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USE OF GPS AND GIS TECHNOLOGY IN SURVEYING AND MAPPING OF WHEAT AND COTTON WEEDS IN KHAIRPUR DISTRICT, SINDH, PAKISTAN

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Abstract

Present study was conducted in the fields of Khairpur district, Sindh for the mapping of some important weeds of wheat and cotton by using GPS and GIS technology. A base map of the district was prepared by using Geographical Information System (GIS) to indicate the sampling sites and physical features of the area. Two more maps were created to depict the density and frequency of weeds of wheat and cotton crops in each Tehsil (Taluka), shown in the form of bar and pie diagrams. Present piece of work will help the scientists and managers to predict those areas, potentially subjected to weed invasion.

Introduction

The term GIS involves powerful, complex computer databases that organize information around a specific location. GIS maps are digital, interactive, loaded with information. Each category of information is called a theme or layer. It is GIS that can integrate layers of information in one place. The GIS technology is fast, becoming an efficient tool in research of all kinds that relate to geographic location in one way or other. Researchers can get benefit from the use of a GIS to more fully investigate data and develop spatially accurate graphical data displays (Main *et al.*, 2004; Ahmad *et al.*, 2010).

For collecting data on the ground, Global Positioning System (GPS) receivers are commonplace. GPS is a satellite navigation system developed by the Department of Defense that can pinpoint a location anywhere on earth. GPS receivers are able to obtain signals from satellites orbiting the earth. Signals from three of the 24 orbiting satellites are needed to calculate latitude and longitude, using basic triangulation methods (Walker *et al*., 2000).

Computer technology has been broadly utilized to design application systems for weed management since last two decades. Miller & Stafford (1991) proposed a map-based approach in which weed populations located on a map can be converted to a treatment or application map and used to control the sprayer. Stafford *et al*., (1996) described a technique for generation of weed distribution maps with GPS in which a backpack weed distribution map recorder enables a farmer to log information on weed patches on a hand-held computer as he walks a field. Since that time, computer technologies have grown up significantly and many different methods and techniques have been developed especially with the introduction of GIS application. Main *et al*., (2004) demonstrated GIS application and suggested that it can be used to make maps that theoretically predict the time of weed emergence from weather data. Mueller-Warrant *et al*., (2008) illustrated dominant spatial features of weed distribution patterns in maps using GIS to monitor distribution and severity of the 36 most common weeds of grass seed crops. A GIS-based photorealistic visualisation method was developed by Ghadirian & Bishop (2008) which provides a dynamic view of the march of the weeds across the landscape. Memon *et al*., (2003) and Memon *et al*., (2007) determined the diversity, density and frequency of wheat and cotton weeds, respectively, from the eight administrative divisions of Khairpur district, Sindh.

The primary objective of present study was to accurately identify and delineate land with populations of unwanted plants. Therefore, an attempt has been made to develop distribution maps of weeds of wheat and cotton by using GIS and GPS technology in the specific geographic area of District Khairpur, as there is a need to consolidate the data into one data base and provide the ability to map and measure current and future infestations.

Material and Methods

This study was conducted during 1999-2001 for the surveying and mapping of wheat and cotton weeds using GPS and GIS technology in Kairpur district. The district is divided into 8 Tehsils (Talukas) viz. Kingri, Gambat, Khairpur, Sobhodero, Kotdiji, Thari Mirwah, Faiz Ganj and Nara. Owing to the cropping pattern, the area was selected for field sampling. Four sampling sites were randomly selected from each Taluka. Five quadrates of $1m^2$ were selected from each site to collect the data of each weed species. Location coordinates were recorded with GPS (Table 1) and were downloaded into GIS software, to create detailed maps. ArcView GIS 3.1, a computerized mapping system was used to prepare the GIS database.

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Table 1. Sites surveyed from each Taluka and their coordinates.

