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INTRAANNUAL VARIATIONS IN WEED COMMUNITIES OF LENTIL FIELDS IN CHAKWAL, PAKISTAN

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Abstract

Weed communities are never static nor are they necessarily at equilibrium as they change in response to external and internal forces. To identify the ecologically operative weed communities, two surveys were carried out at eight sites in lentil fields of District Chakwal during 1999-2000. Twenty nine weed species in 1999 and 36 weed species in 2000 were recorded from the study area. Based on the importance value, 8 weed communities viz, 1) *Asphodelus – Sorghum – Convolvulus* in Bhaun; 2) *Asphodelus – Carthamus – Fumaria* in Dudyal; 3) *Fumaria – Asphodelus – Launaea* in Pindi Gugran; 4) *Sorghum – Medicago – Carthamus* in Balkasar; 5) *Sorghum – Pentanema – Centaurea* in Dulmyal; 6) *Carthamus – Emex – Asphodelus* in Jahtla; 7) *Asphodelus – Carthamus – Cousinea* in Kot Sarang; and 8) *Asphodelus – Carthamus – Convolvulus* in Taman were recognized during 1999. Whereas in 2000 another 8 weed communities viz., 1) *Lathyrus – Anagallis – Vicia*; 2) *Chenopodium – Medicago – Fumaria*; 3) *Asphodelus – Vicia – Convolvulus*; 4) *Asphodelus – Fumaria – Carthamus*; 5) *Asphodelus – Convolvulus – Pentanema*; 6) *Asphodelus – Medicago – Convolvulus*; 7) *Carthamus – Convolvulus – Sorghum;* and 8) *Carthamus – Convolvulus – Asphodelus* were recognized in these sites. *Asphodelus tenuifolius, Carthamus oxycantha, Fumaira indica, Medicago denticulata, Convolvulus arvensis* and *Sorghum halepense* were important dominants in different capacities. An interspecific population shift in weed communities was observed during the growth season of the crop.

Introduction

Lentil is an important legume crop of Pakistan and a major protein source. It is grown as a major winter (Rabi) crop in rainfed tracts of Pakistan (Shah *et al*., 2000). In District Chakwal, lentil is cultivated on 6.700 (000 acres) with a production of 4.113 Mds/acre during 1999-2000 (Anon., 2000). The area under study is arid and receives a rainfall of 250 mm (Anon., 2000). Soils are generally low in organic matter, homogenized with weak structure, moderately calcareous, and with a pH value of about 8.0. Temperature varies from 25ºC to 40.7ºC during the growing season of the crop. The yield of legumes in Pakistan is 0.5-0.6 t/ha which is lower than many other countries (Aslam *et al*., 2000). Hence, low moisture, low soil fertility and poor weed management are the main causes of low yield in the area.

Weeds are major constraints on crop production system and thus cause enormous losses in crop yield. Weed communities continuously change both quantitatively and qualitatively as they react to the biotic and edaphic components of the environment. Thus the information regarding their distribution, ecological importance is a pre-requisite to identify the most noxious weeds in any agricultural system. Moreover comparison of weed communities helps to understand the patterns of interspecific population shift during the growth season of the crops.

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The work on determination of weed communities is scarce (Hussain *et al*., 1998; Qureshi & Bhatti, 2001; Nasir & Sultan, 2003; Jakhar *et al.*, 2005). As for as the weed communities in lentil crops are concerned, no reference is available from any part of the country. Therefore, the present study was conducted to report for the first time the weed communities in lentil fields of District Chakwal during December 1999 and March 2000. The objectives of this study were:

a) to document the distribution and importance values of weed species;
b) to identify the ecologically operative weed communities; and
c) to observe the variation in species assemblage among different weed communities during the growth season of the crop.

These findings will help in recognition of noxious weeds of lentil crop in the area and provide guidelines for future intensive studies on lentil – weed management.

Materials and Methods

In District Chakwal lentil crop is sown in November/December and harvested in May/June. In order to have the complete idea of dynamics of weed communities, two surveys were carried out, first after four weeks of sowing in December 1999 and second in March 2000 when the crop was at flowering stage.

