

Supplementary Data

Table S1. Indices of phytosociological attributes for fifty plant species in the four clusters of *X. strumarium* dominated communities. Values are means (mean importance values (\pm SE) of the importance values obtained from the relative scores of frequency, density and cover data. The symbol (hyphen –) refer to species absent in a particular group.

S. No	Plant Name	Group I	Group II	Group III	Group IV	Overall
1	<i>Xanthium strumarium</i> L.	39.76\pm1.42	45.48\pm0.94	47.05\pm2.30	50.93\pm3.00	45.33\pm0.98
2	<i>Cannabis sativa</i> L.	12.94\pm1.14	12.37\pm0.74	3.01 \pm 0.99	18.22\pm3.01	11.89\pm0.96
3	<i>Parthenium hysterosporus</i> L.	6.15\pm1.05	13.61\pm0.88	2.89 \pm 1.18	2.56 \pm 1.05	7.91\pm0.88
4	<i>Datura innoxia</i> L.	1.04 \pm 0.02	-	4.63\pm1.61	9.78\pm3.07	5.14\pm0.90
5	<i>Sanchus asper</i> L.	0.37 \pm 0.37	0.93 \pm 0.45	-	0.82 \pm 0.82	0.60 \pm 0.24
6	<i>Verbascum thapsus</i> L.	-	0.18 \pm 0.18	-	5.29\pm2.15	0.94 \pm 0.44
7	<i>Erigeron canadensis</i> (L.) Cronq.	1.55 \pm 0.64	1.65 \pm 0.95	1.66 \pm 1.15	-	1.30 \pm 0.45
8	<i>Capsella bursaa pestoris</i> (L.) Medik	-	1.61 \pm 0.78	-	-	0.62 \pm 0.31
9	<i>Trifolium repens</i> L.	-	2.64 \pm 1.11	-	-	1.05 \pm 0.47
10	<i>Calotropis procera</i> (Aiton) W.T.Aiton	0.33 \pm 0.33	0.60 \pm 0.41	-	1.16 \pm 1.16	0.52 \pm 0.27
11	<i>Chenopodium album</i> L.	7.22\pm1.36	4.66\pm0.98	2.68 \pm 1.12		4.11\pm0.65
12	<i>Amaranthus viridis</i> L.	4.43 \pm 1.78	3.71 \pm 0.76	2.31 \pm 1.02	1.12 \pm 0.73	3.18 \pm 0.58
13	<i>Lipidium sativa</i> L.	-	0.77 \pm 0.42	0.89 \pm 0.58	1.42 \pm 1.42	0.72 \pm 0.31
14	<i>Persicaria maculosa</i> S.F.Gray	0.87 \pm 0.87	3.61 \pm 1.09	2.30 \pm 1.59	-	2.07 \pm 0.58
15	<i>Justicia adhatoda</i> L.	-	0.59 \pm 0.59	-	1.26 \pm 1.26	0.47 \pm 0.33
16	<i>Taraxicum officinale</i> Weber	0.67 \pm 0.67	0.77 \pm 0.54	-	0.60 \pm 0.60	0.58 \pm 0.28
17	<i>Brassica campestris</i> L.	-	-	1.88 \pm 1.09	0.54 \pm 0.54	0.43 \pm 0.23
18	<i>Eclipta alba</i> L.	-	0.43 \pm 0.43	0.71 \pm 0.71	-	0.30 \pm 0.21
19	<i>Alternanthera pungens</i> Kunth	1.46 \pm 0.87	0.60 \pm 0.33	0.49 \pm 0.49	-	0.68 \pm 0.26
20	<i>Eryngium coereculum</i> M-Bieb.	-	-	1.38 \pm 1.01	-	0.24 \pm 0.18
21	<i>Amarathus spinosus</i> L.	-	-	1.26 \pm 0.83	-	0.23 \pm 0.16
22	<i>Dysphania ambrosioides</i> L.	0.35 \pm 0.35	0.19 \pm 0.19	2.69 \pm 1.54	-	0.64 \pm 0.31
23	<i>Chrozophora tinctoria</i> (L.) Raf.	-	-	1.09 \pm 0.72	-	0.19 \pm 0.13
24	<i>Tribulus terrestris</i> L.	2.18 \pm 1.72	-	0.28 \pm 0.28	-	0.58 \pm 0.43
25	<i>Polygonum aviculare</i> L.	-	-	0.46 \pm 0.46	-	0.083 \pm 0.083
26	<i>Heliotropium curassavicum</i> L.	1.03 \pm 1.03	-	0.29 \pm 0.29	-	0.30 \pm 0.25

