall. exGing.	5.00	15.00	7.50	12.50	7.50	20.00
37	*Zyziphus mauritiana* Lam.*	5.00	12.50				

***Natural regeneration of trees and ** natural regeneration of shrubs**

Table-4. Abundance of species within different selected study sites

Sr. No.	Name of species	Jamunkiser		Gaunth		Bagthan	
		C	B	C	B	C	B
1	*Achyranthes aspera* L.				3.22		
2	*Adiantum lunulatum* Burm.f.	12.00	9.10	5.75	5.50	6.00	1.63
3	*Ageratum conyzoides*(L.) L.	18.67	9.11	8.20	6.33	8.00	2.00
4	*Ajuga bracteosa* Wall. ex Benth.				4.33	7.00	4.00
5	*Anaphalis triplinervis* (Sims) Sims ex C.B. Clarke	11.00	8.88			7.50	2.50
6	*Bidens pilosa* L.			5.00	5.75		
7	*Carex meiogyna*Nees					3.41	8.96
8	*Carissa carandas* L.**	10.00	7.00	3.50	4.00	9.00	3.57
9	*Cassia tora* Sensuauct.	5.50	10.33	4.67	4.00		
10	*Cheilanthes farinose* (Forssk.) Kaulf	10.00	7.00			8.00	3.20
11	*Chrysopogon montanus* Trin.	6.15	6.93	8.33	7.33	4.62	9.89
12	*Ciissampelos pareira* L.	9.00	5.00	5.00	4.20	7.50	3.00
13	*Cymbopogon martini* (Roxb.) W. Watson	10.29	6.35				
14	*Dicliptera bupleuroides* Nees	12.00	8.50			6.67	3.67
15	*Digitaria sanguinalis* (L.) Scop.	15.33	5.63				
16	*Dryopteris nigro- paleacea* (Fraser-Jenk.) Fraser-jenk.					8.33	3.60
17	*Emblica officinalis* Gaertn.*			3.50	3.20		
18	*Erigeron vulgaris* Scheele ex Nyman		8.71				
19	*Flacourtia indica* (Burm.f.) Merr.*	5.50			4.75	3.00	3.00
20	*Fragaria vesca* L.	11.50	8.50			9.67	3.17
21	*Galiuma parine* L.	13.00	5.00				
22	*Geranium wallichianum* D.Don ex Sweet	7.50	8.50			6.00	3.00
23	*Heteropogon contortus* (L.) P.bewauv. ex. Roem. &Schult.	7.27	7.45	6.11	6.42	4.66	10.76
24	*Hydrocotyl asiatica* L.	6.00				12.50	3.00
25	*Lantana camara* L.**			4.00	4.75	13.00	4.00
26	*Mallotu sphilippensis* (Lam.) Mull.Arg.*			3.50	4.00	4.00	2.00
27	*Murraya koenigii* (L.) Spreng.**		7.00	9.00	5.67	6.67	6.33
28	*Oxalis corniculata* L.	15.00	6.80	8.33	6.75	7.67	5.67
29	*Panicum maximum* Jacq.	11.25	4.12			4.10	10.03
30	*Parthenium hysterophorus* L.			9.33	6.14		
31	*Pinus roxburghii* Sarg.*	2.67	4.00	3.50	3.40	3.00	3.33
32	*Pyrus pashia* Buch.-Ham.exD.Don*	4.00	3.83	4.50	4.80	4.50	3.33
33	*Solanum* sp.	9.00	10.50	3.00	3.00	5.00	3.00
34	*Syzygium cuminii* (L.) Skeels *			3.00	3.50		
35	*Thalictrumf oliolosum* DC.			4.00	3.33		
36	*Viola serpens* Wall. exGing.	7.50	6.00	6.33	4.40	7.33	4.00
37	*Zyziphus mauritiana* Lam.*	4.50	3.80				

***Natural regeneration of trees and ** natural regeneration of shrubs**

Table-5. Importance Value Index (IVI) of species within different selected study sites