Within three tehsils of District Chakwal, eight lentil growing localities were selected viz., 1) Bhaun, 2) Dudyal, 3) Pindi Gugran, 4) Balkasar (Tehsil Chakwal), 5) Jahtla, 6) Kot Sarang, 7) Taman (Tehsil Tala Gang) and 8) Dulmyal (Tehsil Choa Saiden Shah). All these sites were located within the radius of 40 Km from the respective tehsils. Those sites were selected where lentil production had been high for the last five years and at least 100 cultivated fields of lentil were available. All these sites were rainfed and no herbicide was used during the whole season of crop growth. At each site 10 lentil fields were selected randomly and were surveyed following the methodology of Thomas (1985) and McCully *et al*., (1991) with some modifications. Five 1x1m quadrats were randomly placed along an inverted "W" pattern in each field. The first quadrat was placed after walking 20 paces from one corner along the edge of the field, turning 90^0 and then moving 10 paces into fields. This was to avoid edge effect. The distance between each quadrat depended upon the size and shape of the field and any obstructions that may have been present in the fields. The larger the field was, the greater was the distance between quadrats. The identification, field uniformity, density and herbage coverage of each weed was recorded within each quadrat. Herbage coverage was measured as field uniformity and density were not sufficient to give a clear picture of dominant species. To determine the weed communities four quantitative measures were calculated for each weed at each location. Field uniformity and density were measured as outlined by Thomas (1985), while, herbage coverage and importance value was calculated following Smith & Smith (1998).

Field uniformity (FU) was calculated as percentage of the total number of quadrats sampled in which a species occurred (Thomas, 1985).

$$FUk = \frac{\sum_{1}^{n} \sum_{1}^{5} Xij}{5n} \times 100$$

where FUk is the field uniformity for species k, Xij is the presence (1) or absence (0) of species k in quadrat j in field i and n is number of field surveyed. Density (D) of each

species in a field was calculated by summing the number of plants in all quadrats and dividing by area of 5 quadrats (Thomas, 1985).

$$Dki = \frac{\sum_{1}^{5} Zj}{Ai}$$

where Dki is the density (numbers m^{-2}) of species k in field i, Zj is the number of plants of a species in quadrat j and Ai is the area in m^2 of 5 quadrat in field i.

Herbage coverage was determined ensuing Smith & Smith (1998) by estimating how much percent area of quadrat was covered by all individual of a species as viewed from above. Thus herbage cover of a weed in a field was calculated by summing % herbage coverage of species in all quadrats and dividing by number of quadrats.

$$Hcki = \frac{\sum_{1}^{5} Cj}{5n}$$

where Hcki is the herbage coverage (in % m^{-2}) of species k in field i, Cj is the % herbage coverage of all individuals of a species in quadrat j and n is the number of fields.

The importance value of species was calculated following Smith & Smith (1998). These values compared the individual weed species relative to each other. The importance value of each species was calculated by assuming that the field uniformity, density and herbage coverage measures were equally important in describing the relative importance of weed species. This was calculated as follow:

$$\text{Relative field uniformity for Species k (RUk)} = \frac{\text{Field unifirmity value of species k}}{\text{Field uniformaity for all species}} \times 100$$

$$\text{Relative density for species k (RDk)} = \frac{\text{Density value of species k}}{\text{Density values for all the species}} \times 100$$

$$\text{Relative herbage coverage of species k (RCk)} = \frac{\text{Herbage coverage value of species k}}{\text{Herbage corvage values for all the species}} \times 100$$

Each of these three relative values indicate one aspect of the importance of species in the community but a better comparative picture can be painted by adding these relative values for every species to get importance values. Thus,

$$\text{Importance values of species k (IVk)} = RUk + RDk + RCk$$

The communities were named after three dominant species at each site ensuing Hussain *et al.* (1998). The nomenclature followed was that of Stewart (1972), Nasir & Ali (1971, 1993) and Ali & Qaiser (1994-2003).