27	<i>Helianthus annuus</i> L.	0.26±0.26	-	-	-	0.064±0.064
28	<i>Mirabilis jalapa</i> L.	1.14±1.14	0.28±0.28	-	-	0.39±0.29
29	<i>Centaurea cyanus</i> L.	0.73±0.73	-	-	-	0.17±0.17
30	<i>Tagetes erectus</i> L.	-	-	4.08±3.02	-	0.72±0.56
31	<i>Carthamus oxycantha</i> Bieb	2.03±0.87	0.28±0.28	5.15±2.27	0.55±0.55	1.62±0.53
32	<i>Cirsium arvense</i> (L.) Scop.	-	-	1.39±0.93	-	0.24±0.17
33	<i>Utrica dioica</i> L.	-	0.47±0.32	-	-	0.18±0.13
34	<i>Oxalis corniculata</i> L.	-	0.18±0.18	-	-	0.073±0.07
35	<i>Zea mays</i> L.	-	0.21±0.21	-	-	0.087±0.087
36	<i>Silybum marianum</i> (L.) Geartn	3.90±1.29	0.45±0.45	4.80±2.39	0.46±0.46	2.073±0.61
37	<i>Cyprus rotundus</i> L.	-	0.83±0.41	-	0.33±0.33	0.39±0.18
38	<i>Echornia cresipes</i> (Mart.) Solma in DC	0.81±0.81	-	-	-	0.20±0.20
39	<i>Brossentia papyrifera</i> (L.) L'Herit. ex Vent	1.00±0.68	-	0.33±0.33	-	0.30±0.18
40	<i>Cucurbita pepo</i> L.	0.41±0.41	-	-	-	0.10±0.10
41	<i>Solanum nigrum</i> L	0.62±0.42	-	0.45±0.45	0.44±0.44	0.31±0.15
42	<i>Trianthema portulacastrum</i> L.	0.46±0.46	-	-	-	0.11±0.11
43	<i>Prosopis julifolia</i> (Sw.) DC.	-	0.32±0.32	-	-	0.12±0.12
44	<i>Mentha longifolia</i> L.	-	0.34±0.34	-	-	0.13±0.13
45	<i>Acacia nilotica</i> Willd.	-	0.29±0.29	0.57±0.67	-	0.22±0.15
46	<i>Physalis minima</i> L.	0.73±0.49	-	-	-	0.18±0.12
47	<i>Cassia occidentalis</i> L.	0.73±0.49	-	-	-	0.18±0.12
48	<i>Achyranthus aspera</i> L.	0.51±0.51	-	-	-	0.12±0.12
49	<i>cynodon dactylon</i> (L.) Pers.	6.36±1.70	2.07±0.82	-	2.11±1,04	3.74±0.70
50	<i>Tagetes minuta</i> L.	-	-	-	2.98±2.98	0.53±0.53

Table S2: Taxonomic, ecological and phyto-geographical details of plant species associated with *X. strumarium* in Khyber Pakhtunkhwa, Pakistan.