Site	Location	Coordinates
Taluka khairpur		
Site-1	Behind sachal chair, Shah Abdul Latif University, Khairpur.	N 27º 29'-18" E 68º 45'-36"
Site-2	Near to Flour Mill (Katohar Village)	N 27º 29'-20" E 68º 45'-22"
Site-3	Near road from Sukkur towards Pir-Jo-Goth.	N 27º 37'-41" E 68º 41'-12"
Site-4	About 1 km from Mumtaz College, Khairpur.	N 27º 30'-38" E 68º 46'-26"
Taluka Kotdiji		
Site-5	About 3 km from Kumb towards Nawabshah.	N 27º 16'-11" E 68º 35'-38"
Site-6	Near to Mithri machine along National highway.	N 27º 23'-49" E 68º 44'-29"
Site-7	Near Hussainabad Village	N 27º 27'-10" E 68º 45'-05"
Site-8	On way towards Hussainabad	N 27º 27'-10" E 68º 45'-10"
Taluka Thari Mirwah		
Site-9	Near Village Qadir Bux Chano	N 26º 57'-13" E 68º 27'-22"
Site-10	Near Kharira	N 27º 01'-08" E 68º 31'-04"
Site-11	Near Thari Mirwah.	N 27º 03'-39" E 68º 35'-05"
Site-12	Near Khandiari	N 27º 05'-31" E 68º 35'-07"
Taluka Faiz Ganj		
Site-13	Near to Paka chang towards Bhiria Road.	N 26º 52'-03" E 68º 20'-46"
Site-14	Goth Ali Nawaz Hesbani near Karundi.	N 26º 53'-48" E 68º 25'-27"
Site-15	Near Village Hussain Pato.	N 26º 52'-35" E 68º 28'-56"
Site-16	Near Goth Satah (Banbhan).	N 26º 56'-41" E 68º 28'-47"
Taluka Sobhodero		
Site-17	Goth Watni near Ranipur.	N 27º 17'-19" E 68º 28'-40"
Site-18	Near Dargah Mehdi Shah, Village Shahani.	N 27º 17'-33" E 68º 26'-22"
Site-19	Near highway Ranipur.	N 27º 15'-05" E 68º 28'-49"
Site-20	Near Dr. Qadir Bux Memon Zaraee Farm and Phool Bagh.	N 27º 11'-44" E 68º 24'-35"
Taluka Gambat		
Site-21	Near Ripri.	N 27º 30'-24" E 68º 27'-51"
Site-22	Near road 3 km south-west of Khuhra.	N 27º 23'-44" E 68º 30'-16"
Site-23	Near way from Khuhra to Gambat.	N 27º 21'-53" E 68º 30'-57"
Site-24	Village Abdul Karim Phul, close to National Highway.	N 27º 19'-51" E 68º 31'-33"
Taluka Kingri		
Site-25	Near road 4 km towards Sajjan Mahesar.	N 27º 36'-12" E 68º 37'-17"
Site-26	Goth Yaqoob Mangnejo, 2 km from Sajjan Mahessar.	N 27º 37'-07" E 68º 36'-56"
Site-27	Near junction between Ahmedpur and Hadal Shah.	N 27º 35'-46" E 68º 33'-59"
Site-28	Near Goth Shah Muhammad	N 27º 34'-44" E 68º 32'-52"
Taluka Nara		
Site-29	Along the Noaabad Channel which is emerging from Nara Canal No. 283	N 27º 04'-23" E 68º 59'-48"
Site-30	Close to Kadanwari Gas pipeline leading to Nara Canal, Agriculture on its right side and sandy elevated area on left side.	N 27º 02'-30" E 69º 04'-44"
Site-31	Village Noor Mustafa	N 27º 04'-33" E 69º 03'-09"
Site-32	Village Malhar Faqir Bhambhro, Agriculture and adjoining sand dune.	N 27º 05'-18" E 69º 00'-53"

