Libyan Journal of Ecological & Environmental Sciences and Technology
(LJEEST)

LJEEST
ISSN: 2710-5237
www.srcest.org.ly/jou

DOI: https://doi.org/10.63359/texr5p44

Use of Satellite Image Techniques to Determine Distribution and Abundance of the Invasive *Bassia indica* in Benghazi City, Libya

Salem A. El shatshat, Ali M. Albbakosh Fatma F. Alabidiy

ARTICLE INFO

Vol. 7 No.3 Dec., 2025

Pages (64- 68)

Article history:
Revised form 12 November 2025
Accepted 20 December 2025

Authors affiliation
Botany department, Faculty of science, Benghazi University

email: salem.elshatshat@uob.edu.ly

Keywords:
Bassia indica; Invasive plant; Distribution; Satellite techniques; phytoremediation; Benghazi, Libya.

ABSTRACT

Bassia indica is one of invasive plants which widespread and distributed wildly in last decades in Libya and other regions of the world. Because of its ability to grow in harsh environments, this plant invades a lot of places in Benghazi city including disturbed areas, saline soils and salt marsh. GIS and satellite remote sensing provide powerful, scalable tools for assessing plant distribution and abundance. Several satellite platforms provide multispectral and hyperspectral data suitable for vegetation analysis. This study assessed the distribution of *Bassia indica* in Benghazi, Libya, integrating GIS mapping and satellite images techniques. Satellite images analysis revealed uneven spatial distribution, with the Northern district hosting the highest coverage (42.8%), while Bo'aathani had the minimal presence (10.3%, 0.5 km²). *Bassia indica* coverage declined, inversely correlating with urban development (85% to 95% urban area) in the city during last near years. The growth of this species in Northern district which its soil characterized by high saline content reflect its promising features in phytoremediation and soil reclamation.

استخدام تقنيات صور الأقمار الصناعية لتحديد توزيع ووفرة نبات *Bassia indica* في مدينة بنغازي، ليبيا

سالم عبدالعالي الشطشاط، علي محمد البكوش فاطمة فتحي العبيدي

انتشرت بشكل واسع في العقود الأخيرة النباتات الغازية في ليبيا ومناطق أخرى من العالم ومنها نبات *Bassia indica* . ونظرًا لقدرتها على النمو في البيئات القاسية، تنتشر هذه النبتة في العديد من مناطق مدينة بنغازي، بما في ذلك المناطق المضطربة والتربة المالحة والمستنقعات.توفر أنظمة المعلومات الجغرافية والاستشعار عن بُعد عبر الأقمار الصناعية أدوات فعّالة وقابلة للتطوير لتقييم توزيع النباتات ووفرتها. كما توفر العديد من منصات الأقمار الصناعية بيانات متعددة الأطياف ومناسبة لتحليل الغطاء النباتي. قيّمت هذه الدراسة توزيع هذا النبات في بنغازي، ليبيا، بدمج تقنيات رسم الخرائط الجغرافية وصور الأقمار الصناعية. كشف تحليل صور الأقمار الصناعية عن توزيع مكاني غير متساوٍ، حيث سجّلت المنطقة الشمالية أعلى نسبة تغطية (42.8%)، بينما سجّلت منطقة بوعطني أدنى نسبة تغطية (10.3%، 0.5 كيلومتر مربع). وقد تراجعت نسبة انتشار النبات، متناسبةً عكسيًا مع التطور العمراني في المدينة خلال السنوات القليلة الماضية. ويعكس نمو هذا النوع في المنطقة الشمالية، التي تتميز تربتها بارتفاع نسبة الملوحة، مزاياه الواعدة في مجال المعالجة النباتية واستصلاح التربة.

INTRODUCTION

The Chenopodiaceae family includes the annual xerophyte *Bassia indica* (Wight) A.J. Scott [Syn;Kochia indica], also known as "Gedgad" in Arabic. It is primarily native to India and has been introduced to many Mediterranean and eastern Asia countries, including Afghanistan, Algeria, Cyprus, Egypt, Iraq, Kenya, Kuwait, Pakistan, Palestine, Saudi Arabia, Sinai, Sudan, Morocco, Tunisia and Libya (Qureshi and Khan, 2022).