Results and Discussion

During December 1999, 29 weed species were encountered while 36 species were recorded during March 2000 (Table 1). Eight weed communities viz., 1) *Asphodelus – Sorghum – Convolvulus* in Bhaun; 2) *Asphodelus – Carthamus – Fumaria* in Dudyal; 3) *Fumaria – Asphodelus – Launaea* in Pindi Gugran; 4) *Sorghum – Medicago – Carthamus* in Balkasar; 5) *Sorghum – Pentanema – Centaurea* in Dulmyal; 6) *Carthamus – Emex – Asphodelus* in Jahtla; 7) *Asphodelus – Carthamus – Cousinea* in Kot Sarang; and 8) *Asphodelus – Carthamus – Convolvulus* in Taman were recognized during December 1999 (Table 2). *Asphodelus tenuifolius*, *Carthamus oxycantha*, *Centaurea iberica*, *Convolvulus arvensis*, *Fumaria indica*, *Sorghum halepense* and *Emex australis* were dominant in different capacities at different locations (Table 1).

In 2000, 8 new weed communities viz., 1) *Lathyrus – Anagallis – Vicia* in Bhaun; 2) *Chenopodium – Medicago – Fumaria* in Dudyal; 3) *Asphodelus – Vicia – Convolvulus* in Pindi Gugran; 4) *Asphodelus – Fumaria – Carthamus* in Balkasar; 5) *Asphodelus – Convolvulus – Pentanema* in Dulmyal; 6) *Asphodelus – Medicago – Convolvulus* in Jahtla; 7) *Carthamus – Convolvulus – Sorghum* in Kot Sarang; and 8) *Carthamus – Convolvulus – Asphodelus* in Taman were recognized (Table 2). The dominants in different capacities in these communities were, *A. tenuifolius*, *C. oxycantha*, *C. arvensis*, *F. indica*, *Medicago denticulata*, *Vicia monantha* and *Chenopodium album* (Table 1). According to Shaukat & Burhan (2000) the potential of a species to colonize, establish and perpetuate at a site depends on its fecundity, seed and germination characteristics.

There was variation in weed flora during 2000. Twelve new weeds were recorded while 5 weeds were absent during 2000. *Emex australis* was absent during Mar., 2000, probably due to its removal by farmers (Table 1). A root parasite *Orobanche aegyptium* Pers. was recorded during first survey but it was absent during the second survey because of completion of its life cycle.

It was observed that ecological status of weeds in different sites and within area as a whole varies and depends upon time of survey, habitat, climate, edaphic conditions, growth stages of weeds and lentil crop and agricultural practices in the area. Different weed communities embraced at each site during both the surveys (Table 2). This indicated the heterogenous environmental conditions in the area. The edaphic factor as well the agronomic practices (time of cultivation, tillage system, usage of different fertilizers etc.) varied from site to site. As environmental conditions change, both in time and space, the possible distribution and abundance of species also change (Smith & Smith, 1998). An interspecific population shift of weed species was observed during both the surveys. *A. tenuifolius* was first dominant in Bhaun, Dudyal, Kot Sarang and Taman during December, 99. But *Lathyrus*, *Chenopodium*, and *Carthamus* replaced it, at these sites during March, 2000. The possible reason for it could be either the completion of life cycle of *A. tenuifolius* or late germination time of other weed species. But dominance of these weeds reveals large seed banks of these species. In the same way, *Fumaria*, *Sorghum*, and *Carthamus* were the leading dominants during December 1999 in Pindi Gugran, Balkasar and Jahtla, respectively, but all these species were replaced during March 2000 and *A. tenuifolius* obtained the first position at these sites. For second and third position, there was competition between *F. indica*, *C. arvensis*, *M. denticulata*, *V. monantha* and *S. halepense*. These weeds were dominant in different capacities in different communities (Table 2).

Table 1. Importance values of weeds in the lentil fields of District Chakwal during December, 1999 and March, 2000.