Results and Discussion

The most important weeds of wheat crop recorded from study area were *Anagallis arvensis*, *Melilotus indica*, *Chenopodium ficifolium*, *Spergularia marina*, *Rumex dentatus*, *Cynodon dactylon*, *Phalaris minor* and *Medicago polymorpha*, whereas, *Trianthema portulacastrum*, *Dactyloctenium aegyptium*, *Brachiaria eruciformis*, *Corchorus aestuans*, *Euphorbia serpens*, *Setaria pumila* and *Cynodon dactylon* were found as the most prevalent weeds in cotton crop. The values of their density and frequency % are given in table 2 and 3. In order to create maps the collected information of all the weed species, transferred into ArcView GIS 3.1 to create maps, allows for quick reference and printing. A map of general land use in the area was prepared to specify the cultivated and non-cultivated areas of Khairpur district in order to show the general trend of cropped and barren areas and to indicate the sampling points. A general concept of area is given delineating taluka and district boundaries that are supplemented with the preparation of layers for various physical features i.e., main canals, river, roads and towns to portray the base map of the area (Fig. 1). Two more views of map created in this study are showing the density (Figs. 2 and 4) and frequency (Figs. 3 and 5) of some important weeds of wheat and cotton crops in each Taluka which are shown in the form of two themes each representing bar and pie diagrams depending upon the suitability of the illustrations. These maps visibly give the pictures of weed distribution in all Talukas of the Khairpur district and exhibit the visual impression of the characteristics of the weeds density and frequency. This visual enhancement of data is possible with the help of the GIS. Such maps can be used to compare species distribution and location change from year to year and to summarize infestations by area (Korejo *et al.*, 2010)

The information collected from these weed surveys, which has been compiled in the form of maps showed the distribution and severity of weeds in wheat and cotton crops of the area, which further be useful information for scientists and planners. Severity of weeds in the fields of wheat and cotton of the district Khairpur has also been described by Memon *et al*., (2003) and Memon *et al*., (2007).

Table 2. Important weed species of wheat and cotton crops showing density in various Talukas of Khairpur district.

		District Khairpur	Taluka						
			Kotdiji	Thari Mirwah	Faiz Ganj	Sobhodero	Gambat	Kingri	Nara
S. No.	**Weed species of wheat crop**								
1.	*Anagallis arvensis* var. *coerulea* Linn.	32.10	40.00	45.30	6.05	32.70	21.25	46.00	8.85
2.	*Chenopodium ficifolium* subsp. *blomianum* (Aellen) Aellen.	4.25	3.65	6.95	10.60	7.55	5.20	4.25	1.60
3.	*Cynodon dactylon* (L.) Pers.	6.10	2.20	8.50	1.75	9.35	5.50	6.35	4.60
4.	*Medicago polymorpha* Linn.	2.00	62.50	2.00	1.50	0.00	1.50	3.50	0.00
5.	*Melilotus indica* (L.) All.	75.30	53.35	10.45	5.15	25.00	20.50	12.25	9.70
6.	*Phalaris minor* Retz.	10.00	3.25	8.10	2.55	8.25	3.20	4.90	4.20
7.	*Rumex dentatus* Linn.	8.35	4.75	3.15	3.65	15.65	14.75	7.30	5.55
8.	*Spergularia marina* (L.) Griseb.	32.50	68.00	6.00	9.10	6.15	6.75	8.05	18.00
S. No.	**Weed species of cotton crop**								
1.	*Brachiaria eruciformis* (J.E. Sm.) Griseb.	13.40	19.85	8.35	7.00	11.60	9.50	13.00	10.50
2.	*Corchorus aestuans* Linn.	7.80	10.25	9.50	9.60	7.85	11.90	14.80	9.55
3.	*Cynodon dactylon* (Linn) Pers.	6.50	3.00	3.85	5.75	7.50	6.50	6.75	4.20
4.	*Dactyloctenium aegyptium* (Linn.) Willd.	11.50	11.55	10.60	13.50	11.50	14.10	9.40	7.90
5.	*Euphorbia serpens* Kunth.	14.25	21.15	13.20	11.50	8.60	17.90	12.95	11.30
6.	*Setaria pumila* (Poir.) Roem. & Schult.	5.75	5.75	8.25	6.70	7.10	9.35	6.25	8.75
7.	*Trianthema portulacastrum* Linn.	13.55	13.50	16.90	15.45	10.55	13.05	13.50	8.00

Table 3. Important weed species of wheat and cotton crops showing frequency % in various Talukas of Khairpur district.