As it appears in figure (1), *B. indica* is annual subshrub has a compact pyramidal habitat with a lot of branching close to ground, creating dense thickets. It is densely branched at the base, creating a cushion, up to 205 cm high and 20-200 cm in diameter with sharp points leaves, and black broad elliptic seeds (Ashraf, 2004). After developing more quickly in summer, its growth become restricted in winter (Youssef *et al*., 2009).

According to its ability to grow in abiotic stress environment, it has been used in the repair of saline lands, phytoremediation, soil conservation and management (Hand, 2003). *B. indica* is considered to have potential as green fodder cross the world for animals such as cattle (Hashem *et al*., 2016). Additionally, *B. indica* is a promising salt-tolerant forage crop that benefits from salinity even in its early stages and may be grown in saline environments due to its obligatory halophyte nature (Hashem *et al*., 2015). Moreover, use this plant in folk medicine as anti-inflammatory, anticancer, antioxidant, antibacterial and more properties have also been documented (Bibi *et al*., 2021).

Fig. (1): The morphological characteristics of *Bassia indica* plant found at Benghazi area

B. indica is a tough plant that can grow in saline environments by accumulating and storing Na and other salts in its leaves and branches. This ability, combined with its quick and sizable annual growth, makes it a perfect choice for a natural clean-up process called phytoremediation (Shelef, *et al*., 2012).

The plant *B. indica* is originally native to South Asia, from India to Afghanistan (Ali and Quiser 2023). However, it has been introduced to different countries by human activities and spread beyond its native habitat (Figure 2) and is now considered as invasive plant in north African like Egypt, Morocco and Libya (Boulus, 2009; Shaltout, and El-Beheiry, 2000).

Fig. (2): Distribution map of *Bassia indica* cross the world.

During last decades, the growth, distribution and abundance of *B. indica* were increased rapidly especially in Benghazi city. And according to our knowledge, the information about *B. indica* in Libya are scarce. Because of lake of data, the aim of this work is to shade some light on population's distribution and habitat of growth of this species.

MATERIALS AND METHODS

Study area

Benghazi city is located in North eastern part of Libya between geographical coordinates of 32°07′N latitude, 20°04′E longitude and it is situated on the Mediterranean Sea as coastal city. Its soil is characterized as coastal semi-arid environment with pH ranged from 7.8 to 8.3. Some places of the city, is mixed and polluted with construction debris and polluted wastes, thus, disturbed soil can be clearly noticed, in addition, salt marches. The climate is influenced by the Mediterranean Sea, therefore, it has a semi- arid climate and classified as (Köppen: BSh) with hot summer and rainy short winter.

Distribution range and abundance of *B. indica* subshrubs in Benghazi region

To find out the distribution and abundance of this plant, the city area was divided to four locations (A, B, C and

D) according to the electric and road map of the city. And satellite technique was used as the following:

Data source: A satellite images for the city from Landsat 8 were downloaded via the United States Geological Survey (USGS) platform. Bands 3 and 5 were selected, where band 3 represents the green visible spectrum, while band 5 corresponds to the near-infrared spectrum. This combination enhances the interpretation of land features such as vegetation and urban areas. Specialized software (ENVI and ArcGIS) was used to merge the bands producing a composite image that highlights variations in land cover.

Field survey: a field survey was conducted using a GPS device to record coordinates of sample points representing target plant species within the study area. These points serve as ground truth points (GTPs), providing accurate data on the real distribution of *B. indica* vegetation.

Data integration: After collecting field data, the GPS coordinates were overlaid onto the satellite imagery using ArcMap. This integration of field data and satellite imagery enables verification of the geographical accuracy of plant distribution.

Spectral analysis and classification: a spectral signature was defined for the vegetation class based on its spectral reflectance. The software extrapolated these spectral signatures across the entire satellite image to generate a classified map showing the distribution of vegetation classes in the study area.

Accuracy assessment: the output map was analyzed to evaluate classification accuracy by comparing field sample points with the classified categories by using Confusion Matrix and Kappa index.

