

## 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, Sobhoderi, 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<sup>2</sup> 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
<b>Taluka khairpur</b>		
Site-1	Behind sachal chair, Shah Abdul Latif University, Khairpur.	N 27° 29'-18" E 68° 45'-36"
Site-2	Near to Flour Mill (Katohar Village)	N 27° 29'-20" E 68° 45'-22"
Site-3	Near road from Sukkur towards Pir-Jo-Goth.	N 27° 37'-41" E 68° 41'-12"
Site-4	About 1 km from Mumtaz College, Khairpur.	N 27° 30'-38" E 68° 46'-26"
<b>Taluka Kotdiji</b>		
Site-5	About 3 km from Kumb towards Nawabshah.	N 27° 16'-11" E 68° 35'-38"
Site-6	Near to Mithri machine along National highway.	N 27° 23'-49" E 68° 44'-29"
Site-7	Near Hussainabad Village	N 27° 27'-10" E 68° 45'-05"
Site-8	On way towards Hussainabad	N 27° 27'-10" E 68° 45'-10"
<b>Taluka Thari Mirwah</b>		
Site-9	Near Village Qadir Bux Chano	N 26° 57'-13" E 68° 27'-22"
Site-10	Near Kharira	N 27° 01'-08" E 68° 31'-04"
Site-11	Near Thari Mirwah.	N 27° 03'-39" E 68° 35'-05"
Site-12	Near Khandiari	N 27° 05'-31" E 68° 35'-07"
<b>Taluka Faiz Ganj</b>		
Site-13	Near to Paka chang towards Bhiria Road.	N 26° 52'-03" E 68° 20'-46"
Site-14	Goth Ali Nawaz Hesbani near Karundi.	N 26° 53'-48" E 68° 25'-27"
Site-15	Near Village Hussain Pato.	N 26° 52'-35" E 68° 28'-56"
Site-16	Near Goth Satah (Banbhan).	N 26° 56'-41" E 68° 28'-47"
<b>Taluka Sobhodero</b>		
Site-17	Goth Watni near Ranipur.	N 27° 17'-19" E 68° 28'-40"
Site-18	Near Dargah Mehdi Shah, Village Shahani.	N 27° 17'-33" E 68° 26'-22"
Site-19	Near highway Ranipur.	N 27° 15'-05" E 68° 28'-49"
Site-20	Near Dr. Qadir Bux Memon Zaraee Farm and Phool Bagh.	N 27° 11'-44" E 68° 24'-35"
<b>Taluka Gambat</b>		
Site-21	Near Ripri.	N 27° 30'-24" E 68° 27'-51"
Site-22	Near road 3 km south-west of Khuhra.	N 27° 23'-44" E 68° 30'-16"
Site-23	Near way from Khuhra to Gambat.	N 27° 21'-53" E 68° 30'-57"
Site-24	Village Abdul Karim Phul, close to National Highway.	N 27° 19'-51" E 68° 31'-33"
<b>Taluka Kingri</b>		
Site-25	Near road 4 km towards Sajjan Mahesar.	N 27° 36'-12" E 68° 37'-17"
Site-26	Goth Yaqoob Mangnejo, 2 km from Sajjan Mahessar.	N 27° 37'-07" E 68° 36'-56"
Site-27	Near junction between Ahmedpur and Hadal Shah.	N 27° 35'-46" E 68° 33'-59"
Site-28	Near Goth Shah Muhammad	N 27° 34'-44" E 68° 32'-52"
<b>Taluka Nara</b>		
Site-29	Along the Noaabad Channel which is emerging from Nara Canal No. 283	N 27° 04'-23" E 68° 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 27° 02'-30" E 69° 04'-44"
Site-31	Village Noor Mustafa	N 27° 04'-33" E 69° 03'-09"
Site-32	Village Malhar Faqir Bhambhro, Agriculture and adjoining sand dune.	N 27° 05'-18" E 69° 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	Sobhadero	Gambat	Kingri	Nara
<b>S. No.</b>	<b>Weed species of wheat crop</b>								
1.	<i>Anagallis arvensis</i> var. <i>coerulea</i> Linn.	32.10	40.00	45.30	6.05	32.70	21.25	46.00	8.85
2.	<i>Chenopodium ficifolium</i> subsp. <i>blontianum</i> (Aellen) Aellen.	4.25	3.65	6.95	10.60	7.55	5.20	4.25	1.60
3.	<i>Cynodon dactylon</i> (L.) Pers.	6.10	2.20	8.50	1.75	9.35	5.50	6.35	4.60
4.	<i>Medicago polymorpha</i> Linn.	2.00	62.50	2.00	1.50	0.00	1.50	3.50	0.00
5.	<i>Melilotus indica</i> (L.) All.	75.30	53.35	10.45	5.15	25.00	20.50	12.25	9.70
6.	<i>Phalaris minor</i> Retz.	10.00	3.25	8.10	2.55	8.25	3.20	4.90	4.20
7.	<i>Rumex dentatus</i> Linn.	8.35	4.75	3.15	3.65	15.65	14.75	7.30	5.55
8.	<i>Spergularia marina</i> (L.) Griseb.	32.50	68.00	6.00	9.10	6.15	6.75	8.05	18.00
<b>S. No.</b>	<b>Weed species of cotton crop</b>								
1.	<i>Brachiaria eruciformis</i> (J.E. Sm.) Griseb.	13.40	19.85	8.35	7.00	11.60	9.50	13.00	10.50
2.	<i>Corchorus aestuans</i> Linn.	7.80	10.25	9.50	9.60	7.85	11.90	14.80	9.55
3.	<i>Cynodon dactylon</i> (Linn) Pers.	6.50	3.00	3.85	5.75	7.50	6.50	6.75	4.20
4.	<i>Dactyloctenium aegyptium</i> (Linn.) Willd.	11.50	11.55	10.60	13.50	11.50	14.10	9.40	7.90
5.	<i>Euphorbia serpens</i> Kunth.	14.25	21.15	13.20	11.50	8.60	17.90	12.95	11.30
6.	<i>Setaria pumila</i> (Poir.) Roem. & Schult.	5.75	5.75	8.25	6.70	7.10	9.35	6.25	8.75
7.	<i>Trianthema portulacastrum</i> 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.