		District Khairpur	Taluka						
			Kotdiji	Thari Mirwah	Faiz Ganj	Sobhodero	Gambat	Kingri	Nara
S. No.	**Weed species of wheat crop**								
1.	*Anagallis arvensis* var. *coerulea* Linn.	95.00	65.00	90.00	65.00	65.00	70.00	90.00	50.00
2.	*Chenopodium ficifolium* subsp. *blomianum* (Aellen) Aellen.	60.00	50.00	55.00	70.00	60.00	60.00	70.00	55.00
3.	*Cynodon dactylon* (L.) Pers.	45.00	35.00	60.00	50.00	50.00	40.00	60.00	65.00
4.	*Medicago polymorpha* Linn.	15.00	25.00	25.00	15.00	0.00	15.00	15.00	0.00
5.	*Melilotus indica* (L.) All.	85.00	90.00	90.00	55.00	65.00	70.00	60.00	65.00
6.	*Phalaris minor* Retz.	50.00	55.00	60.00	35.00	60.00	30.00	50.00	45.00
7.	*Rumex dentatus* Linn.	70.00	40.00	50.00	50.00	65.00	50.00	60.00	45.00
8.	*Spergularia marina* (L.) Griseb.	65.00	40.00	40.00	70.00	55.00	60.00	55.00	80.00
S. No.	**Weed species of cotton crop**								
1.	*Brachiaria eruciformis* (J.E. Sm.) Griseb.	85.00	85.00	60.00	65.00	70.00	65.00	70.00	65.00
2.	*Corchorus aestuans* Linn.	70.00	80.00	70.00	70.00	65.00	65.00	75.00	55.00
3.	*Cynodon dactylon* (Linn) Pers.	45.00	50.00	60.00	70.00	65.00	60.00	60.00	60.00
4.	*Dactyloctenium aegyptium* (Linn.) Willd.	70.00	70.00	75.00	80.00	80.00	90.00	60.00	65.00
5.	*Euphorbia serpens* Kunth.	60.00	90.00	60.00	60.00	60.00	80.00	70.00	60.00
6.	*Setaria pumila* (Poir.) Roem. & Schult.	60.00	60.00	65.00	50.00	65.00	75.00	55.00	60.00
7.	*Trianthema portulacastrum* Linn.	85.00	85.00	75.00	80.00	60.00	70.00	90.00	70.00

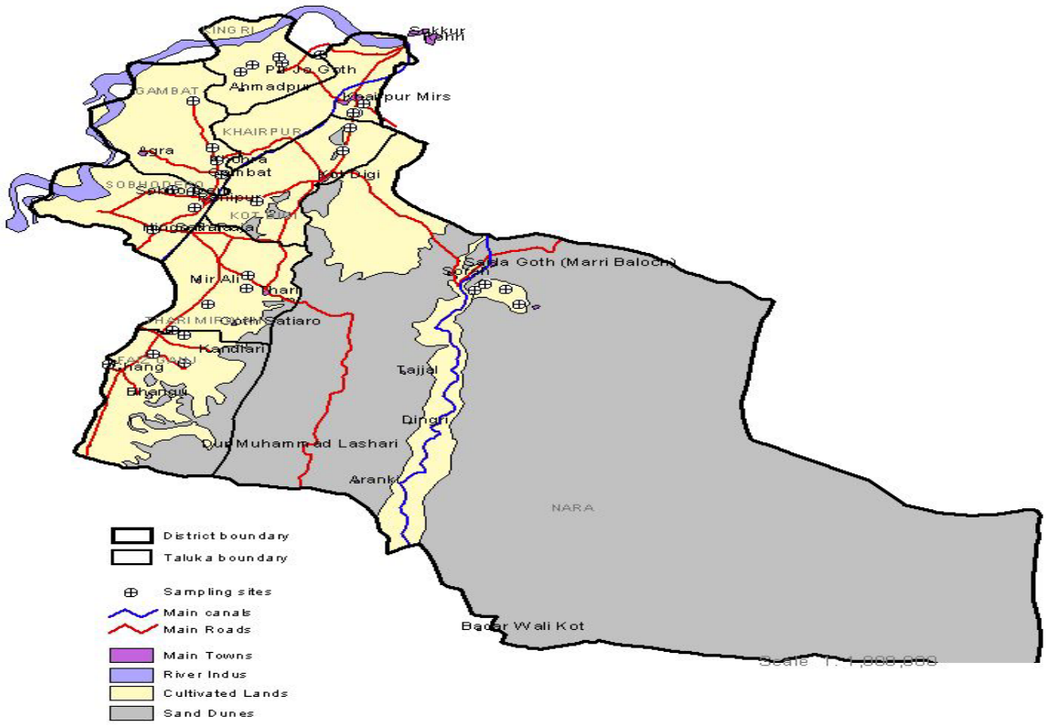

Fig. 1. Base map of Khairpur district showing sampling sites and physical features.