S.No	SC	Plant Name	Local Name	English name	H	sp	F	M/D	L	NC
1	XaSt	<i>Xanthium strumarium</i> L.	Geshke/Jeshke/ Ghana	Clothbur/ Cocklebur	A	I	Ast	D	H	NA
2	CaSt	<i>Cannabis sativa</i> L.	Bhang / Merijwana	Hemp	A	I	Can	D	H	CA
3	PaHy	<i>Parthenium hysterosporus</i> L.	Carrot grass/ Gandhi booti	White top/ Congress grass	A	I	Ast	D	H	NCA
4	DM	<i>Datura innoxia</i> L.	Dhatura	Thorn apple	A/B	I	Sol	D	H	CUSA
5	SA	<i>Sonchus asper</i> (L.) Hill	Shawda pae	Prickly Sow Thistle	A	I	Ast	D	H	E
6	VT	<i>Verbascum thapsus</i> L.	Khar Gwag	Jangli Tamak/ Sfaid bhang	B	N	Scrop	D	H	ES
7	EC	<i>Erigeron canadensis</i> (L.) Cronq.	Maloch	horseweed/butterweed	A	N	Ast	D	H	CAN
8	CBP	<i>Capsella bursaa pectoris</i> (L.) Medik	Bambaisa/Bibi Painsa	shepherd's purse	A	I	Br	D	H	E
9	TR	<i>Trifolium repens</i> L.	Shawtal/Shaftal	white clover/Dutch clover	P	I	Fab	D	H	E
10	CP	<i>Calotropis procera</i> (Aiton) W.T.Aiton	Spalmai	apple of Sodom/ rubber bush	P	N	Ap	D	S	A
11	ChAl	<i>Chenopodium album</i> L.	Sarme	goose foot	A	N	Am	D	H	EA
12	AV	<i>Amaranthus viridis</i> L.	Chalwaye	green amaranth	A	I	Am	D	H	SA
13	LS	<i>Lipidium sativa</i> L.	Cress	garden cress	A	Cl	Br	D	H	EWA
14	PM	<i>Persicaria maculosa</i> S.F.Gray	Soor Palpulak	lady's thumb	A	N	Poly	D	H	AE
15	JA	<i>Justicia adhatoda</i> L.	Baikarh	Malabar nut/adulsa	P	N	Ac	D	H	P
16	TO	<i>Taraxicum officinale</i> Weber	Peryan dolae/boda bodai	common dandelion	P	Nt	Ast	D	H	E
17	BC	<i>Brassica campestris</i> L.	Sharhsham/Sarson	Mustard	A	I	Br	D	H	E
18	EA	<i>Eclipta alba</i> L.	----	false daisy	P	I	Ast	D	H	SA
19	AP	<i>Alternanthera pungens</i> Kunth	Khaki Boti	Joyweed	A	I	Am	D	H	TA
20	EC	<i>Eryngium coereculum</i> M-Bieb.	Manzari panja	eryngo/amethyst sea holly	A/P	N	Ap	D	H	TA
21	AS	<i>Amarathus spinosus</i> L.	Ganharh	spiny pigweed/prickly amaranth	A	I	Am	D	H	SA
22	DA	<i>Dysphania ambrosioides</i> L.	Binnakai	worm seed/ Maxican tea	A/P	N	Am	D	H	CA/ SA
23	CT	<i>Chrozophora tinctoria</i> (L.) Raf.	-----	dye's croton/turnsole	A/P	N	Eup	D	H/S	I/Pk/ CA
24	TT	<i>Tribulus terrestris</i> L.	Markundai	cat's-head/devil's eyelashes	A	Nt	Zyg	D	H	Pt
25	PA	<i>Polygonum aviculare</i> L.	Bandakai	prostrate knotweed	A	N	Poly	D	H	ErNA
26	HC	<i>Heliotropium curassavicum</i> L.	Wasnal	salt heliotrope	P	Nt	B	D	H	SA
27	HA	<i>Helianthus annus</i> L.	Nwar paras	Sun flower	P	C	Ast	D	H	NA
28	MJ	<i>Mirabilis jalapa</i> L.	Gul bada	Japanese 4 'o' clock	P	Nt	Nyc	D	H	SA
29	CeC	<i>Centaurea cyanus</i> L.	Gul Tokna/Neeli Botle	cornflower/bachelor's button	A	Nt	Ast	D	H	E