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

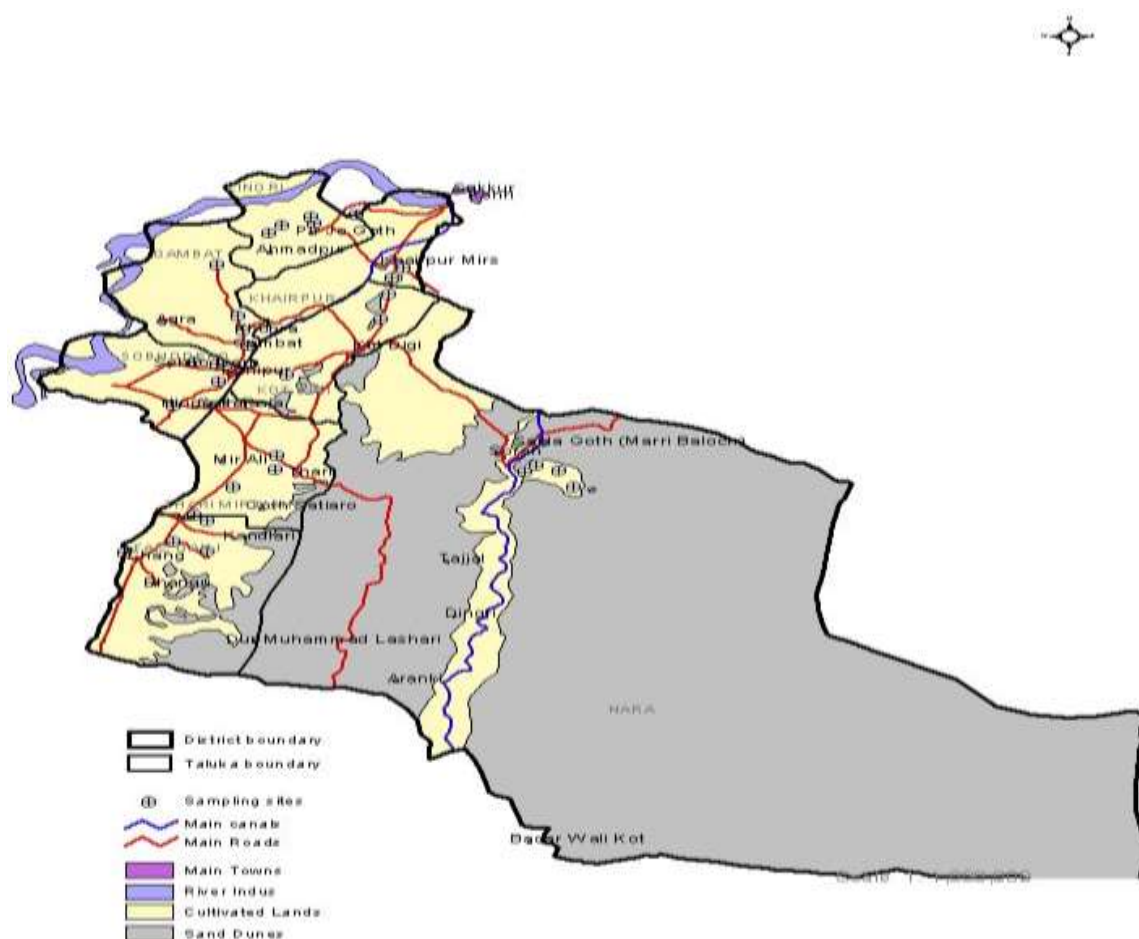


Fig. 1. Base map of Khairpur district showing sampling sites and physical features.