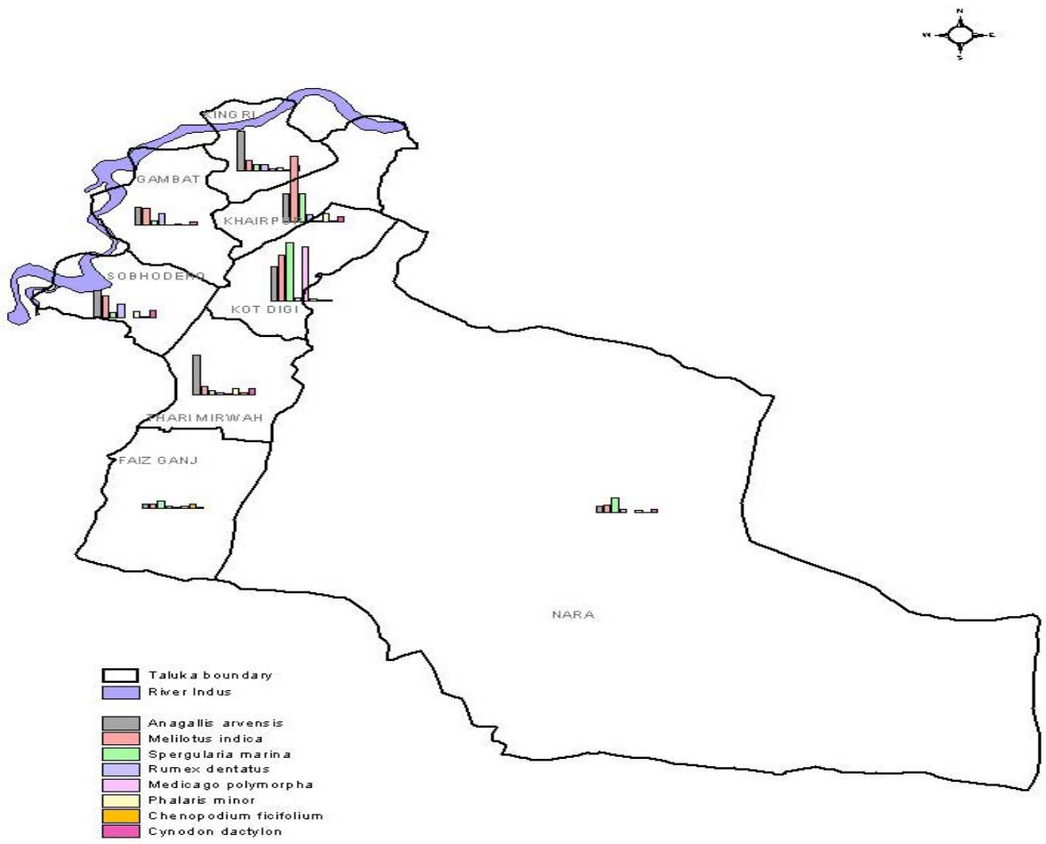

Fig. 2. View of map showing density of some important wheat weeds in different Talukas of Khairpur.