RESULTS AND DISCUSSION

The results of abundance and distribution showed that *B. indica* has uneven distribution across the city (Table 1 and figure 1). Northern district reflected highest proportion of *B. indica* (42.8% of the total plant area), covering 2.1 km² out of 23.62 km² indicates a significant presence of the plant in this zone. In Western district, 1.3 km² allocated to the plant (26.5% of the total vegetation area). Reflects relatively high coverage, lower than the Northern zone.

On the other hand, Eastern district revealed moderate presence, with 1.0 km² (20.40%). dedicated to *B. indica*. While Bo'aatani area represented the minimal coverage with 0.5 km² (10.3%), highlighting the plant's limited presence in this smallest operational zone. The table 1 illustrates the distribution of areas allocated to *B. indica* across different zones, detailing the plant's total coverage and its percentage share within each zone.

Table (1): The total area of *Bassia indica* abundance at different Benghazi districts.

Distribution District	Total Area (km²)	*B. indica* Area (km²)	Share %
Northern District	23.62	2.1	9%
Western District	26.36	1.3	5%
Eastern District	22.98	1	4%
Bo'aathani area	21.35	0.5	2%

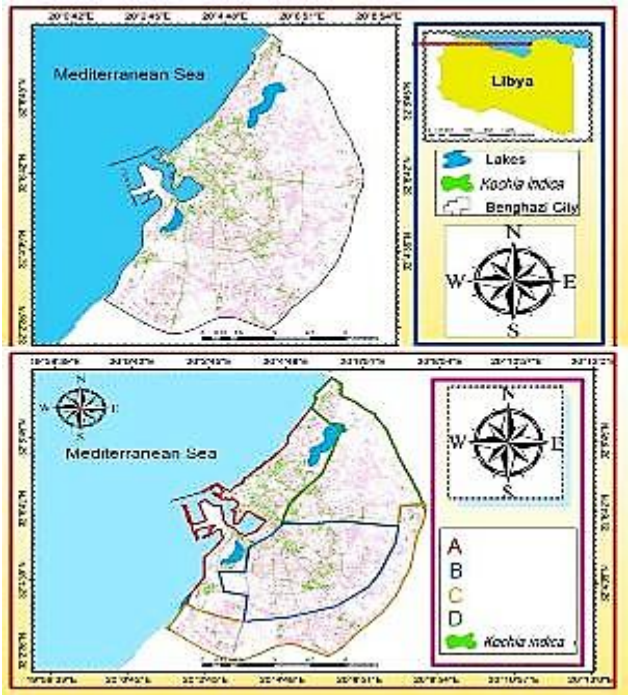

Fig. (3): The distribution map of *Bassia indica* plant at Benghazi city. Above, the total abundance of the plant, while below revealed the distribution in each district.

Understanding plant distribution and abundance is critical for ecological research, conservation, and sustainable land management. Traditional field surveys, while accurate, are time consuming and limited in spatial coverage. Fortunately, modern technology offers a powerful solution. By using satellite imagery and digital mapping (Known as GIS), we can now be monitoring the health and spread of vegetation over huge areas in much more efficient and cost-effective way, giving us the big-picture view we need (Turner *et al*., 2003).

GIS and satellite remote sensing provide powerful, scalable tools for assessing plant distribution and abundance. Advances in machine learning, cloud computing are enhancing the accuracy and efficiency of vegetation monitoring (Gorelick *et al*., 2017). Like these researches are focus on improving of species-level discrimination and integrating multi-source data for global ecological assessment (Nagendra, 2001; Wang and souse, 2009; Ustin and Gamon, 2010; Mulla, 2013).

Several satellite platforms provide multispectral and hyperspectral data suitable for vegetation analysis. Landsat offers a long-term archive since 1972, making it useful for temporal studies (Wulder *et al*., 2016). Sentinel-2 (10-60) resolution has a high revisit frequency, ideal for seasonal vegetation monitoring (Druch *et al*., 2012). MODIS (250 m- 1 km) is suitable for large scale phynology studies (Running *et al*., 2004). These facts are agreeing with this study while using landsat-8 was useful to determine the vegetation coverage of *B. indica* in Benghazi region.