Sr. No.	Name of species	Jamunkiser		Gaunth		Bagthan	
		C	B	C	B	C	B
1	*Achyranthes aspera* L.				14.22		
2	*Adiantum lunulatum* Burm.f.	13.49	15.86	17.45	14.75	8.01	10.57
3	*Ageratum conyzoides* (L.) L.	12.32	12.03	28.38	13.38	10.37	8.18
4	*Ajuga bracteosa* Wall. exBenth.				9.13	7.63	7.83
5	*Anaphalis triplinervis* (Sims) Sims ex C.B. Clarke	5.34	11.67			9.70	8.38
6	*Biden spilosa* L.			13.12	13.28		
7	*Carex meiogyna* Nees					26.49	29.24
8	*Carissa carandas* L.**	7.48	13.08	7.57	7.33	5.43	6.66
9	*Cassia tora* Sensuauct.	6.91	11.57	10.22	8.76		
10	*Cheilanthes farinose* (Forssk.) Kaulf	9.95	9.00			9.57	10.67
11	*Chrysopogon montanus* Trin.	40.51	25.63	37.27	32.41	38.41	29.97
12	*Ciissampelo spareira* L.	14.20	11.41	12.75	11.21	8.16	7.94
13	*Cymbopogon martini* (Roxb.) W. Watson	14.53	20.50				
14	*Dicliptera bupleuroides* Nees	9.94	9.75			6.37	8.89
15	*Digitaria sanguinalis* (L.) Scop.	15.72	20.89				
16	*Dryopteris nigro-paleacea* (Fraser-Jenk.) Fraser-Jenk.					7.22	8.55
17	*Emblica officinalis* Gaertn.*			14.60	9.74		
18	*Erigeron vulgaris* Scheele ex Nyman		10.44				
19	*Flacourtia indica* (Burm.f.) Merr.*	6.95			6.68	3.83	6.75
20	*Fragaria vesca* L.	11.22	8.21			7.54	8.78
21	*Galiuma parine* L.	5.70	10.41				
22	*Geranium wallichianum* D.Don ex Sweet	9.44	9.71			3.35	7.89
23	*Heteropogon contortus* (L.) P.bewauv. ex. Roem. &Schult.	42.68	26.82	29.60	30.02	39.24	33.73
24	*Hydrocotyl asiatica* L.	7.09				12.34	8.07
25	*Lantana camara* L.**			7.25	14.72	10.72	6.42
26	*Mallotus philippensis* (Lam.) Mull.Arg.*			11.29	10.62	10.12	6.07
27	*Murraya koenigii* (L.) Spreng.**		9.03	17.52	10.28	10.16	10.03
28	*Oxalis corniculata* L.	11.48	7.43	14.93	12.55	5.55	8.99
29	*Panicum maximum* Jacq.	17.22	18.86			25.53	33.30
30	*Parthenium hysterophorus* L.			13.76	16.55		
31	*Pinus roxburghii* Sarg.*	8.66	5.41	9.06	11.91	8.11	4.86
32	*Pyrus pashia* Buch.-Ham.exD.Don*	12.64	8.15	7.65	10.81	5.53	8.31
33	*Solanum* sp.	5.51	14.72	13.98	11.87	10.38	7.94
34	*Syzygium cuminii* (L.) Skeels *			7.33	10.13		
35	*Thalictrum foliolosum* DC.			9.85	9.13		
36	*Viola serpens* Wall. exGing.	5.43	5.39	16.42	10.54	10.23	11.98
37	*Zyziphus mauritiana* Lam.*	5.58	4.05				
	Total	**300.00**	**300.00**	**300.00**	**300.00**	**300.00**	**300.00**

***Natural regeneration of trees and ** natural regeneration of shrubs**

3.5 Diversity Indices

3.5.1 Distribution pattern of species:

The contiguous distribution pattern for all the species was recorded as per the ratio of A/F for herbs in control as well as burnt in all the sites

3.5.2 Concentration of Dominance (Cd)

The maximum value of concentration of dominance (Cd) was 0.065 at Bagthan and minimum was 0.051 at Jamun Kiserin control whereas in B, highest was 0.061at Bagthan and lowest was 0.051 at Jamun Ki Ser (Table-6).