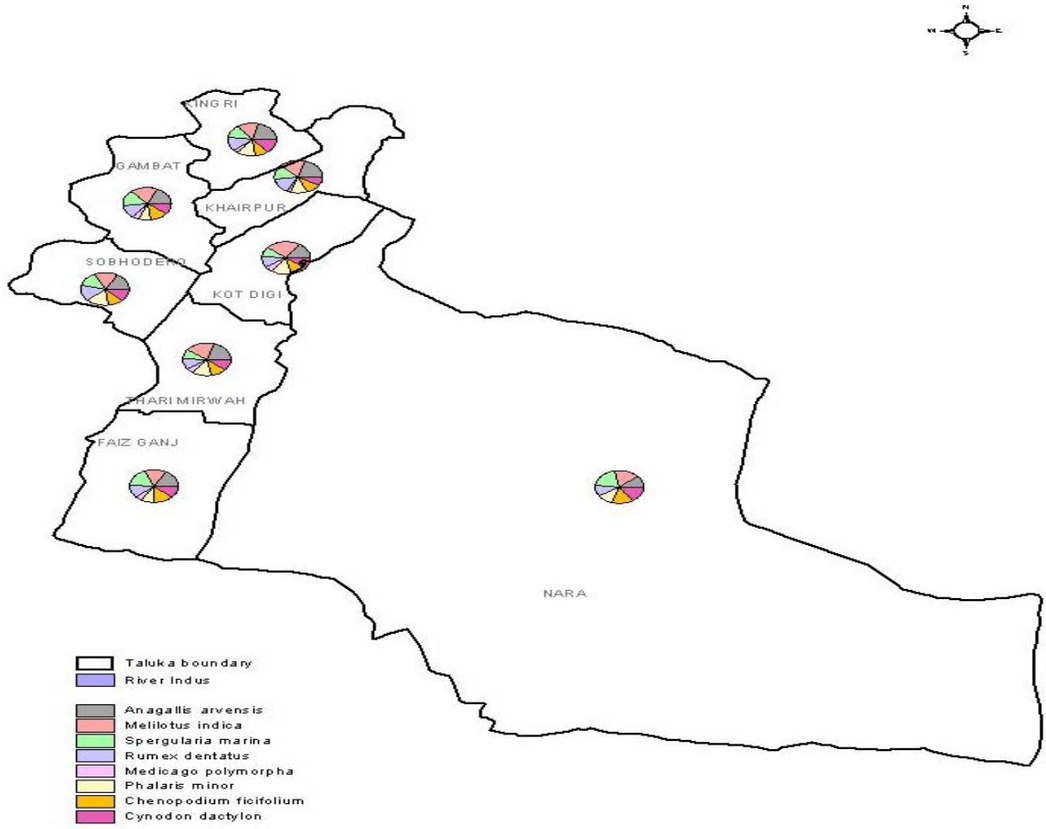

Fig. 3. View of map showing frequency of some important wheat weeds in different Talukas of Khairpur.