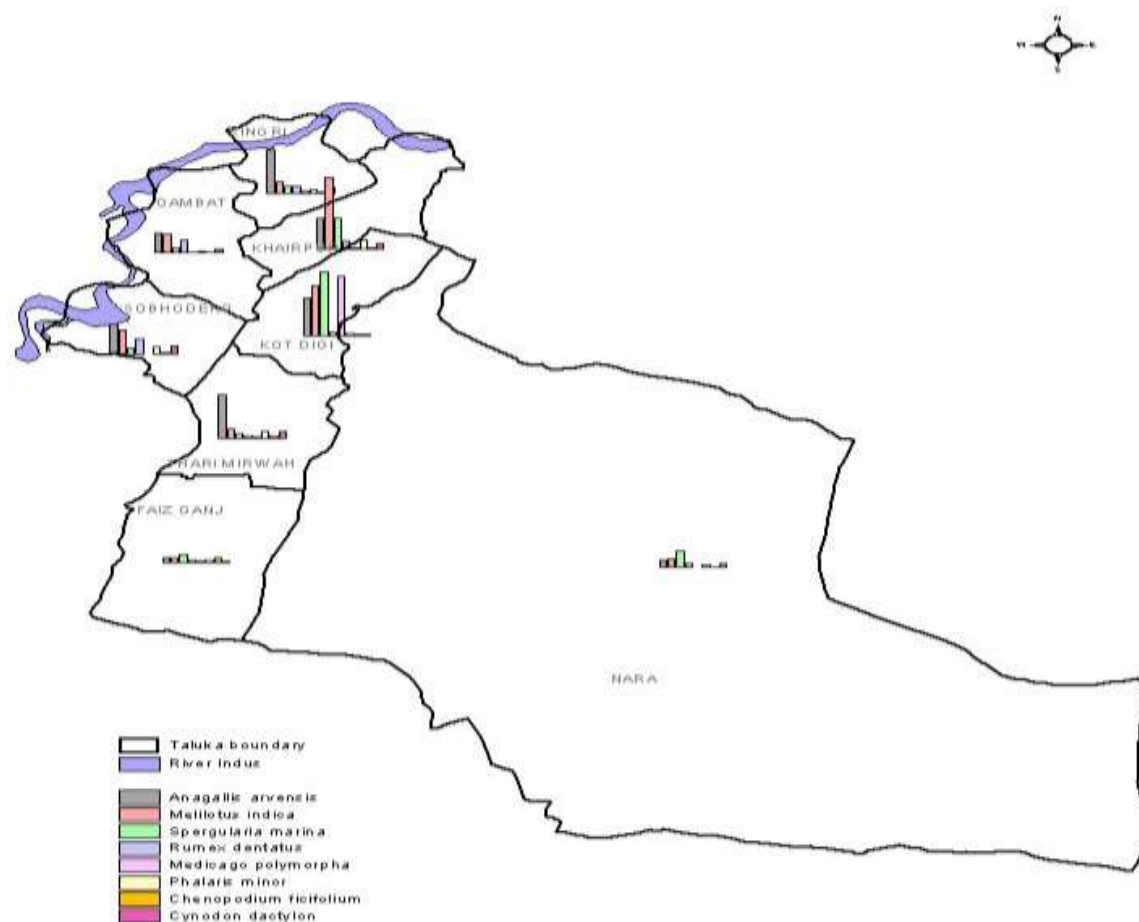


Fig. 2. View of map showing density of some important wheat weeds in different Talukas of Khairpur.