30	TE	<i>Tagetes erectus</i> L.	Damber gwle/ Hmesha	Mexican marigold	A	Cl	Ast	D	H	SA
31	CO	<i>Carthamus oxycantha</i> Bieb	Kareza/Pohli	distaff thistles	A	Nt	Ast	D	H	Er
32	CA	<i>Cirsium arvense</i> (L.) Scop.	Kandai	creeping thistle	P	N	Ast	D	H	E/NA
33	UD	<i>Urtica dioica</i> L.	Sezonki/Jalbang	common/stinging nettle	P	N	Urt	D	H	E
34	OC	<i>Oxalis corniculata</i> L.	Taroke/Manzaken	yellow sorrel/sleeping beauty	P	Nt	Oxal	D	H	E
35	ZM	<i>Zea mays</i> L.	Jwar	Maiz	A	Cl	P	M	S	SA
36	SM	<i>Silybum marianum</i> (L.) Geartn	Wrojakai	Milk thistle/Mary thistle	A	I	Ast	D	H	E
37	CR	<i>Cyprus rotundus</i> L.	Wakha	Java grass/purple nut sedge	P	I	Cyp	M	H	Pt
38	EC	<i>Eichornia crsipes</i> (Mart.) Solma in DC	gul-e-bakauli	common water hyacinth	P	I	Pont	M	H	SA
39	BP	<i>Brossentia papyrifera</i> (L.) L'Herit. ex Vent	Gul toot	Paper mulberry	P	I	M	D	T	SEA
40	CP	<i>Cucurbita pepo</i> L.	Kadu	Pumpkin	A	Cl	Cuc	D	V	SA
41	SN	<i>Solanum nigrum</i> L.	Kachmcho	Black nightshade	A	Nt	Sol	D	H	M
42	TP	<i>Trianthema portulacastrum</i> L.	-----	black/giant pigweed	A	I	Aiz	D	H	TA
43	PJ	<i>Prosopis julifolia</i> (Sw.) DC.	Kabali kekar	Aippia	P	I	Fab	D	S/T	N/SA
44	ML	<i>Mentha longifolia</i> L.	Wenale	horse mint	P	Cl	Lam	D	H	E
45	AN	<i>Acacia nilotica</i> Willd.	Kekar	gum arabic tree/babul	P	Nt	Fab	D	T	M
46	PM	<i>Physalis minima</i> L.	Mangote	gooseberry/wild cape	A	N	Sol	D	H	A/Np
47	CA	<i>Cassia occidentalis</i> L.	Kasondi	septic weed/coffee senna	A	I	Caes	D	S	SA
48	AA	<i>Achyranthus aspera</i> L.	Jishkay	chaff-prickly/chaff flower	A	N	Am	D	H	SA
49	CD	<i>Cynodon dactylon</i> (L.) Pers.	Kabal	Grass/og's tooth grass	P	N	P	M	H	Pt
50	TM	<i>Tagetes minuta</i> L.	Hamesha	wild marigold/black mint	A	I	Ast	D	H	A

Note: H: Habit, A: Annual, B: Biennial, P: Perennial, SP: Status in Pakistan, I: Invasive, Nt: Naturalized, N: Native, C: Casual, Cl: Cultivated, F: Family, Ast: Asteraceae, Can: Cannabaceae, Sol: Solanaceae, Scrop: Scrophulariaceae, Fab: Fabaceae, Br: Brassicaceae, Ap: Apocyanaceae, Am: Amaranthaceae, Pol: Polygonaceae, Ac: Acanthaceae, Ap: Apiaceae, Eup: Euhorbiaceae, Zyg: Zygophyllaceae, Oxal: Oxalidaceae, P: Poaceae, Cyp: Cypereaceae, Pont: Pontederiaceae, M: Moraceae, Cuc: Cucurbitaceae, Aiz: Aizoaceae, Lam: Lamiaceae, Caes: Caesalpinaceae, NC: Native Country, NA: North America, CA: Central Asia, NCA: North Central America, CUSA: Central United State of America, E: Europ, Er: Euroasia, CAN: Central and North America, A: Africa, EA: Eastern Asia, SA: South America, EWA: Egypt and Western Asia, AE: Asia and Europ, P: Panama, TA: Tropical America, CA/SA: Central America/South America, I/Pk/CA: India/Pakistan/Central Asia, Pt: Panetropical, ErNA: Euroasia and North America, E/NA: Europ/ North Asia, SEA: South East Asia, M: Midterrenian, Afg/Np: Afghanistan/Nepal.