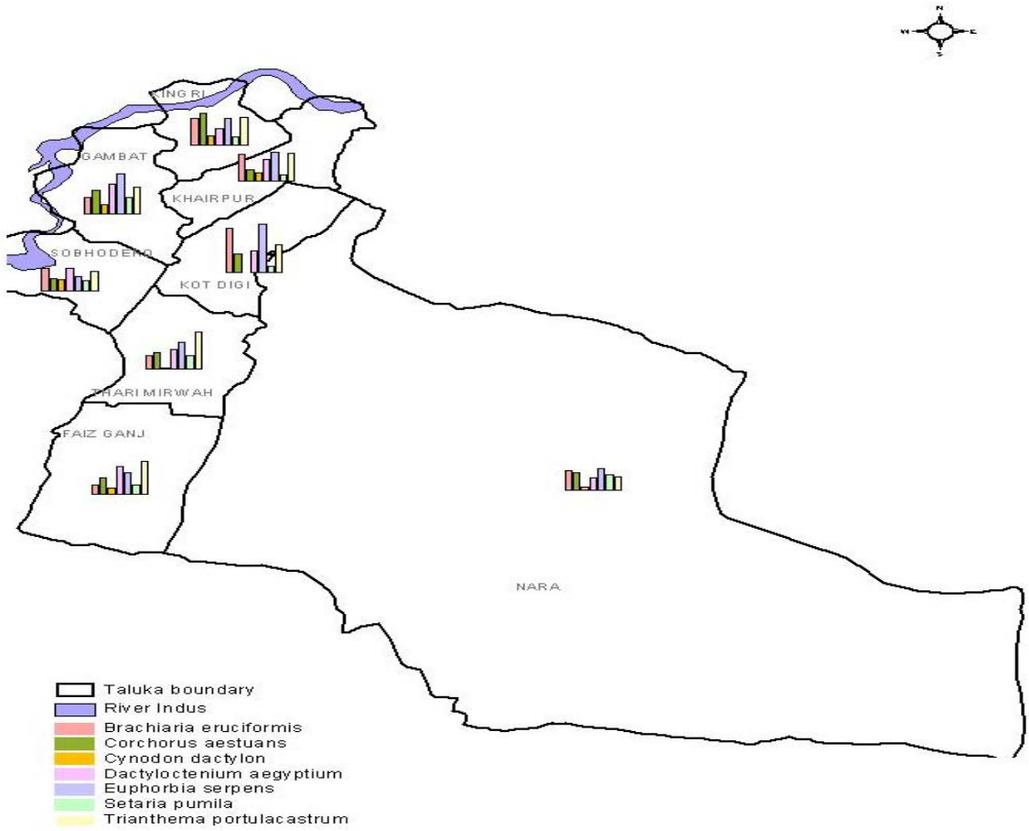

Fig. 4. View of map showing density of some important cotton weeds in different Talukas of Khairpur.

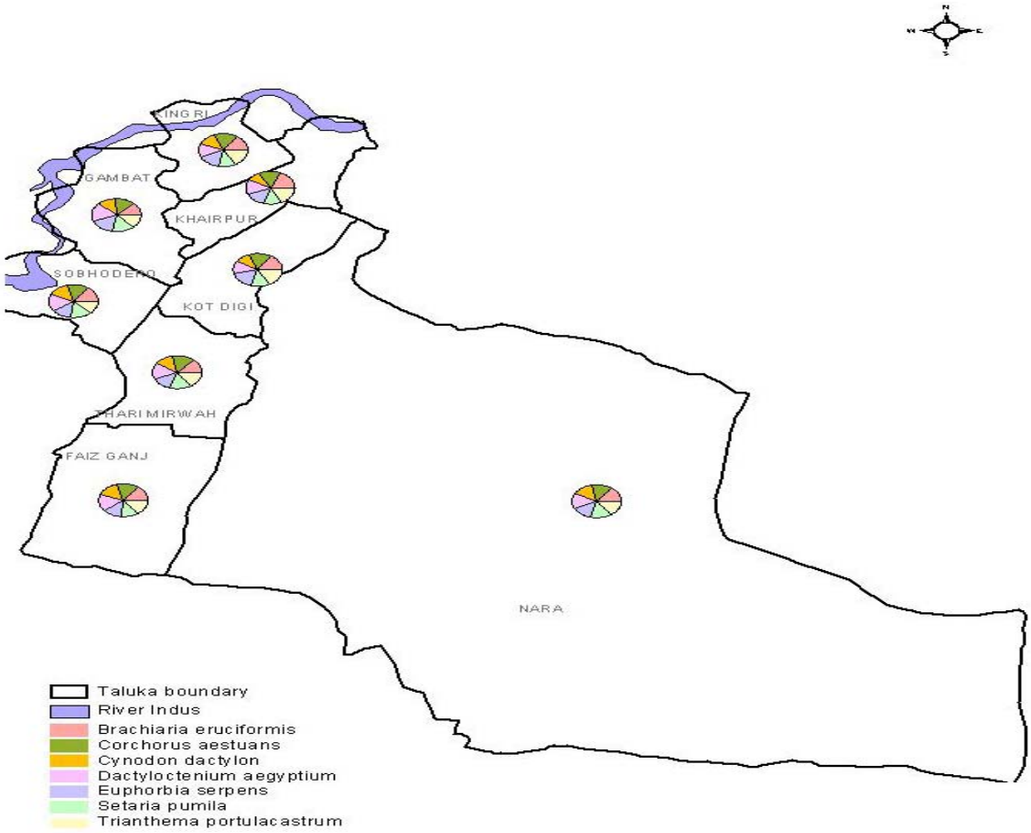

Fig. 5. View of map showing frequency of some important cotton weeds in different Talukas of Khairpur.

Conclusion

The present study leads to conclude that the ability of using GPS is twofold. One is to accurately record the position of infested sites and the second is its integration with GIS to accurately locate weed infestations in connection to other recognizable physical features of map.

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