3.5.3 Diversity index (H)

The highest value of diversity index (H) was 3.07 in B at Jamun Ki Ser followed by 3.05 at Gaunth in B and lowest was 2.88 in C at Gaunth (Table-6).

3.5.4 Species richness index (R)

The species richness index (R) was maximum (3.613) in C at Jamun Ki Ser followed by 3.325 in B at Gaunth and minimum (3.080) in Bat Jamun Ki Ser (Table-6).

3.5.5 Evenness index (E)

The evenness index (E) was highest (0.972) in B at Gaunth followed by Jamun Ki Ser (0.966) in B and lowest was 0.934 in C at Bagthan (Table-6).

Table-6: Concentration of dominance (Cd), diversity index (H), richness index (R) and evenness index (E) of different selected study sites.

S.No.	Name of Site	Concentration of dominance (Cd)		Diversity index (H)		Richness index (R)		Evenness index (E)	
		C	B	C	B	C	B	C	B
1	Jamun Ki Ser	0.051	0.051	2.97	3.07	3.331	3.080	0.934	0.966
2	Gaunth	0.053	0.053	2.88	3.05	3.159	3.325	0.960	0.972
3	Bagthan	0.065	0.061	2.98	3.02	3.613	3.276	0.925	0.937
	Mean	0.056	0.055	2.943	3.05	3.418	3.227	0.936	0.958

4. Discussion

The knowledge on impact of controlled burning on the plant succession is important for management of vegetation in fire prone area. It is also matter of scientific interest. The behavior of ground flora after burning season is complex and survival of plants depend upon the quantity of fuel consumed and season (Knapp *et al*., 2007; Kauffman and Martin, 1990; Main and Barry, 2002, Sparks *et al*., 1998 and Hiers *et al*., 2000). It was found variation in number of species in control and burnt areas in each sites. Total number of species varies from 20 to 25 in C and whereas 23 to 25 in B. Total number of species in all the three sites were 36 in C and 38 in B. The fire changes composition of species, structure and function in vegetation type in various landscapes in the world (Flannigan et al., 2009).The changes in species composition have also been reported by Hutichinson *et al*. (2005). Total density/m^2 ranged from 10.23 to 24.95in C and 18.68 to 43.80 in B. The density/m^2 was higher in B as compared to C. The abundance of species also varied from site to site which also depend upon the micro-site conditions and reproduction mean of species which may be responsible for changes in composition of species and richness. The herbs may also be benefitted because of minor increase in availability of light (Hutichinson *et al*., 2005 and Sparling, 1967) and less competition among species in community. The commonest pattern of distribution of plants in nature is contiguous in the nature. The concentration of dominance (Cd) was lower in B as compare to C which indicate that diversity was higher in Bin all sites. The diversity index (H) was higher in B as compare to C. The diversity has also been enhanced with increasing shrub free area created by burning (Greenberg, 2003; Johnson & Abrahmson, 1990; Hawkes & Menges, 1996 and Young &Menges, 1999).The various authors has reported variable effects of burning on herbs (Hutchinson *et al*., 2005; MeGee *et al*., 1995; Ducey *et al*., 1996; Arthur *et al*., 1998 and Franklin *et al*., 2003).There is change in species richness afterburning treatment which is reported by various researchers (Knapp *et al*., 2007; Brockway and Lewis, 1997; and Spark's *et al*., 1998). The richness of species in any site depends upon diversity, seasonal variation, edaphic factors and anthropogenic disturbances.

Conclusion

Total 37 species belonging to 37 genera and 27 families were recorded in all three sites. The controlled burning increased the density and diversity of the herbs after monsoon period.

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