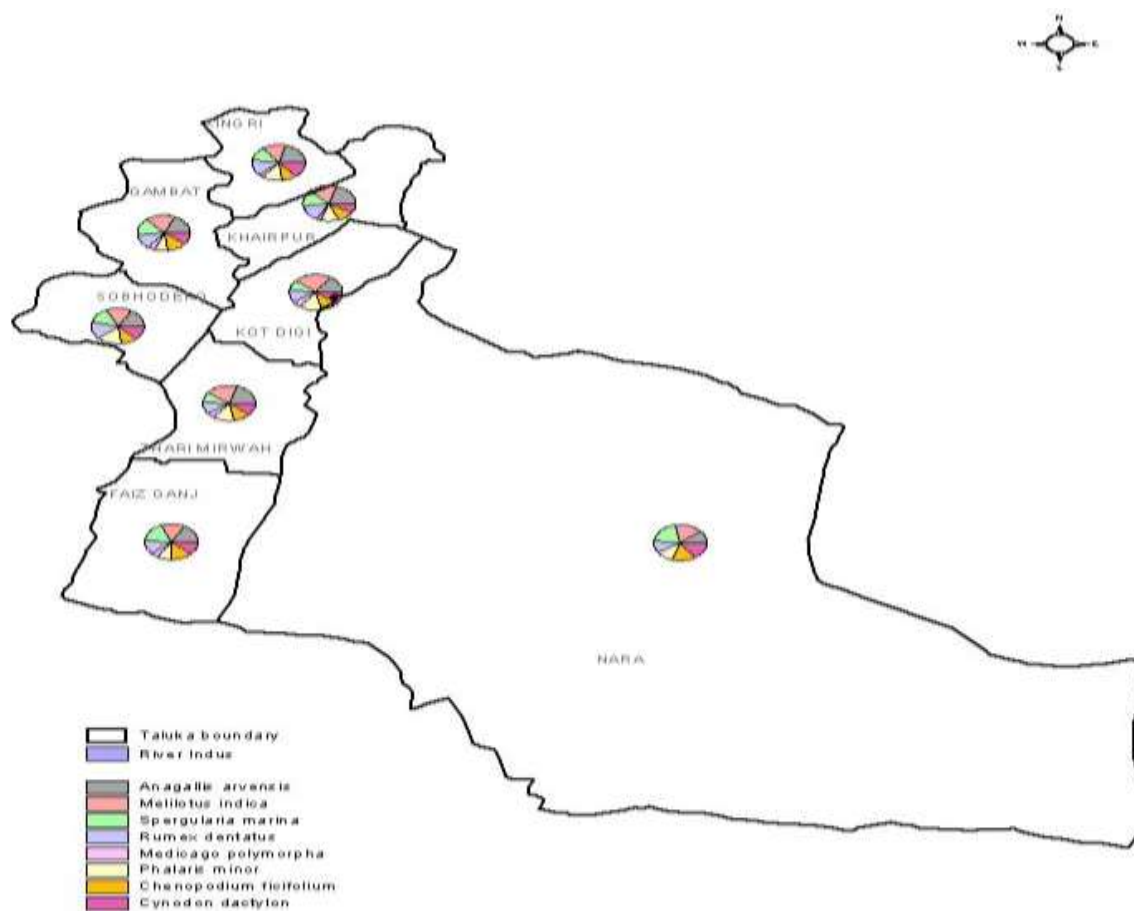


Fig. 3. View of map showing frequency of some important wheat weeds in different Talukas of Khairpur.