Table S3. Correlation coefficients among different environmental variables influencing the distribution of *X. strumarium* in Khyber Pakhtunkhwa, Pakistan.

	Elev	N°	E°	AA	Cl%	Si%	Sa%	P1:5	OM%	OC%	L %	TC%	N	P	K	EC
Elev	1															
N°	0.17	1.00														
E°	0.54	-0.09	1.00													
AA	-0.05	-0.06	0.01	1.00												
Cl%	0.17	-0.09	0.20	0.12	1.00											
Si%	-0.31	-0.09	-0.08	-0.06	-0.47	1.00										
Sa%	0.22	0.17	-0.07	-0.02	-0.22	-0.76	1.00									
P1:5	0.06	-0.40	0.13	-0.05	0.28	-0.23	0.05	1.00								
OM%	0.49	0.10	0.36	0.08	0.43	-0.32	0.03	0.08	1.00							
OC%	0.49	0.10	0.36	0.08	0.43	-0.32	0.03	0.08	1.00	1.00						
L %	-0.48	-0.02	-0.04	-0.24	-0.27	0.60	-0.46	-0.17	-0.27	-0.27	1.00					
TC%	0.49	0.10	0.36	0.08	0.43	-0.32	0.03	0.08	1.00	1.00	-0.27	1.00				
N	0.35	0.14	0.05	0.27	0.06	-0.22	0.19	0.04	0.39	0.39	-0.22	0.39	1.00			
P	0.16	0.28	-0.03	-0.27	-0.07	-0.09	0.15	-0.05	0.05	0.05	-0.09	0.05	0.10	1.00		
K	-0.20	0.24	0.14	0.05	-0.02	0.17	-0.16	-0.03	-0.13	-0.13	0.29	-0.13	-0.01	0.25	1.00	
EC	0.29	0.15	0.08	-0.09	0.01	0.10	-0.13	0.03	0.10	0.10	-0.12	0.10	0.31	0.36	0.13	1.00
TDS	0.29	0.15	0.08	-0.09	0.01	0.10	-0.13	0.03	0.10	0.10	-0.12	0.10	0.31	0.36	0.13	1.00
WP	0.17	-0.10	0.21	0.10	0.99	-0.47	-0.21	0.29	0.42	0.42	-0.24	0.42	0.06	-0.05	-0.02	0.02
FC	0.03	-0.16	0.20	0.07	0.89	-0.03	-0.63	0.21	0.32	0.32	0.02	0.32	-0.04	-0.12	0.06	0.06
D	-0.05	0.12	-0.15	-0.15	-0.91	0.10	0.56	-0.22	-0.35	-0.35	0.09	-0.35	0.01	0.13	-0.03	-0.07
SP	0.05	-0.12	0.15	0.15	0.90	-0.10	-0.56	0.22	0.35	0.35	-0.09	0.35	-0.01	-0.13	0.03	0.07
AW	-0.31	-0.16	-0.03	-0.03	-0.20	0.95	-0.90	-0.14	-0.22	-0.22	0.59	-0.22	-0.25	-0.18	0.14	0.07
XaSt (IVI)	0.25	-0.04	0.15	-0.07	0.00	0.19	-0.21	0.16	0.08	0.08	-0.21	0.08	-0.06	-0.02	-0.04	0.05
XaSt(D/Ha)	0.28	0.02	-0.09	0.00	-0.04	-0.19	0.24	0.03	0.30	0.30	-0.43	0.30	0.04	0.18	-0.16	0.05
XaSt(A.D)	0.25	0.08	-0.20	-0.07	-0.04	-0.07	0.10	0.15	0.04	0.04	-0.37	0.04	-0.12	-0.03	-0.25	0.05
XaSt(C/Ha)	0.00	-0.28	-0.08	-0.02	-0.09	0.02	0.04	0.02	0.08	0.08	-0.30	0.08	-0.03	0.12	0.01	-0.07
XaSt (A.C)	0.06	-0.08	-0.22	-0.10	-0.11	0.09	-0.02	0.09	-0.07	-0.07	-0.26	-0.07	-0.17	-0.04	-0.14	-0.07
XaSt(V/Ha)	-0.10	-0.28	-0.02	-0.02	0.01	0.04	-0.05	-0.04	0.10	0.10	-0.06	0.10	-0.07	-0.05	-0.01	-0.15
XaSt(A.V)	-0.03	-0.14	-0.20	-0.12	-0.12	0.19	-0.12	0.01	-0.09	-0.09	-0.12	-0.09	-0.17	-0.10	-0.07	-0.20
(H/)	-0.39	-0.23	-0.21	-0.01	0.03	-0.07	0.05	-0.02	-0.18	-0.18	0.17	-0.18	-0.10	-0.10	0.00	-0.03
(J)	-0.08	-0.14	0.20	0.05	0.08	0.00	-0.06	-0.07	-0.18	-0.18	0.23	-0.18	-0.07	-0.12	0.06	-0.03
	TDS	WP	FC	D	SP	AW	XaSt (IVI)	XaSt (D/Ha)	XaSt (A.D)	XaSt (C/Ha)	XaSt (A.C)	XaSt (V/Ha)	XaSt (A.V)	(H/)	(J)	
TDS	1.00															