S.	Name of species	December 1999								March 2000							
no.	Localities	Bh	Dud	Pi	Ba	Dul	Ja	Ko	Ta	Bh	Dud	Pi	Ba	Dul	Ja	Ko	Ta
1.	*Anagallis arvensis* L.		8.83			8.02				34.6b	34.53	16.2		7.8	28.5		
2.	*Artemesia scoparia* Waldst & Kit.	1.50													2.9		
3.	*Asphodelus tenuifolius* Cavan.	52.9a	69.95a	48.1b	28.85	21.91	41.7c	57.7a	117a	25.15	19.48	30.7a	83.5a	50.3a	125a		44.1c
4.	*Avena fatua* L.											6.13					
5.	*Buglossoides arvensis* (L.) Johnston.	3.91										17.3					
6.	*Calendula arvensis* L.								36.35	15.35		14.5				21.35	42.39
7.	*Carthamus oxycantha* M.B.	17.92	40.5b	18.19	57.5c	27.12	61.2a	55.4b	51.9b	16.44	24.72		55.5c	21.1		74.2a	68.6a
8.	*Cenchrus ciliaris* L.													4.1			
9.	*Centaurea iberica* Trev. ex. Spreng.					37.2c								33.3			
10.	*Chenopodium album* L.	8.28	15	23.16	39.05			10.4		10.19	52.7a	16.7	24.98			28.44	
11.	*C. murale* L.			14.07						7.45							
12.	*Cirsium arvense* (L.) Scop.											11.3					
13.	*Citrullus colocynthis* (L.) Schard.													3.1			
14.	*Convolvulus arvensis* L.	34.6c	21.67	23.89		20.29	40.63	26.61	51.83c	13.66		23.2c		33.9b	44.3c	71.3b	57.6b
15.	*Cousinia thomsonii* C.B. Clarke.							50.6c							34.67	8.3	30.08
16.	*Cynodon dactylon* (L.) Pers.				20.51		16.7						20.31				
17.	*Dactyloctenium aegyptium* (L.) P.Beaur		3.87														
18.	*Dicanthium annulatum* (Frossk) Stapf.	9.16						7.23									
19.	*Emex australis* Steinch.						42.1b										
20.	*Eragrostis poaeoides* P.Beauv.													17.81			

Table 1. (Cont'd.)

S. no.	Name of species / Localities	December 1999 Bh	Dud	Pi	Ba	Dul	Ja	Ko	Ta	March 2000 Bh	Dud	Pi	Ba	Dul	Ja	Ko	Ta
21.	*Euphorbia dracunculoides* Lam.					27.2								25.1			
22.	*E. helioscopia* L.	7.31	12.27	18.96						10.81	22.77	20.1					
23.	*Fumaria indica* (Hausskn.) H.N.		33.56c	56.5a	14.54	26.99	25.6	25.88			43.37c	10.1	66.7b	25.9		32.61	
24.	*Galium aparine* L.											9.7					
25.	*Heliotropium europeaeum* L.								9.46								39.14
26.	*Lathyrus aphaca* L.											9.1		7.5			
27.	*L. sativus* L.	31.83	22.95	15.5						52.1a		13.8					
28.	*Launaea nudicaulis* N.K.F. (nonless)	20.87		34.4c			27.65	16.76			8.9	10.23					27.91
29.	*Malva parviflora* L.												12.77	6			
30.	*Medicago denticulata* Willd.	10.16	15.38		66.6b	8.73	34.57	20.24	33.09	22.74	44.28b		20.43	7.6	50.5b		
31.	*Orobanche aegyptiaca* Pers.	4.62															
32.	*Otostegia limbata* (Btr.) Boiss.					19.17											
33.	*Pentanema vestitum* (Wall. ex. DC) Ling.					43.7b								33.6c			
34.	*Silene arenosa* C.Koch.											10.6					
35.	*Sonchus asper* (L.) Pers.										2.26	8.4					
36.	*Sorghum halepense* (L.) Pers.	47.2b	20.04	22.21	72.9a	46.7a		19.27		21.1	21.23	18.8	15.98		13.57	44.5c	
37.	*Spergula fallax* (Lowe) E.H. L.Krause.													9.9			
38.	*Trifolium polycerata* L.	14.92	13.56							16.98	29.46	17.2					
39.	*Veronica agrestis* Auct. non. L.											6.5					
40.	*Vicia monantha* L.	28.19	23.17	19.85		12.89	9.56			31.8c		27.4b		10.76			
41.	*Withania somnifera* (L.) Dunal.	3.94								5.16							

Key: Bh (Bhaun), Dud (Dudyal), Pi (Pindi Gugran), Ba (Balkasar), Dul (Dulmyal), Ja (Jahtla), Ko (Kot Sarng), Ta (Taman), a (First dominant), b (Second dominant) c, (Third dominant).

Table 2. Comparison of the weed communities established in lentil fields during December, 1999 and March, 2000.