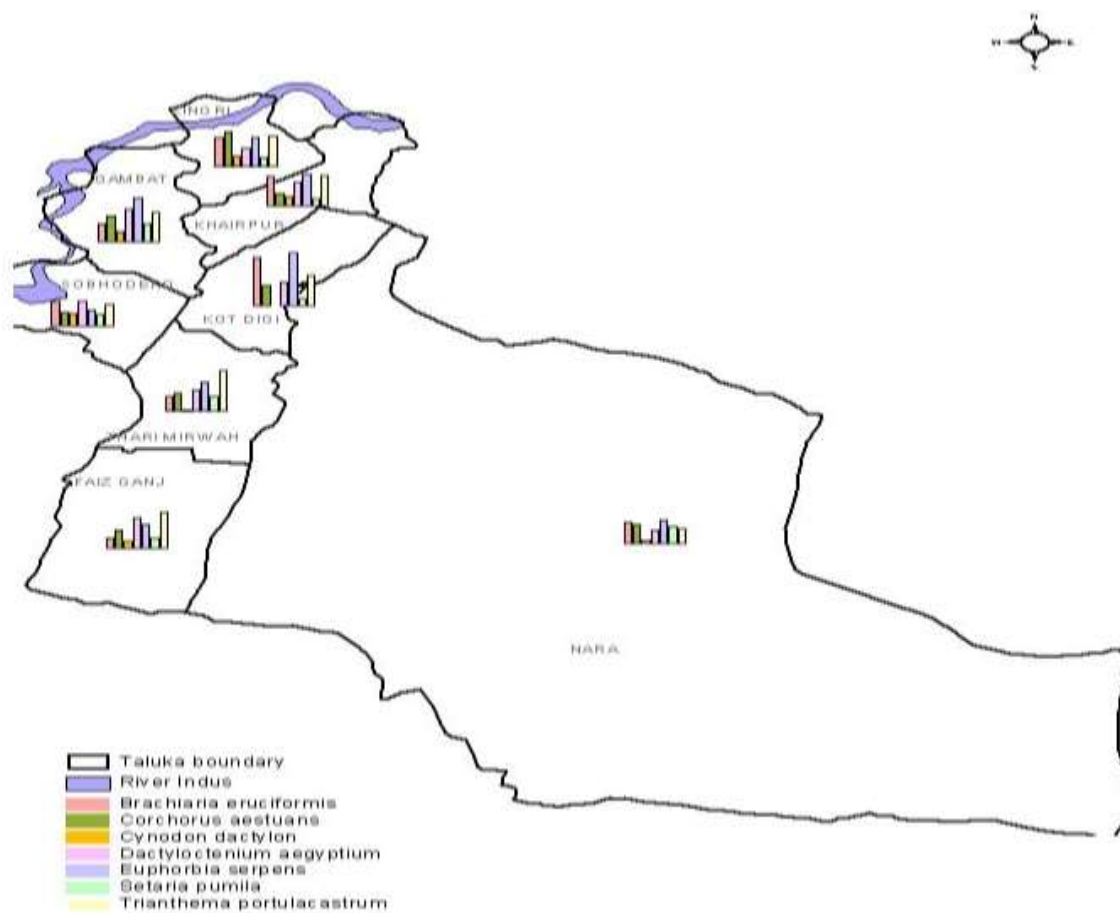


Fig. 4. View of map showing density of some important cotton weeds in different Talukas of Khairpur.