According to the results of abundance and distribution of *B. indica* in Benghazi city (Table 1 and figure 2), it has uneven distribution across the city. Northern district reflected highest proportion of *B. indica* indicates a significant presence of the plant in this zone. While it is mostly near the lakes in Benghazi city, where the salt content is high, and revealed that the habitat is suitable for this plant. In contrast in other districts, the vegetation area of this species reflects relatively lower coverage, than the Northern zone. From the mapping results (figure 2), it is clear that uncontrolled randomly urban (which appear in pink color in the map) was spread rapidly in other zones especially after 2015. This development eliminated vegetation from these areas, even though the conditions were otherwise suitable for plant life.

A number of studies reported the impact of soil salt content on its key growth stages, including germination, biomass, and how it accumulates salts in its tissues (Ayad, 2011; Shelef *et al*., 2016; Vymazal, 2011; Hashem *et al*., 2019; Zulfiqar *et al*., 2021). *B. indica* is a halophytic species (salt-tolerant plant) and one remarkable thing about this plant is its ability to live in high salinity conditions. Thus, using this plant species is one of important methods in remediation of saline soils to remove salts and/or heavy metals (Hassanuzzman *et al*., 2014). Therefore, it is highly recommended to use in like these environments, in addition, in feeding of livestocks, especially in arid saline regions like some locations of Libya.

CONCLUSION

During last decades, the growth, distribution and abundance of *B. indica* were increased rapidly especially in Benghazi city. And according to our knowledge, the information about *B. indica* in Libya are scarce. Because of lake of data, the aim of this work is to shade some light on population's distribution and habitat of growth of this plant.

This study assessed the distribution of *Bassia indica* in Benghazi, Libya, integrating GIS mapping and satellite images techniques. Satellite images analysis revealed uneven spatial distribution of this species. The growth of this species in Northern district which its soil characterized by high saline content reflect its promising features in phytoremediation and soil reclamation, in addition, to plant it as feeding crop in different regions of the country.

REFERENCES

Ali, S. I and Qaiser, M. (Eds.). (1993–2023). *Flora of Pakistan*. Missouri Botanical Garden.American–Eurasian Journal of Agriculture and Environment Science 5, 63–68.

Ashraf, M. (2004). Some important physiological selection criteria for salt tolerance in plants. Flora. 199: 361-376. DOI: 10.1078/0367-2530-00165

Ayad J. (2011). Effects of Salinity Stress on Germination, Growth and Some Physiological Characteristics of Kochia (Kochia scoparia L.). Plants Jordan Journal of Agricultural Sciences, 7, (2), 284-298.

Bibi, H., Manzoor, H., Gul, J., Ghulam, M., Siraj, K. and Ihsan, U. (2021). Phytochemical analysis and antimicrobial activities of *Kochia indica* (Wight), plant growing in District Karak Khyber Puhktunkhuwa, Pakistan. Pure Appl. Biol., 10(3):789-796.

Boulos, L. (2009). Flora of Egypt Checklist. Al Hadara Publishing, Eygpt.

D. Thau and R. Moore (2017). Google Earth Engine: Planetary-scale geospatial analysis for everyone. Remote Sensing of Environment, 202, 18-27.

Drusch, M., U. Del Bello, S. Carlier, O. Colin, V. Fernandez, F. Gascon, B. Hoersch, C. Isola, P. Laberinti, P. Martimort, A. Meygret, F. Spoto, O. Sy, F. Marchese and P. Bargellini (2012). Sentinel-2: ESA's optical high-resolution mission for GMES operational services. Remote Sensing of Environment, 120, 25-36.

Gorelick, N., Hancher, M., Dixon, M., Ilyushchenko, S., Thau, D. and Moore, R. (2017) Google Earth Engine: Planetary-Scale Geospatial Analysis for Everyone. Remote Sensing of Environment, 202, 18-27. https://doi.org/10.1016/j.rse.2017.06.031

Hand, R. (2003). Supplementary notes to the flora of Cyprus III. BGBM Berlin-Dahlem (2ed.) Willdenowia 33: 305-325. DOI: 10.3372/wi.33.33209

Hasanuzzaman, M., Nahar, K., Alam, M. M., Bhowmik, P. C., Hossain, M. A., Rahman, M. M., ... & Fujita, M. (2014). Potential use of halophytes to remediate saline soils. BioMed Research International, 2014, 589341. https://doi.org/10.1155/2014/589341

Hashem, A., AbdAllah E., Alqarawi, A. and Al-Huqail, A. (2015). Impact of plant growth promoting Bacillus subtilis on growth and physiological parameters of Bassia indica (Indian Bassia) grown under salt stress. Pak. J. Bot. 47(5): 1735-1741.