Site	Weed communities during December, 1999	No. of weed species	Weed communities during March, 2000	No. of weed species
Bh	*Asphodelus – Sorghum – Convolvulus*	16	*Lathyrus – Anagallis – Vicia*	14
Dud	*Asphodelus – Carthamus – Fumaria*	13	*Chenopodium – Medicago – Fumaria*	11
Pi	*Fumaria – Asphodelus – Launaea*	11	*Asphodelus – Vicia – Convolvulus*	20
Ba	*Sorghum – Medicago – Carthamus*	7	*Asphodelus – Fumaria – Carthamus*	8
Dul	*Sorghum – Pentanema – Centaurea*	12	Asphodelus – Convolvulus – Pentanema	16
Ja	*Carthamus – Emex – Asphodelus*	9	*Asphodelus – Medicago – Convolvulus*	7
Ko	*Asphodelus – Carthamus – Cousinea*	10	*Carthamus – Convolvulus – Sorghum*	7
Ta	*Asphodelus – Carthamus – Convolvulus*	6	*Carthamus – Convolvulus – Asphodelus*	7

Key: Bh (Bhaun), Dud (Dudyal), Pi (Pindi Gugran), Ba (Balkasar), Dul (Dulmyal), Ja (Jahtla), Ko (Kot Sarang), Ta (Taman).

During both surveys the number of weed species at various sites varied significantly and ranged from 7-20 species (Table 2). In general, the number of weed species at different sites during both the surveys was almost equal but, a dramatic increase was observed in number of weed species at Pindi Gugran, where it rose from 11 to 20 species (Table 2). As for as the weed flora is concerned, there was a slight variation in weed flora, due to introduction of new species. For example, *Eragrostis poaeoides, Galium aparine, Lathyrus aphaca, Malva parviflora, Silene arenosa, Sonchus asper, Spergula fallax* and *Withania somnifera* were only recorded during the second survey. However, these species differ in their importance value and this difference in their ecological status resulted into a different weed community at each site during both the surveys. The observed difference in number of weed species was probably due to difference in agro climatic and farming practices at each site. A study by Pysek *et al*., (2005) on the effects of abiotic factors on species richness and cover in Central European weed communities showed that in their case the differences in weed flora were largely attributable to management and partly related to crop-specific agricultural practices.

Most of the sites were dominated by *A. tenuifolius* during both the surveys. This was probably due to its wide ecological amplitude as it can grow both on light and heavy soils (Gupta, 1987), has low water requirement (Ashiq *et al*., 1996), but develop thick stands with adequate moisture (Gupta, 1987). It is note worthy that there was heavy down pour before the second survey. Thus, difference in moisture level might have played a catalytic role in changing ecological status of different weed species during both the surveys. According to Stefanic *et al*., (2005) notable fluctuations in weed communities correspond with variation in weather patterns and management practice. Recently, Batlla & Benech-Arnold (2006) suggested that fluctuations in soil water content could be an additional factor affecting dormancy and weed emergence patterns under field conditions.

Some of the collected weeds (*C. arvensis*, *S. halepense* and *C. album*) were reported as worst weeds of the world (Holm *et al*., 1977). Climbing and twining weeds like *C. arvensis*, *L. sativus*, *G. aparine* and *V. monantha* not only distort the lentil plant but also reduce light supply. Spiny weeds like *C. oxycantha*, *Cirsium arvense* and *E. australis* reduce the human efficiency.

The present study showed that *A. tenuifolius*, *C. oxycantha*, *S.halepense*, *F. indica*, *C. album*, *M. denticulata* and *L. sativus* are the most problematic weeds in lentil fields of district Chakwal. *E. australis* and *C. arvense* are spreading at an alarming rate in lentil fields and will be the problematic weeds in future. A noxious weed *Parthenium hysterophorus* was recorded through out the study area, particularly along the road sides and field margins in form of thick stands. There is a strong likelihood that it will transfer from field margins into fields in the near future.

It is vital to know the bioecological features, which includes dormancy, germination, seedling development, emergence, vegetative growth, flowering, seed setting, maturity and seed dispersal of prevalent weed species for designing an optimal control method. The dominant weeds at each site were broad leaved so, herbicide should be used accordingly. An integrated approach that employs cultural, mechanical and chemical control is the most effective method for controlling weeds. Weed is a green plant with all characteristics and qualities of such a plant. We cannot totally eradicate them, the task, which must be undertaken, is to maintain their population to such a level so that they could not severely affect the crop.