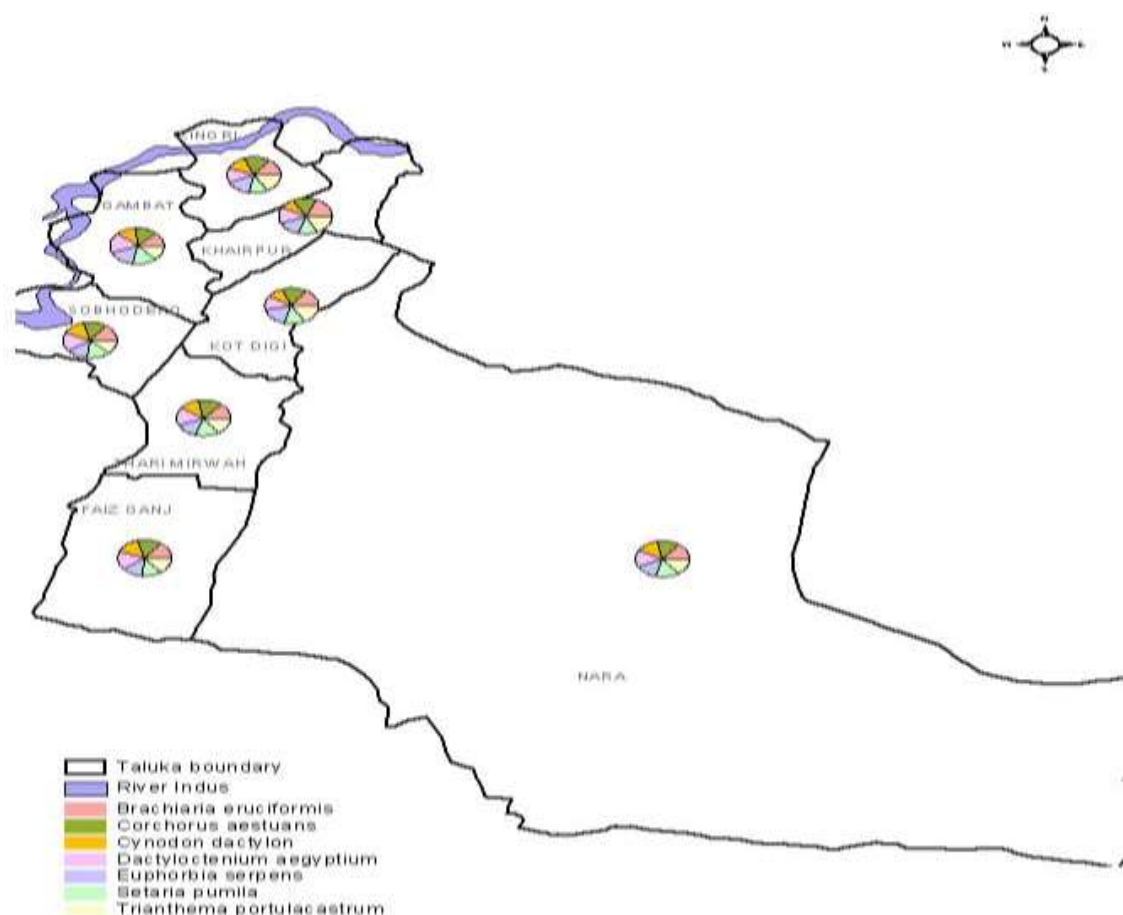


Fig. 5. View of map showing frequency of some important cotton weeds in different Talukas of Khairpur.

## 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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## References

- Ahmad, S.S., A. Sherazi and M.T.A. Shah. 2010. A preliminary study on climate change causing decline in forest cover area in district Chakwal, Pakistan. *Pak. J. Bot.*, 42(6): 3967-3970.
- Ghadirian, P. and I.D. Bishop. 2008. Integration of augmented reality and GIS: A new approach to realistic landscape visualization. *Landscape and Urban Planning*, 86(3-4): 226-232.
- Korejo, F., S.A. Ali, S.S. Tahir, M.T. Rajput and M. T. Akhter. 2010. Comparative morphological and biochemical studies of *Salvadora* species found in Sindh, Pakistan. *Pak. J. Bot.*, 42(3): 1451-1463.
- Main, C.L., D.K. Robinson, J.S. McElroy, T.C. Mueller and J.B. Wilkerson. 2004. A guide to predicting spatial distribution of weed emergence using geographic information systems (GIS). Online. Applied Turfgrass Science.
- Memon, R.A., G.R. Bhatti and S. Khalid. 2003. Weed diversity of wheat crop in Khairpur District, Sindh. *Pak. J. Weed Sci. Res.*, 9(1-2): 99-103.
- Memon, R.A., G.R. Bhatti, S. Khalid, R. Soomro and S. Ahmed. 2007. A survey of weeds found in cotton fields of Khairpur district, Sindh, Pakistan. *Pak. J. Bot.*, 39(7): 2265-2274.
- Miller, P.C.H. and J.V. Stanford. Herbicide application to targeted patches. 1991. *Proc. of British Crop Protection Conference on Weeds*, 18-21 November, 1991. Brighton, pp. 1249-1256.
- Mueller-Warrant, G.W., G.W. Whittaker and W.C. Young. 2008. GIS Analysis of spatial clustering and temporal change in weeds of grass seed crops. *Weed Science*, Publ. *Weed Sci. Society of America*, 56(5): 647-669.
- Stafford, J.V., J.M. LeBars and B. Ambler. 1996. A hand-held data logger with integral GPS for producing weed maps by field walking. *Computers and Electronics in Agriculture*, 14: 235-247.
- Walker, M., J. Casper, F. Hissong and E. Rieben. 2000. Geographic Information Brings Environmental Sciences to Life. *Science and Children magazine*. Pub. by the National Science Teachers Association. pp. 07.

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