Hashem, A., AbdAllah, E., Alqarawi, A. and Malik, J. (2016). Role of calcium in AMF-mediated alleviation of the adverse impacts of cadmium stress in Bassia indica [Wight] A.J. Scott. Saudi J. Bio. Scie.

http://dx.doi.org/10.1016/j.sjbs.2016.11.003.

Hashem, A., AbdAllah, E., Alqarawi, A., Malik, J., Wirth, S. and Egamberdieva, D. (2019). Role of calcium in AMF-mediated alleviation of the adverse impacts of cadmium stress in Bassia indica. Saudi Journal of Biological Sciences 26(4):828-838.Hydrobiologia, (674) 133-156. *Same DOI; 2016 is the "online first" DOI, 2019 is the final issue placement.)*

Mulla, D. J. (2013). Twenty-five years of remote sensing in precision agriculture: Key advances and remaining knowledge gaps. Biosystems Engineering, 114(4), 358-371.DOI: 10.1016/j.biosystemseng.2012.08.009

Nagendra, H. (2001). "Using remote sensing to assess biodiversity." International Journal of Remote Sensing, 22(12), 2377-2400. DOI: 10.1641/0006-3568(2004)054[0547:ACSMOG]2.0.CO;2

P. Roy (2016). The global Landsat archive: Status, consolidation, and direction. Remote Sensing of Environment, 185, 271-283.

Qureshi, R. and Khan, M.A. (2022). Morphometric variation in Bassia indica across environmental gradients in Pakistan. Flora, 284, 151-162.

Running, M., Ramakrishna R., Faith, A., Maosheng, Z., Matt R. and H. Hashimoto (2004). A continuous satellite-derived measure of global terrestrial primary production. Bioscience, 54(6), 547-560.

Shaltout K. and El-Beheiry M. (2000). Demography of Bassia indica in the Nile Delta region, Egypt, Flora, 195:4; 392-397.

Shelef, O., Amit, G. and Shimon, R. (2012). The use of Bassia indica for salt phytoremediation in constructed wetlands. Water research (46) 3967-3976. DOI: 10.1016/j.watres.2012.05.020

Shelef, O., Tanya, G., Yitzchak, G. and Shimon, R. (2016). Low water availability and salinity effects on seedling viability of B. indica compared to B. iranica and B. prostrata (Amaranthaceae). Seed Science Research, (26) :77–83. DOI: 10.1017/S0960258515000409

Turner, W., Spector, S., Gardiner, N., Fadeland, M., Sterling, E.and M. Steininger (2003). "Remote sensing for biodiversity science and conservation." Trends in Ecology & Evolution, 18(6), 306-314. DOI: 10.1016/S0169-5347(03)00070-3

Ustin, S. L., & Gamon, J. A. (2010). "Remote sensing of plant functional types." New Phytologist, 186(4), 795-816.

Vymazal, J. (2011). Plants used in constructed wetlands with horizontal subsurface flow: a review.

Wang, L., & Sousa, W. P. (2009). "Distinguishing mangrove species with satellite imagery." Remote Sensing of Environment, 113(6), 1138-1148.

Wulder, M., Joanne C., Thomas R., Curtis E., Alan S., Warren B., Eugene A. F., Jerad S., Jeffrey G., and

Youssef, K.M., Fahmy, A.A., Abeer, M.E.E. and El Shaer, H.M. (2009) Nutritional studies on Pennisetum americanum and Kochia indica fed to sheep under saline conditions of Sinai, Egypt.

Zulfiqar, U., Ayub, A., Hussain, S., Waraich, E., El-Esawi, M., Ishfaq, M., Ahmad, M., Ali, N. and Maqsood, M. (2021). Cadmium toxicity in plants: Recent progress on morpho-physiological effects and remediation strategies. Journal of Soil Science and Plant Nutrition 1-58.