References

Ali, S.I. and M. Qaiser. 1994-2003. *Flora of Pakistan*. Botany Deptt. Karachi University, Karachi.

Anonymous. 2000. *Annual Report. Deputy Director Agriculture Chakwal. Government of the Punjab*.

Ashiq, M., M.M. Nayyar and M.L. Shah. 1996. *Weeds of the crops and their control*. Agronomy Deptt. Ayub Agriculture Research Institute, Faisalabad. pp. 82.

Aslam, M., I.A. Mahmood, T. Sultan and S. Ahmad. 2000. Inoculation approach to legume crops and their production assessment in Pakistan. A Review. *Pak. J. Bio. Sci*., 3: 193-195.

Batlla, D. and R.L. Benech-Arnold. 2006. The role of fluctuations in soil water content on the regulation of dormancy changes in buried seeds of *Polygonum aviculare* L. *Seed Sci. Res.*, 16: 47-59.

Gupta, O.P. 1987. Predominant weeds of Indian Agriculture. *Advances In Weed Science. A case of Indo-Pak Subcontinent*. Proc.Pak-Indo-Us Weed Control Workshop, NARC, Islamabad. March 11-14. pp. 309-317.

Holm, L.M., D.L. Plucknett, J.V. Pancho and J. Herberger. 1977. *The world's worst weeds*. University Press of Hawaii, Honolulu. pp. 609.

Hussain, F., M. Ayaz and K.M. Aslam. 1998. Weed communities in the wheat fields of Mayar-Jandool, District Dir. *Pak. J. Pl. Sci*., 4: 53-59.

Jakhar, G.S., S.A. Abro, A.Q. Maher and R. Qureshi. 2005. Weed communities of wheat crop under diverse edaphogropghy of district Khairpur, Pakistan. *Pak. J. Bot*., 37: 709-714.

McCully, K.V., M.G. Sampson and A.K. Watson. 1991. Weed survey of Nova Scotia, Lowbush bluebery (*Vaccinium angustifolium*) fields. *Weed Sci.*, 39: 180-185.

Nasir, E. and S.I. Ali. 1971-1993. *Flora of Pakistan* Nos. 1-172. Pak. Agric. Res. Council, Islamabad.

Nasir, Z.A. and S. Sultan. 2003. Weed communities in the wheat fields of district Chakwal. *Sarhad J. Agric.*, 19: 113-120.

Pysek, P., V. Jarosik, Z. Kropac, M. Chytry, J. Wild and L. Tichy. 2005. Effects of abiotic factors on species richness and cover in Central European weed communities *Agri. Eco. Env*., 109: 1-8.

Qureshi, R. and G.R. Bhatti. 2001. Determination of weed communities in wheat (*Triticum aestivum* L.) fields of District Sukkur. *Pak. J. Bot*., 33: 109-115.

Shah, Z., S.H. Raza Ullah, S.H. Shah, D.F. Herridge and M.B. Peoples. 2000. Does lentil (*Lens culinaris*) in the Swat river valley need Rhizobial inoculation? *Sar. J. Agric.*, 16: 179-187.

Shaukat, S.S. and N. Burhan. 2000. Fecundity, seed characteristics and factors regulating germination of *Rhynchosia minima* (L.) D.C. *Pak. J. Bot.*, 32: 211-226.

Smith, R.L. and T.H. Smith. 1998. *Elements of Ecology*, The Benjamin/ Cummings Publishing Company, Inc. 2725 Sand Hill Road, Menlo Park. pp. 267-312.

Stefanic E., I. Stefanic and A.J. Murdoch. 2005. Response of a weed community to different management practice in field bean. *J. Pl. Dis. Protec*., 112: 437-446.

Stewart, R.R. 1972. *An Annotated Catalogue of Vascular Plants of West Pakistan and Kashmir*. Fakhri Printing Press, Karachi. pp. 1028.

Thomas, A.G. 1985. Weed survey system used in Saskatchewan for cereal and oilseed crops. *Weed Sci.*, 33: 34-43.

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