WP	0.02	1.00													
FC	0.06	0.89	1.00												
D	-0.07	-0.88	-0.95	1.00											
SP	0.07	0.88	0.95	-1.00	1.00										
AW	0.07	-0.20	0.25	-0.19	0.19	1.00									
XaSt (IVI)	0.05	-0.02	0.09	-0.11	0.11	0.24	1.00								
XaSt(D/Ha)	0.05	-0.05	-0.15	0.09	-0.09	-0.20	0.42	1.00							
XaSt(A.D)	0.05	-0.06	-0.09	0.03	-0.03	-0.04	0.52	0.69	1.00						
XaSt(C/Ha)	-0.07	-0.11	-0.11	0.05	-0.05	0.00	0.37	0.72	0.42	1.00					
XaSt (A.C)	-0.07	-0.13	-0.09	0.03	-0.03	0.11	0.44	0.59	0.85	0.69	1.00				
XaSt(V/Ha)	-0.15	0.00	0.03	-0.03	0.04	0.06	-0.02	0.27	0.12	0.61	0.41	1.00			
XaSt(A.V)	-0.20	-0.15	-0.06	0.01	-0.01	0.21	0.30	0.39	0.64	0.67	0.92	0.54	1.00		
(H/)	-0.03	0.04	0.00	0.02	-0.02	-0.11	-0.81	-0.37	-0.50	-0.21	-0.36	0.20	-0.23	1.00	
(J)	-0.03	0.09	0.09	-0.06	0.06	-0.01	-0.70	-0.65	-0.67	-0.47	-0.55	-0.09	-0.37	0.68	1.00

XaSt: *Xanthium Strumarium*, IVI: Importance value index, D/Ha: Density/hectare, A.D: Average density, C/Ha: Cover/ hectare, A.C: Average cover, V/Ha: Volume/hectare, A.V: Average volume, H: Shannon-Winner diversity index, J: Evenness index, Value in bold: significant at $p < 0.0$

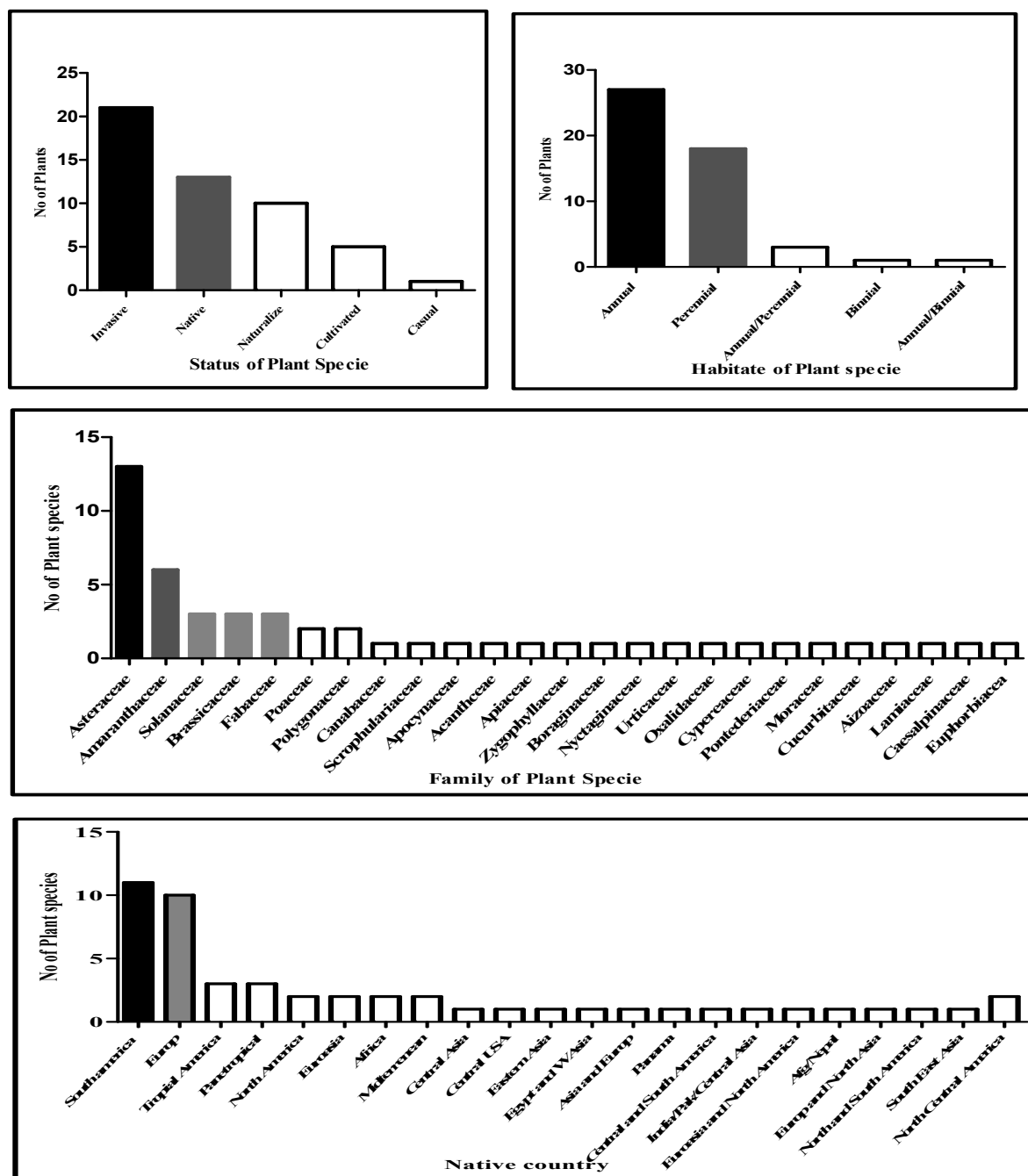


Figure S1. Status, Habitat, Family and Native country wise distribution of plants found in association in *Xanthium strumarium* dominated communities of KP Pakistan.